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**Come Rain or Shine**

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addressing project underperformance

**Exports and Leasing**

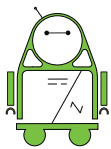
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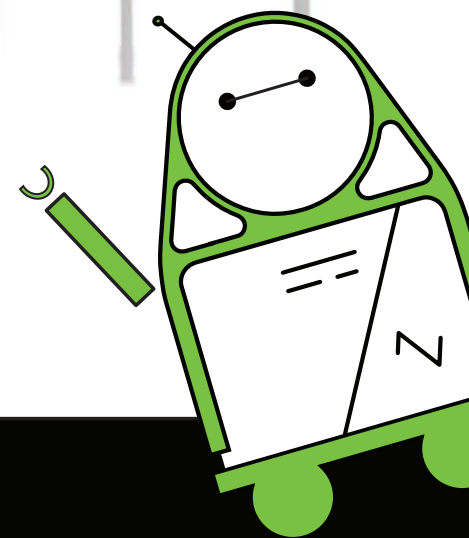
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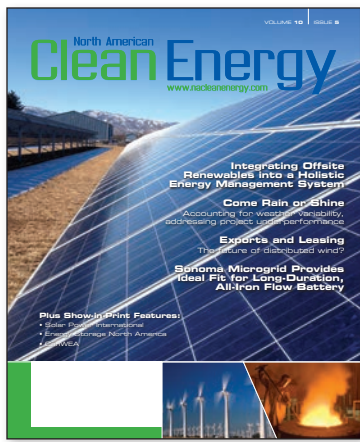
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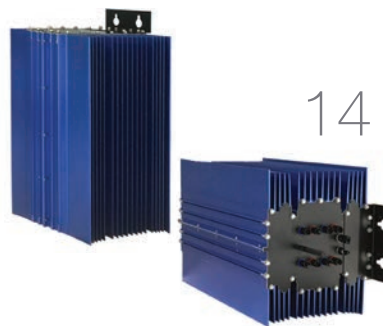
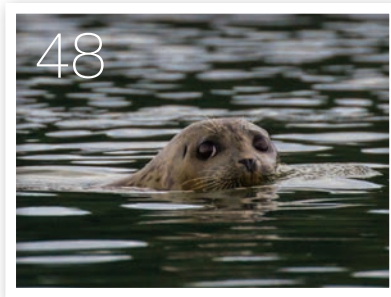
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Built by Quanta Services entities, The Ryan Company, Inc. and Inter Mountain Electric, the 3 acre, 632 kWdc fixed tilt ground-mount community solar project is located in Larimer County, CO. The Ryan Company provided EPC, Hanwha provided the 235W and 305W modules, Renesolar provided the 300W modules, and Solectria provided the 100kW inverters.

## The Ryan Company, Inc.

www.ryancompany.net

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**THERE ARE MULTIPLE DIFFERING OPINIONS ABOUT THE STATE OF OUR NATURAL RESOURCES, CLIMATE CHANGE,** and how our energy should be produced. Especially now, in this election year, we are hearing loud voices detailing their positions, the applause of supporters and the jeers of dissenters. In the midst of all the noise, it would be nice to take a moment to realize the possibility of compromise. It doesn't have to be all or nothing when it comes to using clean energy. I understand and I've said it before, change is scary, and since the North American electric utilities have been doing their business since the 1920's, the view may be, "If it's not broke, don't fix it." But with an aging infrastructure, increasing demand, and the integration of renewables into the energy mix, it's clear that some change must be made.

Investors, businesses, and lawmakers are already altering their perspective on renewable energy and the benefits it has to offer. While gas prices remain lower than last year, reductions in the cost of solar power, coupled with developing technologies and efficiencies are making this renewable source of energy cost-competitive in a traditional energy market. While U.S. PV manufacturing has shrunk from 43% in 1995 to 7% in 2010, initiatives such as the DoE's SunShot, are helping businesses regain their dominant position in the clean energy marketplace and create more jobs through manufacturing, distribution, and installation. The politicians may argue about funding come January, but in the meantime, solar energy is one of the fastest growing industries in the U.S. and there is now enough installed solar capacity to power the equivalent of 4 million average-sized American homes.\* Companies including Walmart, IKEA, Costco, FedEx, Apple, Verizon, Mortensen Construction, L'Oreal, the Better Business Bureau, Forever 21, General Motors, Ford, Toyota, Volkswagen, Owens Corning, Intel, and Johnson & Johnson are all relying on renewable energy to not only help their bottom line, but also to make an environmentally responsible choice in powering their plants, stores, headquarters, and distribution centers.

Now it is time for individual citizens to open their minds as well. Simply acknowledging renewable energy is a good thing isn't enough if you have the NIMBY (not in my backyard) mentality. Many residents will be supportive of a solar farm which generates enough clean energy to power tens of thousands of homes, until a developer applies to build it near their community. They are afraid that their property will decrease in value, or their view will be disrupted, or the environment will be impacted. But what about the big, global picture? Instead of looking at the horizon off the coast of Rhode Island and lamenting the view has changed, why not embrace America's first offshore wind farm for the possibilities it brings. Europe's offshore wind farms have been operational for decades, and now, in the U.S., we finally have the opportunity to explore the renewable energy generated from offshore winds. It's a change, but in the end, I believe it's one for the better good.

Enjoy the read.

*Jill Walters*



\* <http://energy.gov/eere/sunshot>



**Crops in space**

Philips Lighting collaborated with The University of Arizona Controlled Environment Agriculture Center (CEAC) to test energy efficient ways to grow food to help feed astronauts on missions to the moon, Mars, and beyond. A recent study, found that replacing water-cooled high-pressure sodium (HPS) systems with energy efficient LED lighting from Philips in a prototype lunar greenhouse resulted in an increased amount of high-quality, edible lettuce while dramatically improving operational efficiency and use of resources. Lettuce grown under Philips LED modules achieved up to 54 grams/kWh of fresh weight, edible lettuce compared to lettuce grown under a high pressure sodium system which achieved only 24 grams/kWh of fresh weight, edible lettuce. This represents an energy savings of 56%. The project was completed over a six month period by a team led by Dr. Gene Giacomelli within the Mars-Lunar Greenhouse created by Sadler Machine Co. During a nine week period, four harvests of lettuce heads weighing 5 to 6 ounces were analyzed. All plant production and growing practices remained constant between two distinct growing systems—LEDs with the specially developed light recipes from Philips Lighting versus a traditional high pressure sodium system, which included a glass water jacket for removing the concentrated heat from the lamp bulb.

**The University of Arizona Controlled Environment Agriculture Center** | [www.ceac.arizona.edu](http://www.ceac.arizona.edu)  
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**New Solar System Powers SF Animal Shelter/Clinic**

A 586 kW solar system was recently installed on one of the campuses of the San Francisco SPCA, which is an animal shelter, a spay/neuter clinic, and a full-service public animal hospital. Installed by Berkeley, CA-based Sun Light & Power (SLP), the roof-mounted PV system is expected to last at least 25 years and offset nearly half of the non-profit organization's electric bill for that property. The system consists of 1,859 Canadian Solar modules and 59 HiQ Solar inverters.

Founded in 1976, SLP is celebrating its 40th continuous year of designing and building solar systems in California. It is one of the first companies in the state to become a Certified Benefit Corporation as well as being the first solar company to be certified as an Alameda County Green Business. The SF SPCA is the oldest U.S. animal welfare organization on the West Coast. Founded in 1868, its mission is to save and protect animals, provide care and treatment, advocate for their welfare, and enhance the human-animal bond. The SF SPCA has committed that the money they will save on their energy bill to go directly back to their mission: helping animals in need.

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# Integrating Offsite Renewables into a Holistic Energy Management System

by Duncan McIntyre

**WE HAVE REACHED A POINT WHERE MOST BUSINESSES ARE AWARE OF, AND ACCEPT AS TRUTH,** renewable energy's environmental and financial benefits. Until recently, however, renewable's upfront investment was too great for many organizations to even consider implementation. The availability of onsite solar power purchase agreements (PPAs), where developers absorb all of the initial costs in exchange for "ownership" of the power generated, has created a viable option for commercial and industrial (C&I) entities to reap the benefits of renewable energy.

While onsite PPAs have broadened the availability of renewable energy, many organizations don't have the space or appropriate infrastructure to house onsite renewable projects. This market gap has spurred the growth of offsite renewable PPA offerings, and third-party consultants to help companies determine what makes the most sense for their unique business needs. The combination of the two have generated broader appeal and adoption of renewable energy for a wide range of companies.

Offsite PPAs for renewable energy projects are especially attractive to large energy users, who are looking to complement or create a more holistic energy management system. Such PPAs allow organizations to lock in a consistent rate for several years, as opposed to being at the mercy of fluctuating, and sometimes volatile, rate increases. Additionally, renewable energy is less expensive in many markets than non-renewable sources; that extra savings will have a very positive impact on the bottom line.

Forward-looking companies such as Microsoft and Procter & Gamble, have signed PPAs with developers of large-scale renewable energy projects, and are already supporting their sustainability goals and making their future energy costs more predictable. These offsite renewable PPAs are no longer limited to the largest energy users. Smaller companies can also benefit from the energy savings offered by large-scale renewable PPAs, through an innovative program that warehouses PPAs for a period of time, and allows smaller chunks to be acquired by a variety of buyers. This program enables smaller buyers to benefit from the scale of larger projects (best pricing) via a collaborative approach.

Most people associate offsite renewable projects with wind turbines and solar panels in wide open spaces; depending on factors like topography, climate, or space limitations, however, wind and solar may not necessarily be viable options. Other sources can be vital components of an offsite renewable energy program, depending where the source is located. Such alternatives include:

- Biomass, which is energy derived from organic materials, such as virgin wood, energy crops, agricultural residue, and food waste. For obvious reasons, biomass availability is most commonly found in more rural areas.
- Landfill gas (50 percent methane, 42 percent carbon dioxide, seven percent nitrogen, and one percent oxygen) can be captured as waste decomposes and is converted into energy.
- Hydroelectric, which converts energy created by dammed waterways.

Navigating the complications and nuances of securing a PPA for offsite renewable energy is not easy; in fact, the wrong choice can result in a disaster that unnecessarily increases risk, costs millions of dollars, and could tarnish an organization's reputation (as well as its bottom line). More and more, companies are turning to renewable energy advisors to handle the myriad details that go into ensuring their PPA will achieve the technical and economic benefits of offsite renewable energy. In vetting an advisor, organizations should concentrate on the following areas:

- **Track Record:** Ask how many PPAs a prospective partner has helped clients execute, and be sure to inquire about specifics. They should be able to share information regarding the number, size, and scope of transactions, and in which markets and industries these projects have been completed.
- **Market Access:** A third-party energy advisor should be able to share the number of projects on which comprehensive economic and developmental intelligence is maintained—and how frequently it is refreshed. Learn how quickly they can share a short list of projects based on specific criteria, and how they develop these criteria.
- **Analytics:** The economic and risk analytics required to properly arm senior corporate decision-makers are one of the most critical capabilities an energy advisor needs to provide. Developer-supplied project data needs to be reviewed and normalized. An advisor should be able to explain how they evaluate and contextualize future energy prices, how they take weather variations into account, and how developer and project risk are evaluated and ranked.
- **Developer Relationships:** An energy advisor needs to be fully independent and invested in the best interests of the customer, not the developer. Inquire about their compensation structure with developers and whether or not it is subject to negotiation. It is also important to know if the energy advisor accepts compensation from developers to influence project inclusion or selection.
- **The Team:** Renewable energy analysis and execution requires a team with multidisciplinary knowledge and experience. For example, find out how many renewable energy transactions staff have executed before joining the firm. It is also important to know how the team handles accounting treatments of PPAs.

Organizations have unprecedented options to enjoy the many benefits of offsite renewable energy. Making sense of available opportunities and properly vetting third-party advisors, helps companies position themselves to make a decision that meets sustainability requirements, and has a positive impact on energy costs for years to come.



*Duncan McIntyre is the president of Altenex, an Edison Energy Company.*

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# Come Rain or Shine

## Accounting for weather variability, addressing project underperformance

by Gwen Bender

For states struggling with drought, the increased levels of rainfall witnessed across the US throughout 2015 will have come as some relief. Not for the solar industry, however, as recent performance analysis reveals that solar irradiance levels fell 5% below long-term averages for much of the southern US.

The impact on emerging US solar markets was greater still; Texas, for example, saw irradiance levels fall by more than 10% when compared with its long-term average.

High storm activity, coupled with a strong El Niño towards the end of the year, led to greater levels of cloud and rain in the region, with many southern states receiving twenty inches of rainwater or more in the second quarter. Texas, again, suffered more than most, experiencing severe flooding and its wettest twelve months on record from January to December.

This weather activity will give cause for concern in a state where over 300MW of new solar projects were scheduled to come online last year. A 2GW construction boom is expected to provide impetus as the solar sector looks to emulate the success of the wind industry in the region.

However, many operational solar sites in the region struggled with poor production in 2015. A key challenge for the sector is to address a lack of monitoring when it comes to the impact of weather deviations from long-term conditions on performance.

While solar irradiance is much less variable than wind, there is a clear correlation between the type of deviations from the long-term average witnessed in 2015, and their impact on project performance. For example, a 2% reduction in solar generally equals a 2% reduction in power produced.

As a result, there is a clear need to analyze the effects of solar resource variability on power output, which allows for project performance to be 'weather-adjusted'. Awareness of deviations from the norm in solar irradiance conditions can help avoid a great deal of waste, both of time and operational budget, by allowing project operators to distinguish potential equipment problems based on a lack of resource.

Weather and forecast data feeds also affect decisions on the cost effectiveness of snow removal in regions such as the Northeast US, that often encounter heavy snow and ice in winter. For example, this information can help decide whether it is worth removing snow at a fee of \$2,500 from a 2.5MW system in order to produce \$3,100 worth of power. It can also determine whether more snow is expected or forecasted, or if sunshine will clear the panels in due course.

Another increasingly important use for plant data is in evaluating a plant's performance by a potential buyer, or for bank refinancing. This data can also contribute to a plant's financial forecasting; it allows owners and operators to perform detailed liquidity analyses and assess their ability to meet debt service during low irradiation months.

Regulators often require storage of specific datasets, and having this information on hand can help prove compliance with national and federal energy regulations. Additionally, detailed historical performance data can be critical when making plant enhancements, such as adding storage to, or repowering solar assets, ensuring sound engineering, and financial decision-making.

Using on-site measurements or a regular weather data feed are the crucial first steps towards monitoring weather conditions and assessing a solar plant's performance against expectations. Larger utility-scale plants will often have on-site measurements as standard practice.

Pyranometers are often thought to give the best account of resource conditions, but their accuracy can vary according to the type of equipment used and how well it is maintained. Adverse weather conditions, such as heavy snow or hail, will similarly

impact the performance of weather measurement equipment. Independent data feeds can help mitigate this, by either validating or substituting for on-site irradiance measurements.

Important factors to consider when selecting a weather data source include the cost and quality offered, as well as availability. Ideally, a data source will provide coverage across the entire existing and potential project network, and guarantee reliable data throughout the year.

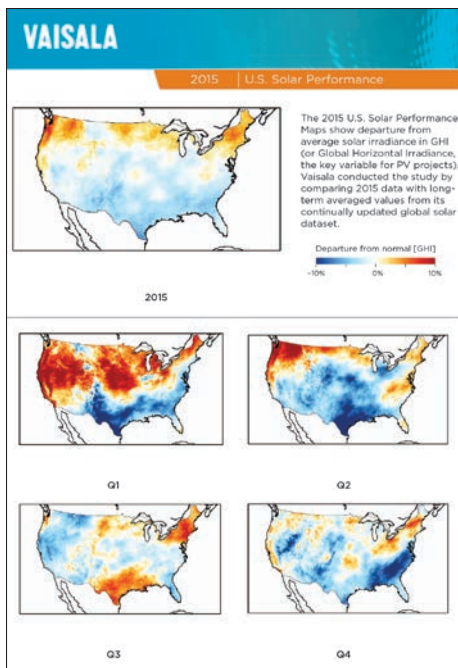
Additional considerations include the availability of consistent data across sites, allowing for ease of comparison, and how straightforward it is to integrate the source with existing performance monitoring platforms.



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After finalizing the data source, the next step is to ensure that the datasets produced are useable and optimized. The analyses produced will prove relatively useless if the underlying data cannot be trusted because they are missing or incorrect.

One way to significantly improve data quality is by comparing inputs from two similar datasets, such as monitoring inverter data against utility meter data, with automated algorithms or manual validations. Thorough and consistent records for alarms, alerts, and events (both internal and external, i.e. grid outages, curtailments, etc.) should be maintained. Changes to any data, the reasons for doing so, the date an alteration was carried out, and who made it, should also all be auditable.

Adhering to these best practices may initially appear to involve a great deal of work, but the benefits of doing so are obvious and immediate.

Consider, for instance, a new plant manager on a Texas project, which, as discussed, can be subject to a somewhat turbulent climate. When having to discuss and explain last year's performance, they are much better positioned to do so if able to show, in detail, the root causes of underperformance on a case-by-case basis.

The benefits of engaging in a proactive monitoring campaign are clear: embracing reliable data collection and analysis can ultimately mitigate the impact of adverse weather, unlock long-term operations and maintenance cost savings, satisfy regulatory requirements, tackle underperformance, and enhance the overall profitability of the site. It's a crucial step towards creating an investment-grade, bankable asset that continues to deliver throughout its operational lifetime.



*Gwen Bender is the project manager for solar assessment for Vaisala.*

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# Managing Environmental Issues

## Keys to a successful utility-scale solar project

by Joseph B. Platt, Ph.D.



**AN INCREASING NUMBER OF UTILITY-SCALE SOLAR FACILITIES ACROSS THE UNITED STATES** are helping reduce our dependence on fossil fuels and improve our quality of life. But these projects also come with their own set of environmental issues developers need to consider. Below are some common environmental issues having the potential to block a utility-scale solar project, and some solutions to overcome these obstacles.

### **Problem: Disruption to protected species**

Utility-scale solar projects in the United States can approach 600MW and cover hundreds of acres. The projects are usually located on flat, undeveloped land in sunny realms—typically desert areas. These areas are often home to protected species of wildlife and their habitats. Any ground disturbance, such as grading or road construction, has the potential of disrupting plants and animals. Such large solar projects can have lasting effects on the ecosystem. Various state and federal agencies need to give approval to disturb such sites.

### **Solution: Biological surveys done early in the planning**

To determine what species may be present, qualified biologists need to examine the project area as well as surrounding areas. Biologists also will contact state and federal agencies for information about protected species that may be using the proposed project area. By conducting surveys at the appropriate time of the year, biologists will be able to identify habitats and protected species. These studies need to be done early enough in the process so the project design can be modified, if needed, to avoid or minimize negative influences.

### **Problem: Regulating desert waterways**

While developers are aware of the need to survey their sites for plants and animals, they are often surprised they must also look for waterways. Yes, even the desert has waterways regulated by the government, though they may only see water once in a decade. Solar projects can affect these dry washes when contractors build access roads or grade the site.

### **Solution: Get a permit specialist involved early**

The U.S. Army Corps of Engineers oversees compliance with the Clean Water Act. Simply stated, this Act regulates how a project interacts with the aquatic environment, which includes the desert washes. Applying for a permit to disturb a desert waterway (commonly known as a 404 permit) requires developers to show the steps they have taken to avoid affecting aquatic resources. Developers also have to demonstrate how they have minimized potential effects, and how they will mitigate for any effects which can't be avoided. The studies needed to determine the presence of protected waterways and prepare the permit application, can be carried out at any time of the year.

### **Problem: Habitat fragmentation**

The construction of a utility-scale solar facility removes several hundred acres of foraging and living space for wildlife, and can also disrupt the movement of wildlife from one place to another. This is called "habitat fragmentation", and is considered a serious problem for some species.

### **Solution: Build habitat corridors in the project site**

Developers can reduce fragmentation by leaving a corridor, such as a vegetated wash, through their projects. This is effective, for example, for the desert tortoise, kit fox, and other small animals.

### **Problem: Lake Effect**

An unexpected concern has arisen with large photovoltaic and solar tower facilities, especially in the desert. Called the Lake Effect, it occurs when birds mistake a field of solar panels or heliostats for water and attempt to land on them. Incidents usually involve ducks and other water birds. The birds can be hurt or killed as they collide with the panels and heliostats. Just a small number of birds have been affected. These incidents only become biologically significant when a rare species is involved.

