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A PV MANAGEMENT MAGAZINE

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editor's view

By David Ridsdale, editor-in-chief

Change as expected

ALTHOUGH IT IS HARD FOR MANY TO HEAR, the changes affecting the solar and PV industries are entirely expected and the consolidation and changing market opportunities have been tipped for a number of years. The only surprise may be the speed of such changes but there is nothing happening that should be news to the industry.

Even efforts to slow down the change through trade disputes and court cases appear to have had little effect on global movements. The recent trade dispute between China and Europe has come to a resolution that many feel has only helped the top Chinese companies consolidate their leadership in manufacturing. Many of the European companies that took the challenge through the European courts are finding life difficult. Some of the difficulty has been their legal fees in a time of narrow margins.

It is not a great time for small and medium size companies, especially those who had built their growth in specific European markets. The emerging opportunities in Europe have diminished and larger companies are using their clout to tie up market share that is available. With much of the major global growth developing in the Asian region the locally based companies have a major advantage to the European companies attempting to develop a presence in the region.

Despite the shake up, the global industry continues to grow with PV and solar uptake. With price improvements continuing a number of regions are now increasing their PV technology uptake without the need for subsidy support. While this is not the case for many regions we should expect the reduction of subsidy to continue and the industry to begin to function on its own merits. The inability to survive without subsidy support has been one of the biggest criticisms against the growing PV industry and achieving a subsidy free environment may be a few years away but will be a positive turning point for the industry

Renewable energy sources continue to become a more important part of the global energy mix and PV and solar have extremely important parts to play. This will only increase as energy storage technology begins to deliver on the promises of the last few years. The ability to store energy for later use will be the next turning point for industry growth. There are a number of promising technologies moving away from the expensive and non-renewable battery options.

The focus for companies in the solar and PV industry for the next year or two will be on opportunities in emerging regions. Expect Japan to feature strongly with solid growth both forecast and evident, as well as the emerging MENA region. Once logistics and policies are settled in the MENA region you can expect some of the fastest growth for a region the industry has seen. There is a still a ways to go for the region to provide the right environment for industry growth but the impetus and political will is finally there.

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what's inside

news

MENA

The reverse of this edition has a supplement introducing the Middle East and North African regions to potential investors in this growing area

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Capital expenditure set to improve for global solar industry

ITHE SUN IS FINALLY RISING on the global solar business, with growing demand in developing regions helping to ignite the first increase in industry wide capital spending in three years in 2014, according to the PV Manufacturing & Capital Spending Tool from IHS.

Global capital spending by producers of photovoltaic (PV) modules, cells, ingots, wafers and polysilicon is expected to rise by 30 percent in 2014 to reach $3.0 billion. This will mark the first time that expenditures have increased since 2011, when they grew 8 percent.

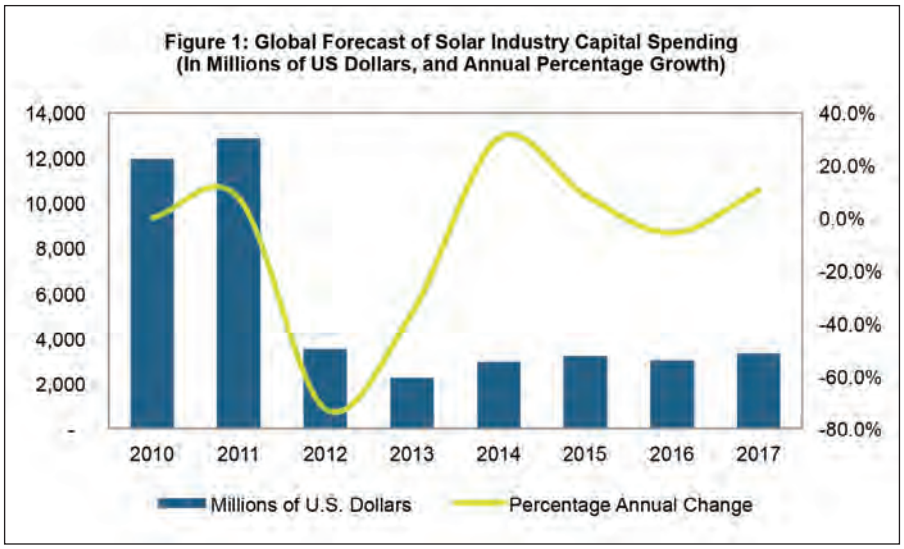
The projected growth will bring to an end a two-year period when spending dropped—by a stunning 72 percent in 2012, and by an anticipated 36 percent this year in 2013. During this period, PV industry capital spending will plunge by a gut-wrenching total of $10.6 billion, falling to $2.3 billion in 2013, down from $12.9 billion in 2011.

Solar industry players engage in capital spending in order to purchase manufacturing equipment and facilities used to produce PV raw materials or products. Spending has fallen in recent years because of massive overcapacity and oversupply, which has sent prices down throughout the supply chain.

However, a sustained increase in capacity from emerging economies is set to spur the 2014 recovery.

“South America, Africa and the Middle East now are leading the world in solar capacity additions—and they also are leading the capital expenditure segment of the PV business out of its slump,” said Jon Campos, solar analyst at IHS. “The overcapacity in PV production mainly has been concentrated in the developed solar regions of the United States, European Union and China.

But as demand expands in new areas, PV manufacturers are gaining interest in producing their wares in these regions,



resulting in new factory openings and boosting local capital spending.”

After going up 23 percent in 2013, solar capital spending in emerging economies is expected to rise in the low 40 percent range for every year through 2017.

In contrast, following zero growth in 2013, the established markets are expected to shrink by 5 to 10 percent during every year through 2017.

Among all the emerging economies, the largest percentage increase in capacity is occurring in South America, Africa and the Middle East.

Emerging markets account for 7.9 gigawatts (GW) of the world’s total announced capacity for PV materials and products from ingots through modules, with the potential to climb to nearly 11GW by 2017. Capital investments for the foreseeable future will largely remain in the areas of crystalline wafer production, cell and module equipment.

The expected increase in capital spending comes as a welcome and long-anticipated change from the dismal conditions that have plagued the market in recent years. The solar shakeout has peaked and an inevitable return to reinvestment in equipment and technology is due in the near term.

“Our research is showing a return to market equilibrium with regard to supply and demand,” Campos said. “Overcapacity seems to be correcting itself, and from the last few financial announcements, a handful of solar companies have returned to profitability and widened margins. The last piece of the recovery puzzle is capital spending and investment in high-efficiency technology.”

Beyond the rise in demand from emerging countries, other factors are contributing to the recovery in capital spending.

PV suppliers are engaging in new technology upgrades in order to enable higher efficiency and lower dollar-per-watt production costs. Equipment is also critical in allowing PV manufacturers to differentiate their products. Such differentiation can improve profitability and margins.

Current and potential trade conflicts concerning Chinese PV products could drive production to other locations, such as South America, Southeast Asia, Africa and the United States.

In particular, U.S. states like Mississippi and Michigan are attractive regions for PV production because they provide cheap electricity and affordable land to manufacturers.

China EU deal only helps the big manufacturing companies

SETTING A MINIMUM PRICE and a volume limit on EU imports of Chinese solar panels has become the final solution to solar trade dispute between China and Europe. According to EnergyTrend, a research division of TrendForce, the settlement is likely to increase entry barriers toward the European market and drive out destructive market price so first-tier manufacturers can focus on product and service quality to achieve industrial concentration in a faster pace. Meanwhile, first-tier manufacturers have started to build factories overseas and look for opportunities to export to the emerging market in case the trade war repeats itself in the future.

EnergyTrend further emphasizes that the agreement may not solve the market issues in the long-term. Companies should think ahead regarding whether the trade war will return after the launch of the two-year agreement. Besides, how to find new opportunities from all the disputes for PV manufacturers in regions such as Korea and Taiwan will be the topic that concerns the most people in the new era.

As indicated in the announced implementation plan, 60% of quota is allocated based on the proportion of Chinese manufacturers' module shipments to Europe from July 2011 to March 2013. Thus it can be a bad news to PV companies with fewer shipments during this period. A total of ninety-four Chinese manufacturers are in the scheme, which is still too many in contrast to the number of manufacturers in the market.

EnergyTrend believes that the current quota allocation plan will not be helpful to industrial concentration which the market is looking forward to. The quota held by first-tier manufacturers may be lower than their total shipments to Europe in 2012. The market is doubtful about the indefinite quota allocation and it may not be a good thing for Chinese PV development if industrial concentration is achieved this way. Price elevation allows first-tier manufacturers to provide better service rather than focus on lowering the price in order to compete with second/third-tier manufacturers. It doesn't mean that there won't be loss to first-tier manufacturers because volume limits will lead to sales stagnation in the European market, which would in turn encourage manufacturers to transfer shipments to other regions. As competition becomes more intense, how to be profitable under the quota limit in the European market will be the concern.

The EU-China settlement allows Europe to be exempted from low-cost competition. Apart from that, the minimum price of cell may not be too high in order to support the development of European module manufacturers. Take cell cost, for example; the cost of Taiwan's high-efficiency cells with a market share of 15.2% that ranked second in the world is about US$0.4-US$0.42. The cost of first-tier Chinese cells is about US$0.37-US$0.39. If Chinese cells can be exported to Europe and processed into modules in Europe, Chinese manufacturers are likely to maintain notable advantages on cost.

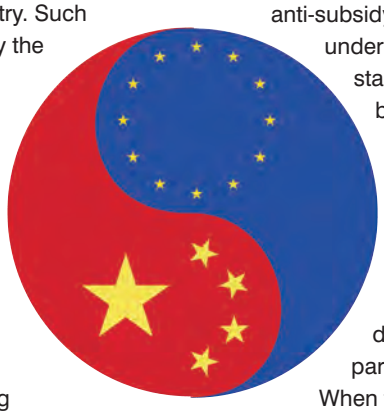
On the other hand, the current floating price is 0.56 Euros, which is 2-4 Euros higher than the average module cost in the market. The cost will be offset by non-module system component cost and project cost. System development can also lower unit cost through using high-efficiency modules. European developers can accept the price range. With Europe moving toward smaller systems, the difference in price sensitivity will be less.

Building factories overseas has always been another option for Chinese companies to choose from. Although the decision to build factories overseas will increase Chinese solar panel cost, many manufacturers have started to get involved in that to avoid trade issues. For example, CSUN chose to build factories in Turkey, whereas ReneSola's OEM manufacturing sites can be found in India, South Africa, and Poland. Rumours suggest that Hareon and Yingli may build factories in Taiwan and Thailand, respectively, later on. Regardless of the progress, Chinese companies will continue to move toward global factory expansion. EnergyTrend believes that PV companies in either China or other countries have to accelerate the development in each region since the only way to stay competitive in the industry is to become a global enterprise.

EC pledges no punitive tariffs but anti-subsidy investigation will continue

THE EUROPEAN COMMISSION will not impose provisional measures in the anti-subsidy proceeding concerning solar panels, cells and wafers originating in the People's Republic of China. The anti-subsidy investigation is running parallel to the EU's anti-dumping investigation on solar panels. The European Commission can, within a period of 9 months, decide to impose provisional anti-subsidy duties. This investigation will continue without provisional measures and the Commission will continue working on the case in order to arrive to definitive findings that are due at the end of this year.

As any injury to the Union industry has already been removed, at the preliminary stage, by the provisional anti-dumping measures and the price undertaking on the same products, this decision does not have an impact on the protection of the Union industry against unfair trade practices. The decision not to impose any provisional anti-subsidy measures does however not, in any event, prejudice any subsequent decision which may be taken at the definitive stage of this proceeding. The Commission is legally obliged to open an investigation when it receives a complaint from Union industry which provides evidence that a product exported is being subsidised and causing injury to the Union industry. Such complaint was lodged by the Union industry last year concerning the imports of solar panels, cells and wafers from China. EU and WTO rules permit the initiation of parallel anti-dumping and anti-subsidy investigations.



The parallel anti-dumping investigation continues after provisional duties were imposed on 5 June 2013 and a price undertaking by the Chinese exporting companies has been accepted by the European Commission. Experts are now analysing comments and submissions received within the framework of the investigation after the imposition of provisional measures. The agreement on an undertaking announced on 27 July 2013 is based on the provisional measures imposing anti-dumping duties. The undertaking entered into force on 6 August. The Commission has expressed its readiness to follow the necessary procedures to include the anti-subsidy investigation into the undertaking at the definitive stage, should such action be warranted.

When the Commission finalises its analyses in both the anti-dumping and anti-subsidy cases, the findings will be disclosed to all interested parties for comments. When the comments submitted are analysed and considered, the Commission will issue findings in both investigations. The deadline for the imposition of definitive duties in both cases is 5 December 2013. The Commission is conducting an anti-dumping and anti-subsidy investigation on imports of solar glass from China, one of the raw materials used in the production of solar panels. This case is however independent and is not subject to findings in the solar panel cases.

Top manufacturers increase market share

QUARTERLY SOLAR PHOTOVOLTAIC (PV) module shipments for the 20 leading PV manufacturers exceeded 5.8 gigawatts (GW) during the second quarter of 2013 (Q2'13). This record-high module shipment volume represents 21% growth from the Q2'12 level of 4.8 GW, according to findings in the new NPD Solarbuzz Module Tracker Quarterly.

When the final results become available over the next few weeks they are expected to show that Chinese tier-one manufacturers, including Yingli Green Energy, Trina Solar, Jinko Solar, Renesola, and Hanwha SolarOne broke their quarterly module shipment records in Q2'13. In particular, Yingli Green Energy's quarterly shipments are expected to have reached 0.8 GW, which would represent a new world record for any single PV supplier.

"Yingli Green Energy has been strongly focused on market share gains over the past four quarters," said Ray Lian, senior analyst at NPD Solarbuzz. "The company is rapidly approaching 10% global market share, and has now become the clear leader in megawatt shipments.

The leading solar PV suppliers are now starting to pull away from the pack, which provides strong evidence that the anticipated industry consolidation is finally in progress."

However, setting new records in shipments is not the only tactic being employed. Some module suppliers are prioritizing profitability over market share, resulting in only moderate shipment increases for Q2'13. Priorities for this subset of suppliers include downstream project expansions or market share gains in only premium-price regions. In Japan, the highest growth PV end-market today, Chinese tier-one manufacturers Canadian Solar and JA Solar have now become the leading overseas module suppliers.

However, buyers in Japan remains strongly loyal to Sharp Solar, Kyocera, Solar Frontier, Panasonic, and other domestic brands. Over the past four quarters, these four suppliers have accounted for 54% of modules shipped by the 20 leading module suppliers to Japan.

First solar aims for 1GW total in 2013

FIRST SOLAR INC. is living up to its name this year, with the No.1-ranked company expected in 2013 to become the first engineering, procurement and construction (EPC) firm ever to install 1 gigawatt worth of solar or photovoltaic (PV) power systems in a single year.

The U.S.-based company is forecast to install 1.1 gigawatts (GW) of solar systems in 2013, more than double the 516 megawatts (MW) in 2012, according to information and analytics provider IHS (NYSE: IHS). This high rate of growth will allow First Solar to maintain its leadership in the EPC business for the year, despite even faster growth from Chinese rivals, No. 2 China Power Investment Corp. (CPIC) and third-ranked GD solar.

EPCs, sometimes called system integrators, are vertically integrated contractors that build large-scale solar projects. Companies like First Solar are capable of a full range of installation tasks, including designing installation projects, procuring materials and building assignments. First Solar and a number of

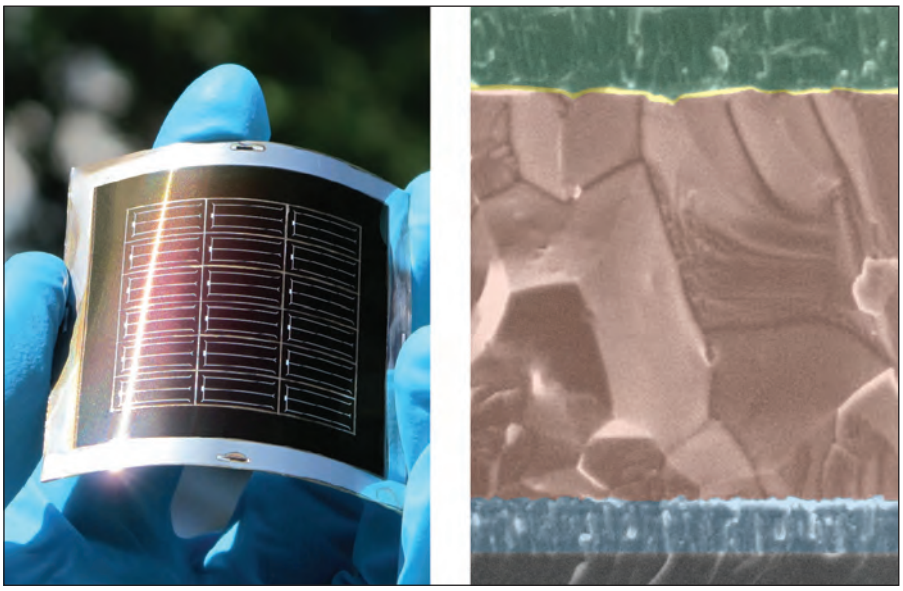
companies build projects developed in-house, generating revenue from the sale of completed PV power plants. Others focus on EPC for third-party developers, sometimes in combination with in-house development.

First Solar's growth is built on its strategy to cultivate a pipeline of PV projects, in which it takes on major undertakings, sells them to other firms and then uses the proceeds to buy other large-scale installations.

For example, First Solar in May announced the sale of the Campo Verde Solar Project, which is under construction in Southern California. Campo Verde will have a nameplate capacity of 139 MW of alternating current (MWac) when it is completed at the end of 2013. With the money it made from the sale, First Solar expanded its pipeline with the acquisition of three other projects under development with a total capacity of 260 MWac, due for completion by the end of 2015.

"First Solar's successful strategy of acquiring, installing and divesting projects will keep the company among the world's leading solar system integrators over the next years," said Josefin Berg, senior analyst for downstream solar research at IHS. "This approach not only offers a sales outlet for modules, but more importantly also generates project-sales revenue that cushion the company when seeking new growth markets."
In January, First Solar took a major step toward expanding its business outside the United States when it acquired Chilean PV developer Solar Chile and its early-stage 1.5 GW project.

Swiss scientists improve thin film on metal foil



FLEXIBLE THIN FILM solar cells that can be produced by roll-to-roll manufacturing are a highly promising route to cheap solar electricity. Scientists from Empa, the Swiss Federal Laboratories for Materials Science and Technology, have made progress in the industrialization of flexible, light-weight and low-cost cadmium telluride (CdTe) solar cells on metal foils. They succeeded in increasing efficiency from below eight to 11.5 percent by doping cells with copper, as they reported in the current issue of "Nature Communications".

In order to make solar energy widely affordable scientists and engineers all over the world are looking for low-cost production technologies. Flexible thin film solar cells have a huge potential in this regard because they require only a minimum amount of materials and can be manufactured in large quantities by roll-to-roll processing. One such technology relies on cadmium telluride (CdTe) to convert sunlight into electricity. With a current market share that is second only to silicon-based solar cells CdTe cells already today are cheapest in terms of production costs. Grown mainly on rigid glass plates, these so-called superstrate cells have, however, one drawback: they require a transparent supporting material that lets sunlight pass through to reach the light-harvesting CdTe layer, thus limiting the choice of carriers to transparent materials.

The inversion of the solar cell's multi-layer structure – the so-called substrate configuration – would allow further cost-cuttings by using flexible foils made of, say, metal as supporting material. Sunlight now enters the cell from the other side, without having to pass through the supporting substrate. The problem, though, is that CdTe cells in substrate configuration on metal foil thus far exhibited infamously low efficiencies well below eight percent – a modest comparison to the recently reported record efficiency of 19.6 percent for a lab-scale superstrate CdTe cell on glass.

One way to increase the low energy conversion efficiency of substrate CdTe cells is p-type doping of the semiconductor layer with minute amounts of metals such as copper (Cu). This would lead to an increase in the density of "holes" (positive charge carriers) as well as their lifetimes, and thus result in a high photovoltaic power, the amount of sunlight that is turned into electrical energy. A perfect idea – if CdTe weren't so notoriously hard to dope.

"People have tried to dope CdTe cells in substrate configuration before but failed time and again", explains Ayodhya Nath Tiwari, head of Empa's laboratory for Thin Films and Photovoltaics.

His team decided to try nonetheless using high-vacuum Cu evaporation onto the CdTe layer with a subsequent heat treatment to allow the Cu atoms to penetrate into the CdTe. They soon realized that the amount of Cu had to be painstakingly controlled: if they used too little, the efficiency wouldn't improve much; the very same happened if they "over-doped".

The electronic properties improved significantly, however, when Lukas Kranz, a PhD student in Tiwari's lab, together with Christina Gretener and Julian Perrenoud fine-tuned the amount of Cu evaporation so that a mono-atomic layer of Cu would be deposited on the CdTe.

"Efficiencies increased dramatically, from just under one percent to above 12", says Kranz. Their best value was 13.6 percent for a CdTe cell grown on glass; on metal foils Tiwari's team reached efficiencies up to 11.5 percent.

For now, the highest efficiencies of flexible CdTe solar cells on metal foil are still somewhat lower than those of flexible solar cells in superstrate configuration on a special (and expensive) transparent polyimide foil, developed by Tiwari's team in 2011.

Stephan Buecheler, a group leader in the laband co-author said, "Our results indicate that the substrate configuration technology has a great potential for improving the efficiency even further in the future." Their short-term goal is to reach 15 percent. "But I'm convinced that the material has the potential for efficiencies exceeding 20 percent." The next steps will focus on decreasing the thickness of the so-called window layer above the CdTe, including the electrical front contact. This would reduce light absorption and, therefore, allow more sunlight to be harvested by the CdTe layer. "Cutting the optical losses" is how Tiwari calls it.

The study was supported by the Swiss National Science Foundation (SNSF) and the Competence Center Energy and Mobility of the ETH Domain (CCEM-Dursol).

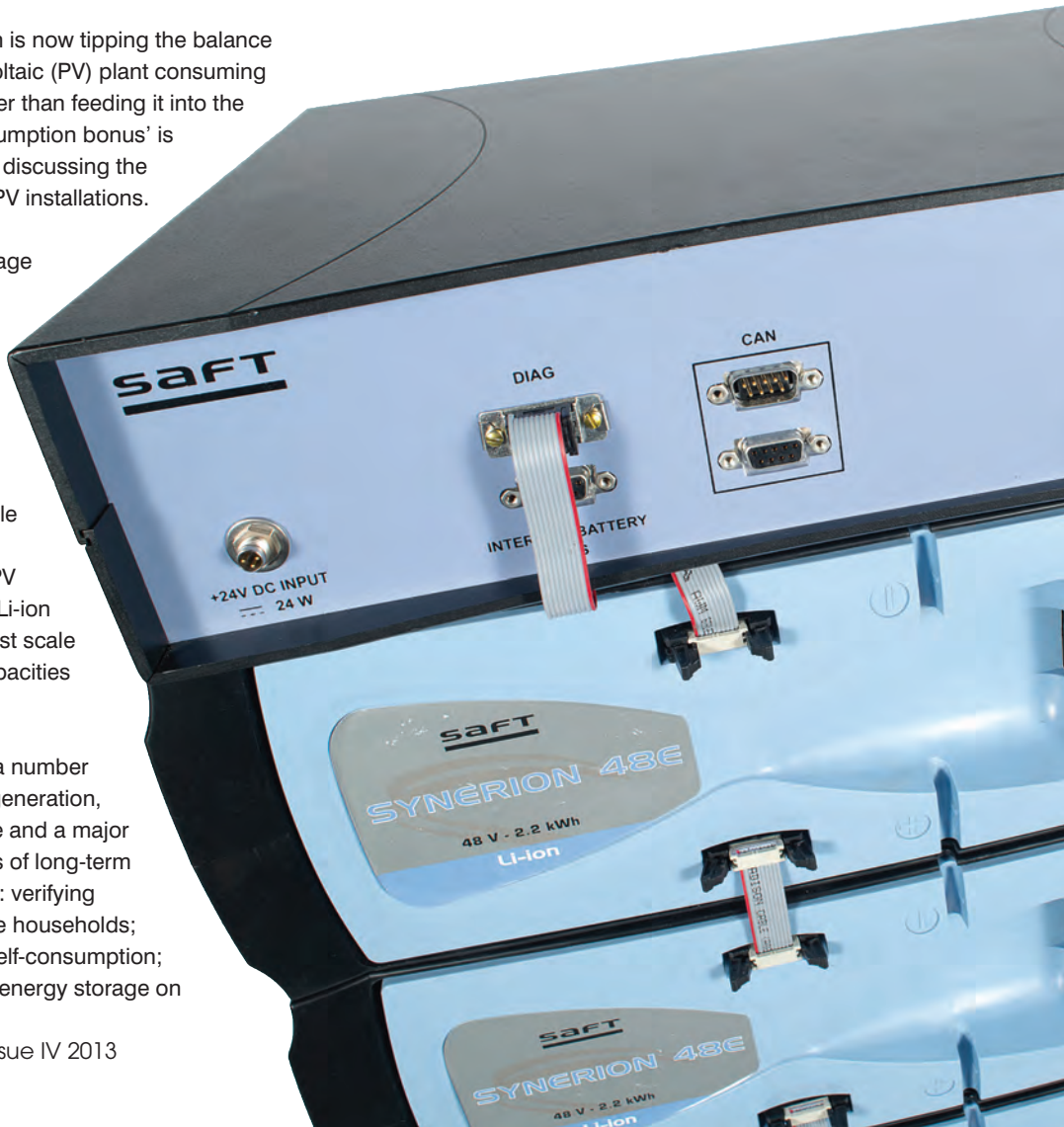
Li-ion energy storage helps domestic PV installations access the 'self- consumption bonus'

Michael Lippert, of Saft's Energy Storage Systems Division, reports on the results of some recent long-term field trials of lithium-ion (Li-ion) energy systems in domestic installations.