### **Solution: Identify and avoid potential hazards**

Although avoiding bird deaths caused by the Lake Effect has proved a tough problem to tackle, there are some steps that developers can take. For example, make solar sites less attractive to birds by reducing the size of nearby water features such as settling ponds or wetlands. Also, avoid locating solar facilities on flight paths of migrating birds, or near habitat used by sensitive species of water birds.

Solar energy is an important alternative to fossil fuels, but its development involves a number of environmental tradeoffs. Developers can manage potential regulatory roadblocks and costly project delays by using sound science and planning. Steps to a successful utility-scale solar project include:

- Surveying sensitive resources;
- Understanding complex regulations;
- Designing projects to avoid, minimize, or mitigate potential negative effects.

These measures can help developers take advantage of the opportunities available to create a successful project.

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*Dr. Joseph B. Platt is a senior ecologist for POWER Engineers, Incorporated in the Environmental Services Project Management Group.*

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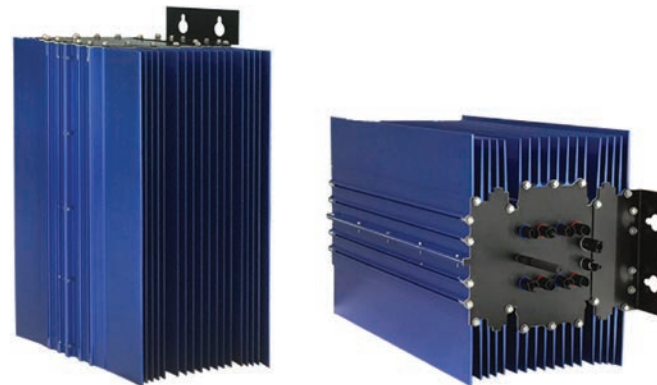
# If Henry Ford Manufactured PV Inverters

## How harmonic neutralization helps harvest more power and reduce BoS costs

by Dr. Oleg Fishman



2.5 MW inverter modules, use a unique, patented Harmonic Neutralization to improve the yield and reduce the cost of utility-scale PV installation.



A DC to DC string level optimizer used in conjunction with an HN-based inverter. It steps up voltage transmission to the inverter from a string of PV module and also provides maximum power point tracking (MPPT).

**WHEN WE THINK ABOUT THE AGENTS OF CHANGE IN THE HISTORY** of industry and technology, Henry Ford's name always comes to mind. In addition to revolutionizing automobile production, Mr. Ford left us with several nuggets we can apply to the technological advancements we see in the market for solar inverters; the devices that convert the variable direct current (DC) output of a photovoltaic (PV) module into an alternating current (AC) at utility frequency which can be fed into a commercial electrical grid, or used by a local, off-grid electrical network.

Mr. Ford once said "If you always do what you've always done, you'll always get what you've always got."

As such, to make utility-scale solar plants economically appealing sources of power, we'll need to take a more novel approach to the inverter piece of the PV plant to drive a step-wise reduction in the

overall balance of system (BoS) cost. Over the past decades, market forces have driven the cost of PV modules down to the point where little opportunity for cost savings exist. As a result, any further economies need to be found elsewhere. Harmonic Neutralization (HN) is a breakthrough power inverter technology for utility-scale solar, wind, or mixed solar/wind installations allowing PV operators to drive those needed economies. This new approach to inverter design helps break through the AC power-output ceiling found in the traditional, utility-scale PV inverters which rely on the pulse-width-modulation (PWM) method of power conversion.

PWM is a derivative of technology developed for AC motor controllers. With PWM, transistors inside an inverter are switched thousands of times per second with variable pulse durations to modulate current into a sinusoidal form. This technology is

effective for small and medium inverters, but does not scale up well to the higher megawatt power ranges needed for utility-scale power conversion. The main reason for this limitation are the high switching losses inherent in PWM technology which can cause semiconductors to overheat in the absence of proper cooling.

A conventional PWM technique generates sinewave current from a DC source by commutating switching devices to produce a series of high frequency pulses (generally 3,000 to 15,000 Hz for larger systems) of variable width running through output inductors integrated to produce near sinewave current. By contrast, HN technology allows switching of DC sources at the frequency of the electrical grid (50/60 Hz), anywhere from 60 to 300 times lower than PWM, while still generating a sine wave current meeting IEEE 519 standards.

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The wave forms of inverter currents from each of the four inverter modules shown. The blue, green, yellow, and magenta oscilloscope tracing show the phase. A distorted currents of each inverter module. The red tracing in the bottom of the picture demonstrate a clean sine wave of harmonically neutralized current delivered into the grid.

HN allows inverters to be built with several inverter modules connected in parallel to a common DC bus. Each inverter module is synchronized with the grid frequency, however with specifically calculated lead or lag phase angles between output current and grid voltage, uniquely set for each inverter module in the system. The output AC currents are then summed on a phase shifting transformer to return phases of all currents to a single combined output, with adjustable phase to the grid's voltage. This maneuver sums the fundamental currents in all of the inverter windings into the grid winding but neutralizes the higher harmonics and prevents injection of those harmonics into the distribution grid. As a result, HN allows for simpler solar array topology, lower initial installation costs, increased energy yields, and lower power losses.

The HN approach to inverter design has a number of technical benefits over PWM, including:

- Smaller size, higher power density, and lower equipment cost per MW rating as a result of utilizing very large semiconductors;
- High efficiency (99.5%) achieved through low (50/60 Hz) switching frequency – hundreds of times lower than conventional PWM inverters;
- Unsurpassed reliability from simplified construction: Several three phase heavy-duty inverter modules operate concurrently from the same DC source into the same load assuring even the entire loss of one module only minimally affects power generation.

With HN, the benefits don't stop at the inverter level. Where HN really gets compelling is at the BoS level. The key

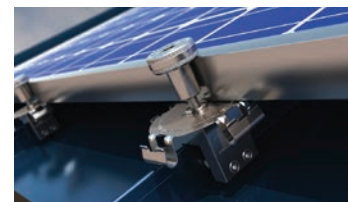
to high-energy yield from HN-based inverters is granular, optimized PV power harvesting. The HN system achieves this via string-level DC to DC optimizers. These string level optimizers provide maximum power point tracking (MPPT) to minimize the impact of uneven soiling, cloud cover, sporadic damage, and module degradation. These powerful DC to DC optimizers replace the dizzying amount of combiner boxes found in a typical utility-scale PV plant. Additionally, this approach drives the BoS cost down further by decreasing both the quantity and size of the DC cables needed to complete the installation.

Another quip famously attributed to Mr. Ford is, "If I had asked people what they wanted, they would have said faster horses." It's understandable why this sort of change in thinking has not come from the traditional inverter manufacturing community. After all, one of the great challenges in implementing any utility-scale project is the issue of bankability. In this environment, project sponsors tend to be risk averse in straying from "tried and true" solutions and suppliers, which can place a greater focus on evolutionary technologies over perhaps revolutionary ones. However, this is the sort leap we'll need to take in order to help utility-scale PV projects achieve their ultimate promise.



*Dr. Oleg Fishman is the chairman of Alencon Systems, LLC.*

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# To Attach or Ballast?

## The pros and cons of roof-mounted PV installation options

by Bill Taylor



Factor in tax breaks, energy savings, and other local or state-sponsored incentives, and it's no surprise that companies and buildings with 5,000 square feet or more of low-slope roof space are eager to incorporate solar arrays.

However, there is still some debate as to whether or not a ballasted system or attached system is the best choice. The short answer is that the best choice depends on the specific roof being used. If the roof's fundamental construction can accommodate easy-to-install attachments, there can be noticeable cost savings for an attached system as opposed to a fully ballasted system. It is important to realize price should never be the only determining factor in an industrial-size solar installation. There are quite a few other factors that should play a role in the decision-making process as well.

### **CONSIDERATION #1:** *The gap between roof function and roof construction*

For decades, the primary purpose of a roof has been to protect interior structures from exterior elements such as water, weather, and more. Construction methodology has followed this idea and sought to make commercial roofs more reliable and affordable through the use of lightweight materials and minimal structures supporting large spans. The decision to change the main purpose of a roof to also become a support platform for solar equipment means that some new technical aspects must be considered in order to ensure long-term performance of the roof and any existing warranties.

In many cases, only large lightweight roofs are well suited for, or can successfully accept, a fully penetrated (attached) or hybrid (ballasted and attached) system. Depending upon the characteristics of the racking system being used, these options are typically faster to install, and with a lower risk of damage to existing roof structures or membranes. In some states, building regulations require these more robust, traditional roof designs to cope with weather conditions such as hurricanes, seismic activity, or safety concerns - such as for schools or civic buildings.

The National Roofing Contractor Association (NRCA) has been supporting attached mounting systems because it requires a roof and a PV system be designed to work with one another rather than a one-size-fits-all solution. The organization has been offering various solar technical programs, certifications (such as RISE), and various installation recommendations to assist in wise decision making, which is the single-most important factor for successful installations.

### **CONSIDERATION #2:** *The age of roofs vs. the age of solar systems*

Unless the commercial property is a new build or has completely redone its roof within the past 2-5 years, it is likely the roof will need service or replacement

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well in advance of any solar array. Most solar systems today have life expectancies between 25-30 years, while roof systems are typically built to satisfy 20-year warranties. The additional cost of 25- to 30-year roof warranties are often unattractive to property owners who first installed roofs for “standard” purposes only. If a roof system cannot be expected to last the life of a solar array, it will require disassembly and re-installation of solar equipment in order to service or replace the roof – thus doubling the expense of the solar installation.

Those companies and property owners wishing to experience an immediate short-term benefit from solar may be better suited for an attached system over a ballasted system for 4-5 years, or until their current roof needs replacing. This is due to the expense of removing or uninstalling the roof attachment connections compared to moving thousands of pounds of ballast block only to replace them afterwards. When installed correctly, the attached mount can be re-installed on a new, more appropriate roof base, and should require less maintenance over time as there is no concern about shifting, inadequate ballast, or heavy weather conditions.

**CONSIDERATION #3:** *Optimized total system weight*

Because of accepted building codes and commercial clients’ desire for cost efficiencies, the vast majority of commercial roofing systems are built to accept maximum weight loads, creating a structural loading design problem, and requiring total PV system loads to come in less than 4 psf. This fact often designates a fully attached system is more appropriate for a particular commercial property. However, since roof warranties are often voided when surface membranes are deliberately penetrated, attached systems are only applied when approved attachments are applied. At the same time, higher-level wind zones require additional ballast requirements in order to properly anchor the system, and those requirements will eliminate ballasted systems because they will exceed the roof’s total weight threshold. Therefore, attached systems are more effective at lowering the overall structural building load.

Generally speaking, if the roof membrane can accommodate easy-to-install attachments then it truly is the preferred method because it is a secured system, an overall lighter structure, easier to install, and requires less maintenance. Otherwise, a ballasted system is the ideal second choice.



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Bill Taylor is the CEO of DCE Solar.

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## 2016: State of the Art

### The horizontal single-axis tracker and its supply company

by Tim Murphy

The horizontal single-axis tracker (HSAT) has evolved commercially since the 1980's, when 357 MW of solar thermal electric "tube-and-trough" HSAT CSP power plants were constructed in California's Mojave Desert.

Fast forward ten years, when HSAT commercialization ramped up for PV applications. In some cases, the decision matrix regarding PV fixed-array versus tracking-array began to favor tracking, largely due to the high cost of silicon PV and the HSAT performance promise of "22% to 32%" increased irradiance capture. It's the classic bang-per-buck product development driver.

The primary downside-tradeoffs of tracking were the perceived increased risks and costs of mechanical complexity, in contrast to the beautifully simple fixed application. Fix it in place properly, and mechanical maintenance was virtually a non-issue for the next twenty-five years. Tracking, on the other hand, meant motors and gears, moving structures and power bills, as well as the associated equipment controllers, protections, boxes, cabling, and monitoring, not to mention maintenance and replacements over time. If it didn't work, who was left footing the bill?

The early commercialized HSAT PV equipment was a linked-row drive system type, with approximately one grid-powered motor per 500 kWp of PV mounted on several linked torque-tube tracker structures. This design can still be seen in the HSAT PV market.

Fast forward to the present. The independent-row HSAT PV design, with about five years in commercialization, is gaining remarkable traction in the market, largely the result of a combination of features that augment the bang-per-buck driving force.

Decision matrix parameters have evolved as well. The mechanical downside is largely accepted now that the installation and operation track record of HSAT PV is fulfilling its promise. In the current market, duly diligent entities will finance HSAT PV projects within the risk-averse finance and utility sectors, and moreover, while applying rigorous EPC criteria.

They seem to work after all. Market analysts believe HSAT will take the lion's

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share of the anticipated US utility-scale PV installations market through 2020.

Those considering HSAT, and pursuing best bang-per-buck on the bottom line of yield, know that not all HSAT PV equipment is the same. They should insist on the following three key and interrelated aspects:

- 1. Highest yield potential, which is more than just power-fill on the tracker.**  
The independent-row type provides greater site-fill yield potential. Look for 120°+ tracking range and configuration options providing highest tracker power-fill.
- 2. Land-use options, which have direct impact on yield potential.**  
Look for high-slope tolerance on the North-South axis where yield may be increased, but where it may be expensive or not feasible to build. Look for greater installation tolerance on irregular land (short-steps, contours, not-square property) combined with shorter standard-blocks that will reach further into increased yield; along with the environmental and economic benefits of less grading and other civil works.
- 3. Low-cost installation and maintenance.** Look for wide assembly tolerances at the crucial pile-tracker interface, where misalignment can cause construction refitting and delay. Look for a lower piles-per-MW count to reduce first costs and environmental impact of construction. Look for self-powering provisions, wider aisles between tracker-rows, and the latest communication technology in local and wide area networks.

PV specialist companies of the US utility-scale sector have evolved, as well.

In the 90's, a Berkeley-based PV specialist broke some molds with "value engineering" steps that got us over the paradigm of satellite applications at any cost, in favor of pragmatic construction practices on earth; corresponding with the emergence of large-scale grid-connected PV applications.

Greater market materiality heralded the entry of larger and non-specialist companies, and the crucial financial investment sector. Global reach was extended, and project bankability was established, for viable players.

Today global reach is indispensable, and, thanks in part to technology, has become more accessible to a less extensive corporate structure. For better or worse, immediacy has become the

norm. That, in turn, demands innovation in customer service and communications, as well as tapping into some astounding business technology.

Company experience is a vital credential. As of 2016, a preferred supplier threshold is likely 10+ years in the sector, with GW's of HSAT PV in the past few years. The scale of the 357 MW Mojave project, while unprecedented in the 80's, represents just a good quarter for one global HSAT PV supplier today.

Companies must maintain a current knowledge and skill set to keep pace with the constant change and tremendous growth in the

PV sector. The need for good people is ongoing, fed by the excellent quality of professional candidates. PV is now 20 years solidly into mainstream academics – a vast improvement from the 90's.

Although PV remains far from its potential in application for various reasons, this sector now has the people and product to deliver the goods.

*Tim Murphy is the communications manager at Soltec America, LLC*

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# The Circular Economy in Action

by Terry Jester

**HOW “CLEAN” ARE THE PROCESSES USED TO CREATE clean energy?** Ironically, not very.

By-products from manufacturing have a significant negative impact on the environment: they are often highly toxic, and the non-toxic by-products are frequently put into landfills, dumped as pollution, or simply mishandled. Unfortunately, this is true even for green products, despite the fact that we have been talking for decades about rejecting the traditional linear economy of “take, make, dispose,” in favor of the “circular economy” model, which replaces non-renewable and hazardous materials and waste with renewable and safe materials that can be recycled in some way.

Recently, the circular economy concept was given some new life: it was a topic of significant discussion at the 2015 World Economic Forum. At the conference, a group of companies pursuing circular economy strategies discussed the model and how it can be expanded throughout all industries, and called on investors and world leaders to drive change.

Throughout various industries, there are already a number of companies that are currently pursuing circular economy models. These include Renault in the automotive industry, H&M in the fashion industry, and HP in the printing industry, to name a few. It is time that our industry, solar manufacturing, stands up and takes notice of this necessary change.

The silicon in more than 90 percent of today’s solar modules is produced through the Siemens process – and has been for more than 50 years. The process creates electronic grade (EG) silicon or solar silicon using forms of silane, a toxic gas. Disturbingly, it also creates dangerous by-products along the way: tetrachlorosilane, yet another toxic gas; and tetrachloride, a toxic and combustible substance.



Furthermore, purifying the silicon to EG standards requires high energy use in silicon plants, up to 125 kWh for a single gram of EG silicon.

Using toxic substances, creating harmful by-products, and high energy use, is in direct contradiction to the environmental aspirations of the solar industry. It’s also unnecessary.

EG silicon is best suited for use in semiconductors for consumer electronics; solar cells don’t require the same level of purification or design capabilities, but rather, a simpler form of silicon that is highly reliable and can maintain its strong performance throughout its lifetime. However, there is one innovative alternative. It utilizes a metallurgical process using aluminum to draw boron and phosphorous out of the silicon, rather than the hazardous chemicals involved in other processes. The creation of solar silicon also requires far lower temperatures – and reduced energy use. In fact, the process can use as much as two-thirds less electricity per ton, compared to other methods. More importantly, the refining process creates no waste, as any scrap of silicon that remains is reintroduced into earlier steps of the system to be processed again. And it yields no hazardous by-products; instead, it produces aluminum alloy and polyaluminum chloride, which are recycled for use in the automotive, aerospace, and

wastewater treatment fields. It could even be said that the aluminum used to produce solar silicon is essentially rented, as it is resold to the aluminum companies it is purchased from in its new alloy form, thus completing the circle.

Solar cells, clothing, printers, and even cars can be produced in an efficient way which protects and sustains the environment. It is time we abandoned our disposable attitude and put the circular economy into action.



*Terry Jester is a 37-year veteran of the solar industry with extensive leadership experience in the manufacturing and engineering of photovoltaics. She joined Silicor Materials in 2010 following her active involvement in the company as entrepreneur in residence at Hudson Clean Energy. Ms. Jester has managed large solar operations and held engineering positions for SoloPower, SunPower, SolarWorld, Siemens, Arco, and Shell. She holds a degree in Mechanical Engineering from California State University Northridge.*

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# Adhesives

## Solar power's unsung hero

by David McDougall

To anyone not living and breathing adhesives day-in and day-out, the idea that glue is changing the world may sound like hyperbole. But one need only look at the solar industry to understand this idea isn't too farfetched. The impressive growth in solar, combined with the need to optimize budgets, has driven innovations in hardware and installation advancements, including adhesive technology. After all, it's the glue that holds it all together.

Literally.

Despite making big leaps in a short amount of time, the solar industry is still grappling with pressing issues. Growing installation challenges, fiercer competition, and difficulty in finding the right partnerships all present challenges to industry professionals. One way to address these issues is by leveraging the power and innovation of adhesives.

### Installations present challenges

Sealants and adhesives are helping solve some of the solar industry's toughest problems, including the high cost of installation. Users are recognizing these costs don't end with the purchase of panels; they continue in the form of maintenance and installation fees. A customized adhesives package that integrates into an installer's procedure is one way to reduce installation costs.

### Installation's challenges also extend beyond dollars and cents.

Because they occur outdoors and in locations where they will experience maximum heat and radiation, solar installations face several challenges. Systems must be able to withstand rain, moisture, and seasonal changes. In order to amortize final costs, systems must be able to endure these conditions for decades. Therefore, it's crucial for manufacturers to select a robust adhesive that will help their project last. Depending on the job specifications, manufacturers can choose from a number of solutions, including:

- **Butyl solutions:** A versatile solvent, compatible with a wide range of resins. Used in architectural, household, and industrial markets.
- **MS polymers:** Used in roof materials, like asphalt. Best suited for projects with low surface areas.
- **Silicones:** Ideal for projects with metal-to-metal systems.

### A crowded playing field

It is a buyers market. Consumers reap the advantages of companies battling each other to win business. In solar, this translates into technology developments and lower costs. Given the stiff competition, now more than ever, developers must distinguish themselves by creating increasingly efficient technologies, reliability, and cost-competitiveness – all while being first to market with products lasting longer and achieving high profit margins.

Solar manufacturers aren't just competing amongst themselves. The energy sector as a whole – wind, natural gas, fossil fuels, etc. – is battling for every dollar. In order to stay competitive against other energy forms, the solar industry must do a couple of things: create new materials addressing the latest trends (e.g. back contact or dual glass modules), and remaining cost competitive. This may seem obvious, but it's crucial for an industry competing with cheaper options like coal and gas.

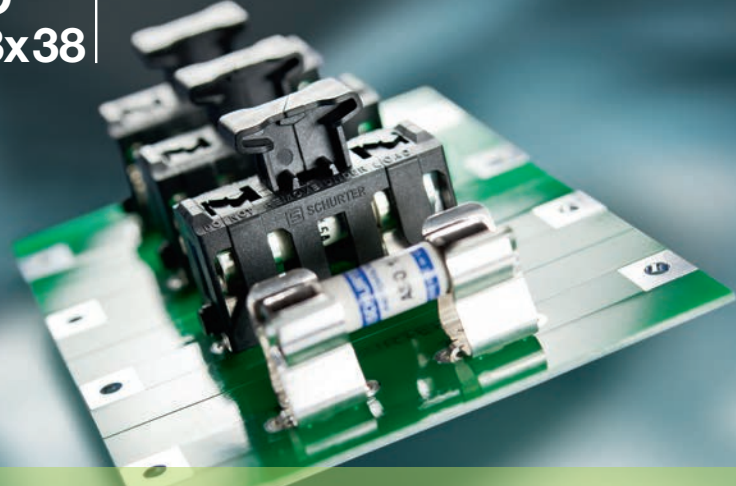
### In solar, change happens quickly

*As in many rapidly growing industries, technology advancements have developed quickly in solar. These changes mean today's solar panels are quite different from those in the recent past. Some of the updates include:*

- *Solder is being replaced by conductive adhesives, helping streamline manufacturing;*
- *Thinner glass and lighter frame components have made modules lighter;*
- *Degradation occurring from exposure to the elements is being addressed by utilizing double glass, producing stronger modules;*
- *Innovations in glass and sealing technology have allowed some frames to be eliminated entirely;*
- *Structural adhesives allow for simpler and faster installation of completed panels.*

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### Finding the right adhesives partner

Adhesives can help manufacturers throughout the entire solar production and supply chain, from development to installation. It's important to consider not only the value of the adhesive, but the specific solution needed for a project. After all, adhesives are not commodities.

One of the obvious factors in choosing a solution is understanding how it may impact or change the production method. Adhesives and sealants can boost product life and decrease labor requirements, so they help control costs. Having a trusted partner walk through these implications and strategies can help manufacturers find the right material.

Another factor is the sheer number of adhesive and sealant technologies available, and the variations within each. An experienced partner will help identify the proper solution for each part of the design and production process. With so many technologies to choose from – dozens of which could work for any single application – making a decision can be a bit overwhelming. Cost, compatibility with materials, and other factors must be taken into account.

Finally, a partner with global reach will not only offer supply assurance, but also understand what is required for products to perform across a broad spectrum of geographies and environments. The following is a quick checklist for choosing an adhesives partner and material:

- A partner with a wide range of offerings ensures “technology agnostic” advice;
- Don't overlook any aspect of a solution, no matter how minor it may seem. Shelf-life, storage, and mixing requirements are just a few considerations;
- New materials aren't always the best. Choose a solution that is proven to last;
- Remember a material is only as good as its provider's ability to meet the needs of their customer, and offer support on a global scale from a project's beginning to its end.

### What's next?

The disrupted energy market presents many challenges and opportunities for those in the solar industry. To be successful, companies must view solar holistically. That includes understanding the role adhesives play in the manufacturing and installation of panels. To distinguish themselves amongst the fierce competition, businesses should engage in strategic and deliberate thinking about how adhesives can help them meet, and create, the latest industry trends while boosting their bottom lines.

*David McDougall is the senior business development manager for H.B. Fuller's photovoltaic group. The company has been a provider of adhesives, sealants, and specialty chemicals for over a century and serves customers in engineering, electronic and assembly materials, hygiene, construction, automotive, packaging, and other consumer businesses. With the purchase of TONSAN Adhesive Inc. in 2014, the company has become a player in the market for solar products worldwide.*

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### Automatic PV panel cleaning

Washpanel designs and manufactures semi-automatic and automatic robots for the washing and cleaning of PV panels. These portable solutions for solar fields and roof-tops are able to guarantee better performance due to the frequency of high quality washings.

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# PV Plant Safeguarding

## Evolving from passive to proactive

by Huawei FusionSolar

The global photovoltaic (PV) industry has seen rapid development in recent years, and investments in PV plants are booming. Safety directly affects the return on investment (ROI), and as PV plants expand, PV plant owners face challenges to improve plant safety and diminish risks.

Based on insurance data, only 2% of accidents are due to fire, but fire damage accounts for 32% of accident compensation. Likewise, surge accidents account for 30% of compensation.

Safety and reliability are critical to PV plants, but if cost is a top consideration, safety may be compromised.

Often, fires are inverter-related, and problems usually involve noncompliance with national power grid requirements and lack of related standards between manufacturers. For example, the serial and parallel connection structures for equipment with a capacity of 35kV or lower, are non-standard, as is the supporting electrical equipment. The resulting complications can have a huge impact on PV plant owners, causing significant losses.

Technical experts agree most PV plant accidents stem from defective deployment solutions, as well as a lack of proactive protection. In mainstream string inverter-based smart PV plant solutions, large-scale ground PV plant projects must utilize proactive safeguarding because it has the following features:

1. Shift from DC to AC, minimizing use of risky high-voltage DC systems;
2. Fuse-less design;
3. Proprietary PID technology to remove personal safety risks;
4. Intelligent management system implementing string-level precise monitoring to identify risks early.

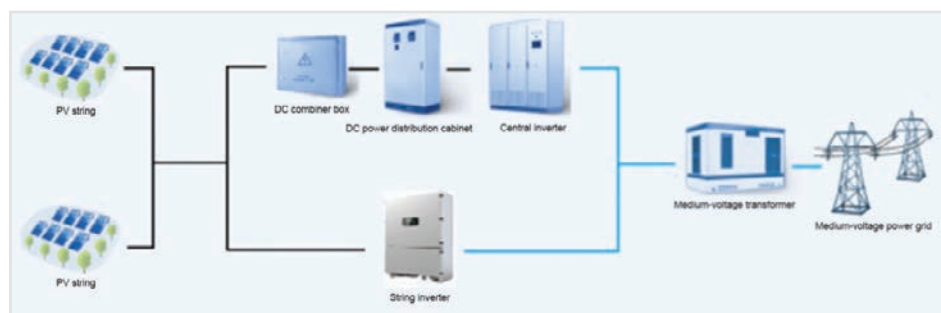


Figure 2. Comparison between the conventional central inverter-based PV plant solution and the smart PV plant solution

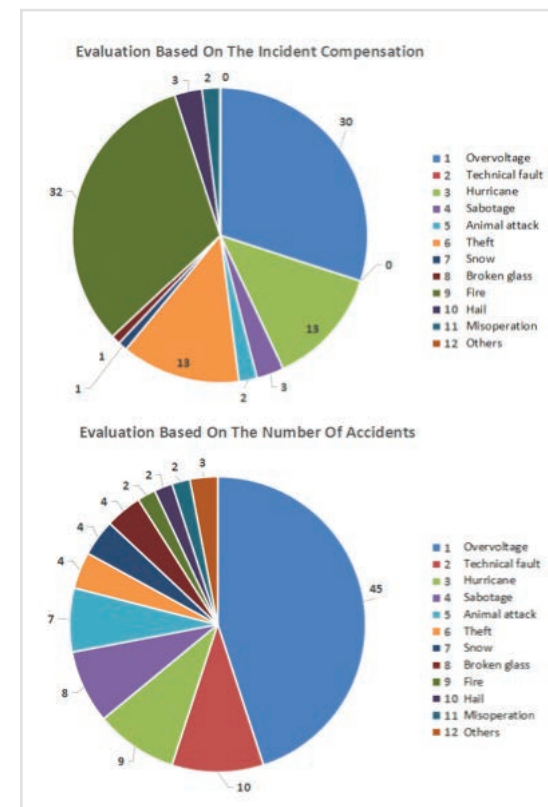


Figure 1. Evaluation based on the number of PV plant accidents and compensation amount

### Shift from DC to AC

More than 80% of fire accidents in PV plants are caused by DC faults, and in a conventional PV plant (with central inverters), three high-voltage DC devices are used: DC combiner box, DC distribution cabinet, and the inverter. In a smart PV plant, the only DC device used is the inverter. This configuration shortens the transmission distance of DC power cables, and reduces the hidden hazards resulting from DC faults.

Arcing is a main cause of fire, and AC arcing can extinguish at the zero crossing point, but DC arcing will not extinguish until much later, giving it a higher risk. When a DC combiner box and DC power distribution cabinet are deployed in a conventional PV plant with central inverters, the DC electricity transmission distance is long. This involves a number of nodes and increases the probability of DC arcing.

An AC electricity system provides better short-circuit protection. Since an AC fault involves short-circuit energy from the power grid, the energy is sufficient to trip the circuit breaker.

Using fuses and circuit breakers on DC transmission lines can be risky, as they only provide passive protection. A smart PV plant is designed without a DC combiner box or distribution cabinet. DC power from PV strings is directed to the inverter, where the power is converted into AC power for long-distance transmission. This design avoids safety issues involved in DC transmission, and reduces the safety risks of DC arcing.

### Fuse-less design

A 1MW PV plant with central inverters has 400 fuses with 1600 DC nodes and the boxes require reliable cable installation, which is not easy to obtain. Poor contacts can cause burning or DC arcing.

According to fuse failure rate statistics, the failure rate of fuses increases with service life, and exceeds 15% for fuses in service for more than five years. The high failure rate of fuses cause huge energy yield loss, making it harder to ensure PV plant safety.

A smart string PV inverter is connected to PV strings in parallel. If either string short-circuits, the back-feed current will not exceed 10A, and will not damage DC cables or PV modules. This fuse-less string design solution protects PV modules and cables at the source and avoids safety risks and loss incurred by fuse failures.



Figure 3. Fire accidents caused by DC arcing

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**Figure 4.** Fire accidents in mountainside PV plants

As the quota for PV plants increases and the construction cycle shortens, many PV plants are being built rapidly. Safety is vital during large-scale ground constructions. Conventional passive safeguarding cannot prevent PV plant accidents. Instead, proactive safeguarding should be practiced and reinforced. Evolving from passive safeguarding to proactive safeguarding will ensure the 25-year lifespan of PV plants.

**Huawei FusionSolar** | [www.huawei.com](http://www.huawei.com)

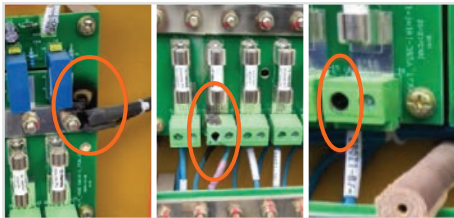


**Figure 6.** Agriculture and fishery-PV plants

**Proprietary PID technology removes personal safety risks**

The PID effect results in severe power attenuation of PV modules. In a conventional PV plant, the input PV is connected to ground using a fuse to prevent the PID problem. A high voltage exists between PV+ and PE, and touching the positive terminal of a PV module can cause electric shock or death. A grounding fault may occur in the positive terminals of PV modules or cables between PV strings and arcing may be generated over the ground cable, which can cause a fire.

When a virtual positive voltage circuit is set in a string inverter-based smart PV plant, positive voltage to ground exists in the negative terminals of all PV modules. This prevents the PID effect. Intelligent residual current detection and circuit cutoff help prevent electric shocks and ensure personal safety.



**Figure 5.** Burnt wiring terminals in DC combiner boxes

**Intelligent management system implementing string-level precise monitoring**

The controller of a string inverter-based smart PV plant detects the voltage and current of each connected string with 10 times the accuracy of a conventional smart combiner box solution. The smart inverter works as a high-precision sensor implementing precise monitoring, identifying risks, and promptly reporting string-level monitoring information to the management system. This feature enables O&M personnel to rapidly locate faults without onsite inspection and simplifies communications by using 4G wireless technology.

Smart PV solutions do not require an inverter room, which means better environmental protection, higher construction safety, less construction workload, lower electromagnetic radiation, less equipment for maintenance, and fewer points of failure.



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When it comes to securing solar panels to commercial rooftops, most racking systems are designed to be secured in place with ballast blocks or cement pavers.

Trouble is that even ballasted rack systems can still move around on the roof. Plus sharp or broken pieces of ballast can damage roof covers, leaving the building vulnerable to leaks and other roof problems. More important, many buildings cannot accommodate the dead load weight that ballasted systems require.

OMG PowerGrip and PowerGrip Plus were designed to help reduce the ballast from these racking systems, and are ideal for use on roofs covered with single-ply roof membranes. OMG PowerGrip products provide a secure connection directly to the roof deck or structural members and once heat welded in place, properly installed PowerGrip products help minimize rack movement and remain watertight.

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# Financial Technology

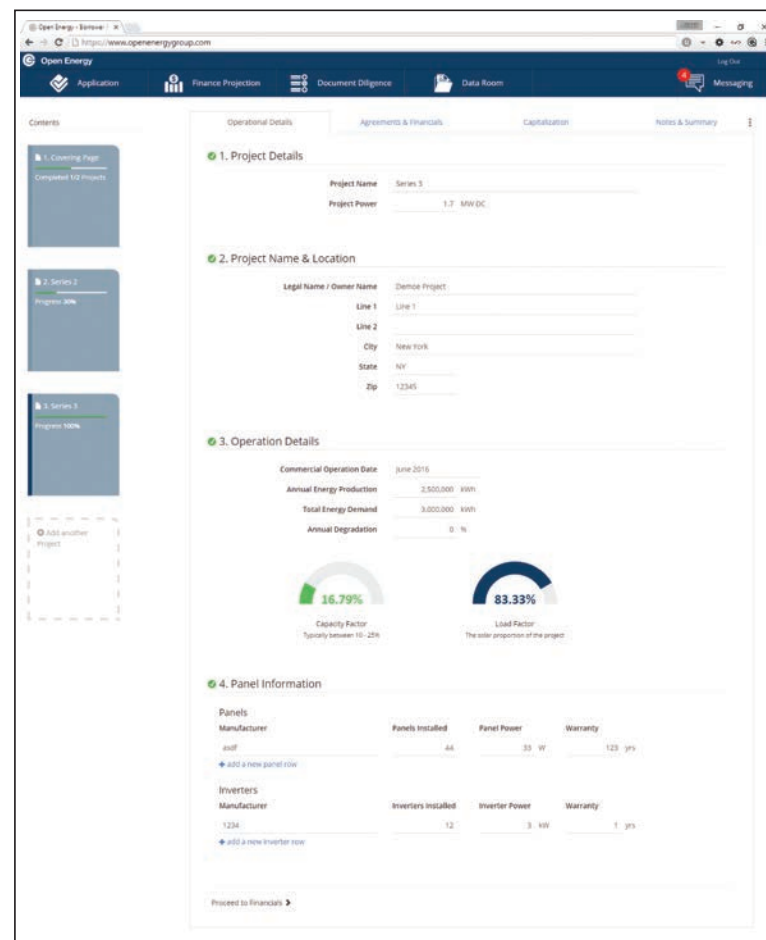
## A pathway to growth in solar

by Graham Smith

**THE SOLAR INDUSTRY HAS FLOURISHED IN THE PAST FIVE YEARS, GROWING FROM 1.85 GIGAWATTS**

installed in 2011, to an estimated 16 gigawatts in new installations by the end of 2016. This growth can be attributed, in large part, to rapid reductions in solar equipment costs through manufacturing efficiencies in panels and inverters. To continue this positive trajectory, however, the industry must see a reduction in soft costs as well. Particularly in the commercial and industrial solar sector, financing remains a common obstacle to project execution. Non-residential solar features a plethora of project sizes and power purchasers, often making the due diligence needed for financing, extremely complex and relatively expensive. Bringing financial technology innovation to solar financing can reduce the overall capital cost for the developer and owners and offer more tailored, streamlined financing solutions.

Bringing commercial solar financing online increases efficiency almost instantly, by reducing the time necessary to apply for financing. Allowing developers to view all of the information upfront that they will need to present in an application, means they can start the process with a clear idea of what their prospective financier will require. An online application also ensures that developers complete the entire process thoroughly, as forms typically cannot be submitted if elements are missing. This saves on time wasted going back and forth to identify missing information, and gets the financiers working sooner.



In addition to being more efficient, online platforms allow solar financiers to be highly responsive to their clients. Most developers have dealt with slow response times, ambiguous instructions, or misplaced information when working with traditional lenders. Simple automations, like securely auto-saving a web form so that data is not lost, can make a big difference in the ease of use experience for developers and asset-owners seeking capital. The solar industry can look to e-commerce for best practices; the consumer retail industry has devoted copious resources to cultivating highly user-centric online experiences. By creating an interface that operates seamlessly and is easy to use, financiers will promote customer loyalty and reduce the time it takes to apply and fund solar projects.

Technology can also help simplify the project due diligence in solar. Without document standardization, especially in an industry known for its variety in projects, it is difficult to take the human review elements out of the due diligence process. However, a good portion of project due diligence involves sending various iterations of documents back and forth among stakeholders to obtain comments and signatures. Allowing developers to upload and edit documents in one centralized location online, can cut financing approval times from months to days. More importantly, this technology already exists in numerous enterprise software platforms. With some simple customizations, the solar finance industry can harness these software systems to further reduce transaction costs.

Innovative financial technology can also reduce the labor involved in processing loans. Automation has transformed personal finance from a slow-moving industry into one that is speedy, customer-oriented, and almost entirely digitized. The solar finance industry needs a similar disruption to make the lenders and borrowers more efficient.

Solar projects are inherently complex and often full of project-specific nuances. While financial technology cannot replace human expertise in solar, it can do much to improve efficiency and streamline processes for developers and lenders alike, significantly reducing financing costs and accelerating the growth of the US solar industry.

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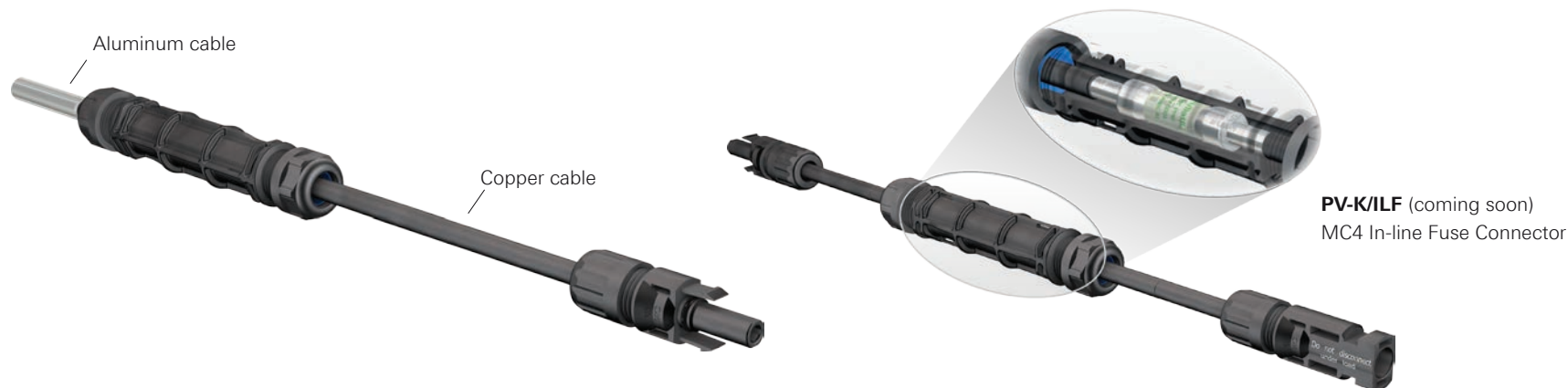
Graham Smith is CEO of Open Energy, an innovative provider of debt financing solutions for commercial solar projects. Smith has over 15 years of experience in renewable energy finance and building capital markets brokerage platforms. He founded Open Energy in 2013 to use financial technology innovation to drive debt financing and unlock the U.S. commercial solar market.