Recent European legislation is now tipping the balance in favour of operators of solar photovoltaic (PV) plant consuming more of the energy they produce rather than feeding it into the local grid. This drive for the 'self-consumption bonus' is therefore becoming a key issue when discussing the profitability and economic viability of PV installations.

The capability of effective energy storage based on lithium-ion (Li-ion) battery technology to maximize self-consumption has been investigated in the French-German Sol-ion multi-partner project. The ultimate objective was to develop an integrated kit for conversion, storage and management of PV energy suitable for production on an industrial scale for decentralized on-grid, residential PV systems. This project has introduced Li-ion batteries into PV systems on the largest scale ever tested in Europe with storage capacities ranging from 8.8 to 13.2 kWh.

The Sol-ion project brought together a number of partners in solar and wind energy generation, power distribution and energy storage and a major component of the project was a series of long-term field trials. These had three objectives: verifying the rate of self-consumption for private households; comparing the different concepts of self-consumption; and measuring the influence of Li-ion energy storage on



the low-voltage grid. Trial sites were spread across the German region of Bavaria and French islands of Guadeloupe and Corsica, as well as the French mainland. Tests undertaken in Germany were focused on prioritising self-consumption and were carried out at E.ON customer locations as well as partner research institutes. The sites in France had the primary goal of promoting islanded operation of the systems they served.

Storage needs

The PV storage system comprised an energy management system, battery converter, inverter and Li-ion battery with energy storage capacity of up to 2.2 kWh. The entire system is comparable in size to a typical domestic fridge freezer, weighs 250 kg and full installation, commissioning and testing takes around half a day.

Before carrying out the field trials, performance in self-consumption and autonomy were estimated based on energy storage capacity and the average measured load profile from 89 households in the German town of Kassel. This indicated that, in theory, the Li-ion energy storage should improve self-consumption by 20 – 30 percent.

Trial installations at Sol-ion project partners were put in place for between three and 10 months, with the trial delivering its results in late 2012. The units were monitored to evaluate battery performance across the seasons of the year and to establish if geographical location impacted whole system performance.

Data recorded was local energy demand, quantity of PV energy produced locally, and quantity of PV energy used locally. The same data was used to calculate how the installations would perform without energy storage.

In 'German self-consumption', the system uses the battery capacity for optimised self-consumption, whereas in 'French back-up mode', the battery was maintained above a level of charge that allows for autonomy should the grid fail.

A typical installation of a containerised energy storage system

Results showed the clear advantages of energy storage, with self-consumption of PV energy improving by 20 – 30 percent, as anticipated. For the entire 10-month test period, this delivered an improvement in self-consumption rising from 38 percent without a battery to 57 percent when four battery modules delivering a total of 2.2 kWh energy storage capacity were used. Figures for autonomy were also significantly improved by the addition of a battery, with the system delivering more than 70 percent autonomy during the summer months from July to August, which was equivalent to an improvement of 20 percent autonomy during the 10-month life of the trial.

The long-term field trials also demonstrated that the efficiency of the entire PV generation and storage system could only be measured in terms of energy efficiency per day by comparing input and output energy. Because the battery and charging system have small losses, a system with energy storage has lower efficiency than a PV generator and inverter alone. This can be overcome by increasing the size of the PV generator to deliver the same output.

The Sol-ion project represented a vital positive step in the practical implementation of energy storage to help integrate renewable energy sources into the grid. It is now being followed by other notable projects including the MILLENER smart grid project and the Nice grid project, both of which are still in the trial phase.

MILLENER smart grid project

The €7.2 million MILLENER smart grid project, funded by the French government, was set up to meet the power supply demands of island communities, where increasing demand for energy, weak power infrastructure and growing use of renewable power spread across the grid are combining to pose challenges. During the four-year project, the project will see a consortium of partners investigating energy and load management solutions on French islands.

Saft will provide around 500 Li-ion energy storage systems on the islands of Corsica and La Réunion as well as other islands,

Each installation has the capability to store between 4 and 8 kWh of energy, with the combined energy storage capacity being 3 MWh and every installation has telecommunication links to the power grid operator to enable remote monitoring and control

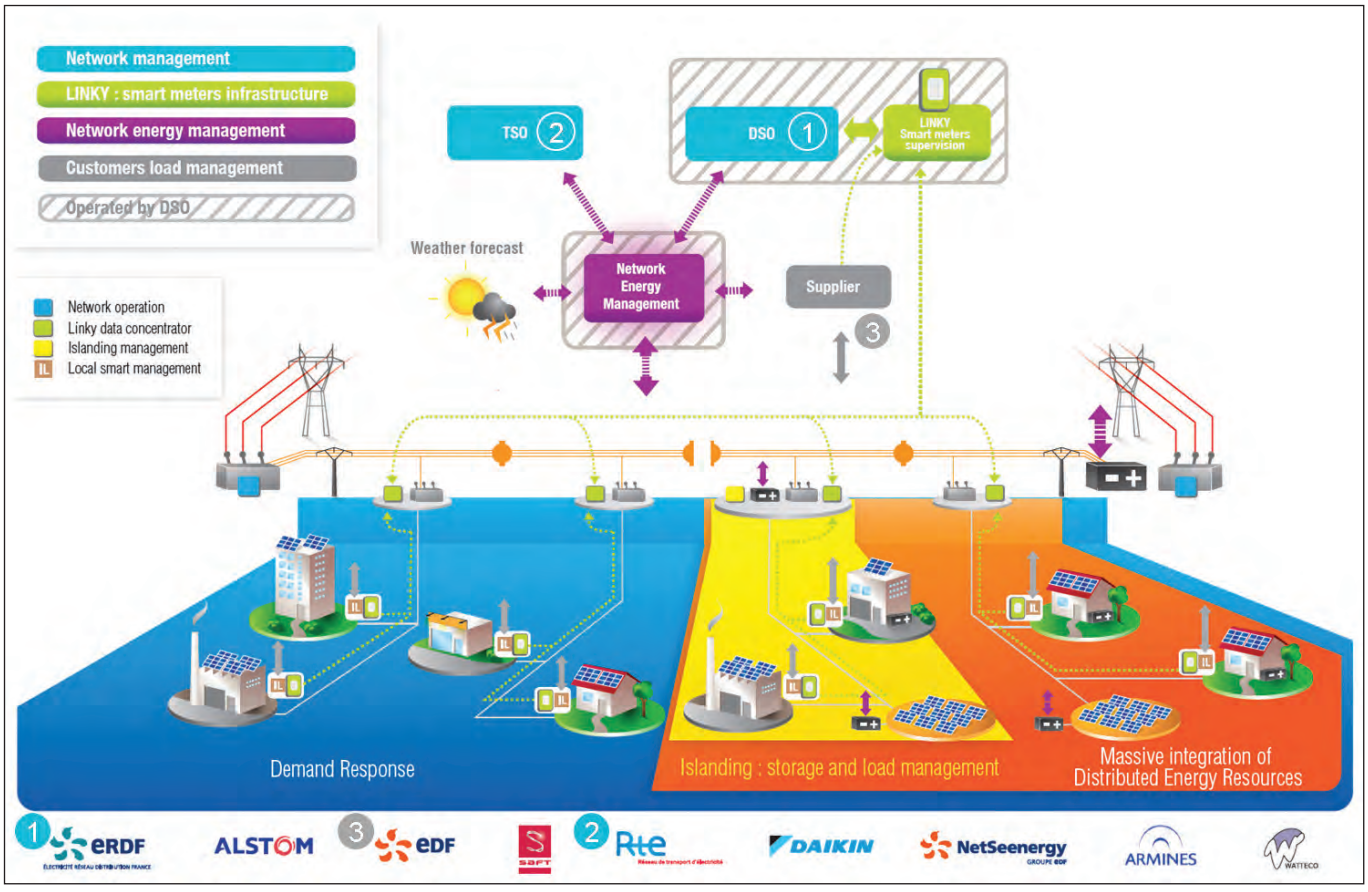
with half of the systems being installed on La Réunion. The installations will evaluate the batteries' ability to deliver in three scenarios: maximising the input of PV energy by supporting grid voltage and frequency control; making the most of the grid infrastructure at times of peak energy production and consumption, therefore avoiding the need for major investments in new infrastructure; and storing PV energy generated locally to make it available at times of peak demand. Each installation has the capability to store between 4 and 8 kWh of energy, with the combined energy storage capacity being 3 MWh and every installation has telecommunication links to the power grid operator to enable remote monitoring and control. With the islands experiencing massive growth in PV energy generation, the performance of the batteries installed for the MILLENER project will be evaluated to improve the integration of renewable energy sources and support the operational balancing of the power grid.

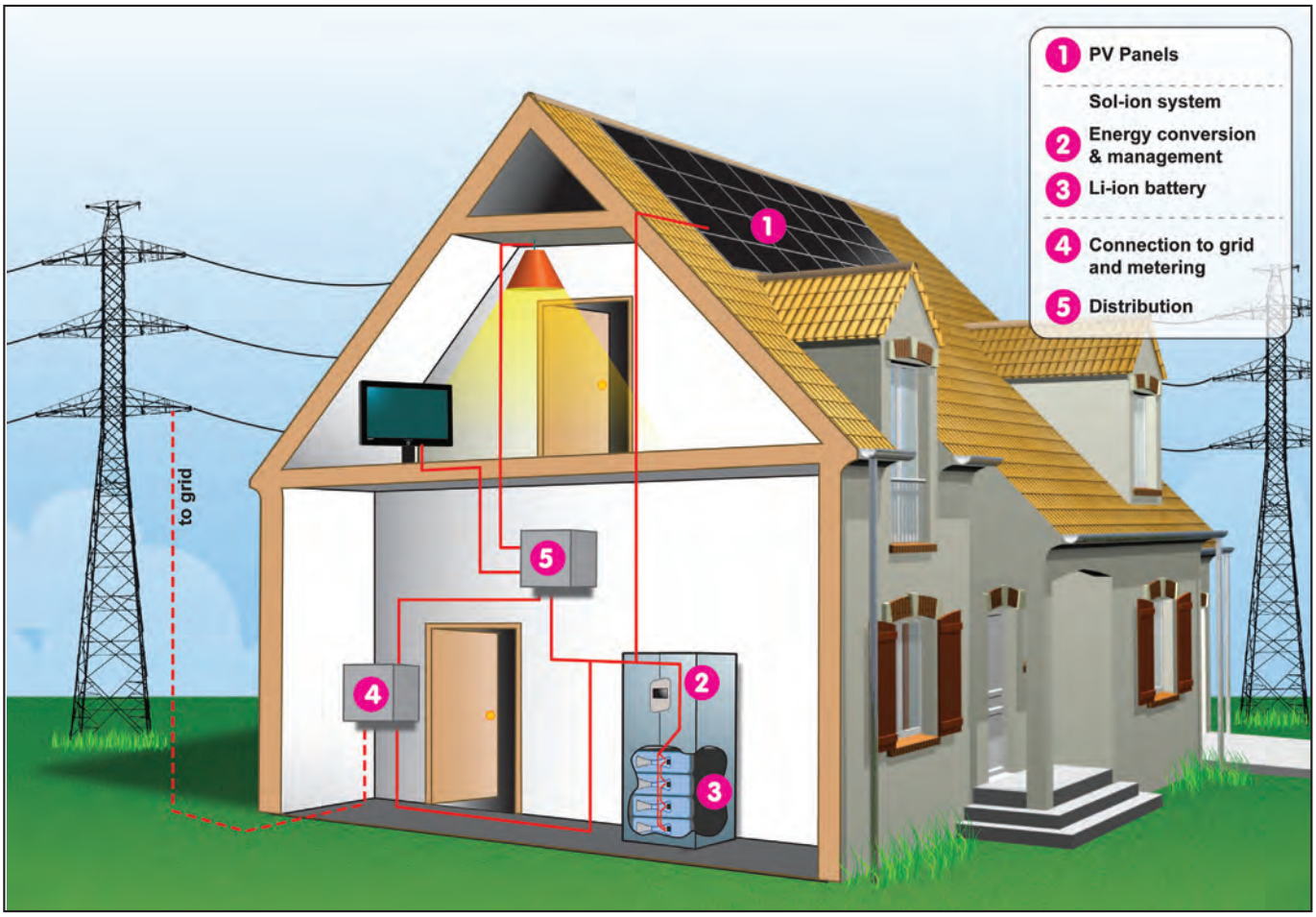
Nice grid

Meanwhile, the Nice grid project is the first life-sized demonstration of on-grid energy storage in mainland France. The €30 million project is part of a pan-European research programme to demonstrate smart grid technology and it will run over a period of four years until December 2015.

The Nice grid is a pilot smart solar district in the town of Carros close to the city of Nice in the south of France, which has the objective of ensuring the smooth integration of PV energy into the local low voltage grid, with rooftop solar panels, energy storage and load curtailment all playing a role. Selected for the project because of its location on the periphery of France's transmission grid, while having abundant sources of renewable energy, Carros was an ideal site to test integration of PV energy storage solutions.

During the four-year project duration, the batteries will enable the testing of multiple functionalities, including levelling of production and consumption peaks, plant shutdown management, and efficient management of multiple distributed energy producers and consumers. Around 200 rooftop PV installations will be integrated into the grid and 1,500 residential and business customers will participate in the project, either by helping to





integrate a PV array, a battery or by volunteering to shed load on request to balance supply and demand. Saft will install around 100 energy storage systems with a combined storage capacity of around 2.7 MWh at three levels within the grid. A single 560 kWh, 1.1 MW Li-ion battery system will be installed at Carros' main substation, linking the local network to the national network.

In addition, five 310 kWh, 100 kW Li-ion batteries will be installed at five medium and low-voltage distribution substations. These will store PV energy and deliver energy during periods of peak demand, also allowing for operation in islanded mode and more effective management of grid voltages. Finally, one hundred 6.6 kWh, 3 kW Li-ion batteries will be installed in the homes of domestic customers, reducing the strain on the grid during peak demand, also known as load shedding. The Li-ion energy storage systems draw on the experience of the Sol-ion project to deliver guaranteed performance levels, overall battery life and energy efficiency.

One important aspect of the project is the recognition that the smart grid technology does not stand in isolation. As PV generation grows in popularity, consumers will become prosumers and will be increasingly important in managing production, consumption and storage of electricity at a local level.

Because of this, both technical and sociological evaluation is central to the project. During the Nice grid project, the efficiency, flexibility and multi-functionality of Li-ion energy storage will be demonstrated at three levels in the grid, improving the grid's capacity to use intermittent renewable energy sources, as well as optimising power flows within the smart grid.

Autonomous beginnings

The Sol-ion project has provided a clear demonstration that Li-ion energy storage can add significant value to electricity grids and consumers by boosting both self-consumption and autonomy, and the ongoing MILLENER and Nice grid projects are expected to reinforce these conclusions. The result is a constantly growing level of practical real-world experience that provides a firm foundation for energy storage to make the transition from these large scale trials to fully commercialized installations.


Ocean sunset in Bonifacio, a commune on the Island of Corsica

Complacency will slow growth

The International Energy Agency (IEA) recently released a report suggesting that renewable energy sources will surpass gas by 2016 in the global power mix. Despite the positive growth the agency also warns industry and governments against complacency in assuming the growth will continue without continued support and vigilance.

POWER GENERATION FROM SOLAR, hydro, wind and other renewable sources worldwide will exceed that from gas and be twice that from nuclear by 2016, the IEA said on release of its second annual Medium-Term Renewable Energy Market Report (MTRMR). According to the MTRMR, despite a difficult economic context, renewable power is expected to increase by 40% in the next five years. Renewables are now the fastest-growing power generation sector and will make up almost a quarter of the global power mix by 2018, up from an estimated 20% in 2011. The share of non-hydro sources such as wind, solar, bioenergy and geothermal in total power generation will double, reaching 8% by 2018, up from 4% in 2011 and just 2% in 2006.

"As their costs continue to fall, renewable power sources are increasingly standing on their own merits versus new fossil-fuel generation," said IEA Executive Director Maria van der Hoeven as she presented the report at the Renewable Energy Finance Forum in New York. "This is good news for a global energy system that needs to become cleaner and more diversified, but it should not be an excuse for government complacency, especially among OECD (Organisation for Economic Co-operation and Development) countries."

Even as the role of renewables increases across all sectors, the MTRMR cautions that renewable development is becoming more complex and faces challenges – especially in the policy arena. In several European countries with stagnating economies and increasing energy demand, debate about the costs of renewable support policies is mounting.

Uncertain factors

In addressing these issues, Ms. Van der Hoeven warned that "policy uncertainty is public enemy number one" for investors: "Many renewables no longer require high economic incentives. But they do still need long-term policies that provide a predictable and reliable market and regulatory framework compatible with societal goals," she stated. "And worldwide subsidies for fossil fuels remain six times higher than economic incentives for renewables."

The forecasts in the report build on the impressive growth registered in 2012, when global renewable generation rose by over 8% despite a challenging investment, policy and industry context in some areas. In absolute terms, global renewable generation in 2012 – at 4 860 TWh – exceeded the total estimated electricity consumption of China. Two main factors are driving the positive outlook for renewable power generation. First, investment and deployment are accelerating in emerging markets, where renewables help to address fast-rising electricity demand, energy diversification needs and local pollution concerns while contributing to climate change mitigation. Led by China, non-OECD countries are expected to account for two-thirds of the global increase in renewable power generation between now and 2018. Such rapid deployment is expected to more than compensate for slower growth and smooth out volatility in other areas, notably Europe and the US.

Second, in addition to the well-established competitiveness of hydropower, geothermal and bioenergy, renewables are becoming cost-competitive in a wider set of circumstances. For example, solar is attractive in markets with high peak prices for electricity, for instance, those resulting from oil-fired generation. Decentralised solar photovoltaic generation costs can be lower than retail electricity prices in a number of countries. Wind competes well with new fossil-fuel power plants in several markets, including Brazil, Turkey and New Zealand.

Policy impacts

Van der Hoeven also cautioned that renewable progress is threatened by poor policy decisions. Whether people like it or not government choices impact the entire process. The worst case occurs in countries, such as Spain, Czech Republic, Bulgaria, which have adopted retroactive policy changes have totally destroy investors confidence, potentially for a long time. Van der Hoeven reiterated comments she recently made in Germany that any form of retroactive tariff cuts, even if applied for only a short period, must be avoided.

Van der Hoeven feels that government complacency is one of the biggest potential stumbling blocks to renewable adoption and seeks to encourage policy makers to be more aware of the details and impact of their decisions. In general terms the rapid growth of renewables has been a success story towards a cleaner, more diversified and more secure energy mix.

The IEA report shows that such a positive trend can continue and even accelerate. There is no room for government complacency, especially among OECD countries who have committed to certain targets and outcomes.

According to Van der Hoeven policy makers need to better understand that any decision increasing uncertainty and volatility results in higher investment risks, higher costs of capital, more difficult access to finance, and ultimately worsens the business

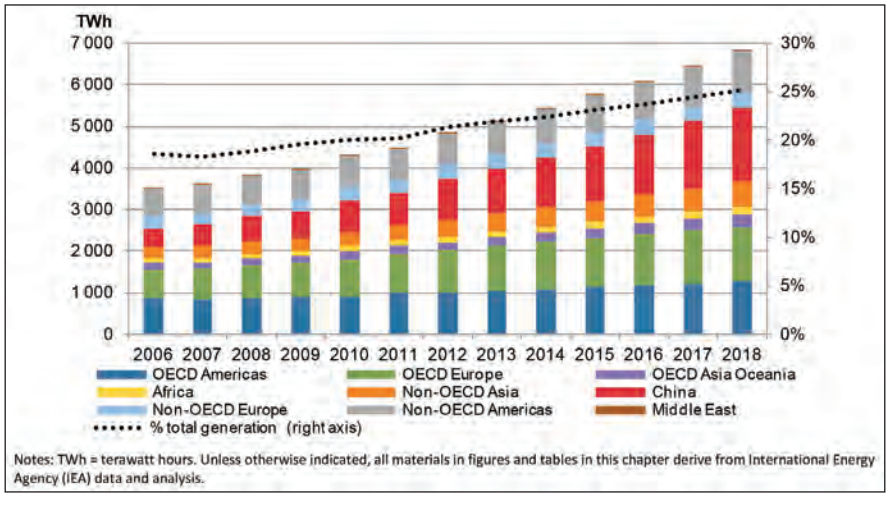


Figure 1: Global renewable electricity production by region

case for renewables. They also need to realize that the competitiveness of renewables depends on the design of the market in which they operate. This is an area that policy makers have a direct impact on.

An important question for policy makers to consider is whether markets based on short term marginal pricing are capable of providing appropriate remuneration flows to encourage investment for capital intensive technologies like renewables.

This calls for a serious reflection on market design needed to achieve a more sustainable world energy mix.

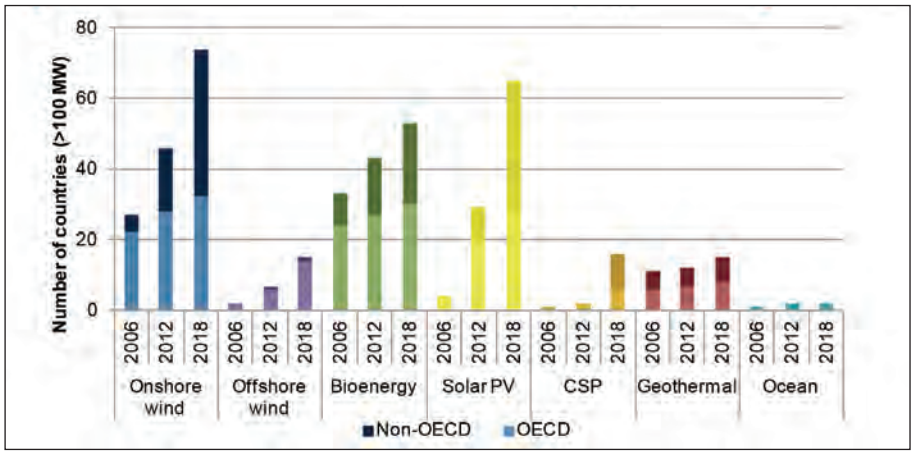
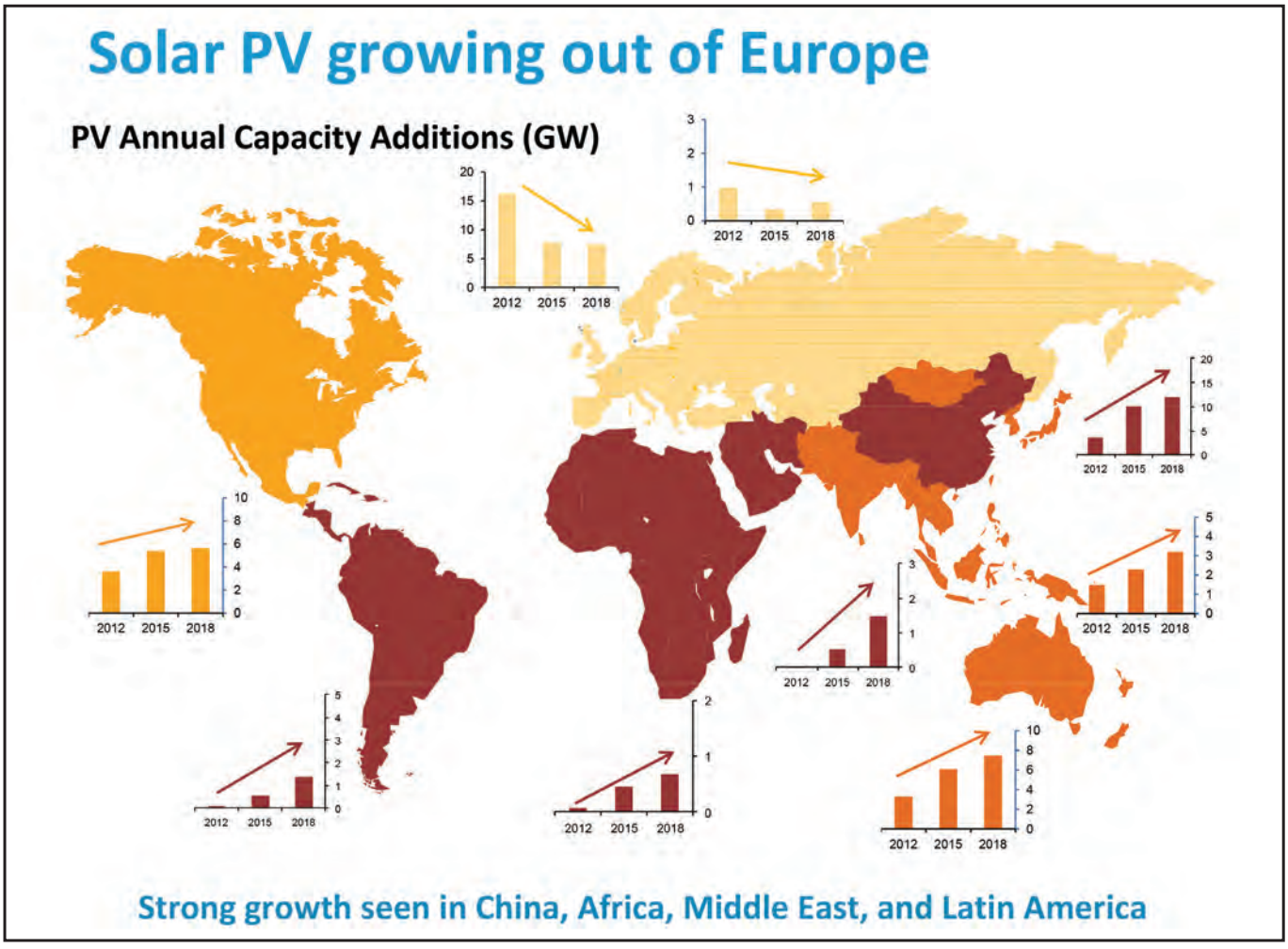


Figure 2: Number of countries with non-hydro renewable capacity above 100 megawatts (MW)

Van der Hoeven continued, "In times of difficult economic context we are often confronted with the question "Can we afford expensive renewables support policies?" The question is not if renewables are needed, but where and when."

Renewables now provide a portfolio of well established and increasingly affordable sources of electricity, where the resources are of good quality and the right policy and market framework is in place. Like any other technology, renewables do not represent a "silver bullet, one size fits all solution to the complex energy needs of the world. "If we are serious in aiming at a more secure, diversified, affordable and cleaner energy mix," reminded Vander Hoeven. " The only conclusion is that no country can afford not having renewables as a fundamental pillar of a portfolio of energy technologies responding to those needs."



CPV looks set for a brighter future

It is difficult to gauge the state of the concentrating photovoltaic (CPV) industry: Amongst system manufacturers, GreenVolts has folded and Amonix scaled back, but Soitec has announced big, bold plans. Although this indicates that life can be tough in the CPV industry, the sector should grow at a healthy rate according to research manager Sam Wilkinson from IHS, who has been talking to Richard Stevenson about the current state and prospects for this technology.

Q Who are the big players in the CPV industry today?

A Soitec is leading the way in terms of deployment. There have been several announcements of the large system that it is going ahead with in Africa. There are also a number of other companies that are still active and really pushing their technology and their product. That's the likes of Semprius, Amonix still to a certain extent; and at the solar cell level, Emcore and Solar Junction.

Q Why have some companies in this industry, such as GreenVolts and SolFocus, folded in the last year or so?

A In any space that is largely populated by start-up companies, it is never the case that all of the start-ups finally make it to be established companies in an established market. And the cost reductions in the silicon PV industry, which was ultimately one of the competing alternatives to CPV, made it incredibly difficult for CPV to compete in its target market. But we still believe that CPV is competitive, and can be a more attractive option in certain conditions and certain regions.

Q I presume the tough global economic conditions must have also made it hard for CPV companies to survive, let alone thrive?

A CPV companies rely heavily on financing and in today's climate financing is difficult to secure for any technology. Choosing where you are investing and where you are lending money – especially given all the press regarding dumping and the rate at which prices have fallen – has made investors very wary of investing in any PV technology, let alone a start-up of that kind of ilk.

Q Over the last few years, there have been several announcements of massive CPV projects, such as Soitec's contract to supply 305 MW to San Diego County. Have these projects fallen by the wayside, or are they underway?

A The PV industry is renowned for announcements of projects that may never happen. I remember when China first announced an incentive and there started to be a domestic market for PV in China: First Solar signed an MoU for a multi-GW plant in Inner Mongolia. That never happened, and that was probably four years ago.

The very first MoU is so far away from actually getting these projects developed and built. Some projects go ahead the whole way, and they turn into what they claimed they would be. But some never get past that very first contract because of a number of other issues, such as grid connections and financing. So many things can potentially hold up a project. Other projects may go ahead in a much smaller version of what they claimed they were going to be. That's probably the case with the large majority of these CPV projects. They will possibly go ahead in some format. However, I have some doubt about whether they will go ahead in the full capacity that once was claimed.

Q How many megawatts of CPV has now been installed around the globe?

A At the end of 2012, we estimated that it was around 150 MW installed in total. That's for high and low concentration, and includes silicon CPV. The large majority of CPV is in the US.

Q In these locations, are there incentives for green technology?

A Right now in the US it's utility driven, signing PPAs [Power Purchase Agreements] and so on. So it's not so much an incentive. But obviously the utilities there are required to meet certain renewables commitments, and so it is indirectly incentivised in that way.

In most other countries where CPV is deployed, it's taking advantage of some kind of feed-in tariff, or some sort of PV incentive. There are some countries where they get an additional bonus – or there is some slightly different structure – for CPV compared to PV.

Q Can CPV make a big impact in rural locations?

A It is already being used there. We do see a huge market for off-grid PV in general, and CPV could definitely fit into that.

Your question relates a little bit to storage. We have found that in those rural locations, the lead-acid storage battery is a huge part of that market at the moment. Over the next few years we will start to see some other new technologies, such as lithium ion and flow batteries come into that market as well. There is also a technology, sodium nickel chloride, which is from Fiam and GE. That's got a lot of great properties for rural,off-grid use.

Q How do you expect CPV deployment to evolve in the next five years, and what factors will determine its success?

A We forecast strong growth for CPV. Obviously, it has hit a bit of a stumbling block in the last few years with the condition of its supplier base and a number of really, really strong challengers for the suppliers that are involved, but we see it growing to reach close to 1 GW in 2016. That's driven by strong activity in developing regions for PV: places like the Middle East, South Africa, and also a lot of activity in China.

We have seen PV system prices fall incredibly quickly over the last few years. But that has really started to slow down, and increase in some regions, given things like anti-dumping and poly-silicon prices starting to rebound a little. So that should give some breathing room back to CPV, and could give it a little bit of opportunity to start moving forward a little bit.

Q Is CPV now a tried-and-tested technology, or is there still concern about reliability?

A It is tried and tested from a laboratory point of view and from a handful of projects. But it's going to be a while before

there are large projects that have been out there for a number of years, and we are looking at these projects as investments. If you go to a CPV conference, you couldn't count the number of times that the word bankability is mentioned. That's really one of the big sticking points of the industry. CPV naturally competes with silicon PV. The amount of silicon PV that is now deployed in the world, the amount of time that it has been out there, and the number of projects that have been performing for a long time, is concrete evidence that the technology works.

Q Emcore and Soitec, two of the heavyweights in the CPV industry, are vertically integrated. Do you believe this gives them an advantage?

A There are huge benefits to vertical integration. Developing cells, modules and optics in conjunction with each other and ensuring that they are working really well with each other throughout the process is surely going to give you some advantages – not to mention the cost-savings by keeping everything in-house. But that said, when you are at low volumes and you are looking to establish yourself, the flexibility of contract manufacturing is quite attractive.

Q What do solar cell providers need to do to win orders?

A Efficiency, reliability and cost are all factors. However, more and more, we are seeing CPV companies forging partnerships with these companies. So, for the cell manufacturers, it come down to having the right partnerships at the right companies: The ones out there deploying their technology are the ones that are going to bring in the most business for them. For a CPV supplier, they are looking for a company that is going to work with their technology and optimise the cell to their optics.

Q There has been a lot of recent funding for multi-junction cell development. Do you think that move is important? Or are there other areas where improvement is more important, such as, for example, tracker technology?

A Almost all areas can be improved. Developing higher efficiency cells starts in the lab, and there they've got to keep increasing efficiencies, although we are already at incredibly high levels. It is also realising that next commercial step of taking technology from the lab to the electricity grid. That, for me, is the most important thing: Proving the technology and getting it deployed.

Q Is there a move to making systems with higher levels of concentration?

A There is and there isn't. People are looking for the highest possible efficiency, and much greater yield, and they are going for the biggest numbers. This is the selling point of CPV.

But at the same time, you see SunPower starting to deploy some significant volumes of their technology, which is low efficiency in CPV terms. It uses their standard, high-efficiency, mono-crystalline silicon. This is far lower in efficiency than any triple-junction cell but very high efficiency in silicon terms. They are doing it on a single axis, keeping it very simple compared to what the big, high efficiency guys are doing.

The interesting thing with Sunpower, of course, is that they are a big player in silicon PV. They are deploying CPV where they think it makes most sense. So the two are not really competing – they deploy them as they see fit.

Q Amonix recently claimed that it had raised the record for module efficiency to 36 percent. Is that evidence that the company is about to renew its commercial activity?

A There is no evidence that they are renewing manufacturing. But there is no way that they'd say that they had got this world record efficiency if they didn't have some commercial plan for the future – quite what that is I don't know, because they are a quiet company.

IHS Research recently published its "World Market for Concentrated PV (CPV)" report.

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Energy storage: Rural electrification's backup

Off grid electrification becomes a more pressing need in rural areas unable to benefit from city wide grids and has been a key driver for the solar industry for half a century. Now that PV technology is making it possible for the most remote areas to benefit from electrical sources there is need to move to the next stage of development. Marcus Wiemann, Secretary General of the Alliance for Rural Electrification discusses the recent developments in developing storage solution to ensure that off grid electrification is no longer a band aid to rural needs.

THE ALLIANCE FOR RURAL ELECTRIFICATION (ARE)'s objective is to stimulate economic development through the promotion off-grid renewable energy technologies for rural electrification in developing countries and emerging markets. While often grid extension is not a feasible option, decentralised solutions are often the better alternative to alleviate energy poverty: they are cost-effective over the system's lifetime, easy-to-deploy, install and maintain and their design can be tailored to demand needs. Plus, these regions offer abundant renewable energy resources.

Despite the solid arguments to support off-grid renewables as the best solution for remote areas, there is still one open question: What happens with the electricity service when the sun stops shining or the wind does not blow anymore? No doubt this is a relevant issue which probably is preventing local energy decision makers from including renewable energy sources in their rural electrification plans. Fortunately, present markets offer technologies that enable storing energy derived from a primary source for its use at a later time. Many of these solutions have reached maturity and therefore are being increasingly used to improve efficiency, reliability and price-competitiveness of electricity services as well as to achieve deeper penetration of renewable energy systems.

Energy storage technologies can be applied twofold: Firstly for off-grid systems installed in rural areas and secondly for decentralised grid backup in peri-urban areas that remain under-electrified. To ease the path to these solutions, ARE has launched the six-month "Energy Storage Campaign".

This initiative aims to inform decision makers in Africa, Asia and Latin America about the added value that energy storage offers to rural areas.

Already moving forward

The success of the campaign has been built upon the expertise of a group of rural electrification experts. These nine members of the Alliance based in three different continents and with a wide experience on the topic have formed the ARE Energy Storage Task Force with the objective of shaping this initiative and to find answers to 'What really matters!'

As a result, the ARE Secretariat jointly with the Energy Storage Task Force has developed the position paper Using batteries to ensure clean, reliable and affordable universal electricity access[1]. This guide paper includes information and recommendations for decision makers, applications of the different types of battery technologies, as well as successful case studies from India, Bangladesh, Jordan, Peru and Mozambique. The position paper has a focus on electromechanical energy storage, in particular on four different families of batteries, as they remain the main technology applied to off-grid.

Possible solutions

Energy storages represent a key element to ensure the proper functioning of any system and will contribute to the positive development of the entire industry:

- Batteries will improve the system's performance and lead to economic savings over its lifetime and thereby lower

operational costs if properly designed and maintained. In this regard, it is of utmost importance to use certified equipment and observe international standards while designing, installing and operating the system in order to ensure its longevity.

- The stand-by battery market is expanding rapidly in developing and emerging markets, which represent important growth niches for the sector. The increasing demand of batteries can facilitate deeper penetration of intermittent renewables in these regions. For example, whereas Africa represented the smallest market for European stand-by battery systems (2V cells and mono blocks) in 2011 with 3,5% of total sales[2], it was the region in the world which enjoyed by far the highest growth rates with an increase of 25% compared to the year before[3].
- Batteries play two major roles in terms of energy management:
- Short-term: The battery regulates the system by absorbing or supplying power to maintain a balance between instantaneous power production and consumption[4].
- Long-term: Allows storing electricity at a period of peak production, thus avoiding wastage of energy at times when it is not required and supplying energy when intermittent primary energy resources are unavailable[5].
- The remote areas where off-grid renewable energies operate are vast and diverse. Thanks to the existence of different chemical battery families, each of them with its own specific features, storage systems can be designed to play a wide range of roles perfectly fitting local conditions.

Not without the public sector

Energy storage applied to rural electrification is attracting a lot of attention these days. However, these are still young markets which need more explanation and promotion. The support from public authorities, particularly regulators, as well as power sector technical bodies -such as rural electrification agencies and public utilities- would certainly help stimulate more investments in the market. To enhance developments, ARE has formulated the following recommendations for decision makers:

- Developing and enforcing a well fitted regulatory framework is critical to ensure the market's sustainable development and consumer's trust.
- A well tailored framework should be complemented via awareness creation campaigns and technical assistance to the operations sector (manufacturers, installers, operators, recyclers).
- Establishing policy targets for batteries, as it is done for renewable energies, could help stimulate the sector's development.
- The achievement of these targets should be stimulated with the establishment of specific support schemes and assistance to the financing sector.

Learning from the past

The kick-off of the "Energy Storage Campaign" was held at Intersolar Europe in June 2013, where ARE celebrated a successful workshop as official side event of the conference. Further promotion activities will include several webinars in collaboration with international organisations such as the United Nations Foundation Energy Access Practitioner Network, the creation of new papers on other storage technologies, as well as other workshops in international events, among others.

Thanks to the experience gained with the "Small Wind Campaign", the expertise of the Energy Storage Task Force and the support of the industry, ARE expects to facilitate business dialogue between private and public sector on the advantages of energy storage.

This is not the first time ARE has launched such a campaign. Last year the focus was small wind power, and now it is the turn of energy storage, a technology that undoubtedly will make a difference in the long way towards achieving universal access to reliable and sustainable electricity in remote areas.

Footnotes:

1: ALLIANCE FOR RURAL ELECTRIFICATION (2013), "Using batteries to ensure clean, reliable and affordable universal electricity access"
2: Algeria, Angola, Cameroon, Congo, Equatorial Guinea, Gabon, Ghana, Kenya, Mauritius, Morocco, Mozambique, Niger, Nigeria, Senegal, South Africa, Tunisia, Uganda and Zambia
3: EUROBAT (2011), "Battery Economic Outlook: Industrial Battery Market Europe, Middle East and Africa (EMEA)"
4: IEA/OECD (2011), "Energy For All – Financing Access for the poor", World Energy Outlook, p.7
5: Ibid. p.7 and 15

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Energy in the hand of the consumer

With an incentive programme now in place, the German PV industry looks to promote self-consumption suggesting a continued reduction on subsidy reliance. Sara Ver-Bruggen asks what do installers and adopters need to know?

IN GERMANY a household looking to protect itself from rising electricity rates over the next couple of decades now has two choices. In the first, and more established, option a household can install a PV system and the government guarantees the owner a fixed payment amount for every kWh of electricity produced by the panel, called a feed-in tariff (FIT), over 20 years from the year of the installation. Within a few years, the homeowner covers their initial investment and gets to pocket the rest.

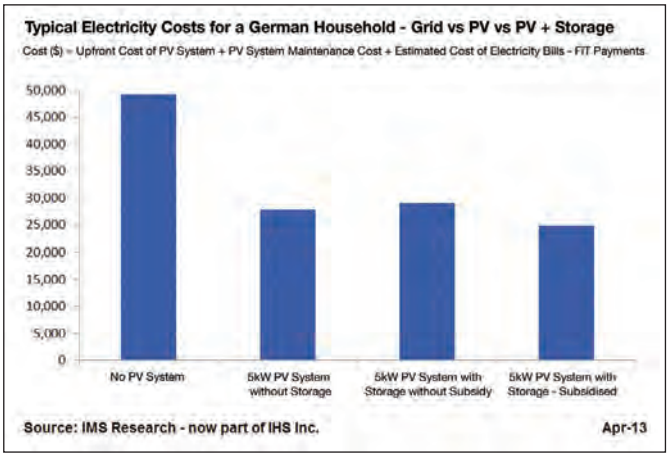
The second option is to invest in a PV and a battery system that lets the household use more of the energy its solar panels produce and reduce its reliance on electricity from the grid. With a standalone PV system, the most electricity generated that can be consumed on site is about 30%, while the addition of storage can increase this to 65-70% or more.In Germany, where PV electricity has reached grid parity in some areas, investing in a PV and storage system can – despite the larger upfront investment compared with a standalone PV system – ensure similar savings on electricity bills spread over 20 years. In Germany, the customer has to pay approximately EUR0.27 per kWh for electricity from the local utility provider, while the FIT rates for residential PV systems are likely to reduce to about EUR0.14 per kWh in mid-2013, so consumers are better off consuming more of their self-generated PV electricity instead of importing it from the grid.

Bonn-based solar and cleantech consultancy EuPD Research recently carried out a survey in Germany and concluded that households, and other end customers, appreciate how PV and storage reduces reliance on grid electricity. Like solar PV adoption in the late 1990s, pioneers of PV and storage will mainly be in the form of residential and small-scale users, the consultancy asserts.

How grid-connected PV and storage works

PV and storage systems must be able to operate within a grid connected configuration, as opposed to off-grid systems, where a household is totally reliant on meeting its entire electricity demand. Grid-connected PV and storage systems minimize the amount of solar energy that is dispatched to the power grid during daylight hours, when it is not needed, and maximizes on-site consumption of solar energy to reduce demand on the power grid during peak periods and, in essence, hedges the consumer against increasing electricity prices over many years.

Typically, the installation of an energy storage system with a PV panel would allow a household, in the morning, to optimise own-consumption of the PV electricity being generated, while any surplus is directed to charge up the batteries in the energy storage system. In the afternoon hours, when the batteries are completely charged, the system provides electricity for the household's own use – for instance for operating appliances that are configured to work during the



day time when no one is at home – and feeds surplus energy, generated by the PV panel, to the grid. In the evening the system switches to using energy stored in the battery and if the battery capacity falls short of night time demand electricity can be drawn from the grid. In the summer months – when days are longer with more sunshine hours – a household could almost use all of its own PV-generated electricity without needing to rely on the grid.

The economics

In a recent report IHS Inc calculated that, based on factors such as electricity rates continuing to rise at a similar trajectory to recent years, then a 'typical' German household can expect to spend nearly $50,000 (EUR39,000) on electricity bills over the next 20 years. Installing a 5 kW PV system, and benefitting from the current FIT rates, this amount is nearly halved. Investing in 5 kW PV system with storage would ensure savings almost on par with the PV system option. However, the additional cost of the energy storage system would roughly double the upfront cost of the investment. While PV panel prices have come down in recent years, batteries – especially high performance lithium-ion (Li-ion) devices – have not seen equivalent reductions, as stationary storage is still very much a new market for Li-ion cells. Faced with both options, there is little incentive for a household to go for the more expensive upfront outlay required for a PV and storage system.

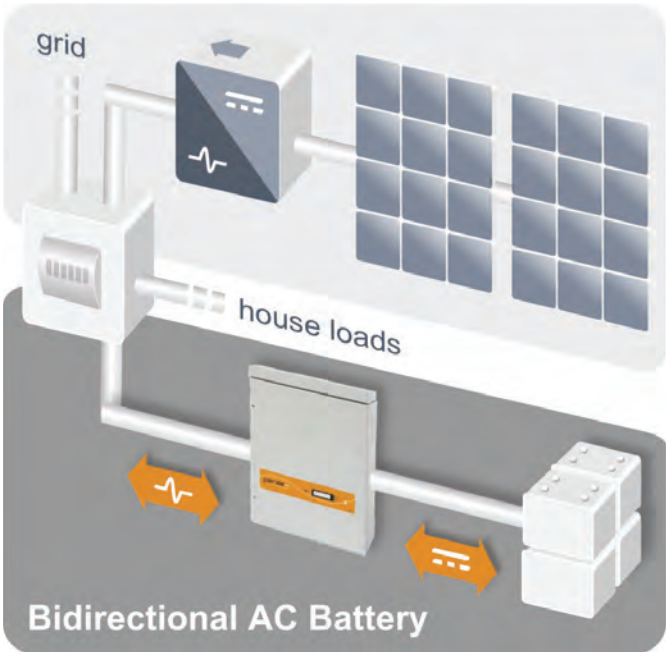
To make households and other small investors consider PV and storage investments, the German government announced plans for a new type of subsidy – a bonus payment – that would, over the 20 year lifetime of the system, make the household better off by several thousand euros, compared with the PV only option. On 1 May, the government finally introduced this new sweetener, which pays out bonus payments for each kW of the system's size. These are paid upfront. Low interest loans, to provide households and other investors with the cash to finance their PV and storage installations, are also available as part of the programme.

IHS Inc forecasts that with a 5 kW PV system a household could expect to pay in the region of $27,000-$28,000 in electricity rates, while the PV and storage with subsidy would reduce this to below $25,000 over the same 20 year period. The subsidy will reduce the average cost of a 20 year PV and storage system by about 10%.

How long the new subsidy initiative will last for is not clear, though the German government has confirmed a budget of EUR25 million for 2013 and the same amount for 2014, according to PV Magazine. If successful, the programme will incentivise investment in storage systems and, as demand grows, battery costs will come down, making storage more cost-effective and mainstream in the years ahead. By 2020 Li-ion batteries will more than halve, from around $500-600 kWh today to $200 per kWh, according to some forecasts, while other projections are more cautious, but seeing how rapidly PV panel prices have fallen in recent years, anything is possible.

Ascertaining demand

EuPD Research suggests that interest in PV and storage systems will occur later in 2013, even early next year, in Germany and from next year demand will start to seed in other European markets, including the UK. In Germany the sorts of companies that are promoting products in anticipation of this new solar self-consumption market include specialist smart energy storage system developers and suppliers and also inverter companies that are beginning to round out their offerings with small storage systems and smart home gadgets that connect up to appliances. However, the number of companies actually producing and delivering goods are fewer in number. They include E3/DC, Varta, Voltwerk (now part of Bosch), Prosol and Dispatch Energy. E3/DC, a subsidiary of German energy, IT and telecoms utility EWE, has made several hundred units so far and is establishing distribution networks through a collaboration with Trina Solar. Prosol, which has had supplied smart energy storages systems for installations by customers since 2010, has established an extensive distribution network that includes German utility RWE. Voltwerk has developed an integrated energy management system, designed to have increased battery capacities, has made models with 4.4 kWh and 6.6 kWh capacities available since May 2013. Varta Storage, part of the Ellwangen-headquartered battery maker, is adding to its wide portfolio of power storage applications with Engion. Start-up Dispatch Energy, which produces its own Li-ion cells, will shortly begin delivering systems to PV partners.



Qualifying for the subsidy

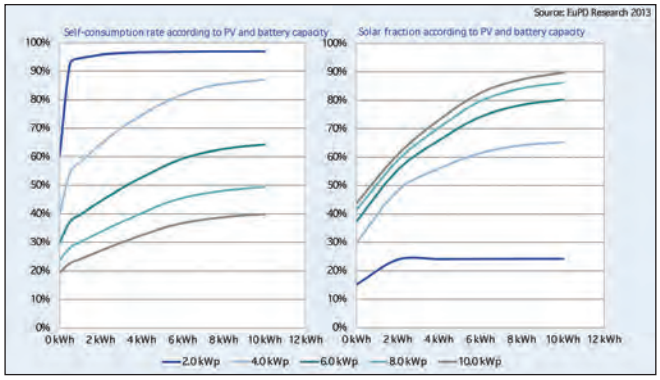
German state-funded bank Kreditanstalt für Wideraufbau (KfW), which provides financing support for the country's renewable energy programme, is in charge of the PV and storage subsidy (programme ref. 275). Households and other customers will first need to go to their local bank with an offer in hand for a system and apply for the bonus, which is a maximum of EUR600 for each kW of the system's size. There are several criteria that systems must meet in order to qualify. For instance, systems must be under 30 kW in size and the maximum amount of PV generated electricity that can be exported to the grid is 60%, over the 20 year lifetime of the PV system. Other criteria span warranties and other issues such as ensuring systems can be replaced with new batteries in future. The criteria need to be met to qualify for the bonus, not for the low-interest loan. Once the application is accepted the funds are made available for the customer to pay for the installation of the system.

While Germany is driving the residential energy storage market, growth has fallen a little short of expectations, due to delays and uncertainty over the storage subsidy, according to EuPD Research. Nevertheless energy storage system suppliers are reporting positive feedback from the market via their distribution partners. Dispatch Energy's MD, Dietmar Gruidl, says: 'We hear there is already a lot of interest'. A Varta spokesperson says the company, which began serial production of Engion in early 2013, is already ramping up production and capacity to meet anticipated high demand for the system, while another smart energy storage system supplier anticipates selling several thousand units during 2013. Depending on system sizes, the subsidy could finance in the region of 15,000 installations, or more, in 2013. Under the scheme retrospective PV installations under 30 kW going back to the start of 2013 can also qualify for the subsidy.

Integrated or kit system approach?