Open Energy | www.openenergy.com

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### New array skirt for rail-less mounting system

Solar Clam-P introduces the new Snap-N-Skirt. With simplicity being the basis of functionality, and uniqueness being the basis of design, the smooth rounded appearance of the Snap-N-Skirt is an aesthetic and functional finishing touch to any solar system. The Solar Clam-P Snap-N-Skirt is a decorative cap which covers the front of the solar array, or can be used as a wind deflector at the ridge. The Solar Clam-P Snap-N-Skirt comes in one piece that attaches onto the Solar Clam-P A-Beam and Beast. The Snap-N-Skirt comes standard in black, and is available in any color.

**Solar Clam-P** | [www.solarclam-p.com](http://www.solarclam-p.com)



### All terrain tracker

Soltec's SF Utility solar tracker conquers slopes up to 17% grade South to North, and reaches far into irregular terrain with wide standard installation tolerances. And it reaches there responsibly with less environmental impact (emissions, grading, pile-driving) on challenging terrain, from delicate land-fill to extreme desert-rocky to heaving frozen-ground. SF Utility mounts double the PV area per tracker length, and cuts tracker length in half for greater land-use precision. It requires fewer foundation-piles per MW and delivers a fast MW installation rate. SF Utility provides high yield land-use and low-cost installation, and with great respect for environmental responsibility.

**Soltec** | [www.soltec.com](http://www.soltec.com)



### Higher output, same price

A generation change has taken place within the coolcept3 inverter range at Steca. The company will replace two inverters with a significantly higher output version in each case. Specifically, the StecaGrid 4803 and StecaGrid 5503 models will be replaced with the StecaGrid 5003 and StecaGrid 6003. With the latest modules, it is now possible to incorporate more output in one string, in other words, in a series connection of modules. The new, higher output coolcept3 inverters have taken this into account. The new StecaGrid 5003 and StecaGrid 6003 inverters don't cost any more than their predecessors, while at the same time providing a great deal more power.

**Steca Elektronik GmbH** | [www.steca.com](http://www.steca.com)



### 1,500-volt solar panel

SolarWorld announced that it will release a 1,500-volt solar panel in time for this year's fourth-quarter peak selling season. The 1,500-volt technology enables installers to increase lengths of solar-panel strings by up to 50%, thereby requiring fewer combiner boxes, less wiring, and trenching and lower labor costs. Analysts have estimated the cost savings at up to 5 cents per watt installed. The technology's application is ideal for large commercial and utility-scale designs. SolarWorld has not needed to increase the size of its 72-cell solar panel to reach the 1500-volt standard. The new solar panel is certified to UL1703; it is free of potential induced degradation (PID), as per IEC 62804-1:2015.

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### Hybrid racking system

Solar Speed Rack's HRS is a racking system that can be used as either a clamped, shared rail, or a combination of both. This is accomplished through use of the SSR Clip Bracket which, when inserted into the rail channel, converts a standard to a shared rail system. Use of the HRS system as a hybrid can eliminate up to 25% of the materials required and virtually eliminates the precision required in a fully shared rail configuration while giving the modules support, not only from the clamps, but also from the underneath rails. The HRS system is fully UL2703 listed.

**Solar Speed Rack, Inc.** | [www.solarspeedrack.com](http://www.solarspeedrack.com)



### Field-installable T4 PV connectors

Canadian Solar Inc. introduces the new T4 Field-Installable PV Connector portfolio to the North American market. The T4 PV Connector is a field-installable PV connector manufactured by TLIAN, a subsidiary of Canadian Solar established in December 2014. The T4 Connector is certified for UL 1500V DC system voltage and has an IP68 rating for highest ingress protection for water / humidity - which increases the reliability and long-term stability of the connector. In addition, the new Canadian Solar connector portfolio supports a broader operating temperature range of -40°C~+90°C to allow the usage in very hot climates such as the Middle East, Central America, and others. The NEC-compliant locking mechanism secures against vandalism and against unplugging under load for maximum safety and protection.

**Canadian Solar, Inc.** | [www.canadiansolar.com](http://www.canadiansolar.com)



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### Powerful, reliable, and flexible micro inverter

Darfon announces the worldwide release of the G320, its third generation microinverter. The Darfon G320 packs power, flexibility, and reliability that can be installed in residential, commercial, or utility applications. This new microinverter is capable of handling both 60- and 72-cell modules with a power rating of up to 350W. The G320 design also leaves the cabling options up to the installer, whether it be a trunk cable or not. To add even more flexibility to the product, the G320 is available in multiple voltage and phase configurations to satisfy commercial or residential installations. The G320 offers the increased safety of microinverters, but with even more reliability. The G320 features a high survivability capacitor design that continues working even if the electrolytic capacitors have problems over time.

**Darfon Electronics Corp.**

www.darfonsolar.com



### Fiber optic connectors

AFL is introducing the TITAN RTD FTTx system featuring AFL TRIDENT Hardened Fiber Optic Connectors. The product set allows for quick and easy subscriber connections anywhere in the OSP network. The sealed and rugged design of both the TITAN RTD Multipoint and TRIDENT connector allow for long-term reliability when installed anywhere in the network—underground, in pedestals, on poles, or on aerial strand or ADSS cables. With the hardened and sealed nature of the connector and terminal interface, TITAN can be placed anywhere in the outside plant network. AFL has developed a detailed solutions guide to provide assistance with what products best serve customer-specific FTTx requirements. These products include not only the new AFL TITAN RTD FTTx system, but also a full line of fiber distribution cabinets, closures, demarcation enclosures, field installable connectors and more.

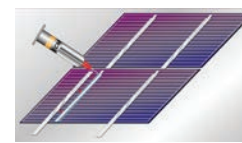
**AFL** | www.aflglobal.com



### Fixed-tilt ground-mount

TF2 is the next generation fixed-tilt ground mount racking solution manufactured by TerraSmart. Based on over six years and 2GW of installed-capacity experience, TF2 not only includes the versatile TerraSmart ground screw foundation, it also incorporates many improvements and features. Leveraging the benefits of their proprietary ground screw foundation to work with any soil condition, TerraSmart focused on the installation process to ensure TF2 offered large efficiencies for in-field teams. TerraSmart's installation machinery not only provides a more precisely installed foundation, their state-of-the-art surveying, rock drilling, and installation equipment also removes project risks and increases installation velocity. All of these benefits improve upon TerraSmart's construction efficiency and raises the bar by offering customers an additional 30% reduction of installation man-hours, saving time on every project.

**TerraSmart** | www.terrasmart.com



### Adhesives for stringing and shingling solar modules

Engineered Material Systems, Inc. (EMS) announces its new 561-400 series Low-Cost Snap Cure Conductive Adhesives. The 561-400 series is designed for stringing and shingling crystalline silicon and heterojunction solar modules. The EMS 561-400 series is designed to be used in modified ribbon stringers. The material will snap cure and fixture ribbons in seconds at 150°C with enough strength to withstand module manufacturing processes until the adhesive cure is completed during the encapsulant lamination process. EMS 561-400 series conductive adhesives can be dispensed by time-pressure, auger or jetting. The adhesive is more stress absorbing than solder to withstand the rigors of thermal cycling and processes at lower temperatures than solder. EMS 561-400 series conductive adhesives are 60% less expensive than pure silver-filled conductive adhesives.

**Engineered Material Systems, Inc.**

www.emsadhesives.com

# COTEK SD Series Pure Sine Wave Inverters



SD 3500

#### KEY FEATURES:

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- Wide DC input range & operating temperature
- Light weight & low profile
- Intelligent software for power management
- Advanced protection features
- Adjustable power saving options

COTEK is a global leader in the manufacture of off-grid, battery-based pure sine wave inverters. This product-line enhances the reputation that COTEK has established since 1986 for innovative technology and total quality assurance. With a 2 year warranty and excellent customer support, the SD series will soon become the industry standard.



CR-10 Remote

### Advanced recyclable renewable energy batteries

From their extensive use of recycled lead and plastic to manufacturing that incorporates solar panels, wind turbines, and geothermal cooling, Crown1 AGM batteries can be considered "green" renewable energy batteries. According to the U.S. Environmental Protection Agency, this battery style is 98% recyclable – more recyclable than any other product in North America, including the aluminum can and all other battery technologies. Crown1 can be recycled into new batteries – for decades. Every Crown1 battery is manufactured at the company's Fremont, Ohio headquarters using the industry's heaviest plates and most active materials, to enhance performance and lifespan. Robotic assembly and aerospace vision systems streamline production and ensure uniformity. And Crown's proprietary cast-on-strap process allows for 100X the precision of manual welding. Crown1 offers 6-, 8-, and 12-volt models with 33-390 Ah (20-hour rating) capacities.

**Crown Battery Manufacturing Company**

www.crownbattery.com



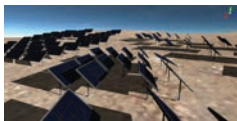
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For complete product specifications visit: [www.cotek.ca](http://www.cotek.ca)



### Microinverter for high-output PV modules

APsystems extends its advanced microinverter line with the new YC500i with EnergyMax power handling and integrated ground, now available in North America. EnergyMax technology allows the dual-module unit to produce 274 watts peak output per side (548W total), an almost 10% increase in peak power output over conventional microinverters to harvest the power of today's high-output PV modules. The YC500i microinverter builds on the same advanced, FPGA chip-based platform as the YC500A flagship model. EnergyMax technology developed by APsystems maximizes the inverter's power output for higher energy harvest across the solar array. The YC500i utilizes a trunk cable, offering installers an alternative to the daisy-chain design of APsystems YC500A microinverters. This provides a solution for installers who favor trunk cable architecture as well as markets where regulatory bodies prefer an integrated ground. APsystems customers with a cabling preference can now choose-daisy-chain connection with the YC500A or trunk cable connection with the new YC500i with EnergyMax.

APsystems | www.apsystems.com



### New PV design software

Meteodyn has developed a solar PV software. meteodyn PV is now available to all solar plants developers, operators, engineers, and consultants. This professional software is dedicated to large scale solar projects. Meteodyn PV software assesses solar resource and production to analyze site suitability. Meteodyn PV computes production and losses assessment based on meteorological analysis tool and detailed shading to design the best PV system layout. The software can compute over very large domains, whatever the terrain, panels, or obstacles. They have chosen to develop a professional software, easy to use, with strong computation capacity and with advanced 3D modeling to visualize projects and help make decisions. Meteodyn's software computes solar energy for urban PV projects and provides solar production forecast services with horizons of a few minutes to a few days.

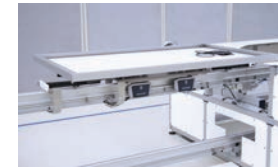
Meteodyn | www.meteodyn.com



### Medium voltage block for utility-scale applications

SMA's Medium Voltage Block is an integral part of the Utility Power System, and pairs seamlessly with SMA's new line of central inverters: the Sunny Central 1850-US, 2200-US and 2500-EV-US. The Medium Voltage Block is a simplified solution mechanically, based on the layout of a traditional ANSI pad mount transformer, with low-voltage connections positioned horizontally in plane with the output bus bars of the inverter. To enable this shorter connection scheme, the low-voltage connections have been relocated to the side of the medium-voltage transformer, in their own connection flange. All of the necessary installation hardware, including the busway, bus bars, grounding straps, connection hardware, and transformer monitoring cable sets, are included. These conveniently kitted components offer simplified field integration, requiring as little as one man hour, while eliminating the need for skid solutions. Engineered to minimize risk, the Medium Voltage Block has been fully type tested and validated at SMA's engineering facility to meet the needs of PV applications with a 25-year service life. Its space-optimized design with a 22% smaller footprint reduces shipping costs while fewer components and easy access maximize serviceability. Transformer monitoring, communicated through the inverter MODBUS registries, reports the health of the transformer, including analog values for temperature and pressure, which enables trend-based predictive maintenance that can considerably reduce O&M complexity.

SMA America | www.sma-america.com



### Shuttles instead of conveyors

The SCHMID Group's montrack transport system connects processing stations with mono rails on which shuttles bring the solar modules from one processing station to the next. The configuration of the module line is very flexible, as the mono rail made of aluminum requires little space and the shuttles also drive curves with very small radii. The shuttles are quiet in operation and provide vibration-free transport of the solar modules with their special frame made of carbon. In addition, the sensor-controlled safety technology with its auto-stop function detects possible obstacles on the monorail, thus preventing collisions. A shuttle can be removed with one hand grip from the production process without stopping the line. So montrack runs at anytime with no single point of failure. Should one processing station be blocked, the shuttle automatically backs out via bypasses. This possibility leads particularly in the cluster layout to an optimal utilization of the machines. The modular design of the system can be adapted to changing processes and can be extended at will.

The SCHMID Group  
www.schmid-group.com

**5-Panel Ballast Ground Mount System**  
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See this, our Solar Carports and 5-High Posted Ground Mount products at SPI booth 2545



### Fast inspection software algorithms for IBC cells

ISRA VISION/GP SOLAR's KFP Light Dome enables different lighting set-ups, allowing high contrast for even the smallest details. By using different types of lighting in their multi-view approach, ISRA and GP SOLAR have succeeded in developing a reliable way to inspect difficult technologies like PERC cells, and the finished products of plating or multiple coating processes. But unlike these inspection tasks, IBC inspection can no longer be achieved through high resolution for defining finger widths alone. IBC cells have wide fingers, but defective positioning and tiny pinholes during the process can lead to severely impaired cell efficiency. Having enabled rear contact inspection by creating sharply contoured images even on colored surfaces, ISRA VISION/GP SOLAR's multi-view technology has reached the next level for IBC inspection. By changing the angle of the incident light to add different types of lighting, ISRA has successful results in IBC inspection. The robust software enables cycle times of less than one second for controlling and monitoring IBC processing, allowing highly efficient production with same yield as with standard technology. This forms the basis of efficiency of more than 23% in industrial-scale cell technologies, a level that has been reserved for tiny laboratory cells for decades.

**ISRA VISION** | [www.isravision.com](http://www.isravision.com)

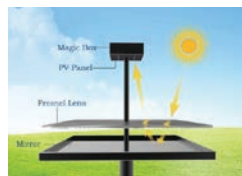
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### Complete set of solar technologies

BolySolar is a complete set of solar system technologies aiming to provide the entire world with affordable renewable energy while solving the problems of energy and water shortages. The BolySolar Concentrators, is a concentration lens system specifically designed for solar energy applications. The Magic Box is a versatile heat utilization device. The BolySolar Post utilizes a reflective Fresnel lens to concentrate light into the focal area supported by the Post or any other support structures. It can be configured to create useful by-products such as artificial fuel and desalinated water; it produces almost no light pollution, as the reflective lens confines light between the solar energy utilizer and reflective Fresnel lens; it is ideal for street lighting and roadside installations, especially where space is limited. The BolySolar Post is the first product of the BolySolar Concentrators product line. It is anticipated that when BolySolar Concentrators and other technologies are fully implemented and utilized, the world can afford to run solely on renewable energy while enjoying the benefits of its by-products.

**Bolymedia Holdings Co. Ltd.** | <http://en.bolymedia.com>



### PV ground-mount solution

Sigma Pure is a PV ground mount system designed for small- to moderately-sized PV arrays. Sigma Pure uses galvanized steel pipes as support legs, which are secured by concrete piers, concrete ballasts, or earth screws. The steel legs support a strong, corrosion-resistant aluminum and stainless steel superstructure. Preassembled clamps and connection hardware help speed array assembly. Sigma Pure can be configured for landscape or portrait orientations. In landscape, modules can be mounted in columns up to 4 high with up to 9 modules per row. In portrait, modules can be 2 high with up to 9 modules per row. Sigma Pure is a robust yet economical PV mounting structure with preassembled superstructure components, which minimizes labor and also reduces cost. Sigma Pure's strong, extruded aluminum superstructure helps maximize the span between supports, decreasing the overall number of supports required. Sigma Pure implements a strategic combination of engineering innovation, fast procurement, and easy installation that is both cost-effective and long-lasting, resulting to a ground mount system ideal for a wide range of system sizes and configurations. All of Sigma Pure's configurations are PE stamped in solar friendly states to facilitate permitting and approval.

**Mounting Systems** | [www.mounting-systems.com](http://www.mounting-systems.com)



### Fully packaged electricity meter

SolarEdge's new electricity meter comes in a NEMA 3R rated enclosure to protect it from the elements and is supplied with two current transformers (CTs). It connects to the inverter via RS485. The meter is accurate to ±1% and is outdoor rated from -22°F to +131°F. The meter is suitable for residential systems (240V split phase) and has three main applications: consumption monitoring to track how much energy a home is using; export limitation to control and limit exports of PV to the grid; and StorEdge Smart Energy Management applications, when combined with a battery, store excess PV energy and use it later to maximize self-consumption of PV. The SolarEdge Electricity Meter comes with a 5-year standard warranty.

**SolarEdge** | [www.solaredge.com](http://www.solaredge.com)

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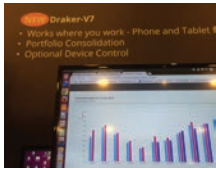
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- 4.500", 5.000" or 5.563" OD
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- True Pitch Helixes: 3", 4" or 6"

- Northern climates with soil susceptible to frost heave
- Expansive soils with high clay contents

[www.ancorapiling.com](http://www.ancorapiling.com)





### Data acquisition and control technology

Draker Corporation announced its new generation data acquisition and control systems for connecting solar power plants with Draker's monitoring and analytics platform. The data-handling protocols and communications interfaces are optimized for Draker's monitoring software, which is offered as a subscription service. Each configuration now incorporates two-way communications and control capability to increase operational efficiency and ensure compliance with demanding interconnection requirements in most global markets, including all states and territories of the U.S. Draker's new entry-level solution is tailored for smaller power plants and sites that require a limited number of data collection points. Draker has tightly integrated everything needed to reliably monitor inverters, performance instruments and meters along with cellular network connectivity into a single low-power device. Their streamlined configuration and practical options provide the essential features needed to track, operate, and meet performance and profitability goals of smaller-scale installations. Draker's new generation flagship product is designed for larger commercial and small utility-scale installations. This system configuration has the performance and capabilities to monitor and control complex sites with hundreds of monitored devices (smart combiner boxes, storage systems, etc.). It draws on Draker's expansive library of interface software to enable connection to nearly any device and collects data at a fast sampling rate. Draker is excited to be offering this data acquisition and control hardware at a price point that delivers value to the industry.

**Draker Corp** | [www.drakerenergy.com](http://www.drakerenergy.com)



### Premium features and options added to string combiners

Yaskawa - Solectria Solar announced premium features and options have been added to its DISCOM and ARCCOM string combiner lines. The combiners have gone through Highly Accelerated Lifetime Testing (HALT) guaranteeing all components are carefully vetted for reliability. They offer utility-scale and large commercial PV designers the design flexibility needed in combiners. These string combiners have already been used in multiple utility-scale projects in the United States from 30-100MW. The premium features added to the DISCOM and ARCCOM satisfy the growing needs of PV system designers and reduce overall system cost and increase ROI [return on investment]. These premium features include: high gloss white polyester powder coat painted steel, this finish is proven to keep the electronics cooler in higher temperatures and reduces extreme thermal cycling, adding to the product life; Heavy Gauge Bus Bars with High Quality Plating: reduces operating temperature, maximizing product life and eliminating failures. The plating is bright tin which prevents corrosion between components maximizing product life; Multi-Contact MC4 or Amphenol H4 Connectorized Wire Whips: Whips are the most robust option reducing installation time and costs; Compression and Mechanical Connectors: designed to fit various wire sizes and copper/aluminum output connectors; 316 Stainless Steel: Bellville spring washers and nuts on output studs in Bellville stainless steel which eliminates corrosion possibility.

**Yaskawa - Solectria Solar** | [www.solectria.com](http://www.solectria.com)



### Project website improvements

Schletter introduces two new features added to PV Powersite. The first is the availability of Schletter's 4200mm rails for the FS System, PvMax, PvMini and Windsafe on [www.pvpowersite.com](http://www.pvpowersite.com). Now, when project information is entered, the design software will automatically calculate how many 6200 and 4200mm rails are needed for the project. The result is a cost savings, reducing the possibility of excess rails in project designs. The second design improvement to PV Powersite is the addition of a save feature for project designs. Projects can still be designed online, parts are calculated into a simple bill of materials, and a calculations package is available as before. With this new save functionality, login and save up to three projects to review and order when ready.