Two routes to market for energy storage systems are emerging. One is where these systems are sold as part of a kit, where the main components of the system, including the storage system and inverters, are sourced separately and put together by electricians or other qualified installer. The other option for the installer is to provide an integrated product.
The global inverter company SMA has two products in the pipeline designed to cater for each approach. The Sunny Island 6.0H is promoted by the company as a flexible storage solution for end-users that want to assert their self-consumption and be as grid-independent as possible. The battery inverter is compatible with all PV plant sizes, PV inverters and battery types including both lead acid and Li-ion and the battery storage capacity can be increased with more batteries to meet changes in the household's electricity needs.

SMA's integrated Li-ion battery-based energy storage product, Sunny Boy 5000 Smart Energy (SE), is designed for smaller households, typically with a 6 kW PV roof system and a 5 kW peak inverter, whereas the flexible Sunny Island system can



work with PV inverters in 5 kW up to 10 kW range. 'Sunny Boy 5000 SE is based on a plug-and-play principle and is a more straightforward product for PV installers to sell to their end-user customers,' explains Tom Rudolph who heads up the company's energy management solutions unit. Both systems can be used as part of SMA's Smart Home, a communications system that maximize self-consumption by connecting up to household appliances and scheduling when to switch them on to use as much PV energy as possible and store the remaining PV energy for the evening hours. The Sunny Boy 5000 SE can also be connected to home management device that ensures the amount of electricity exported to the grid does not exceed 60%.

SMA introduced the 2.2 kWh device for the first time at Intersolar 2012 but it will not be available until later in the year. Rival inverter supplier Power-One recently announced its own prototype of a small Li-ion battery-based integrated storage system. Power-One's prototype will supplied as a standard product with a 4.6 kW inverter and 2 kWh Li-Ion battery, but, if needed, the battery capacity can be expanded up to 6 kWh with the addition of two additional battery modules, so that the household can take advantage of cheaper Li-ion battery prices in future to boost self-consumption further. The system is going into production later this year and is unlikely to be available until early 2014.

Rudolph adds: 'At the moment the market caters for different systems and approaches, with some companies supplying complete systems, which includes a cabinet of batteries that sits in the garage or basement. But some of these approaches require specialist electrical engineering knowledge and understanding of battery systems. Not all installers are going to have this.'

Assessing self-consumption

With ongoing digressions FITs are looking likely to phase out in Germany within two years and the days of big panel installations blanketing a homeowner's roof to maximise earnings from high FIT rates are over; the trend is for smaller panel sizes. Installers must now emphasise the potential for PV and storage systems to save the household money. But this depends on several factors that have to be understood. The key ones are the load-profile, dealing with appliances that use electricity in the house, and energy consumption habits of the end-user. The battery storage capacity, therefore, needs to be matched to meet the self-consumption requirements of the end-user.

Then there other decisions to be taken, such as whether to have a DC- or AC-coupled system. EuPD Research advises that for new PV installations with integrated storage solution the wiser option is to have a DC-coupled battery, where the battery is connected to the circuit prior to the conversion to AC, where a specific inverter, featuring a charge regulator, is used. For a PV system already installed integrating an AC-coupled battery may be the better option as it only requires the addition of a second inverter. However, the additional conversion back to DC leads to further efficiency losses.

A potential game-changer could be the partnership between Prosol and inverter supplier Sustainable Energy Technologies in Canada. In order to connect low voltage batteries to the grid, while reducing efficiency losses, Sustainable Energy has developed an inverter, for AC-coupled systems, which enables single circuit bi-directional conversion of DC to AC and AC to DC to reduce multiple conversion steps. The inverter confirms to VDE 4105, a tough standard for the direct connection of low voltage batteries to the power grid with full European smart grid utility controls, and has the highest round trip (charging and discharging) efficiencies, of more than 90% compared with 80-85% for alternatives. DC-coupling is also an option.

In a PV and storage system the inverter acts as the main control point that manages the interconnection between the batteries, the solar panels, the utility grid and the consumer. Therefore, many inverter suppliers are establishing distribution partnerships with energy storage system suppliers that are suitable for deployment with their system or – like Voltwerk and SMA – are going down the route of developing and manufacturing energy storage systems and related products and services. In order to minimise efficiency losses some energy storage systems available are high voltage, but whether it remains to be seen whether there is mainstream market appeal for households plugged into high voltage battery banks.

For the PV industry's long term growth energy storage could be a significant opportunity in the coming years but it will require

In a PV and storage system the inverter acts as the main control point that manages the interconnection between the batteries, the solar panels, the utility grid and the consumer. Therefore, many inverter suppliers are establishing distribution partnerships with energy storage system suppliers that are suitable for deployment with their system

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some serious commitment for installers to ensure that their teams and staff are able to sell and install energy storage systems well, to ensure customers fully benefit from the savings that storage in conjunction with a PV system can provide. Businesses from other industries will also be looking to expand their offerings and services by supplying energy storage systems.

'In the past installers did not have to be concerned about the appliances in a household that used electricity, now they have to work with customers to evaluate the energy footprint, to carry out a due diligence exercise into the household's energy consumption patterns,' says Rudolph. He says that this requires more understanding of IT and home automation technologies as much of the software for processing this information is done in online software packages.

'Explaining to end-users how they can maximise their PV and storage systems will require that installers understand the different models and benefits for energy storage and are able to clearly explain these to end-users. Energy storage is not a quick, simple sell, which PV is in comparison. For instance, are end-users interested in maximising self-consumption, in which case they might opt for a bigger system, which adds cost, or are they interest in maximising economics?' comments von Versen.

Features and benefits

This makes laying claim a having a best product on the market tricky to judge. Von Versen advises installers to look for systems that are fully accredited and certified and those that can provide data on performance based on systems in pilot schemes, trials and early rollouts, can help when deciding which to choose from. The supplier E3/DC is taking the Apple approach by designing a smart storage system that is as consumer-friendly and is designed to make its use and operation simple and engaging.

The system adjusts the load for all electric appliances in the house. E3/DC and Voltwerk are two examples of companies that have developed systems that allow the user to monitor the energy storage system via a specially design smartphone 'app' or over the internet. Dispatch Energy's Black Diamond storage system, available in 5 kWh and 3.5 kWh capacities, sports a sleek design that will appeal to higher net-worth households, as it uses a newer Li-ion technology where the batteries virtually last the lifetime of the PV panel, even with 100% depth of discharge (DoD), without needing replacing.

Other suppliers have developed modular smart storage systems so the system's storage capacity can be increased if the household needs to increase its electricity consumption. For instance Varta's Engion allows a household or other end-user to expand storage capacity from 3.7 kWh up to 13.8 kWh, which can increase self-consumption up to 70% or even more. The smallest Engion size starts at about EUR11,800. The system is designed as a modular product that can be added to with more battery packs, at any time, to suit the customer's individual requirements. The three product packages can be adjusted individually by increasing the numbers of modules. Engion has been in serial production since earlier this year. Prosol's smallest system, which has a storage capacity of 4.6 kWh, is EUR11,500 plus VAT and installation costs. The company supplies the system in six different capacity sizes, up to 41 kWh.

Earlier this year, IHS Inc conducted an inverter buyer survey to establish what the market would be willing to pay for PV and storage systems. The questions were answered by a range of installers, integrators, wholesalers, distributors and project developers in terms of what these players would expect households and other end users to accept as an additional cost. More than 60% of respondents stated that the acceptable system price increase as a result of storage integration should be 10-29%. Nevertheless, there were also a good 30% who stated that paying more would be reasonable, according to IHS Inc. Many of the systems available are at the premium end of the market, developed to use Li-ion batteries, as opposed to cheaper lead-acid technologies.

Twenty years is a long time so any smart storage systems that can allow easy expansion of the battery storage capacity, to adapt to the changing energy demands of a household over time, can be expected to be popular as this market grows in the years ahead.

This article was originally published in Vol 1, Issue 3 of Energy Storage Journal.

Ultra clear glass holds pole position

PV glass suppliers understand that technological advancement is a major trend in China over the last few decades. Many PV glass suppliers have invested into two PV glass market segments that would typify this trend. Luke Johnson, Analyst at GCiS China Strategic Research suggests that there is some time before the new techniques will develop market traction.

THE PV GLASS MARKET can be segmented into three main products: Ultra Clear glass (Ultra), which is the main choice in the industry; Anti-Reflective (AR), which is more expensive but has a better transmittance; and Transparent Conducting oxide glass, which is designed specifically for thin film solar cells. Presently, AR and TCO products hold a less dominant position, combining to account for about a quarter of the market by output, and slightly more than a third by revenues (see chart).

The large majority of all PV glass sold by output is ultra clear. The AR market accounts for almost 30% of the total market by revenues, although the proportion is not expected to expand in the near future due to cut throat pricing from downstream PV suppliers. TCO in turn is used exclusively on thin-film solar cells, which has grown numerically faster than AR or Ultra Clear, but has started from a much smaller base.

In a survey conducted by GCiS China Strategic Research, when PV glass suppliers were asked about major trends in the market, about a quarter believed that AR and TCO is the current most prominent developmental trend in the industry; another quarter believe that Ultra is the main trend (other trends mentioned included industrial integration, and adoption of industrial promoting policies). But since a concurrent expansion of market share from two market segments is not possible, which is correct?

PV glass market dynamics

Examining present market dynamics in the PV glass industry, there is more evidence to support the continued dominance and short-term continued expansion of Ultra glass over AR. TCO, on the other hand, could gain market share more readily, but this is due more from their specialized application on Thin film solar cells, rather than an end-user preference for it over Ultra glass. There are several indications which support this conclusion of continued ultra glass dominance: differing growth rates among the products

segments, price pressure trends in the overall PV industry, and differing capacity utilization figures. All of which suggest that, while AR and TCO are expected to expand market share in the long-term, their pace of adoption will be slower than initially expected.

Consider first differing growth rates. The TCO market grew the fastest in 2012 at a rate of 9% by revenues year-on-year, but when factoring in the small original size of the market, adoption of TCO glass little progress against Ultra. The figure illustrates that, at least when compared to AR, the ultra market is expanding not only more quickly but is also larger to begin with. More solar cells than last year were covered with Ultra glass over other types of glass when compared to two years ago. This is a high-tech product, but the combined market share of AR and TCO is lower than it was two years ago. In this respect, the low-tech ultra glass is becoming more popular, a move away from the overall desired technological advanced trend.

Low capacity utilization is another interesting metric which reveals market expectations, and actual demand. Overall the entire market is running at large overcapacity. This is expected considering the initial high expectations for downstream PV exports. Nonetheless, while Ultra and AR glass markets are operating at around 45% capacity, the TCO market is closer to about 22%. TCO is technologically more difficult to manufacture, and despite significant investment, many companies have not been successful. What's more, of the roughly five companies which claim to be active in the market, only two successfully made any sales in 2012, and even then, they had significant excess unused capacity.

With idol production lines and furnaces, many are shifting some capacity over to more standard types of glass, with some opting to exiting the PV glass market altogether. Some notable examples of market exit or transfer of capacity include Saint Gobain, Qingdao Jinjing, and AVIC Sanxin.

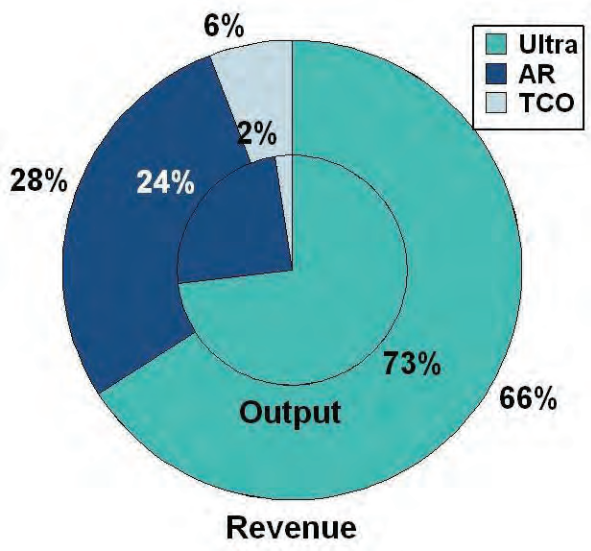


Figure 1: Sales Revenues and Output – China PV Glass Market by Product. Source: GCiS (note that the circle only represents the China market, not exports. Exports only account for about 22% of the market.)

This sheds light on past market expectations and the current market situation. Companies had great expectations about this market. But regardless of how exciting and promising a market is, 22% is a very low figure. After all, if the market continues to expand at 9% every year, then the current companies in the market could supply the market without any expansion of capacity through 2029. This phenomenon is due to expected demand which never materialized.

Finally, current downward price pressure from the downstream industries would suggest that the more expensive AR and TCO glass would not be the first choice by end-user PV OEMs. In the same research by GCiS,

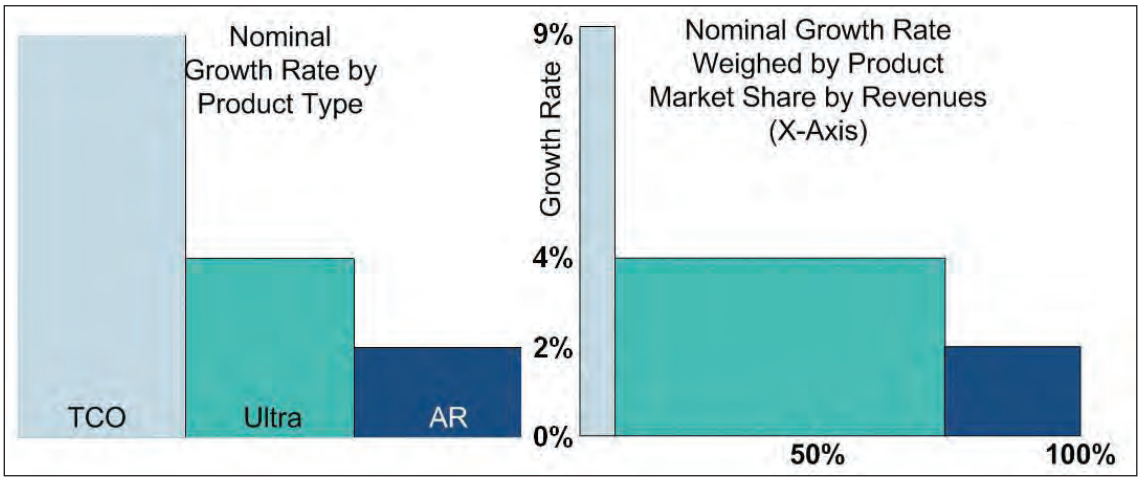


Figure 2: Weighted and Non-Weighted Product Growth Rates
Source: GCiS.

Combining the first figure illustrated, shows how despite growing quickly, TCO still has a way before holding market share

PV glass suppliers were asked where they expected the price of PV glass to move. Only about 8% of suppliers thought the price would rise, while 44% thought the price would drop (the remaining did not expect any change).

Decreasing prices are the result of several factors, summed up nicely by a major PV supplier: “Declining prices are a result of the PV market downturn. There are many [PV] manufacturers with excess capacity which will result in lower prices over the next three to five years. Since there is little relieve in the industry at the moment, prices for us will continue to be depressed.” With current price consciousness in the PV market bordering on a matter-of-life-or-death, it is unlikely that AR, and to a lesser extent TCO, will become a major choice over the next few years.

The future for PV glass in China

Ultra clear glass will remain king in this market for the foreseeable future. The product is of sufficient quality and meets the requirements at a cheaper price than either AR or TOC. Such pressure is due to the PV market’s own overcapacity and commoditization trend. Evolution of the technological level in the PV market will move significantly towards AR only after the PV markets problems are alleviated.

Currently, PV suppliers will have to compensate for the lower-than-expected global demand for Chinese solar cells. A recent dramatic example was China not interfering when one of their once promising solar companies, Suntech Power, declared bankruptcy. So whether through consolidations or bankruptcies, the number of suppliers in the PV market is expected to decline.

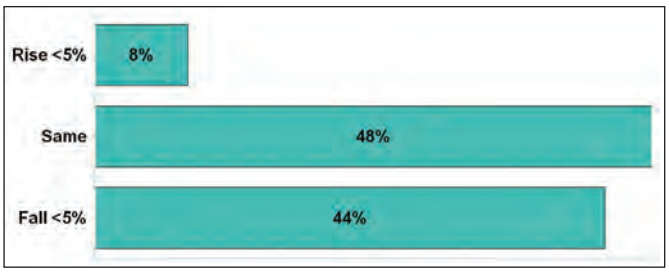
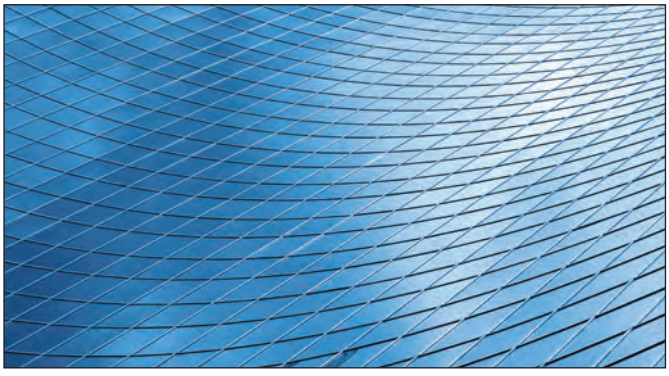


Figure 3: Opinion of Suppliers Concerning Future Prices, by Response Rate. Source: GCiS. Although some companies have expressed that many are selling their PV glass at a loss, studies show that suppliers are still expecting the price to decrease even farther

As it does, a few suppliers will emerge and develop stronger reputations and market power. With market power comes product differentiation and pricing power. It is at these later steps which AR could begin to make strides in market share and usage. Such a transition will take years, however.

By comparison, the future of TCO will be dependent on the adoption of thin-film solar cells. While thin-film solar cells were initially declared a more economically viable product due its lower demand on raw materials and energy to construct, the traditional silicon cells remain competitive because of their own decline in prices. The TCO market is presently small at only a couple hundred million RMB. But if production expenses are compressed, expect the growth rate to rise into the double digits over the next few years with more capacity installed on building tops and areas with lower amount of sunlight, two areas where thin-film solar excels.



The PV glass market moves and shifts with the demands of the solar cell market, and since the PV market has shown a race-to-the-bottom on prices, it is no wonder that the cheaper Ultra clear glass has remained king. But after supply and demand figures are more balanced, suppliers can begin to push and market some other solutions for protecting solar cells, including a more efficient option in AR. Over the next few years, Ultra clear glass will remain the predominant choice for solar cells, although afterwards AR and TCO will only make considerable headway after China’s PV industry gets over this speed-bump.

Interconnection: efficiently

Developments in the slimmed-down thin film sector have led to module efficiencies comparable to crystalline silicon. Using laser and inkjet technology developed for consumer electronics manufacturing, M-Solv's new One Step Interconnect (OSI) technology can help push efficiency and costs to fitness.

SOME remarkable achievements have been announced in the field of thin-film PV recently. First Solar has reported >19% efficient CdTe cells and >16% efficient modules. Several groups have reported > 20% efficient CIGS cells and TSMC and Miasole have reported > 15.5% large area CIGS modules. These efficiencies are comparable with many crystalline silicon products.

Thin film technologies are less mature than crystalline silicon and there is still plenty of room for innovation. One

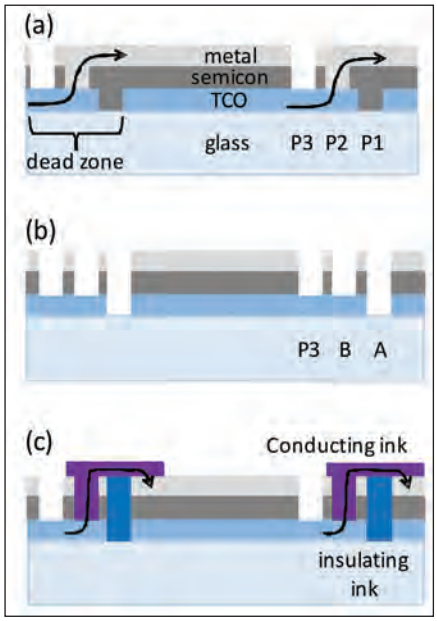


Figure 1: (a) Conventional thin film PV interconnect in CdTe. The scribes P1, P2 and P3 are used to define and interconnect cells, the current flow through the series interconnection is indicated by arrows. CdTe and thin-film Si use all-laser processes but for CIGS, P2 and P3 are most commonly done by mechanical scribers as the laser processes are quite challenging. The "dead zone" between the P1 and P3 scribes where no photocurrent is captured is also shown. (b) OSI laser scribes. (c) OSI with inkjet infill. Again the arrows indicate the current flow through the interconnect, equivalent to the one in (a)

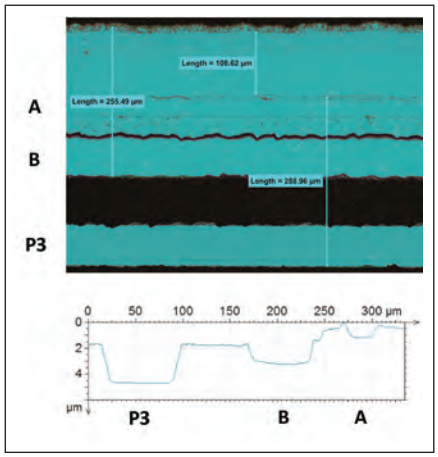


Figure 2: view of the interconnect through the microscope and cross-section from white light interferometer. P3 is an unfilled scribe to the TCO, scribe A is filled with insulator and the conducting ink makes a bridge from the TCO at the bottom of scribe B over the insulator to the back contact on the right of scribe A. The CdTe cell was kindly supplied by Colorado State University.

area where advances can be made is cell division and interconnection. In a crystalline silicon module, cells made from individual wafers are strung together with metal ribbons and integrated into a module. Thin film modules are generally made by various types of vacuum deposition of the thin film layers over the whole module area. These coating steps alternate with laser or mechanical scribing of the layers (usually known as P1, P2 and P3) which divide the module into strip-like cells connected in series (see Figure 1a).

The drawback with this sequential approach is that the coating steps happen in vacuum while the scribes are done in air meaning that the panel has to go in and out of vacuum systems several times during manufacture. To sidestep this issue, M-Solv has developed a process called One Step Interconnect (OSI) where the full thin film stack can be deposited, uninterrupted, followed by a single pass interconnection process. OSI uses a combination of depth-controlled laser scribes which isolate or expose the layers in the stack, followed by inkjet printing of insulating and conducting inks which form the interconnect (see Figure 1b,c and Figure 2). The laser and inkjet process heads can be mounted on a single machine, locked together by the mechanics and control system. This means the process is self-aligning and interconnects can be made where the inactive "dead zone" between the first and last scribes is minimised (see Figure 1).

The electrical properties of OSI interconnects are good, they have low series resistance and the insulator-filled P1 scribes have high shunt resistance. For the production line, there are advantages: three laser scribing machines are replaced with one OSI machine and several of the module's air-to-vacuum transitions are removed. That means that the module never has to be exposed to air until the stack is complete. The vacuum-to-air transit can only take place near room temperature but most of the coating steps take place at high temperatures so heating and cooling stages are needed. Using OSI means that the temperature profile along the production line can be much flatter. This saves energy, makes thermal process control easier and removes heating, cooling and load-lock equipment from the line (see Figure 3).

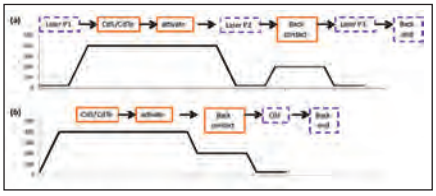
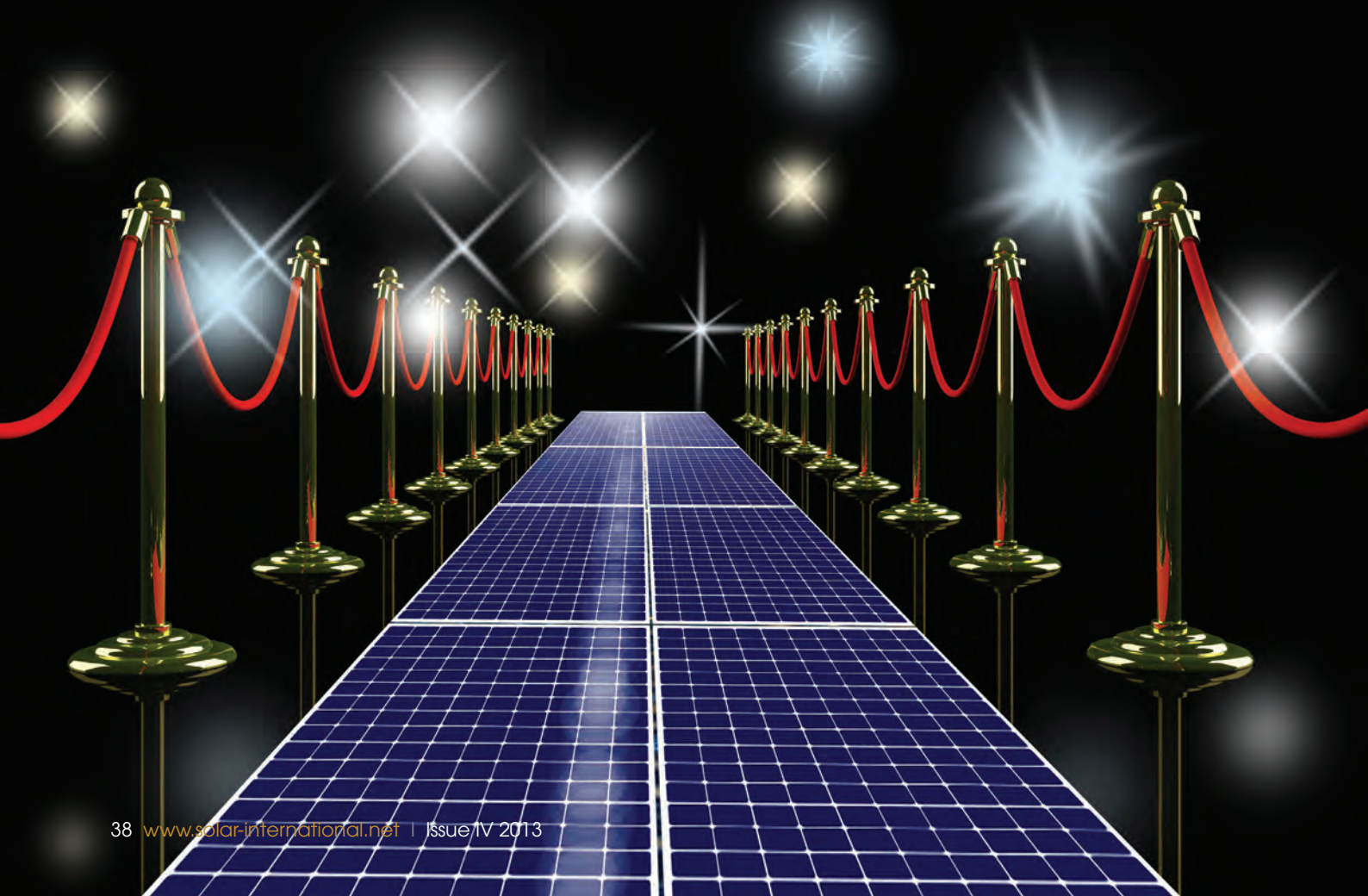


Figure 3: Temperature vs time plot for a CdTe manufacturing process with gas-phase activation process solid orange boxes are vacuum processes and dashed purple boxes are atmospheric; (a) conventional all-laser P1, P2, P3 interconnect (total DT = 1100°C) and (b) OSI: total (DT = 750°C).

Solar Industry Awards 2013 SHORTLIST



PV Materials Enabling Award

Merck KGaA
isishape SolarEtch®

Saint-Gobain Solar
SolarBond® InFrame

Honeywell
PowerShield® Cool Black

3M Solar Energy
3M™ Anti-Soiling Liquid

Thin Film Innovation Award

3D MICROMAC

microSCRIBE OSP

The NSG Group
TCO thin-film coatings

First Solar
CdTe PV modules

Silicon Innovation Award

bSolar
Bifacial PV System

GT Advanced Technologies
DSS™ MonoCast™ Crystal Growth System

MEI LLC
FlashDry Polysilcion and Material Drying

System Integration Award

Also Energy
Power Track Energy Management Software

Eltek
Multisite Monitor

Trina Solar Limited
Trinasmart

PV Tool Award

3D MICROMAC

microSCRIBE OSP

DEK SOLAR

Apollo

LayTec in-line GmbH
X Link

PV Process Award

Calyxo GmbH
CdTe deposition method

Despatch Industries
DriTech Dryer

SoLayTec

InPassion ALD

Balance of System

Chint Power Systems America
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Molex Inc.
SolarSpec™ Smart Junction Box

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3-phase inverter solution

Wagner & Co

TRIC F Box

Energy Usage Enabling Award

Phono Solar
Enercube

SOLARRESERVE

Molten salt power tower technology

Upsolar

Smart Modules

Steca Elektronik GmbH
Coolcept-x inverter

Turnkey Supplier Award

M+W GROUP

Gebr. Schmid GmbH
Spire Corporation

Industry Development Award

Meyer Burger
Atacama Slate

Envision Solar
Solar Tree® Array

SOLARRESERVE

Molten salt power tower technology

Module Innovation Award

Jinko Solar Co Ltd
Double 85 PID-free EAGLE Module

Talesun Solar
Fully Automated Manufacturing Facility

Trina Solar Limited
Trinasmart

Rural Electrification Award

Barefoot College
Bennu Solar

Phaesun GmbH
Solar water supply in Pakistan

Steca Elektronik GmbH
Steca Tarom 4545

Project Development Award

ISOFOTON
HCPV plant Sicily

Masdar
Shams 1, the World's Largest CSP Plant

Upsolar

Solar PV Empowers Earthquake-Damaged Italian Community

PV Materials Enabling Award

Merck KGaA
isishape SolarEtch®

At the end of 2010, silicon solar cells, which are made of polycrystalline silicon, had an efficiency of 16 %. The equivalent figure for those made of monocrystalline silicon was 18 %. Researchers at Merck began to look for ways in which they could increase the electricity-generating area of a solar cell without increasing the cell's size. For example, they considered moving structures that cast shadows on the front side of the cell—which faces the sun—to the cell's rear. And they soon found one such structure: the channel that electrically isolates the front and rear sides of the cell from one another.

Some background information: A solar cell fundamentally consists of a light-absorbing semiconductor wafer that converts sunlight into electricity. To enable the generated electricity to flow out of the wafer, the two sides of the device are covered with differently charged layers. One side is positively biased, the other is negatively biased. When a wafer leaves a coating facility, however, the two sides are still short circuited.

To enable the cell to work at all, the sides first have to be electrically isolated from each other. This isolation is achieved using a channel. Until now, such channels have been burnt into the wafer's surface using a powerful laser. The result is a non-conducting barrier between the layers on the wafer's front and rear sides. However, around 1.2 % of the usable area is eliminated in the process. Although this loss may appear minor at first glance, when you calculate potential savings on the basis of 100 megawatts of solar output, the financial gain is more than $500,000.

The difficulty is that the laser production technology used does not permit the channel to be simply transferred to the rear of the cell. Alternatives such as the wet-etching method also have their disadvantages in the form of more expensive processes and a strong negative impact of the environment. The researchers at Merck are therefore using a new etching paste from the isishape® range, whose products have already been successfully used to mass produce touch panels and high-efficiency solar cells.

The entire process consists of just three steps: printing, etching, and cleaning. In addition, it is carried out at a temperature of about 220 °C. As the temperature used is quite low compared to those used in other processes, this approach saves energy, conserves the cell's material, and does not require aggressive solvents, allowing open water circulation systems to clean the wafers. Merck's unique isishape SolarEtch® concept offers dispensable etching materials suitable for screen printing, allowing simple, efficient structuring in the production of solar cells. As well as increasing cell efficiency, the three-part structuring process also allows economical mass manufacture with standard equipment and environmentally friendly production.

Saint Gobain
SolarBond® InFrame

SolarBond® InFrame is an intelligent, innovative and instant solution for solar module manufacturing. An advanced framing concept for automated PV assembly lines, it is a revolutionary material developed by Saint-Gobain Solar. It combines the best attributes of liquid silicone sealants and frame tapes to create a pumpable material with the immediate adhesion advantage of tape solutions. This technology provides a fast; clean application for a durable seal that ensures a high-quality solar module, all while minimizing the costs associated with waste and production inefficiencies. SolarBond® InFrame helps manufacturer's meets growing demand for solar modules while minimizing waste and related costs.

SolarBond® InFrame is applied warm in a continuous motion, ensuring both accuracy and high bonding strength immediately after contact with the glass, backsheet and frame. This eliminates the setting time needed for silicone products to cure by offering the instant adhesion of frame tapes coupled with a highly automated application process, shortening production cycles, reducing product waste and minimizing the associated production costs.

Additionally, the precision application eliminates the cleaning labour and costs incurred by the runoff cause by silicone sealants. The foamed material fills the aluminium channel in the frame completely, even in the corners, eliminating the risk of water collecting in the frame as experienced with tape solutions.

What results is a strong, long-term, weather-resistant bond for a durable final product. Used with Saint-Gobain Solar's patented single-piece frame, it also reduces the number of corner keys required for framing the module, using just one instead of four as required for both, tapes and silicones, further reducing module costs.

Honeywell
PowerShield® Cool Black

PowerShield® Cool Black is a backsheet that helps reduce solar panel operating temperature by using an innovative and proprietary technology that reflects solar radiation. When panels operate at lower temperatures, their electrical components are able to operate more effectively and generate more power.

Heat reduction is a key factor in improving solar panel efficiency, and black panels are especially susceptible to increased temperatures. Honeywell's innovative product, PowerShield® Cool Black, can help keep black panels cool while making them more efficient, durable and able to blend in with their surroundings."

Independent industry and university laboratory tests have shown that, during periods of peak power demand, solar panels using PowerShield® Cool Black are as much as 7 degrees Celsius (12.6

degrees Fahrenheit) cooler, which can increase their power output by 2 to 3 %. In turn, this increased power output can reduce a panel's cost-per-watt generated by 2 to 3 %.

PowerShield® Cool Black's efficiency benefits can help panel manufacturers achieve industry standards for power output at a lower cost. Panels using the backsheet can meet a building-integrated PV (BIPV) or building-applied PV (BAPV) module output rating with lower-cost cells, or reach a higher module output rating using existing cells.

PowerShield® Cool Black includes Honeywell's proprietary adhesive, which helps make panels more durable and able to withstand harsh environments. The backsheet has been shown to withstand more than 3,000 hours of exposure at an 85°C (185°F) temperature and 85 % relative humidity while maintaining its structural integrity.

PowerShield® Cool Black offers excellent resistance to environmental degradation from sunlight, heat, cold and humidity; strong resistance to acids, bases, solvents, salts and other chemicals; and resistance to excessive moisture infiltration within a module.

3M Solar Energy
Anti-Soiling Liquid

3M introduced a coating for photovoltaic (PV) modules and concentrated solar power (CSP) mirrors Anti-Soiling Liquid is an easy-to-apply coating designed for aftermarket use that helps solar modules stay cleaner, longer. The product significantly reduces dry dust accumulation that often occurs on sun-facing surfaces. This helps increase light transmission to the photovoltaic cells and improve overall power output. Data has shown that modules coated with the 3M Anti-Soiling Liquid generate five to ten % more energy than uncoated modules.

Designed for use during regular cleaning and maintenance operations, the liquid is easily applied with hand tools, is water-based, and is safe for both the environment and for workers with recommended application techniques.

Thin Film Innovation Award

3D-Micromac
microSCRIBE OSP

3D-Micromac has developed a new machine for structuring of thin-film modules. Its One Stop Patterning tool microSCRIBE OSP is deploying a combined laser and inkjet application, which facilitates integration of three classical structuring steps on one single platform.

Classical single Laser scribing after every thin-film deposition is not necessary any more with this tool, which now completely series-interconnects a thin-film module after full deposition of all functional layers.

Classical thin-film structuring requires three scribing steps between the vacuum depositions of the individual functional layers. This results in large dead zones, extensive cleaning procedures, reduced layer and interface quality, longer throughput times and yield losses. The dead zones defined by the full width of the three typical structuring lines, considerably decreases module efficiency. Due to inaccuracies between different scribing tables, tolerances have to be implemented, which further enhance the dead zones and directly lead to efficiency losses.

Furthermore due to the scribing steps, considerable efforts have to be incurred for bringing substrates in and out of vacuum after each thin-film deposition.

The microSCRIBE OSP from 3D-Micromac integrates all three classical scribing steps on one tool and in one process. This is accomplished by employing a combination of ink-jet and laser scribing steps after the deposition of the full layer stacks. 3D-Micromac leverages hereby its wide expertise on such combined tools from other application fields.
Thereby dead zones can be reduced drastically down to 100 μm from todays´ typical 200 – 400 μm. This increases efficiencies by up to 0.8% absolute.
It's the first production equipment worldwide that can conduct the integrated series-connection of a thin- film solar module on one single platform and in one single production step.

The NSG Group
TCO thin-film coatings

Thin-film module manufacturers need to maximize module efficiency while maintaining performance guarantees that meet an expected 25-year lifetime and above. However, cost reduction requirements mean more economical coating solutions in high-volume applications are desired.

The NSG Group is a supplier of transparent conductive oxide (TCO) coated glass for thin-film photovoltaic applications. Its 'TEC' product range is a group of products, including a comprehensive range of TCO coated glass, optimized to suit a variety of thin-film photovoltaic technologies.

With different haze and conductivity levels, the product range is designed to offer flexibility in TCO coatings to thin-film module producers' individual requirements. The TEC products offer a range of conductivity, morphology and haze requirements to help maximize module efficiency.

The durable online pyrolitic coating gives the products a virtually unlimited shelf-life, making them easy to transport, store, handle and process, therefore reducing costs and lead times.

The coated products are also resistant to high processing temperatures and can be fully tempered, toughened or heat strengthened without any damage

to the coating, and without any drop in performance. The multi-layer TCO coating stack offer robust sodium blocking properties, ensuring the module performance is unaffected by sodium migration from the glass superstrate.

First Solar
CdTe PV modules

First Solar has set another world record for cadmium-telluride (CdTe) photovoltaic (PV) module conversion efficiency, achieving a record 16.1 % total area module efficiency in tests confirmed by the U.S. Department of Energy's National Renewable Energy Laboratory (NREL). The new record is a substantial increase over the prior record of 14.4 % efficiency, which the Company set in January 2012.

Separately, First Solar also set a record for CdTe open circuit voltage (VOC), a critical parameter for PV performance, reaching 903.2 millivolts (mV) in NREL-certified testing. This new record marks the first substantial increase in CdTe VOC in over a decade of international R&D. The new records come just six weeks after First Solar announced a new world record for CdTe solar cell efficiency of 18.7 %.

Silicon Innovation Award

bSolar
Bifacial PV System

bSolar is a producer of bifacial photovoltaic (PV) crystalline silicon solar cells that provide 25% and beyond more electricity per cell at a standard cell production cost, lowering the LCOE, doubling the PV project IRR and cutting its payback time. bSolar's bifacial cell delivers industry leading equivalent cell efficiency with over 21% and a target of over 24% in the near future.

bSolar's cell is an excellent solution for flat rooftop and ground installations, as well as for PV trackers, sound barriers, car ports, facades and some forms of BIPV.

bSolar manufactures its bifacial high-performance, high-quality, mono c-si cells in its 30 MWp/year plant in Heilbronn, Germany and is on track with a four-year target of reaching a bifacial cell production capacity of 500 MWp/year worldwide.
Standard photovoltaic cells only harvest energy from a single surface – the side facing the sun. Israeli startup bSolar has found a way to improve upon this unidirectional design with a double-sided solar cell that is able to produce up to 50% more energy. The trick to bSolar's bifacial design lies in the cells' boron "back surface field", which is used instead of opaque aluminum backing – this enables the potent monocrystalline silicon photovoltaic cells to capture light reflected by rooftops, clouds, the earth, and the atmosphere.

While dual-sided solar cells have been developed in the past, bSolar claims that their bifacial solar cells are more powerful, more efficient, and cheaper to produce. The company engineered monocrystalline silicon wafers to collect light from both sides of the solar cell and encased them with a boron "back surface field", which increases the cells' efficiency and durability. bSolar says that their design boosts electricity generation by 10-30% on flat surfaces, and by 30-50% on vertical installations such as fences and highway sound barriers.

GT Advanced Technologies
DSS™ MonoCast™ Crystal Growth System

GT Advanced Technologies Inc., announced the commercial availability of its DSS™450 MonoCast™ crystal growth system in Jan 2012. Modules produced from material grown in GT's DSS™450 MonoCast™ furnace rival modules that incorporate traditional boron-doped batch CZ monocrystalline wafers in terms of total output.

The DSS450 MonoCast furnace incorporates a number of features that result in ≥80 % mono volume yield per slabbed ingot and significantly increases Grade I wafers (>90% mono area/wafer) per ingot than other cast mono technologies. Advancements in ingot casting technologies are opening up new market opportunities for traditional multi-crystalline wafer manufacturers to deliver next generation wafers that enable higher cell efficiency conversions.

Modules produced from GT's MonoCast material rival modules that incorporate traditional boron-doped batch CZ processed monocrystalline wafers in terms of total output. Cells produced from DSS450 MonoCast wafers have lower Light Induced Degradation (LID) and the full square surface dimension area across the wafer provides greater electricity generating surface area than the pseudo square shape of traditional monocrystalline wafers. The result is module efficiencies that are competitive with modules incorporating batch monocrystalline wafers.

The DSS450 MonoCast features new advanced hardware and an industry first automatic seed retention feature that eliminates dipping and operator intervention between melt and growth helping to automate the process and enabling the production worthiness of the DSS450 MonoCast system. When combined with GT's new Acuity™ performance software, the DSS450 MonoCast can produce high quality ingots run after run.

MEI LLC
FlashDry Polysilcion and Material Drying

MEI's FlashDry is a unique rapid drying process that is capable of drying all form factors of semiconductor solar and metal grade polysilicon in minutes with significantly less energy use less material damage and complete drying.

Flash Dry solves a vexing problem for materials processing how to completely dry polysilicon without wasting energy time and creating additional contaminants. Extremely fine form factors

of poysilicon such as slurries muds sands and fines have been considered nearly impossible to dry on a production basis. Lab methods such as heated trays ovens and vacuum chambers where time-to-dry is irrelevant can't compete on a production basis. FlashDry is more than ten times faster than these archaic methods when used on polysilicon muds sands and fines. It can even dry polysilicon slabs placed face-to-face where the surface to be dried is completely occluded.

FlashDry is a product based on a unique process model. This model allows the FlashDry process to remove the optimum amount of water through a mechanical coalescence process followed by a vacuum evaporation process. By using MEI's unique process model FlashDry is able to completely remove all of the water present in a variety of form factors of polysilicon from chunks and slabs to muds and fines in the shortest possible time.

In any evaporative drying process typically 85% of the energy input is used to overcome the latent heat of evaporation of water. Since FlashDry is a non-evaporative process it uses only 10-20% of the energy used by evaporative processes and is ten times faster. Since FlashDry can dry polysilicon fines and slurries not dryable by other production-scale means it allows for the wet chemical processing cleaning and purification of these same fines and slurries. At least two major polysilicon manufacturers had given up after spending years trying to develop such a unique process capability without success MEI is the first to achieve this breakthrough in technology.

System Integration Award

Also Energy
Power Track™

PowerTrack is a software solution providing energy management services to gather data from various sources. PowerTrack is designed from the ground up to handle a virtually unlimited number of sites, allowing you to organize your portfolio to match your business environment. It securely stores the data, and presents it in a way that allows for easy analysis and understanding.

With PowerTrack, you can react to underperforming zones with performance modelling based on actual weather, sun or wind conditions for one or multiple sites. In addition, the system generates alerts and integrates with back office functions and public facing displays.

With PowerTrack, you know how all parts of your energy portfolio are doing. With standard and customizable dashboards, you can view one or multiple sites, giving you the most complete look at your investment. It gives you the big picture on your investment and still has the ability to scrutinize the smallest details so you can maximize the return on your renewable energy investment.

Eltek Power (UK) Ltd
Multisite Monitor

The MultiSite software is a server based tool that gathers statistically data from connected sites and store it in a database. It also includes webpages for viewing the data from the database.

MultiSite Monitor (MSM) tracks the energy performance and status of all your sites. Access performance data that can be used to evaluate investments in hybrid DC power system and for marketing of site fleet's reduced carbon emission. Instant site status makes MultiSite Minotor the 1st line site maintenance tool; whenever there is a site in alarm, it is easily seen in the map, the list and top bar. One click in the site's details view will open the site's webpages in a new tab for further investigation of the alarm.

The MultiSite Monitor server polls all connected sites for data using JSON protocol over http port 80. This transmission is not encrypted and suitable inside customer backbone network. If sites are to be connected through the open internet, IPsec encryption is recommended. Monitoring clients and administrator only needs access to the MultiSite Monitor server webpages.

Service clients also need access directly to the sites to reach their internal webpages for configuration and details about alarms.

Several energy sources can be utilized for feeding the DC load and charging the batteries; AC from mains or generator, and renewable source as wind and solar. The hybrid site controller logs energy produced by the various sources. The energy logs, key parameters and status are sent to the MultiSite Monitor server.

Trina Solar Limited
Trinasmart

Trinasmart is a module-integrated solution that optimises the energy output of PV systems, enhances the safety of solar arrays, improves the installation speed of an array, and reduces BOS costs.

Trinasmart features Smart Curve, which enables the installation of up to 30 per cent longer strings than a traditional module. This reduces the number of balance of systems components required per array, while also making the installation faster and easier. Trinasmart accomplishes this by reducing the maximum output voltage to 32.2V (on the 60-cell DC05A Honey M module) compared to 38.4V without Smart Curve.

The maximum voltage with Smart Curve is constant regardless of the temperature. This technology solution is compliant with all international safety regulations. Overall, Smart Curve reduces the BOS costs by about five cents per Wp, while harvesting more energy due to reduced I2R loss because of the reduced number of strings. Smart Curve is TÜV and CSA certified.

The patented Trinasmart technology is a complete solution with power optimiser and monitoring, as well as Smart Curve

and safety all built into the module junction box. As opposed to other solutions, Trinasmart allows monitoring and control of the PV array at module level and will work with any inverter. Trinasmart with Smart Curve is fully covered by Trina Solar's 10-year product warranty and 25-year linear performance warranty. The enhanced Trinasmart technology comes built into the new high-efficiency DC05A Honey M module series, featuring black monocrystalline cells and a black frame for great aesthetics.

The 260Wp DC05A.25 comes with a black backsheet, making the module a perfect full black fit for dark roofs, while the white backsheet of the DC05A.28 results in a slightly higher power output of 265Wp. Trinasmart also improves the safety of the PV system: in cases of electrical failure (e.g. flashing arc), Trinasmart shuts down the affected modules automatically. Moreover, in the case of an external fire the modules can be totally deactivated, eliminating high voltages and improving the safety of firefighters during an emergency. Trinasmart increases building security and complies with current and future European regulations demanding low voltage shut-off capabilities.

With Trinasmart, all modules operate at their Maximum Power Point (MPP); the optimiser itself fixes mismatches automatically.

Accordingly, every module in a string performs at the maximum level, delivering optimal energy output. When using Trinasmart, designers can use parts of the roof that are prone to shading without causing the entire system to lose power.

Traditional modules would decrease the energy output in the string, but not Trinasmart – the solution automatically takes care of this.

All in all, system output in case of shading and differing module performance within one string is improved by up to 20 per cent system performance can also be monitored and controlled in real time thanks to the web-based Trinasmart platform with a smart mobile device or a PC.

PV Tool Award

3D-Micromac microSCRIE OSP

3D-Micromac has developed a new machine for structuring of thin-film modules. Its One Stop Patterning tool microSCRIBE OSP is deploying a combined laser and inkjet application, which facilitates integration of three classical structuring steps on one single platform. Classical single Laser scribing after every thin-film deposition is not necessary any more with this tool, which now completely series-interconnects a thin-film module after full deposition of all functional layers.

Classical thin-film structuring requires three scribing steps between the vacuum depositions of the individual functional layers. This results in large dead zones, extensive cleaning procedures, reduced layer and interface quality, longer throughput times and yield losses. The dead zones: defined by the full width of the three typical structuring lines, considerably decreases module efficiency. Due to inaccuracies between different scribing tables, tolerances have to be implemented, which further enhance the dead zones and directly lead to efficiency losses. Furthermore due to the scribing steps, considerable efforts have to be incurred for bringing substrates in and out of vacuum after each thin-film deposition.

The microSCRIBE OSP from 3D-Micromac integrates all three classical scribing steps on one tool and in one process. This is accomplished by employing a combination of ink-jet and laser scribing steps after the deposition of the full layer stacks. 3D-Micromac leverages hereby its wide expertise on such combined tools from other application fields. Thereby dead zones can be reduced drastically down to 100 μm from todays´ typical 200 – 400 μm. This increases efficiencies by up to 0.8% absolute. It is the first production equipment worldwide that can conduct the integrated series-connection of a thin- film solar module on one single platform and in one single production step.

DEK Solar Apollo

Apollo is an integrated cell manufacturing metallization platform designed to help manufacturers to meet the future challenges of the solar industry and improve production performance. Renowned for its precision and flexibility, the Apollo platform offers ±10 micron accuracy @ 2 Cpk capabilities. Its advanced automated features deliver repeatability, accuracy and high performance. The industry-leading platform offers a breakage rate of less than 0.15% and can process 1,450 wafers per hour.Apollo delivers these increased capacity features whilst maintaining a small factory footprint in a single line configuration. It is fully optimised for Print-on-Print and Selective Emitter processes. Featuring topside cameras for fiducial or pattern alignment, as well as incorporating handling systems, conveyoring, drying equipment and the ability to integrate directly with other photovoltaic production processes, Apollo is the foundation for DEK Solar's new generation of solar cell metallization solutions.

With the addition of Apollo, DEK Solar is able to offer a comprehensive portfolio of metallization platforms and support the complete spectrum of PV customers, from entry level start-ups right through to multi-national cell manufacturers. Apollo is designed to meet a range of challenges, including the demand for increased cell efficiency in the PV industry. Faced with future demands, DEK Solar developed the Apollo platform as a practical solution for customers looking to improve products and processes in high efficiency cell manufacturing. It overcomes challenges in throughput, alignment, wafer handling and breakage.

Modular and flexible in configuration, Apollo is future-proofed to meet PV Industry Roadmap requirements and it exceeds demands for increased cell efficiency. Its innovative wafer alignment system was designed specifically for the selective emitter, print on print and MWT process which delivers exceptional alignment accuracy and makes these next generation technologies practical. The state-of-the-art print engine design delivers the highest level of print quality by using a unique closed loop control system and precise paste delivery systems. Print results are monitored through an SPC software suite for optimal performance. Apollo offers higher throughput, improved wafer handling and lower breakage rates.