**Schletter Inc.** | [www.pvpowersite.com](http://www.pvpowersite.com)

# Standing up to the test of time

Fibox polycarbonate enclosures recently took part in an independent ISO 4892-2\* (accelerated weathering test) study alongside other polycarbonate and fiberglass enclosure materials.

For over 5,000 hours Fibox's enclosure materials were bombarded with high intensity UV light simulating years' worth of sunlight exposure. The results demonstrated what we knew all along; pound for pound Fibox polycarbonate out performed both the fiberglass and other polycarbonate materials in the test.

The Fibox polycarbonate maintained its durability with a low color change as the UV exposure progressed. Your Fibox enclosure will continue to look great as it protects your products over the life of your design.

Have confidence that your products will be housed in the most resilient enclosure on the market. Easily allowing updates and upgrades throughout the years as your technology advances.

Fibox manufactures NEMA 4X polycarbonate enclosures designed for harsh and hostile environments. With solutions ranging in size from 2x2 to 32x24 inches.

And let Fibox bring your products into the light.



To learn more visit Fibox at SPI booth 440, [www.fiboxusa.com](http://www.fiboxusa.com) or call 410.760.9696



\*The ISO 4892-2 test is five times longer in duration and utilizes a more powerful UV radiation source than the UL 746 UC test. ARCA 242410 shown above with optional ARCA Instrument Protection Window

# Modules

Efficient design and a high-yield performance are key factors in any solar energy project. Regardless of the project size—whether small or utility-scale—selecting the right module is extremely important. To help you find the right choice for your solar project, we've highlighted some of the top contenders in the industry.

## SEE AD ON PAGE 37



### LG

**Product:** NeON 2 Black (LG305N1K-G4)

**Available Power:** 305W

**Maximum Power:** 305W

**Power Tolerance:** -0% / +3%

**Maximum Efficiency:** 18.6%

**Size:** 1640mm x 1000mm x 40mm (64.5" x 39" x 1.57")

**Weight:** 17.0 kg ± 0.5 kg (37.48 lb ± 1.1 lb)

**Warranty:** 12-year warranty

**Certifications/Listings:** IEC 61215, IEC 61730-1/2, IEC 62716 (Ammonia Test), IEC61701 (Salt Mist Corrosion Test), ISO 9001, UL 1703



#### Key Features:

- LG NeON 2 Black has an enhanced performance warranty. The annual degradation has fallen from -0.7%/yr to -0.6%/yr;
- LG NeON 2 Black has been designed with modern aesthetics in mind; thinner wires which appear all black at a distance;
- LG NeON 2 Black generates more electricity on sunny days and even performs more efficiently on cloudy days thanks to its improved temperature coefficient;
- With its newly reinforced frame design with improved firmness, LG has extended the warranty of the NeON 2 Black to 12 years. Additionally, LG NeON 2 Black endures a front load up to 6000Pa, and a rear load up to 5400 Pa;
- The rear of the cell used in LG NeON 2 Black contributes to generation, just like the front; the light beam reflected from the rear of the module is reabsorbed to generate a great amount of additional power.

[www.lgsolarusa.com](http://www.lgsolarusa.com)

## SEE AD ON PAGE 41



### SolarWorld

**Product:** Sunmodule Bisun XL 330 duo

**Available Power:** 330W

**Maximum Power:** 412.50W

**Power Tolerance:** -0% / +5%

**Maximum Efficiency:** 20.04%

**Size:** 1993mm x 1001mm x 33 mm (78.6" x 39.4" x 1.3")

**Weight:** 21.59kg (47.6 lb)

**Warranty:** 25-year linear performance guarantee, 10-year product warranty

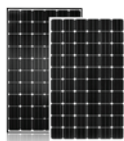
**Certifications/Listings:** IEC 61215 (qualified), IEC 61730 (safety tested), IEC 60068-2-68 (blowing sand resistance), IEC 62716 (ammonia resistance), IEC 61701, (salt mist corrosion) UL 1703, ISO 9001, ISO 14001



#### Key Features:

- Offers up to 25% more energy yield than standard solar modules with the same nameplate power, due to the efficiency of duo bifacial cells, which collect solar radiation on both front and back;
- Increases energy harvest on flat-roof and ground-mounted solar systems;
- The module is available in both 60-cell and 72-cell models;
- Multiple mounting options for system design flexibility.

[solarworld.com](http://solarworld.com)



### itek Energy

**Product:** IT-SE

**Available Power:** 290W - 300W

**Maximum Power:** 315W

**Power Tolerance:** -0% / +2%

**Maximum Efficiency:** 17.89%

**Size:** 1675mm x 101mm x 50mm (65.94" x 3.97" x 1.96")

**Weight:** 19.05kg (42 lb)

**Warranty:** 25-year power warranty, 10-year workmanship

**Certifications/Listings:** ETL

[www.itekenergy.com](http://www.itekenergy.com)



### ZNShine PV-Tech, Inc.

**Product:** ZXP6 72-320/P

**Available Power:** 320W

**Maximum Power:** 320W

**Power Tolerance:** -0% / +3%

**Maximum Efficiency:** 16.48%

**Size:** 1955mm x 990mm x 40mm (77" x 39" x 1.57")

**Weight:** 22.49kg (49.6 lb)

**Warranty:** 10-year workmanship, 25-year linear output warranty

**Certifications/Listings:** UL/CSA

[www.znshinesolar.com](http://www.znshinesolar.com)



### Lumos Solar, LLC

**Product:** LSX Module System

**Available Power:** 250W - 265W (250W to be discontinued)

**Maximum Power:** 265W

**Power Tolerance:** -0% / +5%

**Maximum Efficiency:** 15.3%

**Size:** 1664mm x 1040mm x 27mm (65.5" x 41.0" x 1.1")

**Weight:** 28.4kg (62.6 lb)

**Warranty:** 10-year workmanship, 25-year power

**Certifications/Listings:** UL, IEC, CEC listed

[www.lumossolar.com](http://www.lumossolar.com)



### Hanwha Q CELLS

**Product:** Q.PEAK-G4.1

**Available Power:** 300W

**Maximum Power:** 305W

**Power Tolerance:** -0% / +5%

**Maximum Efficiency:** 18.3%

**Size:** 1669mm x 1001mm x 32mm (65.7" x 39.4" x 1.26")

**Weight:** 18.8kg (41.45 lb)

**Warranty:** 25-year warranty (98% first year, then -0.6% years 2-25)

**Certifications/Listings:** UL 1703; VDE Quality Tested; CE-compliant; IEC 61215 (Ed.2); IEC 61730 (Ed.1) application class A

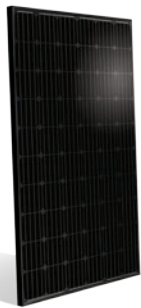
[www.q-cells.us](http://www.q-cells.us)

# Together We Shine

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SunVivo  
PM072MW0  
(up to 355W)



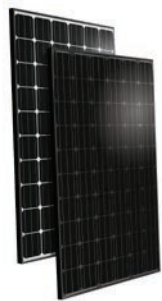
SunVivo  
PM060MBR  
(up to 290W)

AU Optronics (AUO) offers diversified display and solar solutions with exceptional performance and proven quality globally. AUO possesses a vertical integration of value chain from high-efficiency materials, modules to system integration, as well as employs broad technologies to enhance module power output and reliability. Our offering covers high-efficiency solar modules, integrated racking solutions, energy storage and management systems. Contact AUO today to bring the power of your solar system to a new high level!

[solar.AUO.com](http://solar.AUO.com)

**AUO**

SEE AD ON PAGE 35



### AU Optronics Corporation

**Product:** SunVivo PM060MWR / PM060MBR

**Available Power:** 280W - 300W / 270W - 290W

**Maximum Power:** 300W

**Power Tolerance:** 0% / +3%

**Maximum Efficiency:** 18.4%

**Size:** 1640mm x 992mm x 40mm (64.57" x 39.05" x 1.57")

**Weight:** 20kg (44.09 lb)

**Warranty:** 10-year material and workmanship, 25-year linear degradation to 80%

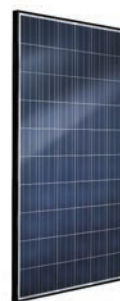
**Certifications/Listings:** UL 1703

**Key Features:**

- 60-cell mono-crystalline photovoltaic module, made in the USA;
- Available with an all black design option for a more aesthetically appealing look;
- Highly strengthened design, complying with advanced loading tests to meet the 5400 Pa loading requirement;
- UL certified;
- Equipped with anti-reflection coated glass to help enhance power performance.

[solar.auo.com](http://solar.auo.com)

SEE AD ON PAGE 38



**Japan Solar**

### Japan Solar

**Product:** JS-260U-RJ160

**Available Power:** 260W

**Maximum Power:** 260W

**Power Tolerance:** -0% / +3%

**Maximum Efficiency:** 16.0%

**Size:** 1640mm x 992mm x 40mm (64.6" x 39.1" x 1.6")

**Weight:** 18.5kg (41.9 lb)

**Warranty:** 25-year linear performance guarantee, 10-year product warranty

**Certifications/Listings:** UL1703, ULC/ORD-C1703-01

**Key Features:**

- Japanese quality management systems with equipment and processes established through 20-years of manufacturing experience;
- Japan Solar uses Japanese branded equipment ensure "Made-in-Japan" quality;
- Final testing and inspection is done multiple times using calibrated Japanese testing equipment;
- Every module embodies Japanese workmanship under the "Japan Solar" brand name.

[www.japansolarus.com](http://www.japansolarus.com)



### Talesun Solar

**Product:** Hipro M350+

**Available Power:** 340W - 350W

**Maximum Power:** 350W

**Power Tolerance:** -0% / +3%

**Maximum Efficiency:** 18.0%

**Size:** 1960mm x 990mm x 40mm (77.2" x 39" x 1.6")

**Weight:** 23.5kg (51.1 lb)

**Warranty:** 25-year warranty linear power output warranty, 10-year material and workmanship warranty

**Certifications/Listings:** CE, UL, JET, CEC approved

[www.talesun.com](http://www.talesun.com)



### AEE Solar, Inc.

**Product:** REC TwinPeak Series

**Available Power:** 280W

**Maximum Power:** 280W

**Power Tolerance:** -0% / +5%

**Maximum Efficiency:** 17.0%

**Size:** 1663mm x 990mm x 38mm (65.5" x 39" x 1.5")

**Weight:** 18kg (39.5 lb)

**Warranty:** 10-year product warranty, 25-year linear power output warranty

**Certifications/Listings:** UL 1703, Fire classification Type 2, IEC 61215, IEC 61730, MCS accredited, IEC 61701, IEC 62716

[www.aeeexpress.com](http://www.aeeexpress.com)

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SYSTEMS

Flexible, Ultra-thin, Light Weight PV Modules  
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SOLARPOWER INTERNATIONAL BOOTH W501  
[solopower.com](http://solopower.com)



### Centrosolar America

**Product:** B-Series (BM60 290BB)

**Available Power:** 290W

**Maximum Power:** 290W

**Power Tolerance:** -0 % / +1%

**Maximum Efficiency:** 17.3%

**Size:** 961mm x 1675mm x 1001mm (37.8" x 39.4" x 65.95")

**Weight:** 18kg (39.7 lb)

**Warranty:** 10-year product warranty, 25-year linear performance warranty

**Certifications/Listings:** IEC61215, IEC61730, IEC60068-2-68, IEC 62716, IEC 61701

[www.centrosolaramerica.com](http://www.centrosolaramerica.com)



### solarnova Deutschland GmbH

**Product:** Custom-made building-integrated photovoltaic modules

**Available Power:** depends on the individualized module

**Maximum Power:** up to 1,650Wp

**Power Tolerance:** depends on the individualized module

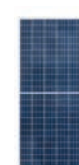
**Maximum Efficiency:** depends on the individualized module

**Size:** up to 3.70m x 2.50m (12.14' x 8.2')

**Weight:** up to 600kg (1322 lb)

**Warranty:** 5-year product warranty, 10-year performance warranty

[www.solarnova.de](http://www.solarnova.de)



### REC Group

**Product:** REC TwinPeak 72 Series

**Available Power:** 330W - 340W

**Maximum Power:** 330W - 340W

**Power Tolerance:** -0% / +5%

**Maximum Efficiency:** 17.2%

**Size:** 2005mm x 1001mm x 45mm (78.9" x 39.4" x 1.8")

**Weight:** 28kg (61.7 lb)

**Warranty:** 10-year materials and workmanship, 25-year linear power output

**Certifications/Listings:** UL 1703, UL Fire Type 2, CEC listed, IEC 61215/61730, ISO 9001:2015, ISO 14001:2004, OHSAS 18001:2007

[www.recgroup.com](http://www.recgroup.com)



## aleo solar GmbH

**Product:** aleo S79 HE

**Available Power:** 280W - 305W

**Maximum Power:** 305W

**Power Tolerance:** -3% / +3%  
(measurement tolerance of PMPP),  
0/+4.99%W (positive classification  
range)

**Maximum Efficiency:** 18.6%

**Size:** 1660mm x 990mm x 50mm  
(65.35" x 38.98" x 1.97")

**Weight:** 20kg (44.09 lb)

**Warranty:** 12-year product warranty  
(upgradeable to 25-years), 25-year  
linear performance warranty

**Certifications/Listings:** IEC  
61215, IEC 61730-1/-2, IEC 62716  
(ammonia resistance), IEC 61701  
(salt mist resistance), IEC 62804 (PID  
resistance), MCS 010, MCS 005, UL  
1703 3rd Ed.

[www.aleo-solar.us](http://www.aleo-solar.us)



## First Solar, Inc.

**Product:** First Solar Series 5

**Available Power:** 360W - 375W

**Maximum Power:** 375W

**Power Tolerance:** -0% / +5%

**Maximum Efficiency:** 16.8%

**Size:** 1200mm x 1860mm (47.24" x  
73.22")

**Weight:** 32kg (70.5 lb)

**Warranty:** 25-year linear  
performance warranty, 10-year limited  
product warranty

**Certifications/Listings:** PID-free,  
thresher test, long-term sequential  
test, ATLAS 25+, IEC 61646 1500V,  
IEC 61730 1500V, CE, IEC 61701 salt  
mist corrosion, IEC 60068-2-68 dust  
and sand resistance, ISO 9001:2008,  
ISO 14001:2004, UL 17093 1500V  
listed Class B Fire Rating (Class A  
Spread of Flame), UL Construction  
and Fire Performance Type 10 (Class  
B) Type 13 (Class A), CSI Eligible,  
FSEC, MCS, CEC Listed (Australia),  
JET, SIL, InMetro

[www.firstsolar.com](http://www.firstsolar.com)



## Sunpreme

**Product:** Maxima GxB370 SMART, 72-cell

**Available Power:** 370W

**Maximum Power:** 425W bifacial

**Power Tolerance:** -3% / +5%

**Maximum Efficiency:** 22% bifacial

**Size:** 1985mm x 990mm x 6mm (78.15" x  
38.97" x 0.24")

**Weight:** 27.4kg (60.5 lb)

**Warranty:** 10-year product warranty, 25-  
year power warranty

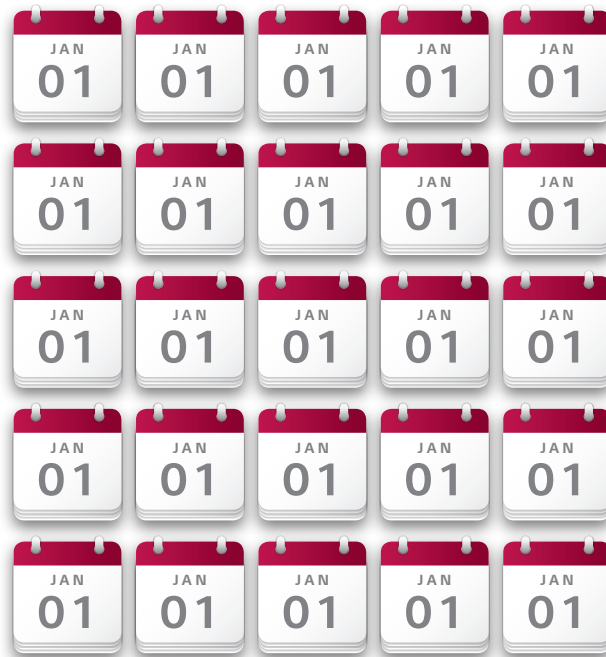
**Certifications/Listings:** IEC 61646, IEC  
61730-01, IEC 61730-02, IEC 61701, UL  
1703, CEC

[www.sunpreme.com](http://www.sunpreme.com)

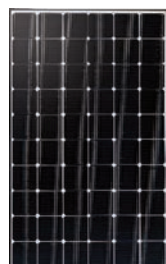
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## LG NeON™ 2



Cello  
Technology



Enhanced  
Warranty

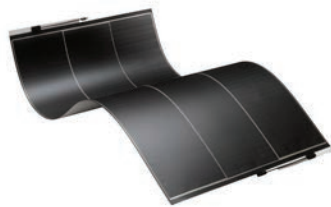


High  
Power Output

LG's new module, NeON™ 2, adopts Cello technology. Cello technology replaces 3 busbars with 12 thin wires to enhance power output and reliability. NeON™ 2 demonstrates LG's efforts to increase customer's values beyond efficiency. It features enhanced warranty, durability, performance under real environment, and aesthetic design suitable for roofs.



SEE AD ON PAGE 36



**Solopower Systems, Inc.**

**Product:** SoloPanel SP3L  
**Available Power:** 200 – 280W  
**Maximum Power:** 280W  
**Power Tolerance:** -5% / +5%  
**Maximum Efficiency:** 18.4%  
**Size:** 2197mm x 1146mm x 2.5mm (86.5" x 45.1" x 0.1")  
**Weight:** 6.1kg (13.2 lb)  
**Warranty:** 5-year materials and workmanship, 25-year power output (90% of nominal rated power for years 1-10, 80% of nominal rated power for years 11-25)

**Certifications/Listings:** UL 1703, IEC 61646, IEC 61730  
**Key Features:**

- Roof-load from module is 0.49lbs/ft<sup>2</sup> /2.4kg/m<sup>2</sup>;
- Suited for low-load bearing structures;
- Buildings located in high-wind or seismic areas;
- Best suited for roof types: SSM, TPO, EDPM, and BUR;
- Transportation applications.

**www.solopower.com**

SEE AD ON PAGE 98



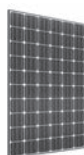
**SS Power Technology**

**Product:** U-Panel (U-100W-18V)  
**Available Power:** 100W  
**Maximum Power:** 90W (constant output power)  
**Power Tolerance:** -0% / + 4%  
**Maximum Efficiency:** 18.5%  
**Size:** 1020mm x 670mm x 41mm (40.2" x 26.4" x 1.61")  
**Weight:** 9.29kg (20.5 lb)  
**Warranty:** 10-year limited warranty

**Key Features:**

- Up to three times faster battery charging;
- Up to ten times more power delivered to most loads;
- Smaller and lighter system weight;
- Low cost of mounting and installation;
- Eliminates the need for MPPTs and DC-DC converters.