LayTec in-line GmbH
X Link

X Link is a metrology system for non-destructive evaluation of the EVA (ethylene vinyl acetate) cross-linking level immediately after lamination.

LayTec developed the in-line device for monitoring the degree of cross-linking in EVA laminates in cooperation with Fraunhofer USA. The method is based on the measurement of physical properties associated with the level of cross-linking. The tool can be integrated into every solar module production line and provides for long-term process stability, high yields, 100 % quality and low production costs. Benefits include: eliminated scrapping of laminates, easy integration in existing lines, 2D product quality control, and process control of lamination, multi-point measurement capability and sturdy design for industrial application.

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

The lamination process is the most critical production step of module manufacturing. Currently a major issue why modules fail in the field is due to bad EVA cross-linking caused by difficulties during the vacuum lamination process itself or unstable EVA foil materials. This system replaces the common and coarse gel content test. The LayTec X Link system ensures a perfect lamination process which is critical in high-quality modules as cross-linking quality and uniformity impact is essential in terms of quality over time.

It analyses the response of the laminated EVA back sheet combination. Placed directly after the laminator, the tool gives direct feedback to the lamination process for the adjustment of heating zones and exposure times. LayTec X Link improves lamination yield by real-time control and gives a detailed proof of the long-term stability of PV modules thereby increasing bankability.

PV Process Award

Calyxo GmbH
CdTe deposition method

The atmospheric deposition process developed and patented by Calyxo offers advantages compared to some other PV processes:–

The module glasses are inserted in the glass oven and heated up to process temperature. The CdTe coating itself takes place via a cadmium telluride gas stream that deposits itself on the surface of the module glass by changing from a gaseous state to a solid (desublimation). The coated module glass is cooled in a controlled manner and removed from the glass oven for further processing.

How is the gas stream created? Storage and provision of the coating materials (cadmium telluride powder) are separated from the deposition unit. A continuous supply of materials is ensured from outside of the deposition unit.

A carrier gas (shielding gas) of the highest purity is used for transporting the semiconductor materials. Heating and evaporation of the gas mixture with subsequent deposition onto module glass takes place in the deposition unit we developed and patented.

What are the advantages of the Calyxo coating process? Deposition rates of a few μm/min semiconductor thicknesses – orders of magnitude faster than other vacuum deposition processes. The conveyor belt never rests since coating takes place as a continuous process and the whole process takes place in atmospheric conditions.

SoLayTec
InPassion ALD

SoLayTec

At the Department of Applied Physics Eindhoven University of Technology Dr. Hoex (currently working at SERIS Singapore published his work in 2008 entitled: “On the c-Si surface passivation mechanism by the negative-charge-dielectric Al2O3”. In a nutshell he revealed that this is an excellent passivation material for p- and n-type c-Si from 5 to 10nm Al2O3. It creates a high negative charge density. However the key remark of his work in which he used temporal atomic layer deposition (ALD was that these tools were not really suitable for mass production due to the low growth rate. InPassion ALD from SoLayTec has the solution for Lab-to-Fab ALD for mass production. InPassion ALD uses spatial ALD for Al2O3 deposition.

This technology is based on the spatial separation of precursor gases instead of time-based separation (temporal ALD. For spatial ALD the different gases are confined in specific process areas as the wafers pass by. Every point on the wafer is sequentially in contact with the wafers deposition rate 1nm/sec. This creates the (real ALD effect and reaction.

In the SoLayTec machines the process takes place in the core deposition units where a wafer is moved upstream and

downstream through an injector head twice per second resulting in eight layers per second (deposition rate of 1nm/sec. The number of modules of a SoLayTec machine can be up to 10 units.

Currently there are several solutions in the market available. But the InPassion ALD has the answer to the following challenges: A Temporal ALD has a low growth rate 01nm/min B Spatial ALD solution like a tunnel concept are less flexible for layer thickness adjustments and in case of a broken wafer the MTTR is rather high C PECVD / APCVD system can't compete on several items with ALD like layer uniformity WtW the minimum layer thickness is 20nm thicker (high TMA usage and relatively high downtime for cleaning

The InPassion ALD can change the Al2O3 layer thickness very easily via the user interface. When adapting the layer into less nm's, the throughput will increase (maximum of 4500wph. In the case that one deposition unit (1 of 10 needs to be stopped for service or caused by an error the other nine deposition units will continue production whereas tools of competitors will be completely down.

The ALD process only needs about 5-10nm which saves the user significantly on TMA usage and the cleaning off such an InPassion system is one hour per week.

InPassion ALD can be scaled in throughput by adding deposition modules up to a number 6 or 10 delivering the maximum capacity. For your first pilot line this means you order the InPassion ALD platform including gas cabinet abatement and choose the right number of throughput with e.g. 4 modules you can reach a throughput of 1440 wph.

At a later stage you can add throughput by adding more modules. Modular deposition unit is field replaceable unit If one of the deposition units is not working properly and cannot be fixed by the customer or SoLayTec service team this module will be replaced by another one. In this way the tool will be running as fast as possible at 100% capacity again. At the same time this module will be sent to a SoLayTec service station to be refurbished.

Despatch Industries
DriTech Dryer

Despatch's innovative DriTech is a revolutionary new dryer for advanced drying of all metallization pastes. The new dryer utilizes hybrid heating technology which enables decoupling solvent and binder burnoff in the solar cell metallization process. The environmentally friendly tool includes Despatch's integral point-of-generation VOC Thermal Oxidizer, providing maintenance free VOC abatement. This critical component is fundamental to Despatch's back end of line thermal solution which ensures consistent drying efficiency in addition to low facility and tool contamination at each process step.

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

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

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

The DriTech's hybrid heating technology enables the tailoring of the thermal profile to the specific paste. Harmonized infrared heating and the innovative application of airflow create the conditions pastes need for efficient, repeatable drying and release of solvents where they can be captured and eliminated. Temperature, airflow and integrated point of generation abatement in the dryer all play critical roles in VOC evolution without overheating the paste, managing the volatile's without smoke, fumes and condensation, and efficient and repeatable drying at fast belt speeds.

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

Where competing drying technologies have proven deficient, the DriTech has demonstrated efficient and repeatable drying that is so critical to a stable furnace environment and consistent peak-firing temperatures.

The integrated VOC Oxidizer has set the standard for VOC abatement using point-of-generation incineration technologies that do not pollute the fab or the environment. Safe and efficient destruction of VOCs eliminates the need for handling and disposal of hazardous by-products. The concept of green products producing green products is fully realized in the DriTech, which offers a fab and environmentally friendly solution to drying technology.

Balance of System (BOS)

Molex Inc.
SolarSpec™ Smart Junction Box

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

The modular concept allows maximum flexibility and easy upgrade of PV-panel functionality, since the electronic PCB always resides in the removable Junction Box cover, this smarter system not only

facilitates lean solar manufacturing processes on a manual or automated assembly line, but also ensures easy access to key components should repair or replacement is ever required.

The Smart Junction Box is based on the original two-part SolarSpec™ Junction Box from Molex featuring a base attached directly to the solar PV panel and a removable cover assembly.

Functionalities include system safety, shut-off and arc detection, security monitoring and theft protection, performance tracking on output levels and panel efficiencies, remote diagnostics and power optimization.

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

SolarEdge Technologies
3-phase inverter solution

SolarEdge 3-phase inverters offer multiple benefits:

With 98.0% weighted CEC efficiency, the inverters represent the highest efficient of any inverter in the 3-phase category. Combined with the innovative Power Optimizers from SolarEdge, they can enable a 1000 Vdc system to be built with 600 Vdc modules.

The SolarEdge system can be divided into two areas: a 600Vdc area where modules and wiring from the modules to the power optimizers see only lower voltage, and a 1000Vdc area that includes the power optimizers, the wiring and other components between the power optimizers and the inverter, and the inverter. This makes system component selection much simpler as 600 V rated modules, not only 1000 V rated modules, can be used in the system.

By controlling the Power Optimizers to maintain a fixed voltage input, and by enabling 1000 Vdc capability, the SolarEdge inverter enables increased string sizing.

Where a traditional inverter is limited by module voltage, the SolarEdge solution controls the voltage removing it as a limitation.

The string length for SolarEdge is based on power and not voltage, meaning string lengths that are 2-3 times longer than with traditional inverters. They are the lightest inverters in their class weighing in at less than 80 lbs – almost the same weight as a 72-cell cSi module. They are approximately 1/3 the volume as well, opening up many options for placement of the inverter.

Wagner Solar
TRIC F Box

Wagner & Co
SOLAR TECHNOLOGY

Most systems will be fixed onto the roof as this ensures the highest degree of certainty. Not all roof types have a suitable surface type to be punctured for traditional roof mounting.

As a result, manufacturers have developed ‘ballasted’ solutions where the system is weighed down onto a roof with bricks/gravel, to stop them from moving when faced with extreme wind/snow. This will add weight which causes problems since not all buildings can take the structural load burdened by a PV system fixed with bricks to weigh it down.

We have developed the TRIC F box as a low ‘ballast’ fixing solution to increase the number of possibilities for commercial system integration. Wagner’s innovation has been achieved through a total innovation of the panel arrangement together with a lower inclination which together allows our system to be fixed down with less ballast (weight) as low as 12kg/m2. The panels are arranged in a portrait (vertical) arrangement as opposed to landscape (horizontal). This means that the panels can sit at a lower inclination – 10 degrees, which makes the system less sensitive to wind/snow loading, and thus allows it to be placed with a lower amount of ballast.

The most important benefit arises from the fact that our system has a lower inclination for the panels. By having an inclination of just 10degrees, the impact of shade is much lower, which means that the inter-row spacing is significantly lower than with other systems, meaning that the installer can now design systems which a higher amount of panel array. This helps the property owner by maximising their roof space to generate more energy.

Even more noteworthy, the system can be placed back-to-back in an East-West arrangement which reduces the shading impact to almost zero and allows in some cases, up to 95% of the usable roof space to be covered in PV.

The system is designed with only 3 components, meaning that installers can easily fix the system together using pre-assembled components to improve the reliability of the installation and save large amounts of time during the installation process.

Chint Power Systems America
Commercial String Inverters

The medium power series of grid-tied, transformerless inverters help to accelerate the use of 1000Vdc and three phase string architecture for commercial and small ground mount utility applications. A UL approved, cost effective alternative to central inverters enabling BoS cost savings, high harvest performance and modular design building blocks.

These models provide up to 98.2% conversion efficiency and wide operating window of 400-900Vdc and dual MPPT’s for maximum cash-flow generation.

Energy Usage Enabling Award

Phono Solar
Enercube

Enercube is an energy management unit that is suitable for both new and existing PV systems. It combines the inverter batteries and the PV system into one compact system. Enercube helps PV system owners to use PV electricity not only during sunlight hours but also at times of less light. Electricity produced by the PV system can be consumed directly stored in the batteries or fed into the public grid. Enercube ensures self-consumption is prioritised Enercube presents you not only with an essential product but with an energy management solution. You will notice nothing different except the reduction in your electricity bills.

In 3-phase grid such as Germany if there is more energy demand on 1 phase the existing similar product will enhance the output power for all 3 phases which is not economical. Thanks to Phono Solar DPT technology when faced with the same situation Enercube will only enhance the output power for the phase in extra energy demand and keep the other 2 phases' output power static which is not only more economical but also it prolongs battery lifetime.

SolarReserve
Molten salt power tower technology

SOLARRESERVE

SolarReserve's concentrated solar thermal power (CSP) plants utilize the world's leading solar thermal technology which features integrated energy storage which solves the problem of intermittent energy generation meaning that they can only provide electricity when the sun is shining.

With inherent energy storage, SolarReserve's CSP plants operate just like a conventional power generator such as coal and natural gas plants but without the harmful emissions associated with burning fossil fuels and without cost of fuel.

SolarReserve's solar power tower technology generates power from sunlight by focusing the sun's thermal energy utilizing thousands of sun-tracking mirrors (called heliostats onto a central receiver. Liquid molten salt is used to both capture the sun's thermal energy and then store the energy until electricity is needed.

The molten salt is pumped from the "cold" tank at 500 degrees Fahrenheit up to the top of the tower where it is circulated through the receiver to collect the sun's thermal energy.

The "hot" salt at 1050 degrees Fahrenheit is then pumped back down the tower to be stored in the insulated "hot" storage tank where it is stored until electricity is needed. When power is needed the hot salt is sent to a heat exchanger to produce steam which in turn drives a conventional steam turbine electrical generator to generate electricity. The cooled molten salt is then pumped back to the "cold" tank where it is stored ready to be reheated by the sun and used again as part of a continuous closed loop. The system is completely zero-emissions and requires no fossil fuels at all.

A robust and diverse energy portfolio is critical to solving global energy security economic and environmental challenges. And solar is a strong part of the energy mix that will reduce reliance on finite dirty fossil fuel sources for power generation. However electricity from traditional solar technologies is intermittent and unreliable which puts a strain on the grid and requires back up conventional generators using fossil fuel to firm up the electricity generation. S

olarReserve has solved this problem. With its use of integrated energy storage SolarReserve's plants provide firm reliable zero-emissions electricity on-demand day or night whether or not the sun is shining. SolarReserve is deploying breakthrough technology to efficiently and cost effectively store energy from the sun so electricity can be dispatchable to meet demand whenever needed. SolarReserve's technology captures and stores the sun's thermal energy and operates on demand just like conventional coal natural gas or nuclear power plants but without the release of harmful emissions or hazardous wastes associated with conventional power plant technology. SolarReserve was formed to solve two of the fundamental barriers of renewable energy: scalability and storage.

Upsolar
Smart Modules

Upsolar

Upsolar's smart modules feature on-board power optimization from industry-leading technology providers. Traditional PV systems are configured in series circuits to either a central or string inverter meaning a system will instinctively lower its output to that of the worst performing module – impacted by issues like partial shading and varying tilts or orientations.

Smart modules in contrast ensure that customers achieve ideal power output levels by using maximum power point tracking (MPPT to increase output at the module level and mitigate module mismatch. By integrating quality PV modules and power optimization technologies Upsolar's smart modules offer a host of benefits to system owners and installers:

- Better system performance: up to 99.5 % conversion efficiency to help customers get the most out of their PV systems at all times.
- Greater design flexibility: Smart modules enable customers to install solar PV systems in otherwise undesirable locations from partially shaded rooftops to uneven natural terrains and to install multiple facets and different types of modules on the same string.
- Slashed installation times: By providing an option for a "plug-and-play" solution Upsolar allows system integrators to reduce the resources required to get systems up and running.

- Real-time system monitoring: customers can track the performance of their PV systems at the module level to quickly and accurately identify and correct performance issues minimizing maintenance costs by enhancing understanding of the cause of the problem from the outset.

Upsolar's smart module systems are equipped with remote shutdown capabilities ensuring greater installer safety and protecting first-responders in the event of a fire Combined the many attributes of Upsolar's smart modules create a more attractive return on investment for global customers.

In addition to design and performance benefits Upsolar's smart modules are helping make solar ownership a more transparent reliable experience. With real-time performance monitoring apps that allow owners and installers to check in on their systems anytime anywhere smart modules make solar ownership more transparent enabling owners and installers to identify and correct issues immediately.

Not only can owners save money by monitoring and maintaining systems more easily they can also share their system's progress with their social network helping demonstrate the benefits of solar to others.

Steca Elektronik GmbH
Coolcept-x inverter

The award winning coolcept series has a new addition, the coolcept-x outdoor version. Based on the same connection principle the inverters achieve the best efficiency on the market with a peak efficiency of 98.6%. High efficiency means lower energy losses resulting in lower temperatures of the electronic components.

This is a prerequisite for the longevity of the coolcept- and coolcept-x inverters and also for maximum yields in the PV system as a whole. The low temperature inside the grid inverter greatly reduces the cooling costs. The ageing process of the components is also significantly slowed down. This extends the total service life of the device and also reduces the risk of system malfunctions. The especially light construction makes the installation of the devices more cost-effective and their transport significantly more environmentally-friendly.

The use of proven standard components and the absence of expensive cooling systems allow the grid inverter to be offered on the market at greatly lower price than competing products. Cost-efficient production of the series devices was already taken into consideration when developing the device.

A new feature is the robust designer casing made of stainless steel with IP 65 protection against dirt and water. The coolcept-x devices will already be equipped with the improved Internet-ready communication module from this summer onwards. This module offers a complete data logger produced as a standard component with a free web portal. The portal is entered via a plug & play installation.

Turnkey Supplier Award

M+W Group

M W Group covers the complete added value chain for Photovoltaic Manufacturing facilities on a global basis with consulting design construction and project management services from Poly Silicon plants to ingot/wafer cell and module manufacturing as well as thin film module manufacturing factories. The scope offering also includes turnkey design/build responsibility from smaller pilot lines through to large-scale PV plants. Having already designed and constructed a manufacturing capacity exceeding 11GWp M W Group is the global market leader in this sector.

With a staff exceeding 7700 people spread throughout five continents M W Group is able to keep pace with their clients' growth strategies and to offer localized expertise around the world. M W Group has had the honour of providing continuous design/build services and accompanying a number of their PV customers on their path from a start-up company to one of the top ten PV players. The high % of repeat customers emphasizes clients' satisfaction with M W Group's performance and commitment. The former trend for scaling up to GW scale manufacturing in the years 2006 to 2010 has changed.

It turned out that cost savings due to scaling effects decrease or are even neutralised at annual manufacturing capacities of or above approximately 600MWp. currently we have observed that market conditions for PV manufacturing facilities have changed with respect to local content regulations in certain countries.

M W Group has addressed these requirements by defining modular and scalable design concepts that can be adapted to the required manufacturing capacities and copied to new locations. Especially for downstream products such as cells and modules demand for smaller (up to 600MWp capacity manufacturing facilities has increased that are located in the proximity of the end market.

The current challenges for the PV manufacturing industry are: - Cost pressure - The main user markets are shifting from Europe to Asia and the Americas - Requirement for increased local content Due to the overcapacity in the PV industry only few new manufacturing sites have been erected within the last 2 years.

As a result new technologies could not be fully implemented into mass manufacturing and the further potential for cost reduction is somehow limited in existing facilities. In order to introduce such new technologies to drive down costs into new markets new facilities with advanced design concepts that satisfy local needs codes and regulations will be required. M W Group is working close together with leading edge equipment and technology suppliers to enable advanced cost-effective solutions for

the PV industry. With this integrated project approach M W Group can tackle challenges such as: -Value engineering and benchmarking using the lessons learnt from previous projects -Modular and expandable building concepts -Manufacturing capacities scalable between 100MWp 200MWp 300MWp 400MWp and 600MWp. -Advanced energy supply concepts -Mass and energy flow modelling to reduce overall life cycle costing With its long-term experience M W Group provides best-in-class solutions with optimum flexibility to future expansions minimum operating costs and fast time-to-market.

Gebr. Schmid GmbH

The SCHMID Group considers itself well prepared for today's requirements of the solar cell manufacturers in the PV market maintaining PV producers are willing to invest, but only in highly efficient technology.

SCHMID Group believes that investing in new equipment, enabling the production of high-performance solar cells with an efficiency of more than 20% is critical. For turnkey solutions they guarantee 18% efficiency in the production of multi-crystalline cells, and 20% for mono-crystalline cells. With regard to the PERC production process SCHMID is the only equipment manufacturer to offer a complete process from a single source, the company says.

SCHMID's PERC portfolio ranges from rear side cleaning and APCVD coating up to laser opening of the coated rear side. All systems can be easily integrated into already existing production lines and offer the lowest cost in the market. According to the calculations of the SCHMID Group application of the required passivation layers and covering layers with the APCVD is about 40-50% cheaper than with alternative ALD or PECVD processes.

PERC cells consist of crystalline silicon. For rear side passivation a layer of aluminum oxide is deposited on the base material by means of APCVD. The backside coating is completed by two covering layers, also produced by the APCVD. Depending on the wafer material the PERC cells reach average efficiency values of 20%-20.5% on Cz and 18%-18.5% on mc-Si, when applying the SCHMID process.

SCHMID's APCVD coating system is the core equipment for PERC and has proved to be outstandingly reliable. Nearly one hundred APCVDs are successfully in industry use since many years for various applications. With this coating system SCHMID has already reached several PERC efficiency records.

PERC cells are PV cells out of crystalline silicon with a selectively optimized emitter layer and a rear side passivation.

Spire Corporation

Spire Corporation is a USA based, global solar company providing turnkey solar module, cell and thin film factories and solutions as well as individual capital manufacturing equipment to feed the rapid expansion in the market worldwide.

For over 35 years, Spire's turnkey factory solutions have been comprehensive and allowed new and experienced customers to rapidly enter and ramp to full production without concern for start up or ramp difficulties. Applying its expertise in materials technologies across all product lines, Spire has a rich heritage of utilizing science and research to develop leading edge products that generate renewable energy and deliver advanced solutions to businesses around the world.

Spire offers a comprehensive package. The Turnkey Approach includes state-of-the art equipment and key technical advice that ensures the workforce is expertly trained and the final products pass the rigorous certification process. In addition, Spire provides finished designs – including facility planning and layout, factory automation, and module design services – and complete material and vendor lists. Spire also passes on the critical embedded process knowledge that allows you to produce products of the highest quality and sell into the most lucrative markets.

Spire's experience is based in years of active research and includes expertise in module production solutions for crystalline and thin film modules, solar cell production, and production of concentrator cells at our own Gallium Arsenide foundry.

Industry Development Award

Meyer Burger
Atacama Slate

The innovative concept presented by Meyer Burger, the solar module "Atacama Slate", meets the need of cost-effective solutions for producing electricity in regions with high solar irradiance, sand storms and high temperatures (i.e. deserts). The Atacama Slate is based on a combination of high efficiency technologies and innovative module design adapted to the specific requirements of desert regions.

The Atacama Slate consists of a bi-facial, frameless, glass/glass module design combining the high efficiency heterojunction and SmartWire connection technology. The combination of all factors leads to an optimum energy yield while lowering the total cost of ownership.

The challenge in desert regions is to achieve an optimal energy yield given the delicate climatic conditions. High solar irradiance, high environmental temperatures, sand storms as well as a different light spectrum need to be considered in the design and technology of solar modules. The

Atacama Slate module is the solution for reaching maximum energy yield by combining high efficiency technologies with a dedicated module design adapted to desert regions.

Heterojunction cells have a low temperature coefficient of approx. 0.20% and are designed for high irradiance

conditions. The SmartWire Connection Technology is a cost efficient method based on cell connection by wires instead of bus bars which are capable of reaching up to 5% higher power output compared to best-in-class bus bar technology. In addition, the Atacama Slate offers the possibility of bifacial use thanks to its vertical installation. Sand and dust retention is countered by a frameless design, while the glass/glass construction enables the long module endurance.

The Atacama Slate combines existing high efficiency technologies with a dedicated module design which takes the climatic conditions into consideration and thus delivers a product specifically adapted to these regions but also a cost-effective solution for producing electricity.

Envision Solar
Solar Tree® Array

Envision Solar's SolarTree® structure is the highest quality fastest deployed and most attractive turnkey photovoltaic parking shade system in the industry. The SolarTree® shades six to eight standard parking spaces while simultaneously producing enough clean renewable energy to fully charge six electric vehicles each day enabling them to become truly emissions free.

The integrated EnvisionTrak™ technology a hybrid multi-axis design allows the entire PV canopy to track the sun whilst consistently remain on a 15° tilt to achieve optimal energy output yet not restrict the traffic flow in drive aisles of parking lots or parking spaces. In addition to it's highly functional purpose EnvisionTrak™ adds to the aesthetic appeal of commercial real estate by changing it's appearance from dawn to dusk as the PV panels reposition themselves every nine minutes a parking lot will never look the same to a customer when they enter as to when they leave.

Envision Solar's Solar Tree® arrays are the ideal combination of form function and sustainability providing the perfect solution to creating sustainable distinguished real estate.

The Solar Tree® structure exclusively addresses the failing of fixed PV panel usage which achieves optimal energy production during peak hours only whereas the Solar Tree® array tracks the sun across the sky throughout the day. Parking lots are under-utilized wasted real estate for property owners but the Solar Tree® array adds value in multiple forms. Light pollution lack of lighting and electricity used to run lighting are all a hindrance for businesses but the Solar Tree® array offers a unique solution.

Electric vehicles are a great alternative form of transportation but charging from the grid means more burning of fossil fuels. However with Envision's CleanCharge™ technology EV drivers have the option of a renewable solution. The Solar Tree® array solves the problem of low energy output with our revolutionary patented EnvisionTrak™ technology. Parking lots are made beautiful by advertising the use of solar power and the product design enables it to enhance any property.

Environmental challenges are addressed through the production of clean renewable energy reducing use of electricity generated by the burning of fossil fuels. With the integration of electric vehicle charging stations the Solar Tree® array enables vehicles to become truly emissions free. It's Drag & Drop™ capabilities offer fast installation and keeps disruption to a minimum.

SolarReserve
Molten salt power tower technology

SOLARRESERVE

SolarReserve's concentrated solar thermal power (CSP) plants utilize the world's leading solar thermal technology which features integrated energy storage which solves the problem of intermittent energy generation meaning that they can only provide electricity when the sun is shining.

With inherent energy storage, SolarReserve's CSP plants operate just like a conventional power generator such as coal and natural gas plants but without the harmful emissions associated with burning fossil fuels and without cost of fuel. SolarReserve's solar power tower technology generates power from sunlight by focusing the sun's thermal energy utilizing thousands of sun-tracking mirrors (called heliostats onto a central receiver. Liquid molten salt is used to both capture the sun's thermal energy and then store the energy until electricity is needed.

The molten salt is pumped from the "cold" tank at 500 degrees Fahrenheit up to the top of the tower where it is circulated through the receiver to collect the sun's thermal energy. The "hot" salt at 1050 degrees Fahrenheit is then pumped back down the tower to be stored in the insulated "hot" storage tank where it is stored until electricity is needed.

When power is needed the hot salt is sent to a heat exchanger to produce steam which in turn drives a conventional steam turbine electrical generator to generate electricity. The cooled molten salt is then pumped back to the "cold" tank where it is stored ready to be reheated by the sun and used again as part of a continuous closed loop. The system is completely zero-emissions and requires no fossil fuels at all.

A robust and diverse energy portfolio is critical to solving global energy security economic and environmental challenges. And solar is a strong part of the energy mix that will reduce reliance on finite dirty fossil fuel sources for power generation. However electricity from traditional solar technologies is intermittent and unreliable which puts a strain on the grid and requires back up conventional generators using fossil fuel to firm up the electricity generation. However SolarReserve has solved this problem. With its use of integrated energy storage SolarReserve's plants provide firm reliable zero-emissions electricity on-demand day or night whether or not the sun is shining.

SolarReserve is deploying breakthrough technology to cost effectively store energy. SolarReserve's technology captures and stores the sun's thermal energy and operates on demand just like

conventional coal natural gas or nuclear power plants but without the release of harmful emissions or hazardous wastes associated with conventional power plant technology. SolarReserve was formed to solve two of the fundamental barriers of renewable energy: scalability and storage.

Module Manufacturing Innovation Award

Jinko Solar Co Ltd
Double 85 PID-free EAGLE Module

The EAGLE solar module -- is the world's first potential induced degradation (PID) free polycrystalline module to be certified by TÜV under weather conditions of 85 Degrees Celsius 85% relative humidity with peak power output of up to 265 Watts (panel with 60 cells. A PV power plant strongly affected by PID may lose 70% or more of its power output thus turning into a disastrous investment.

Under long-term impact of high negative voltage for P type cell or positive voltage for N type cell leakage current through the front glass and encapsulation material lead to accumulation of motion ions at the cell surface. The surface passivation provided by the front surface field of the cell degrades.

The fill factor, short-circuit current density and open-circuit voltage are significantly reduced resulting in the decline of module electrical performance a phenomenon known as Potential Induced Degradation (PID. Once a module is PID affected the output power will decrease to approximately 20-70% of its original power. Thus the entire solar system will suffer from a tremendous power loss. It is reported that some PV installations have lost more than half of their power output over time in extreme cases some installations even measured power losses of up to 80% due to PID.

Many credit institutions have already adopted PID-free as a key bankability criterion which developers have to comply with when applying for project financing.
The high-power EAGLE module contains many innovative characters including wafers with low dislocation and small uniform grains cells with selective emitters and double printed contact as well as newly-designed modules with improved temperature co-efficiency and weak light effects. The improvements in wafer- and cell-processing and module encapsulation all contribute to the anti-PID effect which will guarantee higher power output especially under extreme environmental conditions.

JinkoSolar are the first company in the world to attain PID-free certification under 85% humidity and 85 degree conditions by TÜV (August 2012.) In January 2013 they unveiled the worlds first PID-free mass-produced 'EAGLE' modules which are PID-free under weather conditions of 85 Degrees Celsius 85% relative humidity.

Talesun Solar
Fully Automated Manufacturing Facility

Talesun Solar operates the world's largest fully automated solar manufacturing facility (2260000 square feet. Talesun produces high-quality crystalline photovoltaic (PV modules with industry-leading precision and consistency by streamlining processes that traditionally fell to skilled factory workers in automating nearly every aspect of production. As the largest fully automated solar manufacturing facility it demonstrates one model for successful long-term solar manufacturing focused on manufacturing excellence.

The solar industry is shifting from simply selling the lowest-priced product to selling a product built with attention to quality control and production processes that will result in long-term performance reliability and durability.

Due to our automation Talesun Solar introduces meticulous precision and a systematic production process that consistently delivers a high-quality product to its customers. Human error is dramatically reduced and as a result our process achieves the balance between delivering high-quality long-term performance modules and competitive market pricing.

Talesun's manufacturing produces such consistent quality that our modules are validated by the industry's highest standards set by International Electrotechnical Committee (IEC and the most rigorous certifications tests by Underwriters Laboratories (for example Salt Mist Severity Levels 1 and 6.

Global certifications like the VDE Quality Test that Talesun modules received in May 2012 reiterate the validation from IEC and Underwriters. Only a few solar manufacturers worldwide have earned this level of excellence. Developed by the VDE Institute in partnership with Fraunhofer-ISE the VDE is one of the most stringent certifications available because it requires a larger sample and longer testing period's time to assess durability.

Talesun's manufacturing is also validated by recognized leading third parties in the industry. BEW Engineering a worldwide leader in evaluating solar engineering standards visited Talesun's manufacturing facility and reported that "quality was evident throughout" because our module workshop employed the industry's best practices.

By taking the fully automated approach Talesun operates at the nexus of higher quality and competitive pricing backed by the industry's highest third-party certifications and validators. Our process dramatically reduces human error and harnesses the ability of robotics to cost-efficiently and precisely construct every panel for consistent and reliable quality.

Trina Solar Limited
Trinasmart

Trinasmart is a module-integrated solution that optimises the energy output of PV systems, enhances the safety of solar arrays, improves the installation speed of an array, and reduces BOS costs.

Trinasmart features Smart Curve, which enables the installation of up to 30 per cent longer strings than a traditional module. This reduces the number of balance of systems components required per array, while also making the installation faster and easier. Trinasmart accomplishes this by reducing the maximum output voltage to 32.2V (on the 60-cell DC05A Honey M module) compared to 38.4V without Smart Curve.

The maximum voltage with Smart Curve is constant regardless of the temperature. This technology solution is compliant with all international safety regulations. Overall, Smart Curve reduces the BOS costs by about five cents per Wp, while harvesting more energy due to reduced I2R loss because of the reduced number of strings. Smart Curve is TÜV and CSA certified.

The patented Trinasmart technology is a complete solution with power optimiser and monitoring, as well as Smart Curve and safety all built into the module junction box. As opposed to other solutions, Trinasmart allows monitoring and control of the PV array at module level and will work with any inverter.

Trinasmart with Smart Curve is fully covered by Trina Solar's 10-year product warranty and 25-year linear performance warranty. The enhanced Trinasmart technology comes built into the new high-efficiency DC05A Honey M module series, featuring black monocrystalline cells and a black frame for great aesthetics. The 260Wp DC05A.25 comes with a black backsheet, making the module a perfect full black fit for dark roofs, while the white backsheet of the DC05A.28 results in a slightly higher power output of 265Wp. Trinasmart also improves the safety of the PV system: in cases of electrical failure (e.g. flashing arc), Trinasmart shuts down the affected modules automatically. Moreover, in the case of an external fire the modules can be totally deactivated, eliminating high voltages and improving the safety of firefighters during an emergency.

Trinasmart increases building security and complies with current and future European regulations demanding low voltage shut-off capabilities.
With Trinasmart, all modules operate at their Maximum Power Point (MPP); the optimiser itself fixes mismatches automatically. Accordingly, every module in a string performs at the maximum level, delivering optimal energy output.

When using Trinasmart, designers can use parts of the roof that are prone to shading without causing the entire system to lose power. Traditional modules would decrease the energy output in the string, but not Trinasmart – the solution automatically takes care of this.

System output in case of shading and differing module performance within one string is improved by up to 20 percent system performance can also be monitored and controlled in real time thanks to the web-based Trinasmart platform with a smart mobile dev ice or a PC.

Rural Electrification Development Award

Barefoot College

Barefoot College, since 1989, has been harnessing the sun's energy to help rural communities thrive through applying solar energy solutions in four critical areas of village life: 1) solar electrification of 1000+ villages, 2) hot water, 3) solar cookers, and 4) fresh drinking water through solar powered desalination.

Each of the solar electrification solutions pioneered in rural, remote, non-electrified villages by Barefoot College has proved that both illiterate and semi-literate men and women can fabricate, install, use, repair and maintain sophisticated solar units through basic knowledge share and intense hands-on practical training. The Barefoot College has harnessed solar energy not only to provide light but also to create employment for the unemployable, to boost income for the poor, to save the environment by reducing carbon emission and not cutting trees, and most importantly, to provide self-reliant solutions within village life. For the solar electrification of villages, Barefoot College annually trains about 100 grandmothers from India and 80 grandmothers from international rural villages located in the least developed countries as per the UN.

The grandmothers complete a comprehensive 6 month solar engineering training program at Barefoot College campus in India where they learn how to light up solar home units, solar lamps, and charge controllers. Upon completion of training, the grandmothers return to their village to electrify upto 250 households with solar lighting units and assume the responsibility of repair and maintenance for a minimum of 5 years.

They play a key role in sustaining and replicating solar technology in rural communities by training other women and managing the finances of the solar workshop. The solar electrification program benefits the villages through save money on kerosene and wood and increasing the time spent on education and livelihood.

Barefoot College's solar water heater solution provides rural communities access to a smoke free and eco-friendly source of heating water as well as to generate employment for unemployed rural youth. The solar water heater engineers are trained to fabricate, install, repair and maintain two varieties of solar heaters, oil-based and non oil-based, that can store upto 300 liters of water.

More than 70 solar water heaters have been manufactured and are benefiting hundreds of people living in rural, remote villages in 8 states of India.

The 2.5 square metre, 130kg parabolic solar cookers used to cook food are fabricated, installed and maintained to precise measurements by illiterate and semi-literate women. The eco-friendly solar cookers used in Indian villages feed more than 400 people every day.

The solar powered desalination plant setup by Barefoot College, the first of its kind in India, is a joint partnership with the scientific community that produces

600 litres of water per hour, for 6 hours every day.

Bennu Solar

Bennu Solar is a specialized consulting firm, focused on the multi-billion dollar energy needs in poor rural areas of the developing world. Currently, low-income villagers are paying for energy over ten times the price than people in developed countries pay, and yet these people are under-served. Bennu Solar believe there is a way for villagers to get treated as VIPs and offer resources such as:

Advice: on funding, business models and successful practices by taking advantage of free resources database.
Support: Free to start-ups and can help in planning energy poverty elevating programs.

Quality solar products at lower costs, take advantage of our procurement support.
Bennu Solar was established in 2006, and is managed by Yotam Ariel, their goal: reach 1 billion villagers by the year 2014.

Phaesun GmbH
Solar water supply in Pakistan

Phaesun GmbH installed 200 solar water pumping systems in 12 districts in Pakistan. The systems were successfully put into operation together with the Pakistani partner Izhar Energy by December 2012 in the district of Sukkur.

The project has been initiated and financed by the United Nations Development Programme UNDP to counteract the destructive tidal flood in Pakistan in the summer of 2010. Thousands of families will benefit from the project that secures the water supply for drinking water, irrigation and livestock farming.

The people in Pakistan still suffer from the devastating consequences of the flood disaster in 2010: Thousands of people lost their lives, 6 million people urgently needed humanitarian aid, the infrastructure was severely damaged in many parts of the country. Even the water supply was disastrous in many places. Clean drinking water was often only available after having covered long distances. Organised water supply for agriculture and livestock farming was often not existent in many places.

The UNDP-project aims at a sustainable water supply for local communities by means of renewable energies. In twelve districts of Pakistan, local communities have been identified where the water supply was almost completely disrupted. The 200 solar water pumping systems have been individually sized according to the needs on site such as water amount and pumping head and were installed from November 2011 until December 2012. The systems use pumps of the manufacturer Grundfos which are operated with solar modules between 400 and 700 watts.

Russom Semere, managing engineer at Phaesun reports: It was an enormous logistical effort to realise that project. The infrastructure in many regions of Pakistan has not yet been rebuilt. The components often had to be taken to their point of destination with the help of donkey carts and boats.

The project could be realised in the first place due to the cooperation with the local partner Izhar Energy and the UNDP members on the spot!"
The project has a sustainable effect on the development of the affected regions.

The UNDP initiated and financed the project; Phaesun sized the systems, prepared and supplied the components. The logistics and installation on site was organised together with the local partner Izhar Energy.

Steca Elektronik GmbH
Steca Tarom 4545

In the rural areas where the Steca Tarom 4545 is commonly in use, many end users are not able to read or write. Thus technical aspects are difficult to understand and need to be conveyed to them on a different way. Moreover the installation of solar charge controllers is tricky because of the lack of space and size of the connection terminals at the charge controller. Rising costs for external accessories like data logger programmable switches etc. is another challenge products in this area have to face. The new Steca Tarom 4545 provides a solution to all those problems.

The new device has been equipped with a large multifunctional LCD with graphics capabilities so that the user can easily understand the system by the use of self-explanatory symbols.

New connection terminals also make the installation much easier. Thanks to integrated functions like data logger generator start and excess energy management timer's costs could be reduced to a minimum. A nightlight function as well as 2 programmable switching contacts and an open communication interface amplify this effect.

The new design for the Steca Tarom sets new standards in this power class. A graphic display informs the user about all important system data and enables configuration and adjustment of the controller to the specific requirements of the individual system.

Numerous clever functions allow the user to adjust the controller to the particular features of the system in question.
Thanks to the significantly improved state of charge determination the system is optimally controlled and the batteries are protected.

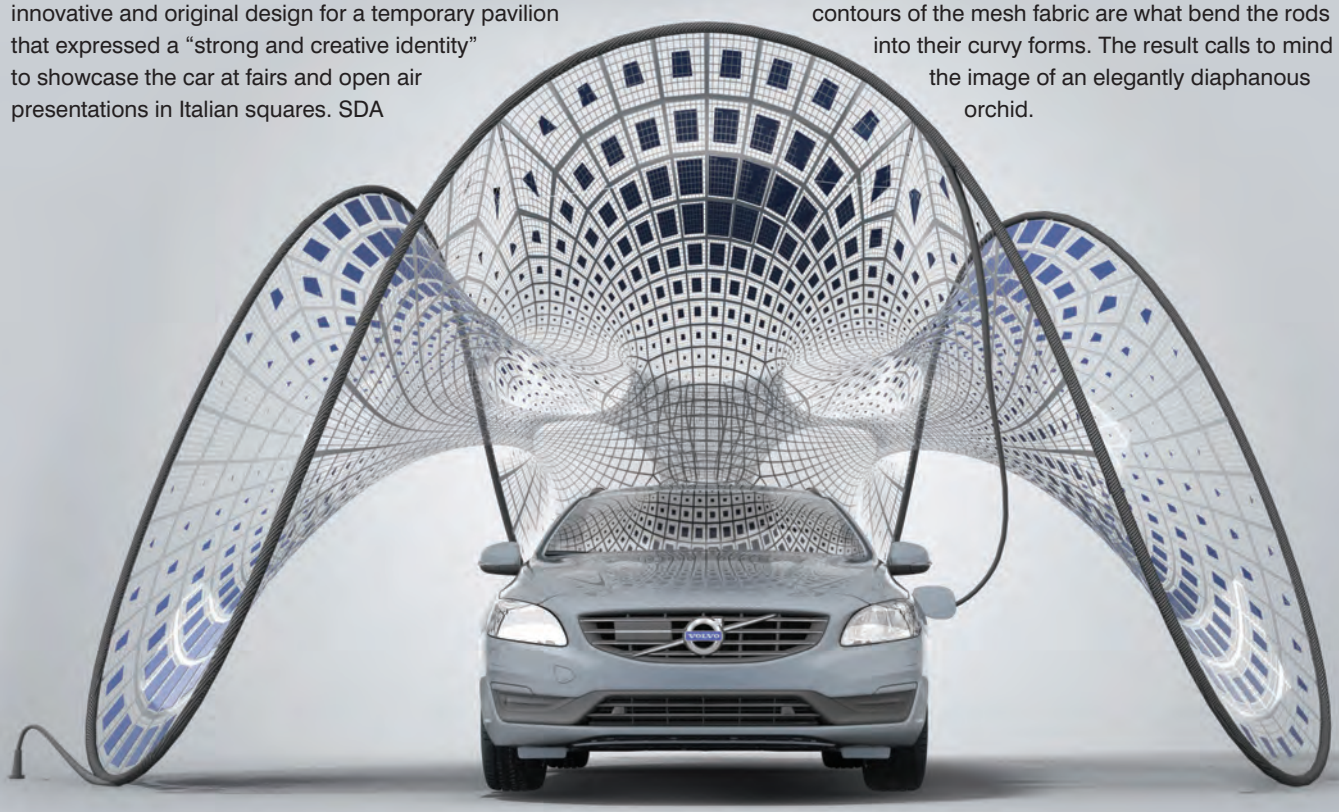
Future design for solar power

A DESIGN and architecture company have won a competition to design a deployable pavilion capable of charging an electric hybrid car using photovoltaic technology and a great amount of design imagination. Synthesis Design + Architecture (SDA), a Los Angeles-based architecture firm led by architect and USC professor, Alvin Huang, recently won an international competition to design a rapidly deployable pavilion to showcase Volvo's new plug-in electric hybrid, the V60.

Volvo's "Switch to Pure Volvo" competition, organized by international architecture magazine THE PLAN, called for an innovative and original design for a temporary pavilion that expressed a "strong and creative identity" to showcase the car at fairs and open air presentations in Italian squares. SDA

SDA's approach was to use the car's design as a flexible and sustainable vehicle as the basis to reimagine the typical trade show pavilion.

Toward this end, SDA emphasized the qualities of dynamic form, interactivity, visual impact, functionality, and efficiency to create a novel temporary structure that while iconic also offers high-performance. The design integrates structure, form, and performance by utilizing a continuous organic form composed of HDPE mesh fabric with integrated photovoltaic panels tensioned over carbon fiber rods. In fact, the digitally designed contours of the mesh fabric are what bend the rods into their curvy forms. The result calls to mind the image of an elegantly diaphanous orchid.



"This competition presented us with a unique challenge as architects," says SDA principal and founder, Alvin Huang. "It addressed issues we are constantly working on and offered the potential to address sustainability as something much broader that can also encompass issues of identity, contemporary culture, materiality, permanence, and personal mobility."

The pavilion itself is highly mobile. In SDA's proposal, it is shown arriving on site in the back of a V60, completely collapsed into a small tent bag. "It was important that it be easy deploy, break down, and move around," says Huang. What is truly remarkable about the design is that once assembled it looks like one continuous smooth surface without the usual expression of components. For SDA it was important that the design be imbued with the same vision of energy efficiency and sustainability as the V60. With its embedded photovoltaics the pavilion functions as "charger" for the V60 on display, with the charging cable concealed within and peeling away from the tubing.

The use of light weight high-tech materials and photovoltaic power generation makes the pavilion extremely cost-effective for fabrication, transportation, and set up. This is another factor that went into the jury's decision. It does not require a large crew or the use of a truck or other additional equipment for installation.

In preparation for the official launch on September 15th in Italy—location to be disclosed at a later date—SDA's team is currently developing the design as the pavilion heads into fabrication. The team will also be working in collaboration with the Volvo Design Center in Camarillo, California.

solar INTERNATIONAL

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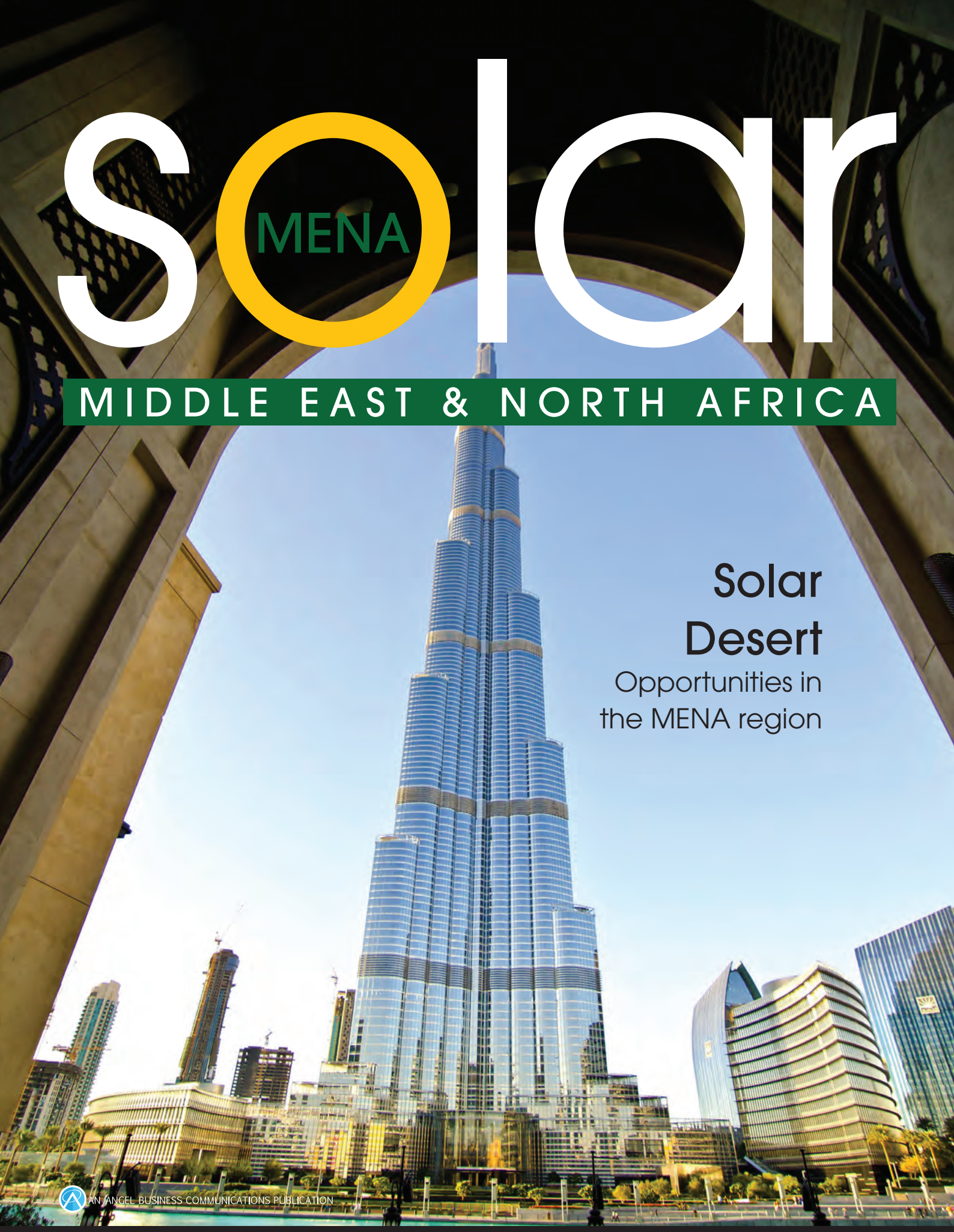

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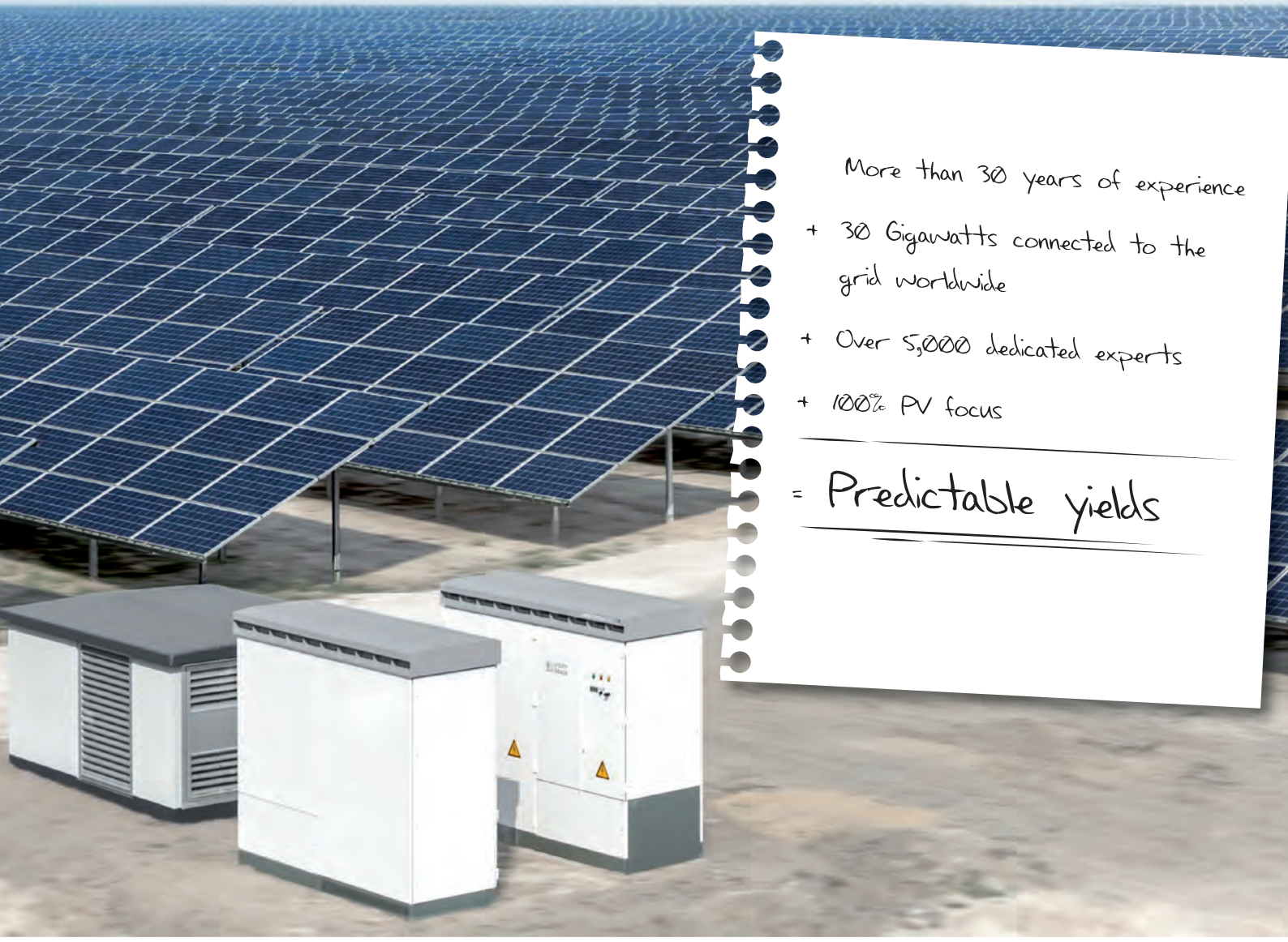

ENERGY THAT CHANGES

SMA

MENA opportunities

With changing dynamics in the global PV and solar industry the search has been on for new markets to enable companies to continue the impressive growth of the last few years. One area that has been garnishing a great deal of attention is the Middle East and North Africa (MENA) region. Despite the hype there is much to consider for companies hoping to take advantage of the growing opportunities.