**www.sspowertechnology.com**



**CertainTeed**

**Product:** Solstice  
**Available Power:** 280W - 285W  
**Maximum Power:** 285W  
**Power Tolerance:** -0% / +3%  
**Maximum Efficiency:** 17.5%

**Size:** 1640mm x 992mm x 40mm (64.5" x 39.1" x 1.57")  
**Weight:** 20kg (44.09 lb)  
**Warranty:** 10-year product warranty, 25-year linear power output warranty  
**Certifications/Listings:** UL 1703  
**www.certainteed.com/solar**



**Beamreach Solar**

**Product:** Sprint  
**Available Power:** 290W - 300W  
**Maximum Power:** 300W  
**Power Tolerance:** -0% / +4.99%  
**Maximum Efficiency:** 18.6% (@300W)  
**Size:** 1646mm x 1012mm x 48mm (64.8" x 39.8" x 1.9")

**Weight:** 17.24kg (38 lb)  
**Warranty:** 25-year warranty linear output warranty, 10-year product warranty  
**Certifications/Listings:** (pending) IEC 61215, IEC 61730, IEC 62716 ammonia resistance; UL 1703, UL 2703, IEC 61701 salt mist corrosion.  
**www.beamreachsolar.com**

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**650-571-5904**

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**Solar Frontier**

**Product:** SF170-S Solar Modules  
**Available Power:** 170W  
**Maximum Power:** 170W  
**Power Tolerance:** -0% / +5%  
**Maximum Efficiency:** 13.8%  
**Size:** 1257mm x 977mm x 35mm (49.5" x 38.5" x 1.4")  
**Weight:** (20kg) 44.1 lb  
**Warranty:** 10-year product warranty, 25-year power output warranty  
**Certifications/Listings:** UL 1703, IEC 61730, IEC 61646, ISO 9001:2000  
**www.solar-frontier.com**



**Mitsubishi Electric US, Inc.**

**Product:** Diamond Premium MLE280  
**Available Power:** 280W  
**Maximum Power:** 280W  
**Power Tolerance:** -0% / +5%  
**Maximum Efficiency:** 16.9%  
**Size:** 1625mm x 1019mm x 46mm (64" x 40.1" x 1.81")  
**Weight:** 20kg (44 lb)  
**Warranty:** 10-year material and workmanship warranty, 25-year linear performance warranty  
**Certifications/Listings:** UL 1703, IEC 61215 2nd Edition, IEC 61730  
**www.mitsubishielectricsolar.com**



**Solarland USA Corporation**

**Product:** SLP150-12  
**Available Power:** 150W  
**Maximum Power:** 150W  
**Power Tolerance:** -5% / +5%  
**Maximum Efficiency:** 16.3%  
**Size:** 1500mm x 675mm x 50mm (59.06" x 26.57" x 1.97")  
**Weight:** 12.1kg (26.68 lb)  
**Warranty:** 25-year limited warranty, 5-year limited warranty materials and workmanship, 10-year limited warranty of 90% power output, 25-year limited warranty of 80% power output  
**Certifications/Listings:** UL 1703, cUL1703, C1D2 Class 1, Division 2 (hazardous environments)  
**www.solarlandusa.com**

SEE AD ON PAGE 71




### Boviet Solar USA

**Product:** BVM6610P – 60 Cell Poly

**Available Power:** 255W - 275W

**Maximum Power:** 275W

**Power Tolerance:** -0% / +5%

**Maximum Efficiency:** 16.9%

**Size:** 1640mm x 942mm x 39.88mm (64.57" x 37.09" x 1.57")

**Weight:** 18.5kg (40.79 lb)

**Warranty:** 12-year product warranty, 25-year linear power output warranty

**Certifications/Listings:** UL 1703, IEC 61215, IEC 61730, CEC LISTED, MCS and CEC, ISO 9001 for Quality Management Systems, ISO 14001 for Environmental Management Systems

#### Key Features:

- 3 EL inspections per cell/module for defect-free consistency;
- Type 1 fire-rating per UL 1703 edition 3;
- Withstand up to 5400 Pa snow load and 2400 Pa wind load;
- High salt and ammonia resistance certified by TUV Rheinland;
- Rugged design for long-term durability.

[www.bovietsolarusa.com](http://www.bovietsolarusa.com)

SEE AD ON PAGE 20



## AIMS POWER™

[www.aimscorp.net](http://www.aimscorp.net)

### AIMS Power

**Product:** AIMS Power 120 watt PV solar panel

**Available Power:** 120W

**Maximum Power:** 120W

**Power Tolerance:** -0% / +3%

**Maximum Efficiency:** 15.3%

**Size:** 1234mm x 668mm x 35mm (48.6" x 26.3" x 1.38")

**Weight:** 9.69kg (21.38 lb)

**Warranty:** 10-year guarantee at 90% efficiency, 20-year guarantee at 80% efficiency

**Certifications/Listings:** CEC

#### Key Features:

- Bypass diode minimizes the power drop during cloudy days;
- Tempered glass, EVA resin, and weatherproof film and pre-drilled aluminum frame for extended use and easy installation;
- Designed for grid and off grid applications with MC-4 female and male connectors;
- Minimum quantity does not apply. Available in 1, 6, 12, and 24 packs;
- Racks available.

[www.aimscorp.net](http://www.aimscorp.net)



### Trina Solar

**Product:** DUOMAX, 72-cell dual-glass module

**Available Power:** 325W

**Maximum Power:** 325W

**Power Tolerance:** -0% / +5%

**Maximum Efficiency:** 16.6%

**Size:** 1978mm x 992mm x 6mm (77.9" x 39.1" x 0.236")

**Weight:** 27.98kg (61.7 lb)

**Warranty:** 10-year product warranty, 30-year linear power output warranty

**Certifications/Listings:** IEC 61215/ IEC 61730/ UL 1703/ IEC 61701/IEC 62716, ISO 9001: Quality Management System, ISO 14001: Environmental Management System, ISO 14064: Greenhouse Gases Emissions Verification, OHSAS 18001: Occupation Health and Safety Management System

[www.trinasolar.com/us](http://www.trinasolar.com/us)

### Canadian Solar, Inc.

**Product:** Canadian Solar Mono SuperPower CS6K-MS

**Available Power:** 290W

**Maximum Power:** 290W

**Power Tolerance:** -0% / +5%

**Maximum Efficiency:** 17.72%

**Size:** 1651mm x 993mm x 40mm (65" x 39.1" x 1.57")

**Weight:** 19.19kg (40.1 lb)

**Warranty:** 25-year linear power warranty, 10-year product warranty on material and workmanship

**Certifications/Listings:** UL 1704, CSA / Take-e-way, IEC 61215, IEC 61730, VDE / CE

[www.canadiansolar.com](http://www.canadiansolar.com)



## A highly secure safety system



### Greeneye Smart PV Switch

- Failsafe safety system
- Individual shutdown feature per PV module
- Protection for firefighters or PV installers and electricians

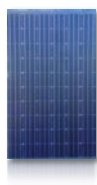
[ep.mersen.com](http://ep.mersen.com)

**MERSEN**  
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### Zebra Energy

**Product:** 150 watt 12 volt polycrystalline solar module  
**Available Power:** 150W  
**Maximum Power:** 150W  
**Power Tolerance:** 3%  
**Maximum Efficiency:** 14.7%  
**Size:** 1473mm x 660mm (58" x 26")  
**Weight:** 12.7kg (28 lb)  
**Warranty:** 5-year workmanship, 25-year limited output  
[www.zebra.energy](http://www.zebra.energy)



### Giga Solar FPC, Inc.

**Product:** Ultra-Lightweight Rigid Modules  
**Available Power:** 285Wp  
**Maximum Power:** 500Wp  
**Power Tolerance:** -0% / +3%  
**Maximum Efficiency:** 18%  
**Size:** 980mm x 1666mm x 6.9mm (38.6" x 65.6" x 0.27")  
**Weight:** 7.98kg (17.6 lb)  
**Warranty:** 25-year warranty  
[www.gigasolarpv.com](http://www.gigasolarpv.com)



### Axitec Solar

**Product:** AxiPlus w/SolarEdge  
**Available Power:** 265W  
**Maximum Power:** 265W  
**Power Tolerance:** +0% / -5%  
**Maximum Efficiency:** 16.29%  
**Size:** 1640mm x 992mm x 40mm (64.5" x 39.1" x 1.57")  
**Weight:** 19.49kg (42.99 lb)  
**Warranty:** 25-year warranty  
**Certifications/Listings:** UL 1703 Type 1  
[www.axitecsolar.us](http://www.axitecsolar.us)



### MiaSolé

**Product:** FLEX-02W Module  
**Available Power:** 380W  
**Maximum Power:** 380W  
**Power Tolerance:** -0% / +10%  
**Maximum Efficiency:** 16.6%  
**Size:** 2598mm x 1000mm (102.3" x 39.4")  
**Weight:** 6.2kg (13.7 lb)  
**Warranty:** 5-year workmanship, 10/25-year power output  
**Certifications/Listings:** UL 1703, IEC 61646, IEC 61730, UL Class A over TPO - slope up to 2.5"  
[www.miasole.com](http://www.miasole.com)

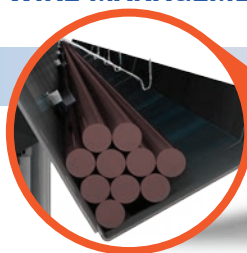


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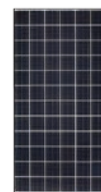


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### Kyocera Solar Energy Group

**Product:** 72 Cell 1000V  
**Available Power:** 315W - 320W  
**Maximum Power:** 320W  
**Power Tolerance:** -0% / +5%  
**Maximum Efficiency:** 16.4%  
**Size:** 1956mm x 992mm x 40mm (77.01" x 39.06" x 1.57")  
**Weight:** 27.5kg (60.6 lb)  
**Warranty:** 25-year warranty  
**Certifications/Listings:** UL 1703 certified and registered, module Fire Performance Type 2, IEC 61215/61730  
[www.kyocerasolar.com](http://www.kyocerasolar.com)



### Silfab Solar

**Product:** SLA-M Series  
**Available Power:** 280-300W  
**Maximum Power:** 32.9W  
**Power Tolerance:** -0% / +5%  
**Maximum Efficiency:** 18.8%  
**Size:** 1650mm x 990mm x 38mm (65" x 39" x 1.5")  
**Weight:** 19kg (41.88 lb)  
**Warranty:** 12-year warranty  
**Certifications/Listings:** ULC ORD C1703, UL 1703, IEC 61215, IEC 61730, CEC listed, UL Fire Rating: Type 2 (Type 1 on request), ISO 9001:2008  
[www.silfab.ca](http://www.silfab.ca)



### Helios America, Inc.

**Product:** 72-cell mono solar panel  
**Available Power:** 360W  
**Maximum Power:** 360W  
**Power Tolerance:** -0% / +3%  
**Maximum Efficiency:** 18.2%  
**Size:** 1960mm x 990mm x 40mm (77.2" x 39" x 1.57")  
**Weight:** 26kg (57.2 lb)  
**Warranty:** 25-year warranty  
**Certifications/Listings:** UL  
[www.heliosamerica.us](http://www.heliosamerica.us)





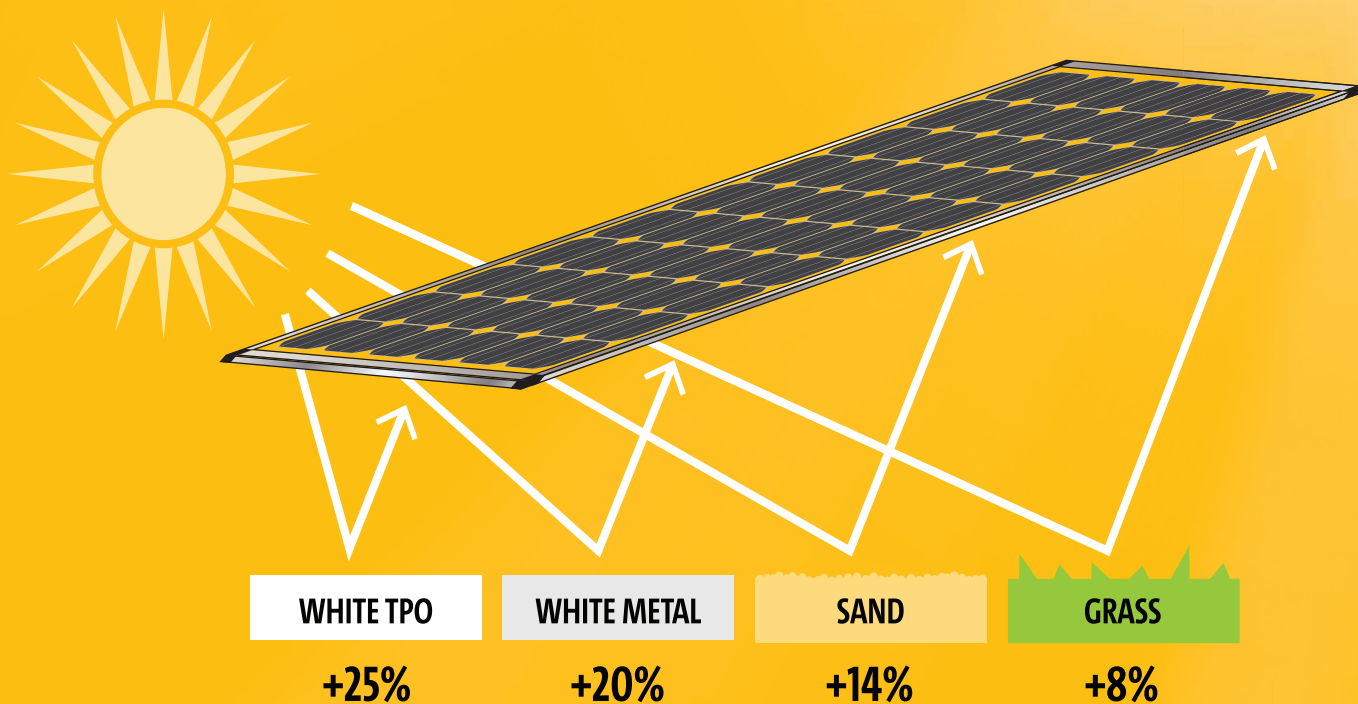
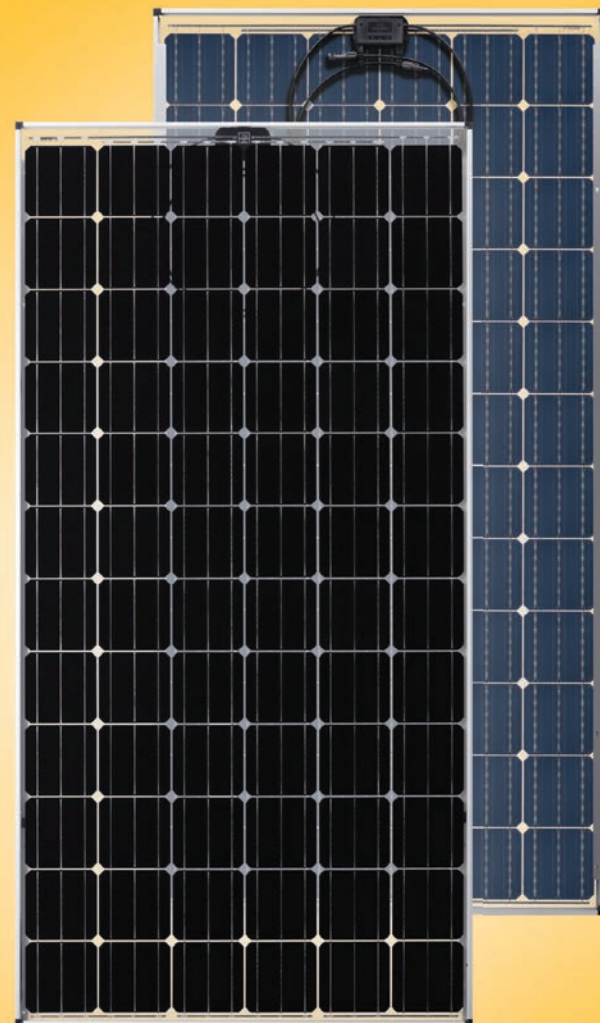
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[solarworld.com/boost](http://solarworld.com/boost)



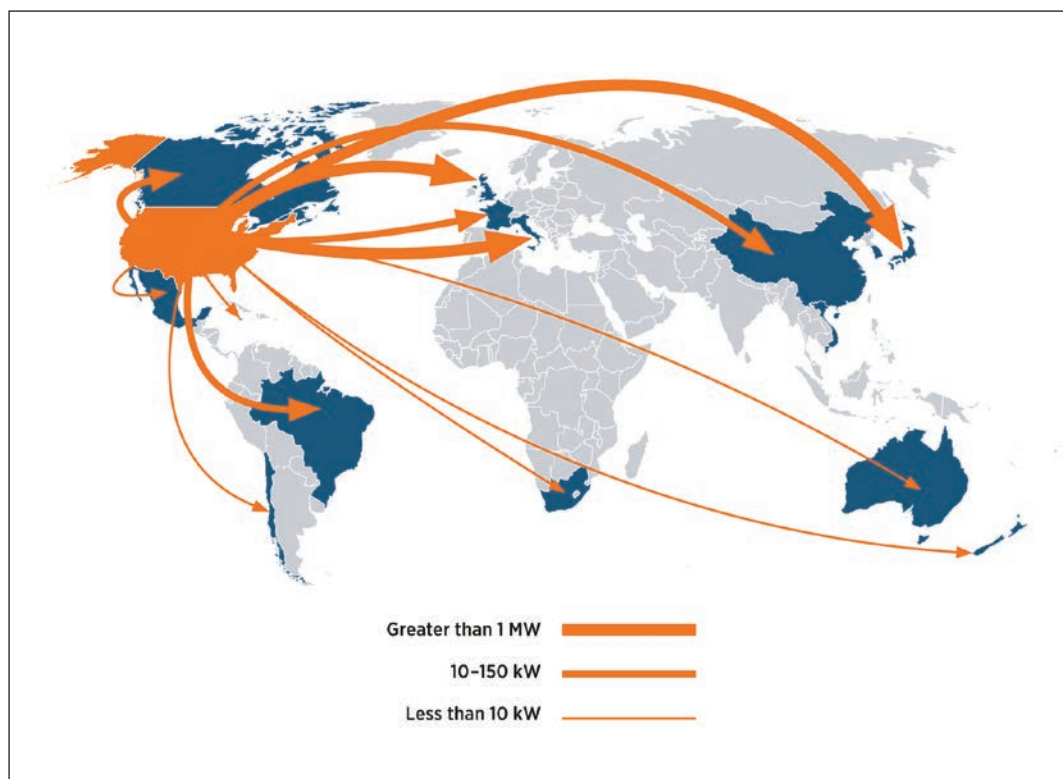
ACHIEVE ENERGY BOOSTS OVER A VARIETY OF SURFACES

\*Energy boost values are estimates and are not a guarantee of performance. Actual boost performance will vary for your specific installation based on the actual albedo, selected racking system, system design parameters and soiling over time.

## Exports and Leasing

### The future of distributed wind?

by Nikolas Foster



2015 U.S. Small Wind Exports across the Globe. Source: DOE

Distributed wind installations in the United States are closing in on the 1 gigawatt capacity threshold. Yet, over the past three years, growth rates in distributed wind have plateaued, pressing U.S. manufacturers to look for new ways to open markets. With record high sales overseas for small wind, and new financing mechanisms redefining opportunities at home, exports and wind leasing represent two markets that might help industry transition into a new chapter for distributed wind.

With over 75,000 wind turbines representing 934 MW of installed capacity in all 50 states, the District of Columbia, Puerto Rico, and the U.S. Virgin Islands, distributed wind has entered markets across the United States. Distributed wind projects support a variety of users- small cabins off the grid, farmers looking for additional power, and revenue streams to support farm operations or industrial plants, such as flour mills, commercial beer bottling facilities, or automotive parts factories.

Despite the breadth of distributed wind projects, both geographically and in terms of types of applications, the amount of distributed wind installed in recent years is relatively small. After strong growth from 2008 through 2012, in which capacity additions easily exceeded 100 MW per year, installations in 2013, 2014, and 2015 have been relatively modest. In 2015, 28 states added 28 MW of new distributed wind capacity, representing 1,713 units and \$102 million in investment.

The reasons for the slower growth are manifold. Reduced funding and incentive programs, both at the federal and state level, have contributed to a slower growth in recent years. For example, the U.S. Department of Treasury's Section 1603 cash payments expired at the end of 2012, contributing to slower sales in the ensuing years. State funding for distributed wind has declined in recent years, as well. Over the past four years, state level funding dropped from a high of \$37 million in 2012 to \$7 million in 2015. And in 2015, while several states offered incentive programs, only five states received applications that led to incentive funding. Competition from solar photovoltaics (PV), which has experienced dramatic drops in costs over the past years, also may be limiting new wind installations.