The MENA region has attracted a great deal of attention in the last year or so as companies seek new markets to maintain growth and expansion as expected of publicly owned companies. While there is certainly a great deal of potential opportunity coming in the area there is also a need to realise there are some specific challenges in the area that must be considered for any success.

The first thing to understand is that the MENA region is an incredibly large and diverse region. It is not like Europe with similar rules and regulations and there is little connecting the countries other than geographical location. Setting up business in Morocco or Tunisia is a very different proposition to Iraq or Saudi Arabia. There is also dispute which countries belong to the MENA region and any list will display a different perception of which areas should be included. In view of such differences companies are better off picking one country to set up in with a view to later expansion.

The second factor in developing business in the MENA region is awareness of the local rules and regulations that can seem completely alien to what companies are used to. The basic requirement for anyone considering taking business to the region is the need for local knowledge to have any chance of success. Each country in the region will have its own laws governing business and in many of the countries you will not be able to develop any business without a local partner.

The MENA region has one of the highest solar irradiance levels on the planet and there has been an expectation of positive market growth for some time. There is also an abundance of vacant land, albeit much of it desert. These two elements provide two of the key factors when

looking for new solar markets. This has ensured that any sense of market growth has attracted global investment interest.

The other key factor for a global market that continues to rely on financial support in its initial stages is political will and throughout much of the MENA region there are strong signs that the regional authorities are keen to develop domestic renewable energy sources.

Traditional approaches

The MENA region is well known throughout the world as the major supplier of energy from oil and gas resources. Despite the size of the MENA region with diverse cultures and geography the rest of the world still tends to think of the region as a fossil fuel supplier. Although only one part of the region's capabilities it is an extremely important part that transformed desert regions into wealth producing nations that continue to be politically and economically dominated by oil and gas.

The MENA region is estimated to contain 60% of the world's oil reserves and about 45% of the global supply of natural gas. The wealth generated from supplying energy to the rest of the world has made some of the region very rich and this attracts potential investors. The wealth is not distributed evenly and is often controlled through a narrower section of the region than many realise.

The reality for many countries in the MENA region is that the cash flow from oil and gas is drying up and the situation is bad enough that any dissent to renewable energy is disappearing in the face of harsh economic realities. Some of these countries have a growing population requiring more energy and it is economically a better solution to develop renewable home grown energy while you can still sell your barrels of oil abroad for around US $100 a barrel.

Another factor in the MENA region that impacts on decision making is political instability or fear of it developing. This can make investors nervous about long term prospects. Unemployment amongst the young in the region is at critical levels and can fuel any local dissent. It is an important issues for local governments in an expanding population. Renewable energy development has been tipped as a potential solution so companies should be prepared for a local employment requirement in any proposal.

Technical realities

The price of solar has reduced so that many new developments do not require the same level of subsidies as before. With perfect conditions the MENA region will achieve grid parity faster than other regions. Developing local assembly plants will be on the agenda for some MENA countries keen to reduce their infrastructure costs as they move towards energy autonomy.

Underlying all these policy and logical financial choices are some technical realities of setting up PV and solar solutions in a desert environment. While it may seem like the perfect choice with sunlight and land there is one additive that changes the technical landscape and that is sand. Sand storms are common along the MENA region and a fact of life for countries situated around the desert. The great Sahara landscape is the dominating feature in the region. An intense sand storm can destroy infrastructure and even bring down buildings. It is not hard to imagine the damage such a sand blasting could do to PV and solar products.

In view of the damage that can occur the region is placing stringent technical parameters on PV expectations. In those countries where guidelines have been written the criteria for higher quality product is evident. The early drafts of technical specifications will enable only a handful of companies to meet the criteria.

PV and solar products that can tolerate the harsh conditions afforded by the MENA region will be in high demand and proof of concept will be expected. A number of research centres have begun the process of identifying local challenges and seeking solutions through best the

technology available. Some are financed at a local level and some are instigated by outside interests wishing to gain a foothold in the region as it expands. The local assumption is now about when is a solar boom going to take off rather than if.

Local knowledge

Regardless of the hype and potential of the region there are basic business concepts that still apply. Be aware of local rules and regulations and expect them to be different. One example is that some areas in the Middle East do not have a recognisable land registry so ensuring you know who owns what land is essential in early planning. It is also wise to be alert to whether the people you are doing business with have the capacity and authority to see a project through.

The simple truth is that it is wise to have local connections you can trust. Some countries will not even consider your applications if you do not have local representation or partnership and a number of PV specific industry bodies have formed in the region and are the best point of call for initial contact and questions. While initial growth forecasts are around 3.5 GW by 2015, the potential beyond this initial flurry is much greater.

The key reason behind the current growth is down to the political will of the wealthiest in the region. Saudi Arabia is talking of a $100 billion investment and the UAE and others are following. Despite the massive energy resources, some of these countries are actually importing more of their energy needs than they are exporting. It makes little sense for countries to use raw resources they can sell elsewhere for 10 or more times.

There is a way to go for the policies and infrastructure to be firmly in place but as one leader from the region told me, you need to be there to have a chance. The risks are high and companies must resist rushing in or trying to service the entire region but patience will be rewarded in an area starving for the benefits that a locally developed renewable sector can bring.

Saudi Arabia in particular is planning to move away from generating electricity using crude oil in favour of PV and solar thermal technologies. A study conducted by GTM Research, Boston, USA, puts this development down to high solar irradiation and rising electricity prices and requirements that arise from an increasing population size. By 2017, the expansion of solar energy is expected to exceed a combined output of 10 GW in the MENA region. With a share of 70%, the majority is set to be implemented in Saudi Arabia and Turkey.

In Morocco, solar plants with a combined output of 2 GW are set to be installed by 2020, which means that the share of renewable energy in the Moroccan power grid could reach a total of 42%. Alongside solar energy, wind energy and hydropower are also expected to form part of this share.

Under the supervision of MASEN (Moroccan Agency for Solar Energy), the construction of a large, impressive project has already begun in the Moroccan province of Ouarzazate, which will be the world's largest solar thermal power plant. A capacity of 160 megawatts (MW) will be installed in the initial expansion phase alone. Once completed, the power plant will reach an output of 500 MW.

With large scale projects becoming the norm for the region we can expect a rather fast growth rate once things have taken off. The projects so far developed in the region have been large and successful and will inspire a new round of investment.

One thing you can say about the MENA region is that healthy competition between regions will instigate further renewable investment. Especially in the Middle East there is a desire to have as much or more as your neighbours and renewable energy development will be no different.

Renewable energy in the Middle East

The Middle East might not immediately appear to have a pressing need to exploit its renewable energy potential, however Michelle T. Davies, Head of Clean Energy at global law firm Eversheds, thinks otherwise. Using a number of Middle Eastern countries as examples, she looks at the motivation for change and explains why it is the right time for investment in this region.

In the Middle East where countries are stereotypically rich in natural resources what impetus is there for such countries to invest in renewable energy? The key drivers for renewable energy programmes differ across MENA, however the extremes are import and export reliance. Each provides its own quandaries, but more often than not, countries within the MENA region face problems arising from both.

Import reliance

Countries who are heavily reliant upon fuel imports, for instance those who cannot meet domestic demand from domestic production, have a realistic and viable solution in renewable energy. Problems of increasing consumption and rising production costs only serve to provide further motivation for change. Developing a domestic renewable energy industry will help to turn the tables and create a skilled domestic workforce in this area, which could itself be a valuable export in its own right.

Export reliance

Export reliant countries may have an abundance of fossil resources, however any significant increase in domestic energy demand would decrease export capacity, and drive up prices. Where domestic energy and hence oil consumption increases, there are concerns that key exporters may not be able to continue exporting oil at the same rates.

These extremes are examples of the situations faced by many countries in the Middle East. The combination of drivers provides a motivation for change in almost all jurisdictions.

Saudi Arabia

Saudi Arabia, being perhaps the most export-reliant jurisdiction in the Middle East, has such a motivation to invest in renewable energy. In comparing development costs for renewable energy projects against potential losses of export revenue, the solution is very plain to see. In the short

to medium term, the higher initial investment is likely to far outweigh the potential and ever-increasing loss in revenues through a reduction in oil exports. If the Saudi programme proves successful, other countries may well follow suit.

In February 2013. the King Abdullah City for Atomic and Renewable Energy ("K.A.CARE") launched ambitious plans to produce 54 GW from renewable energy by 2032. The draft White Paper setting out the Proposed Competitive Procurement Process for the Renewable Energy Programme was issued for consultation.

To date, plans for implementing K.A.CARE's programme are still in the process of being confirmed. K.A.CARE plan to issue a final White Paper and drafts of a Request for Proposal and Power Purchase Agreement to the market for comment. K.A.CARE is planning to host a number seminars and plans to receive written responses.

This is a very significant programme and if all goes as planned, it will be the largest alternative energy programme in the world to date. This could provide a real catalyst for change throughout the Middle East.

The majority of the 54 GW programme is underpinned by wind and solar technologies. Through harnessing natural resources on this scale Saudi Arabia will be able to provide a genuine benchmark for the region. By 2032, the aim is to produce 41 GW through both photovoltaic and concentrated solar power systems, 9 GW from wind, 3 GW from waste to energy and 1 GW from geothermal energy. This target will be achieved through several smaller steps, with a key milestone of around over 23 GW to be reached by 2020.

Three initial procurement rounds were introduced in K.A.CARE's White Paper. An introductory round of between 5 and 7 projects will produce between 500-800GW on pre-

developed sites. The first full round seeks to produce around 2-3 GW and the second currently aims for between 3-4 GW.

In Saudi Arabia, renewable energy developers are able to choose and source their own sites. This is a novel approach which presents a new challenge for bidders. It will involve securing development assets, such as all real estate and access rights, all consents and a grid connection. These must be secured so that they are bankable on a non-recourse basis. Even if initial project finance is provided on balance sheet, securing assets on such a basis would also be prudent in case the developer wishes to exit the market further down the line. Not doing so can severely restrict marketable exit options.

Land ownership is not straightforward in the Kingdom. A registered land system only exists in a limited part of Saudi Arabia. Developers need to plan carefully in order to secure property rights to a bankable standard.

The introduction of localisation under the K.A.CARE programme has raised some concern from a bankability perspective. Although local contect is not likely to be a mandatory requirement in the initial rounds, it is obvious that bids will be looked upon favourably if they demonstrate greater local support.

However, as that the industry is still in nascent stages, if the required level of local support is excessive, especially given that the local supply chain is not particularly developed, the bankability of projects may not be great. Ideally K.A.CARE will balance its aspirations against reality, i.e. the creation of a stable and bankable infrastructure for the supply of renewable energy. With the option to source their own sites, developers have the opportunity to partner with or approach other parties, which can include other companies or local municipalities. Nevertheless, the K.A.CARE programme helps to establish a local supply chain w hich will inevitably help to develop the domestic renewable energy industry.

Jordan

Jordan has also launched an official procurement and tender programme for developing renewable energy projects. Saudi Arabia it too has established the concept of self courced sites. This approach really frees up the potential for development of the renewable energy infrastructure.

As mentioned previously, it is paramount to secure bankable development assets for security of development for funding, and for exit options. Interestingly, international banks are involved with all current projects in Jordan. Local banks have yet to fully engage with renewable energy projects, perhaps due to the infancy of the market. Nevertheless, as the market matures it is likely that this will change.

Qatar

Qatar is the largest energy supplier of liquefied natural gas globally and also a major oil supplier. However, the State's overall energy demand is growing rapidly and over the next few years will be amongst the highest in the world. This places it in somewhat of a similar situation to Saudi Arabia, in that the motivation for establishing renewable energy projects is partly a function of weighing up the costs of renewable energy over export losses.

Qatar has announced that it aims for 20% of its electricity demand to come from renewable sources, the majority of which will be from solar energy.

Although Qatar has yet to procure any renewable energy capacity, a tender has been proposed for a 200 MW solar energy project. A pilot project of approximately 10MW is expected to be launched by early 2014.

Plans have been announced that Qatar will seek tenders for an 1,800 MW solar energy plant in 2014. This will be used to fuel desalination plants, catering for 80% of the country's desalination needs and significantly reducing fossil fuel consumption.

United Arab Emirates (UAE)

The UAE finds itself in somewhat of a peculiar situation. Despite holding a large segment of the world's fossil fuel resources, it is also reliant upon imported gas from Qatar for electricity production. Electricity demand in the UAE is expected to grow at over 10% annually which could put a considerable strain on both imports and exports. The largest Emirates are Abu Dhabi and Dubai who are both reconsidering their energy strategy and mix.

Both Emirates have fairly significant plans in terms of renewable energy production. Abu Dhabi plans to produce 7% of total energy demand (approximately 1.7 GW) from renewable resources by 2020, with Dubai striving to produce 1% by 2020 and 5% by 2030. The Dubai water and electricity authority has just launched an request for proposal (RFP) for advisory assistance with the second phase of its 1 GW solar programme which suggests policy is moving again.

Masdar, a government owned entity, has driven the development of renewable energy in Abu Dhabi. In Dubai, similar state initiatives have investigated current projects. Unlike Jordan and Saudi, neither Emirate has implemented a direct proposal option. However, with the large amount of state endorsement along

with pre packaged projects, the bankability of projects is likely to be somewhat more of a constant. The respective electricity and water authorities in Abu Dhabi and Dubai are likely to play a pivotal role in the growth of the renewable sector in the UAE.

Kuwait

Kuwait has substantial oil and gas reserves, making it a leading exporter of fossil fuels. Over 70% of current electricity generation comes from fossil fuels, with electricity consumption is increasing year on year. Kuwait, also being very export reliant, is therefore potentially reaching an energy production bottleneck.

In order to increase export capacity and reduce dependency on oil, Kuwait recognises that it needs to introduce alternative forms of energy production.

Kuwait currently has a target of producing 1% of electricity output from renewable energy by 2015 and up to 15% by 2030. This target is fairly typical, with the idea of introducing smaller utility scale projects to be followed by the rolling-out of larger scale projects at a later date. Of course, advances in technology over the coming few years will undoubtedly result in renewable energy production becomes more efficient.

Conclusion

Natural resources, both fossil and renewable, have always been abundant in the Middle East. However, with the potential of the former peaking, the challenges previously faced are constantly evolving. Despite the challenges presented by a relatively new and fast evolving renewable energy market, the potential for growth and investment is massive. The combination of needs-based motivation and natural geographic features means that renewable energy is the next natural step.

The Eversheds Clean Energy and Sustainability Team has recently released a new publication, in collaboration with Ernst & Young - Developing Renewable Energy Projects: A guide to achieving success in the Middle East is a guide which examines the development potential in the key jurisdictions in the region.

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SMA's experts work together with various bodies and committees to establish the necessary regulations worldwide. SMA central inverters have been meeting the requirements of country-specific connection conditions for years in a number of countries, including Germany, Japan, and the US.

Challenging environmental conditions

The world's sunbelt regions with countries such as Saudi Arabia are extremely attractive for large-scale PV projects. Countries with rising populations, booming economies and increasing demand for energy supply not only profit from vaster possibilities of energy production but also from the creation of jobs through new technologies. Saudi Arabia has favorable irradiation conditions for the deployment of PV energy generation and therefore the chance to save oil and thus extent the nominal lifetime of this fossil energy resource. When it comes to water desalination PV power is indispensable in countries with dry and hot environmental conditions. The implementation of PV technologies also represents a great opportunity in value chain development.

In addition to high efficiency and low energy self-consumption, SMA central inverters are designed for extreme conditions such as extreme heat or sandstorms. Only inverters with excellent technical properties will guarantee the long-term benefits of PV projects in climatically challenging regions.

Flagship projects in the Gulf region

SMA is the local market leader in Saudi Arabia and has already installed a base of 16 MW in Saudi Arabia specifically and more than 65 MW in the Gulf Region – continuing to rise. Flagship projects are the solar parc KAPSARC (King Abdullah Petroleum Studies and Research Center) equipped with SMA Sunny Central 720 CP inverters and the world's largest parking lot to be covered with PV panels in Khobar with 10.5 MW PV power utilizing 18 Sunny Central inverters.

These are only two examples of recent PV power plant projects in the kingdom which expects its energy consumption tripling until 2032. SMA shows local presence with a service company in Dammam, provides local on-site service, local trainings and education as well as sales and technical support from its presence in Dubai and Abu Dhabi. SMA is optimally positioned in the market and preparing for an even stronger engagement in Saudi Arabia according to the local requirements.

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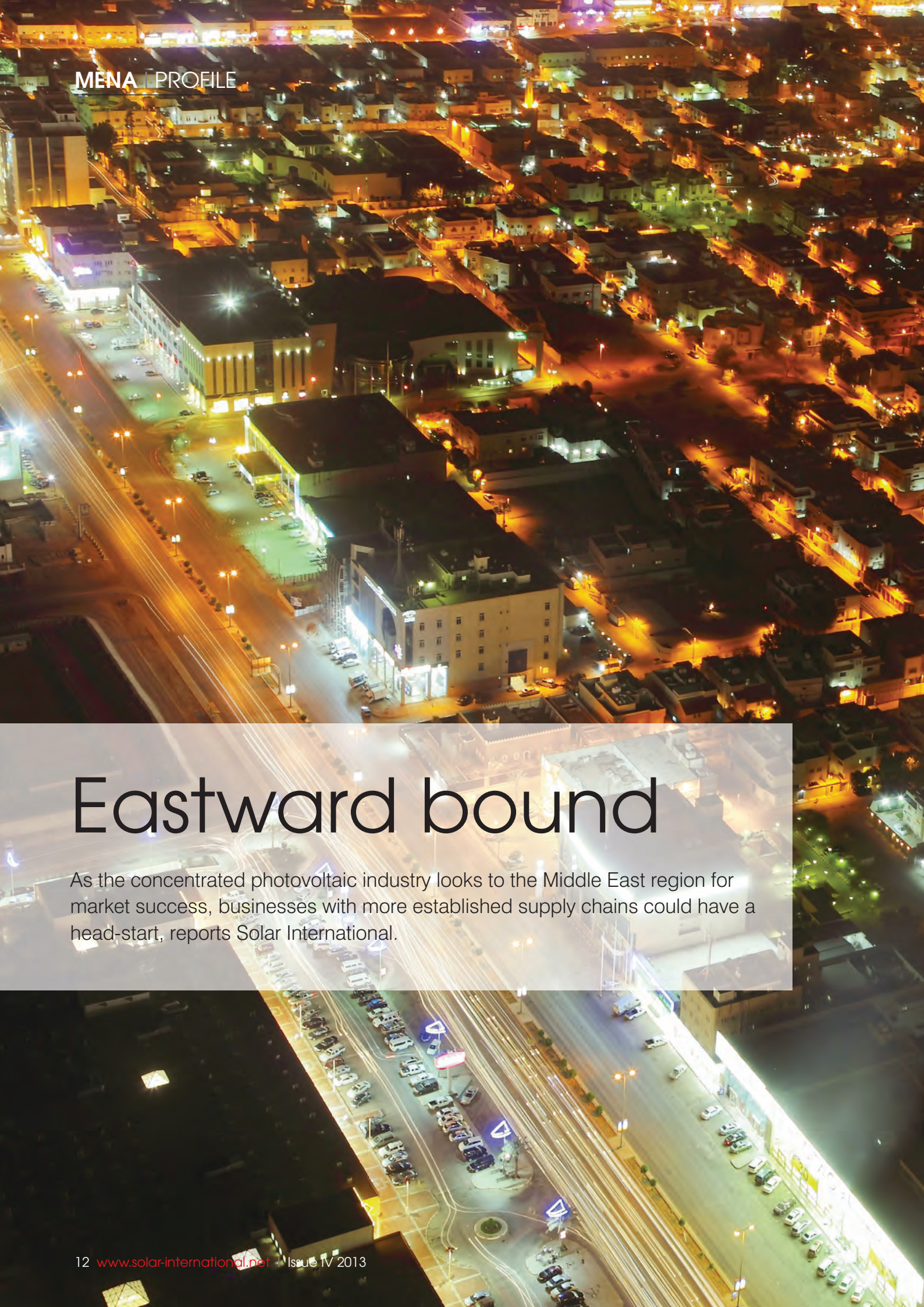

Eastward bound

As the concentrated photovoltaic industry looks to the Middle East region for market success, businesses with more established supply chains could have a head-start, reports Solar International.

WITH THE CONCENTRATED PHOTOVOLTAIC INDUSTRY acclimatising to the US and European economic slowdown, surviving businesses are now looking elsewhere for more action. Still reeling from plummeting standard photovoltaic panel prices, and to date, poor bankability, key players have had to sit back and re-assess where best to focus efforts.

Speaking at a recent PV Insider webinar to debate the next steps for the CPV industry - for both III-V and silicon cell manufacturers - Amonix chief technology officer and founder, Vahan Garboushian, and Solaria senior director of product management, Mike Mehawich, were both looking east.

"The Middle East and North Africa present a lot of market for CPV but CPV can also offer a lot employment locally and indigenously," says Garboushian. "If you look at our [III-V] technology, only the cell cannot be made in the Middle East but everything else can be made indigenously."

Indeed, as the CTO highlights, this region is desperately trying to replace some oil consumption with photovoltaics. "Saudi Arabia will soon be consuming all the oil it produces leaving nothing to export. CPV can take care of these problems and bring local employment," he adds.

Mehawich agrees that regions with high direct solar irradiation including MENA offer new opportunities to CPV manufacturers, but highlights how Solaria is also looking to China. According to Mehawich, the manufacturer of silicon-based modules has poured vast resources into developing reliable tracking systems and having recently established operations in China, hopes to meet this nation's rising demand for large-scale solar projects. As he adds: "Our technology is designed to be compatible with existing single-axis trackers in the market and we have also built our own. For us it's about building this tracker market. We still find that certain emerging markets need education on the benefits of tracking... but in countries like China we're seeing opportunities developing."

Looking back

The shift in focus from West to East follows many industry ups and downs. In 2012, just as Amonix ended manufacturing in Nevada and ABB pulled the plug on Greenvolt's funding, SolFocus was gearing up to provide thousands of systems to a 450MW project in Baja, California and Soitec and Schneider Electric were installing pilot projects in Morocco. As Garboushian puts it: "A lot of people in the financial world jumped into the market early to make CPV systems and make money, but this was premature. The industry has seen a lot of consolidation."

A year on, Amonix is back with a revamped cheaper module but Garbouishian believes his industry's biggest challenge is to lower costs further. "Cell efficiency is a major factor to driving costs down... and we expect module efficiency to

be at 38% by 2015, which will reduce system cost drastically," he says. But still the industry need more. As he highlights: "Cost reduction remains a major issue. We now need consolidation of technologies so spot buyers have access to an orderly and low cost supply chain and we need large-scale manufacturing."

Historical head start

Garbouishian believes its time for 'big balance' companies to step into the industry to develop the supply chain and drive manufacturing forward. "We need to get these long-term strategic companies involved rather than having venture capitalists that want to turn this around in a year or two," he adds. "Amonix has reduced the cost of its new product by 50% and is now looking to manufacture it on a very large scale."

Mehawich agrees with Garbouishian saying: "It's all about finding a way to achieve the scale to compete with massive incumbents in the industry."

But the silicon-based CPV manufacturer may have a head-start on manufacturability. As Mehawich points out, from word go, Solaria has focused on fitting into the existing supply chain of the silicon PV industry.

"We wanted to go with the flow rather than build a supply chain from scratch," he says. "So for everything from the back sheet to junction box and cells, we've been trying to insert the technology into the supply chain... to achieve scale."

And as Mehawich highlights, the company has already partnered with industry players that have 'critical mass in the industry'. "We can get there from a cost standpoint, and so we're much more competitive," he says.

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