As the domestic market for distributed wind plateaus, two important market drivers, exports and wind leasing programs, stand out as having the potential to transform the small wind-market (defined as turbines sized 100kW and smaller). With the decline in domestic demand, U.S. based manufacturers of small wind turbines have, over the past several years, started to aggressively seek out opportunities abroad. Europe, Japan, and South Korea are the most popular destinations; they all have relatively steady policy environments that support deployment of renewable energy. US manufacturers of small wind turbines have made inroads into these markets and have greatly increased overseas sales. From 2012 to 2015, exports increased from 8 MW to 22 MW, representing a \$122 million value in 2015 alone. Looking at the past twelve years, this trend is even more dramatic. Between 2003 and 2010, the share of exports (measured in MW) compared to total sales, stood at 27 percent. Between 2011 and 2015, the share stood at 59 percent.

The second important driver is wind leasing. This refers to third-party financing options that support property owners who are interested in hosting turbines on their property.

The leasing company manages the procurement, siting, installation, interconnection, operation, and maintenance of the turbine, saving the property owner money, as well as a lot of tedious paperwork often needed to get a project installed and deployed. In exchange, the property owner pays monthly payments for the turbine and receives a reduced electricity bill. This leasing model has already been successful in growing the residential solar PV market across the United States.

Some wind turbine companies have already financed a number of projects, and are on target to develop considerably more in 2016. Several other companies are following that lead by launching their own leasing programs.

While the domestic market for distributed wind remains flat, U.S. manufacturers are looking for new opportunities both within and outside of the United States. The combination of growing demand for electricity in emerging nations across the globe, as well as increased environmental awareness and calls to action (signified by the 2015 Paris climate agreement) support a growing global market for renewable energy. Over the past years, US manufacturers of small wind turbines have succeeded in opening new markets for their products, and are poised to expand their footprint in other countries. The wind leasing model can also help distributed wind reach greater market penetration across the United States, especially in those states where wind resources, state incentives, and high electricity rates drive new business ventures and customers. The lasting success of these individual efforts is unclear, but they have the power to propel the distributed wind industry into its next chapter.



Nikolas Foster is the co-author of the U.S. Department of Energy's Distributed Wind Market Report. At PNNL, he supports national and international projects in the area of energy efficiency, energy policy, and market analysis. Nik is also interested in finding ways to better integrate buildings with the electric grid, leading to efficiency gains and energy savings for building operators, owners, and tenants.

Pacific Northwest National Laboratory | [www.pnnl.gov](http://www.pnnl.gov)



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Hi-Line Utility Supply Co. | [www.hilineco.com](http://www.hilineco.com)



### Kilowatt-class of life extending services

Moventas has now launched a suite of services for Vestas V42, V44, and V47 as well as Gamesa G42, G44, and G47 fleets. The Extra Life for kW is available in Moventas workshops globally. The cornerstone of the Extra Life for kW offering is Moventas' ability to service gearboxes on an OEM level, thanks to its 35-year experience of wind gearboxes. With its multi-brand capability, the Extra Life and OEM level repairs also concern Hansen, Winergy, and Bosch Rexroth gearboxes in addition to Moventas, Metso, and Valmet made gearboxes. The Extra Life service concept is about understanding and removing known gearbox failure modes, and replacing old solutions with new and improved ones. The core Moventas technologies that will be applied in the Extra Life services are bearing upgrades, integrated planet gear bearings, and case carburized ring gears. In addition to upgrades, Extra Life for kW is available for multi-brand replacements, factory service, plug & play accessories, up-tower services, spares, and inspections. Moventas also provides a new and improved replacement gearbox for the Vestas and Gamesa fleets in question, with integrated planet bearings. The kilowatt class offering also includes a batch of several used Moventas and Hansen units that Moventas has acquired from the market to refurbish and sell for these fleets.

Moventas | [www.moventas.com](http://www.moventas.com)

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# Wind Turbine Certification in North America

## An overview

by Anant Jain

**WIND TURBINE CERTIFICATION ON AN INTERNATIONAL** platform dates back to the late 1980's when the International Electrotechnical Commission (IEC) began developing standards specifically for the design of wind turbines. At that time, wind turbine technology was in its infancy and only a handful of original equipment manufacturers (OEMs) and certification bodies (CBs) existed. The rapid increase in the number of OEMs, concerns about the viability of wind energy and reliability of wind turbines, competition among the OEMs for market placement, project finance and commercialization requirements, and the much-needed reduction in the levelized cost of energy of wind turbines via optimization are several of the critical factors that led to the growth of certification within the wind industry.

There are several options for certifying wind turbines, one of which is the IEC. A certification system is based on a conglomeration of standards where each standard is designed to address the requirements or recommendations for certifying a particular category or aspect of operational systems of a wind turbine. In addition to standards, there are several wind turbine certification guidance documents known as "guidelines".

### Differentiating between a standard and a guideline

Standards are developed through a controlled consensus process including input from a cross-section of the stakeholders from the industry. If the document is issued by one entity without formal industry stakeholder input, it is a guideline. When a standard is considered preliminary and unable to attain a consensus level, the document is temporarily categorized as a "technical specification". IEC 61400-13 (mechanical loads measurement) and IEC 61400-23 (rotor blade testing) were technical specifications for several years before qualifying and accepted as standards worldwide. Sometimes stakeholder groups, such as American Wind Energy Association (AWEA), issue a "recommended practice" (RP) as a precursor to a standard. The RP allows the industry to try out the recommendation before making it a mandatory standard.

### IECRE, AWEA, and standards development and harmonization

The main certification standards for wind turbine design in the IEC system are IEC 61400-1 (large wind turbines), IEC 61400-2 (small wind turbines), and IEC 61400-3 (offshore wind turbines); the overall umbrella standard is IEC 61400-22, covering the complete scope of certification: prototype, component, type, and project. The IEC system is becoming more organized and transparent so every applicant is evaluated using a similar process defined by "The IEC System for Certification to Standards Relating to Equipment for Use in Renewable Energy Applications" (IECRE System). The system is being developed to harmonize the certification process for stakeholders involved in wind turbine design, manufacturing, testing, and certification. The IECRE is not limited to wind turbine standards, but encompasses the standards development tasks for several other renewable energy sources. IEC is also increasing the number and scope of standards for wind turbine certification; IEC 61400-5 and IEC 61400-6 are upcoming wind turbine blade design and wind turbine tower and foundation design standards, respectively.

AWEA has developed a small wind turbine certification standard and has been working towards adopting IEC standards through the American National Standards Institute (ANSI). Canada, through the Canadian Standards Association (CSA) Technical Committee on wind turbines has adopted several IEC wind turbine standards and published an electrical standard for wind turbines. In addition, AWEA has issued guidelines, specific to wind turbines, with other existing US-based organizations such as the American Society of Civil Engineers (ASCE). The current recommended

practices issued by AWEA are AWEA 9.1 Small Wind Standard; ASCE/AWEA RP 2011 for support structures; and the AWEA Offshore Compliance RPs.

AWEA and UL are also heavily co-involved in developing national standards for electrical compliance of wind turbines in the US. UL 6142 and AWEA 6142 (small wind turbine electrical safety standard) were released in 2015. Similarly, UL 6141 (large wind turbine electrical safety standard) recently became an American National Standard.

### Minimum requirements for compliance to install and operate a wind turbine in the US

- 1. Mechanical and structural safety certification:** Authority Having Jurisdiction (AHJ) require compliance with building codes from ASCE for support structures (including tower and foundation design) in several US states. Some states also require seismic analysis, soil analysis, etc., depending on the site conditions. The wind turbine rotor nacelle assembly is usually kept out of the scope. In these cases, compliance is determined by the AHJs on the basis of analysis reports issued and stamped by a professional engineer. Depending on the design of the wind turbine, the AHJ may require analysis of the entire turbine.
- 2. Electrical safety:** AHJs require compliance with published American National Standards such as UL 6142 for small wind turbines.

These requirements vary from one county to another in the US. There is speculation that the main reason for AHJs requiring compliance with American National Standards is a federal law known as the National Technology Transfer and Advancement Act of 1995. The law requires local regulatory agencies to mandate compliance with existing standards developed by committees that include a majority of stakeholders involved with the product category.

A common misconception about wind turbine certification is the CB which writes the standard is the only agency which can certify to that standard. In fact, any CB can certify to a standard as long as it is accredited to that particular standard and scope. OEMs should always verify the accreditation of labs where they test wind turbine components as well as the accreditation of the CB.

### Federal government regulations and initiatives

Federal government agencies such as the Occupational Safety and Health Administration (OSHA) and Bureau of Ocean Energy Management (BOEM) have their own requirements commonly titled as code of federal regulations (CFRs). For IEC certification, compliance to OSHA regulations is not required but is highly recommended and several CBs use them as bare minimum requirements. Several ANSI standards also provide similar but detailed guidelines compared to federal government agencies, for example, ANSI/ASSE Z359.1 for fall arrest systems testing and certification. On the financial side, the Internal Revenue Service (IRS) issued the requirement to qualify for investment tax credits for wind turbines rated less than 100 kW; to get the credit, the turbine has to comply with AWEA 9.1 or IEC 61400-1; IEC 61400-12, and IEC 61400-11. This requirement is one of the most direct examples of government initiatives and financial benefits of certifying wind turbines.

The leading wind turbine certification option for US OEMs is the IEC system because IEC is recognized worldwide. The IEC system of standards is becoming more elaborative and robust, and is evolving into a fully developed IECRE system. Standards harmonization efforts are taking place at a faster pace than ever before; and the standards development committees in the US and Canada are actively leading the North American wind industry towards becoming a safer and more reliable source of renewable energy.



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# Wind Generation O&M Strategies

## Lessons from conventional generation

by Todd Williams

**THE NORTH AMERICAN WIND INDUSTRY HAS REACHED AN INFLECTION POINT. NO LONGER** a small but growing part of the electricity mix, wind has reached a scale that calls for a greater focus on how the fleet is operated and maintained. For the past 15 years, the key to success has been primarily driven by development: the ability to bring the project to completion with OEM support. As warranties expire and more wind generation operators choose to insource operations and maintenance (O&M), the key to success in the future will be increasingly derived from the quality of the operations and maintenance of the generating assets.

How can an operator extract the most value from the assets? What does it mean now to run a large fleet of sometimes disparate assets, economically and efficiently? How will wind play the role of good citizen on the grid? The answers to these questions may be informed by the lessons from conventional generation fleet operators who have had to deal with these issues before us.

### Lessons from Conventional Fleets: Management Playbook

The American Wind Energy Association (AWEA) has noted, “Wind turbine operations and maintenance (O&M) represents a growing segment and business opportunity in the wind energy industry.”<sup>1</sup> Operators are leveraging a variety of technologies and approaches to improving performance and reducing costs. One approach conventional generators have found successful is to implement an operational system

or management playbook to systematically drive operational excellence and thereby achieve greater value from their fleet of generation assets.

A generation management playbook is a management system used to delineate how the business will operate in order to create alignment and predictability. Benefits include creating greater alignment on specific goals, driving intended results, ensuring predictable and best practice operations standards, and implementing a means of continuous improvement.

Typically, a playbook emphasizes four key components that are critical to ensuring a well-run fleet:

- Vision and values – What we aspire to and how we measure success
- Planning and monitoring – How we improve our business and how we hold ourselves accountable
- Operational controls – How we run our plants
- Organization and accountability – How we assign accountability

While wind has many differences from a conventional generation fleet, the playbook concepts still apply and can bring value. One leading wind generation operator applied the playbook approach to significantly improve the results of their safety program.

As a result of the playbook implementation, contractor safety incidents decreased by more than 50%, and corporate safety incidents remained very low.

Conventional Generation Playbook	Wind Safety Example
<b>Vision and values</b> brings a shared sense of focus to the organization. In the case of conventional generation, results-oriented measures serve to create clarity and align focus on measures such as forced outage rates, cost per MWhr, and safety. This kind of clarity can prevent mixed signals and drive desired behaviors, investment, and actions.	The overall vision for safety was distilled into a single statement—our work is never so urgent, nor our schedule so important, that work cannot be performed safely. Including contractors in this vision and measurement of safety results represented a fundamental shift in expectations that reverberated throughout the model.
<b>Planning and monitoring</b> provides leadership with the means of ensuring plans exist and resources are properly allocated to achieve desired results. Business plans, performance indicator reviews, and management review meetings are common in conventional generation fleets.	Two employee and contractor metrics were established and benchmarked. Stretch goals were set: <ul style="list-style-type: none"> <li>• Total Recordable Incident Rate (TRIR)</li> <li>• Days Away Restricted or Transferred (DART)</li> </ul> Gaps in performance were formally identified and specific gap-closing initiatives were designed and put into the budget. Examples include establishment of minimum contractor safety requirements that were negotiated with each prime contractor, active site indoctrination programs for any new personnel, and safety observations using punch-cards with auto-readers. Results were tracked as part of ongoing management to ensure improvement actions were executed successfully.
<b>Operational controls</b> are the governing process and program standards. They articulate clear accountabilities and represent the “one way, best way” generation fleet personnel execute their work to ensure predictable, high quality results across many plants. Conventional generators have evolved many best practice standards critical to success such as lockout tag-out, outage management, and confined space entry. Done well, this enable a continuous improvement approach allowing the standards to evolve with new best practices.	With legacy assets and organizations as a result of acquisitions, creating a common view on the approach to safety was a critical alignment factor. Two key safety documents were identified and written to establish a fleet-wide standard: <ul style="list-style-type: none"> <li>• <b>Safety Program</b> – defining high-level accountabilities and requirements</li> <li>• <b>Safety Process</b> – defining key safety activities, including communications, hazard identification, observations, and corrective action</li> </ul>
<b>Organization and accountability</b> captures the human element of the playbook. Most importantly, it establishes programmatic ownership of the key areas established in the vision. It defines how program owners are to work together with line leadership and makes them accountable for designing, implementing, and updating operational controls. In a conventional generation fleet, there are job titles across sites, succession plans, and incentive programs tied to plan goals.	A fleet wind safety manager was named and charged with leading overall program ownership, and accountability for results. This program owner worked together with designated wind site safety leads to define and implement functional area standards. Together, they formed the peer group to drive consistency and determine best practices.

### Conclusion

As wind fleets mature, operators will increasingly face a need to operate and maintain their assets in order to extract value. Conventional generation fleets provide a model for how to successfully manage and operate a fleet of assets through a management playbook. This approach can offer a success path for wind operators faced with the need to manage geographically separate, market-differentiated, OEM-diverse, fleets of assets.

*Todd Williams is a partner at ScottMadden, where he focuses on electric generation. He has been consulting with energy companies for more than 15 years.*

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<sup>1</sup>AWEA website: <http://www.awea.org/gencontentv2.aspx?ItemNumber=4613&mainnav=8192&navItemNumber=8213>

# FOR THE REALLY **LONG** HAUL

## 199 FOOT WINDMILL TRAILERS EXPAND LANDSTAR'S CAPACITY TO SERVE THE WIND INDUSTRY

Hauling windmill blades across the country is a big task, even for the most experienced owner-operator; it's a delicate practice of planning and patience. Just a decade ago, windmill blades were a lot smaller than they are today. Of course, even a small windmill blade can span dozens of feet and take days or even weeks to move from one place to another.

The art of hauling wind blades is ever changing. In October 2015, Landstar unveiled its newest capacity addition, a 199 foot windmill blade trailer. The new trailer allows Landstar BCOs to haul the longest wind blades ever built. The trailers weigh in at 49,000 pounds and are able to haul a 36,000 pound windmill blade.

"This gives Landstar greater flexibility in transporting longer windmill blades and enhances Landstar as a key player in wind energy transportation," said Landstar Vice President of Trailer Management Matt Miller.

The extendable trailers were specifically designed and built to meet the demands of the evolving wind energy industry, putting Landstar's new windmill blade trailers at the cutting edge in wind transportation, and Landstar among the premier blade haulers in the United States.





*SmulteaSciences/Vanessa James*

## It's Not Easy Being Green

### Minimizing the impact of offshore wind on wildlife

by Dr. Sarah Courbis, Dr. Mari Smultea, and Heidi Cocca

#### **THE OFFSHORE WIND INDUSTRY IN THE UNITED STATES IS STILL RELATIVELY NEW.**

Many obvious challenges face the industry, including supply chains and power agreements. Another less-obvious challenge is requisite wildlife permitting and mitigation. Because part of the appeal of wind energy is that wind is “green,” it is important for offshore wind to minimize its impacts on wildlife. However, as Kermit the Frog once lamented, “It’s not easy being green.”

The regulatory framework for offshore wind permitting in the U.S. is complex, involving an alphabet soup of agencies and laws. For wildlife permitting, the main laws are the National Environmental Policy Act (NEPA), Marine Mammal Protection Act (MMPA), Endangered Species Act (ESA), Coastal Zone Management Act (CZMA), Magnuson-Stevens Fisheries Act (MSA), and National Marine Sanctuaries Act (NMSA). The National Oceanic and Atmospheric Administration (NOAA) is responsible for the implementation of these Acts. Each Act is administered by different offices within NOAA, which sometimes operate more independently than is ideal. The Bureau of Ocean Energy Management (BOEM) is responsible for permitting energy exploration and development in marine regions and must consult with NOAA and meet the requirements of NEPA. Overall, the main permits required for offshore wind development involve BOEM permits and Incidental Harassment Authorization (IHA) under the MMPA.

The great thing about these laws is they are intended to balance development with wildlife conservation, a goal we all share. The drawback is there can be unintended consequences, poor application, litigation, inefficient consultation, and ineffective or cost-prohibitive mitigation. As such, it is important to consider wildlife issues early during planning of offshore wind development. Choices regarding technology, siting, and construction timing can have considerable impact on wildlife permitting and mitigation. In addition, being prepared for the amount of time it may take to complete permitting processes is important; it is not unusual to take between 6 and 12 months to obtain an IHA, which is valid only one year from issuance. It is important to use existing science to propose reasonable and effective mitigation and monitoring plans. Relying on agencies may be tempting, but an operator must know what makes sense for his/her site. This was important in a situation in which the agencies suggested a permit requiring shut-down of geophysical equipment whenever a marine mammal was within 500m of a survey vessel. Unfortunately, the survey was taking place in an area with a dense population of sea lions. Modeling suggested it was not necessary to use such a large exclusion area for sea lions, so in retrospect, 57 shut-downs could have potentially been avoided.

New acoustic guidelines proposed by NOAA are expected to be finalized soon. These guidelines codify the received sound levels expected to result in potential injury to marine mammals and may have substantial impact on the size of shut-down zones. They also include a dual metric for evaluation, peak received level and cumulative sound level, which will increase the complexity of modeling and shut-down zones. However, the guidelines will not affect

the current policy of a 160 dB (rms) re 1 $\mu$ Pa received sound level used as the threshold for evaluating acoustic behavioral harassment of marine mammals.

We have the opportunity to learn from the offshore oil & gas and European offshore wind industries, but there are some wildlife challenges unique to U.S. offshore wind. The industry should consider using platforms like the American Wind Energy Association (AWEA) to collaborate and create a collective voice regarding wildlife. It is to the industry’s benefit to consider wildlife issues jointly and not submit highly disparate analyses and models in permit applications. However, site-specific and equipment-specific issues may call for some differences. Experience gained through permitting seismic work in the U.S. Atlantic (permits still pending two years later) shows lack of coordination creates confusion for the agencies, public, and advocacy groups who may ultimately litigate.

#### **Lessons learned include:**

1. Begin permit planning early;
2. Make appropriate use of existing data;
3. Apply for permits appropriate to site conditions;
4. Thoroughly evaluate mitigation/monitoring options;
5. Recognize the importance of situational learning.

In addition, it is important to consider the harassment estimation process for marine mammals. The MMPA requires that NOAA be able to make “negligible impact” and “small numbers” findings. Because data regarding marine mammals are often poor and most models include broad assumptions, there is a tendency to be conservative in estimations. This supposedly assures not exceeding the allotted “take” and having to stop a project, but ultimately, depending on project scale, it can make it difficult for NOAA to support the necessary findings.

#### **Some suggestions**

6. Model to reflect uncertainty and evaluate probability within a risk assessment framework;
7. Empirically test models against monitoring;
8. Improve technologies to reduce sound;
9. Use simple models.

Data collected should be shared and published, so the information collected will be the best available science on which to base future assessments and mitigations. Evaluate different mitigations and adapt proposals to support the most effective and cost-efficient approaches. Much of the data on marine mammals in the U.S. is either very large scale or estimated by proxy. This means data collected during projects will better reflect the specific project area and be helpful to the whole industry.





The offshore wind industry in the U.S. has hurdles to overcome with respect to existing and pending wildlife regulations, but these regulations are designed to protect valuable marine resources and ecosystems. It is imperative to consider wildlife issues in early planning, use the lessons learned from other offshore industries, collaborate and speak with a united voice, use and share data, and work together with advocacy groups, agencies, and the public. An effort to do what is right will be valuable because the public wants to support “green” energy. Doing what is right is not necessarily at odds with cost-efficiency or competitiveness if it is approached practically and knowledgeably.



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*Courbis received her master's in Biology (Behavior & Physiology) from San Francisco State University and her doctorate in Biology (Ecology & Evolution) from Portland State University. She is a member of the AWEA Offshore and Siting & Environmental Compliance committees.*



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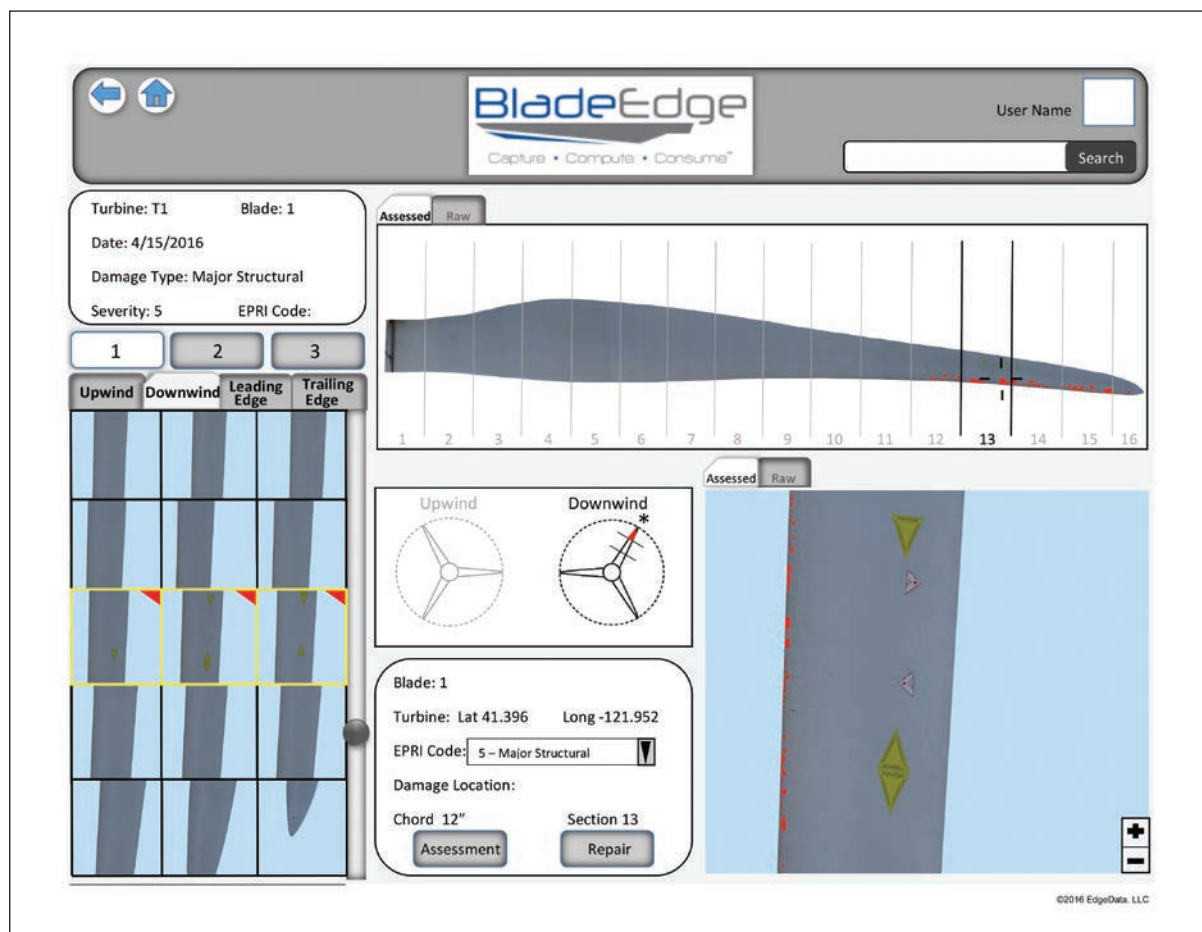
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## Evolving Wind Power with Actionable Blade Intelligence

by Chris Shroyer

**IS THAT BUG SPLATTER OR IMPACT DAMAGE? IS THAT A CRACK OR JUST SOME DIRT?** Is that lightning protector damaged? What repairs does that blade need and what would the ROI be on those repairs? And how can you tell without the significant expense and putting human lives at risk?

For the wind industry, actionable turbine blade intelligence is the invisible key that unlocks a new level of efficiency, safety, and infrastructure longevity. And with the convergence of a developing UAV (unmanned aerial vehicles, or drones) industry and ever-more-sophisticated software, that key is finally within reach.

### Unlocking the power of data

There is a vast gulf between raw data, – gigabytes of high-res photos of a turbine blade – and useful information. Transforming raw data into actionable intelligence poses three fiendish challenges.

For one thing, data must be gathered in a way that is consistent and repeatable in order to ensure accurate analyses over time. This doesn't sound like a big deal until a pilot must maneuver a small UAV around a turbine while the wind is kicking at 20 miles per hour.

After that, assuming the capture challenge has been defeated, it has resulted in tens of thousands of high-resolution images of turbine blades. Managing those images; associating each with the correct blade, preserving all relevant metadata about position and capture conditions, and processing those tens of thousands of raw images to arrive at an accurate condition assessment for each blade is the next challenge.

Finally, presenting the condition assessments and other analytics must be done in a way that is actually useful for the user. Owners, operators, repair companies, and manufacturers have very different concerns. If actionable data intelligence is to achieve practical-use status, its presentation must be customized for different user groups and designed to be easy to consume.

Though this sounds like a tall order – and it is – remarkable progress in solving these challenges has been made.

### Asset intelligence in the field

Recently a field test of UAV inspection technology occurred at a 500 MW wind farm boasting some of the tallest wind turbines in North America.

The wind was blowing a brisk 20 miles per hour. But, contrary to what one might expect, it was not necessary to scrap the flight. A skilled pilot zipped the UAV to the top of the rotor and began a controlled descent, with the payload operator snapping pictures along the way. Wind technicians from the farm watched the images flicker in from the payload: a high-resolution camera. In less than fifteen minutes the blade was completely captured: leading edge, trailing edge, high-pressure side, and low-pressure side.

The wind technicians went to the next blade and spotted a potential concern - what appeared to be a long crack, the kind that would keep the turbine out of service for a long time pending a major repair job and resolution of any warranty issues. When the UAV was piloted to the trouble spot, the “crack” was revealed as nothing more than a line of sand encrusted on the blade.

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There is now commercially available software that can take the kinds of images gathered during that field test and process them through a sophisticated analytics engine, stitching the images together and outputting automated condition assessments with a high degree of accuracy. In other words, the software processes thousands of raw images in order to identify damage, detecting lightning strikes, delamination, trailing-edge cracks, leading-edge erosion, damaged vortex generators, and more. The software categorizes the type and location of the damage.

The damages are presented to the user in an organized, prioritized manner, and are linked with the relevant images, so the user can get the most important information at a glance.

A repair company might want detailed measurement information and materials needed to expedite their repair. A blade manufacturer might want to look for indications of damage trends on a particular blade model. And owners, operators, and integrators want to optimize budgets and performance of the turbine. There are many layers of value in the data.

#### What's on the horizon

With 2015 seeing a 6 percent reduction in average winds across North America and 2016 continuing the trend, wind farm efficiency will attract the higher level of attention it deserves.

In the coming years, viable solutions to real-time intelligence in wind power will continue to emerge, accelerated by strategic partnerships – public-private, for example, or between startups and complementary established companies.

As those solutions emerge, are refined, and attain widespread adoption, blade condition management will evolve from an art into a data-driven science. Every blade on every turbine will have a lifetime record of its condition over time. Sophisticated analytics tools – some of which have already hit the market – will be used to guide and optimize decisions.

For example, one can use such tools to compare two timeframes (such as an annual inspection result) to monitor the progression of damage as a result of wear or a particular event. This information will generate predictive insights to help optimize investments in maintaining or improving condition.

The wind industry will adopt preventative maintenance practices, just like the scheduled oil changes and inspections that are so prevalent in the auto industry. Repairs will be prioritized based on ROI and scheduled in advance.

Steered by real-time intelligence, these enhanced maintenance practices will ultimately yield longer turbine lifespans and more efficient, profitable wind farms.

*Chris Shroyer is the president and a founding member of EdgeData, LLC makers of the BladeEdge analytics software. He spearheads operations and new-market development in order to fulfill the company's mission of improving the wind power industry by transforming raw data into actionable intelligence.*

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# Top Treating Oils with Additives

## Does it deliver optimal equipment performance?

by Gary Hennigan



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Recently, there has been talk about the potential benefits of top treating wind turbine gearbox oil with additives to mitigate lubricant degradation and extend oil life. But relying on additive top treating as part of a primary lubrication strategy is not a recommended long-term solution to extending lubrication intervals; it may introduce potential complications, something no wind turbine operator wants.

Instead, the key to long-term lubrication performance is to select an oil that is formulated with the right mix of advanced base oils and additives, and delivers the required performance over many years without the need for additive top treating.

### What is top treating?

The additive top treat concept seems simple: operators use condition monitoring to identify when an oil's additives start to deplete and then re-additize that oil with the addition of after-market additive packages.

While it's true that all wind turbine oils will eventually start to deplete additives as they work to protect the gearbox, relying on top treating to extend oil life is not a recommended best practice for various reasons, including:

#### Potential for an unbalanced formulation:

Additive top treating may actually introduce new components, or contaminants, that could impact the performance of a wind turbine equipment by generating an unbalanced formulation. For example, surface active additives like anti-wear additives and rust inhibitors both compete for space on the metal surfaces in a gear box. Formulating an oil so that both of these types of additives are present in the correct

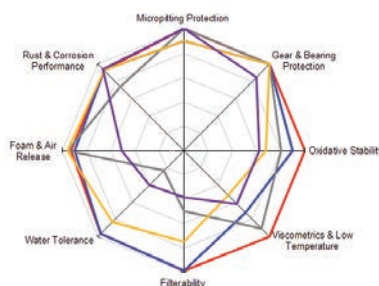
amounts (to properly protect the machine elements from both wear and rust) is a delicate balance. Topping up with different ratios or different types of these additives could disturb the balance, creating more potential harm than good.

**Increased Safety Concerns:** Top treating oils with additives increases with equipment interaction. While top treating may not be as invasive as flushing and replacing an oil, regular additive top treating requires more frequent equipment interaction which, in turn, increases the potential for safety issues.

### Choosing the right oil is better than top treating

Instead of relying on additive top treating to extend lubricant life, prudent operators should focus on selecting an oil that is formulated with the right mix of advanced base oils and additives to deliver long-lasting performance, without the need for additional additive top treatment.

The best formulated oils will last longer – in some cases years longer – so it will not be necessary to top treat the oil to maintain the expected level of performance. This also results in several key advantages, including less frequent interaction with equipment, and minimized risk of accidentally



**Figure 1.** This spider chart compares the performance of various wind turbine gearbox oils. The red line represents the performance characteristics of a high quality synthetic oil that has a balanced formulation. This oil delivers significant performance benefits over many other oils, particularly for key areas such as oxidative stability and filterability, while maintaining a balanced overall performance profile.



### Ultra-low headroom wire rope hoist

Expanding its comprehensive line of high-quality wire rope hoists, Columbus McKinnon Corporation introduces the Yale LodeKing LT ultra-low headroom top-running wire rope hoist. Available in capacities ranging from 10 to 25 tons, the LodeKing LT is the ideal choice when purchasing a new or replacement hoist for facilities with space limitations. Manufactured in Wadesboro, North Carolina, the LodeKing LT is designed for heavy-duty CMAA Class D service. Each hoist comes equipped with a Magnetek closed-loop variable frequency drive that allows for accurate and precise load control while reducing brake wear. Packed with safety and performance features, the Magnetek IMPLUSE VG+ Series 4 drive includes multiple control and power supply options, an external hoist brake resistor, motor thermal overload protection, keypad with digital display and a recorded fault history that aids in troubleshooting and maintenance. The LodeKing LT also features plastic-infused wire rope specifically developed for maximum performance on overhead cranes. This unique wire rope has a plastic core that prevents metal-to-metal contact between strands, helping to reduce abrasion and wear within the wire rope, while increasing the rope strength by 15 to 20%.

**Columbus McKinnon** | [www.cmworks.com](http://www.cmworks.com)



introducing insoluble contaminants into the lubricants during a top treat service.

In fact, some of the industry's top synthetic wind turbine oils are warrantied for up to seven years, demonstrating the capability for the fluid to protect the machine even after 60,000 hours in service.

Figure 1 compares various wind turbine gearbox oils. It is evident the high quality oil, formulated with the right mix of base oils and additives, delivers better performance across a wide range of parameters. For key parameters such as oxidative stability, the best formulated lubricant can deliver exceptional performance; it has the potential to better withstand degradation than oils with a less robust formulation.

That's why, when it comes to wind turbine equipment, the first, and most important consideration should be lubricant formulation. By selecting the right lubricants, the equipment will be better protected in the long run and it won't be necessary to take risks with top treating.

*Gary Hennigan is the national accounts executive at ExxonMobil.*

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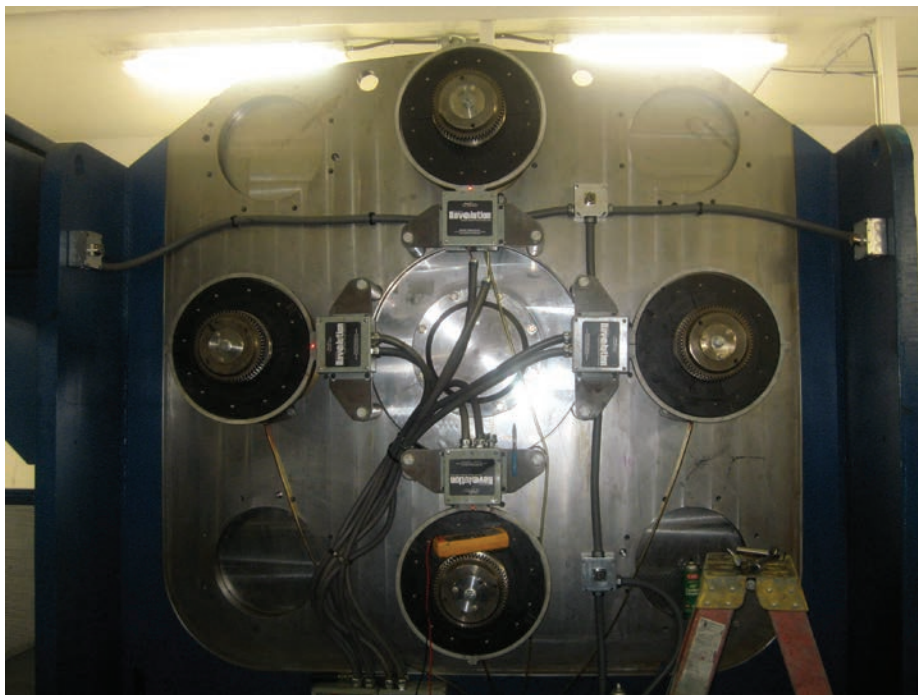
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# Torque Data

## Key to wind turbine design and production

by Jim Schramski



**TORQUE IS AN IMPORTANT VARIABLE TO THE DESIGNERS AND MANUFACTURERS** of wind turbine technology. Torque data is especially critical in the evaluation of wind turbine components such as bearings, gears, and braking systems. By providing the true mechanical work being generated by the rotor shaft, torque can be used to determine the true efficiency of the system: mechanical energy in - versus electrical energy out.

In order to collect torque data, a bondable strain gage is typically applied to the shaft. The strain gage is usually a Wheatstone bridge circuit that changes resistance in response to distortion of the shaft surface when rotated under load. The relationship between this distortion (strain) and the mechanical work being generated (torque) is linear in the elastic region and based on the physical properties of the shaft. One of the best methods for collecting strain data from a rotating shaft is via a telemetry system that reads the analog signal

from the strain gage and transmits it as a digital signal to a stationary receiver where it is collected for analysis or used for real-time process control.

Many monitoring systems in today's market provide torque, power (hp or kW), rpm, and direction of rotation data continuously using inductive power and data transfer. These systems have been used successfully for multiple applications in the wind industry, where the typical service life goal for wind turbines is 20 years and meaningful validation trials may last on the order of months or years.

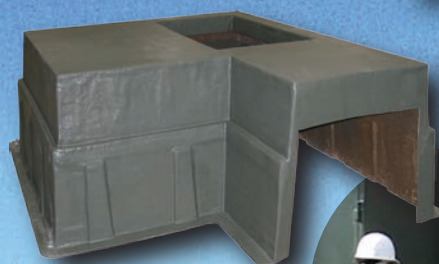
### Design validation

One common application is to test a scaled-up design of a patented vertical wind turbine for 18 months. For example, a 25-100 kW turbine can feature unique stationary stators that funnel and accelerate wind into the rotor blades. The robust, unique combination of the stator and rotor design of such a turbine allows it to operate in Class 6 and 7 wind speeds (25-30 m/s), while many other turbines cut-out at 25 m/s. Design professionals typically use monitoring equipment to capture torque data for a publishable power curve. The data can help validate the full-size models developed from 1/12-scale wind tunnel prototypes. The results can also be used to scale-up designs in the 0.25-1 MW range and scale down designs in the 1-5 kW range.

### TMA 25 kW vertical wind turbine

The National Renewable Energy Laboratory has specified over 150 sensors that can measure all dynamic motions and

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## Inspection and service mobile/cloud solution

After extensive development Romax InSight are launching Field Pro, a mobile/web application for windfarm inspection and service to bring the wind industry further towards data-driven O&M. With the release of Field Pro, a step change is possible for managing wind farm data by transitioning to mobile and cloud technology. Software organizes maintenance and inspection data automatically as soon as data is collected via smartphone technology. Synched devices and streamlined data transfer remove the tedium and error from transferring data from borescopes, thermal cameras, and other O&M tools. Managers and technicians can access data in the cloud from anywhere in the world using the web portal. Additionally, the standardized terminology for issue classification allows for the creation of a useful database to analyze failure data across a farm or fleet.

**Romax** | [www.romaxtech.com](http://www.romaxtech.com)



## Rescue harness

The latest innovation from Tractel is the Rescue Harness. The Rescue Harness combines safety, versatility, and comfort. The special Y-shape design includes a simple attachment point making an easy and quick donning. The strap configuration allows better fastening to the body and gives the worker extra mobility when bending. The many frontal attachment points allow the harness to be used in various applications. It also features a unique independent leg strap design which allows complete freedom of movement and flexibility while climbing, walking, and bending without the unwanted tugging and pulling between the thighs. The TracX back pad brings extra comfort on shoulders and back, and also contributes in keeping the harness' shape for quick donning. Along with its many different features, the Rescue harness offers day-long comfort without neglecting safety.

**Tractel** | [www.tracetel.com](http://www.tracetel.com)

loadings on a generic gearbox typically employed in most large-scale turbine designs. The goal of collaborative efforts with the Department of Energy, wind turbine OEM's, drivetrain component and lubrication suppliers, and turbine owners and operators is the development of a complete mathematical model of the entire TMA system, available in the public domain for the validation of improved gearbox designs.<sup>1</sup>

Two gearboxes in the 600-750 kW range were built and instrumented for the investigation. One runs on a 2.5 MW dynamometer at the National Wind Technology Center and the other operates in the field on a turbine in the Ponnequin wind farm, both located in Colorado. Monitoring sensors allow studying of torque loads when braking on high speed shafts. It's common to find that generators may carry torque for a short period of time.

### Test stands applications

Ensuring quality and reliability is a reason why design and maintenance teams invest in test stands for the gearboxes that represent the core of their powertrain. A 2.5 MW wind turbine typically splits the torque from the rotor shaft through a multipath, load-distributing design to drive four generators, reducing component failures and extending the operating life.<sup>2</sup>

### Monitoring systems on gearboxes

To test production gearboxes, a common practice is to combine a test stand with torque sensors. For example, many sensor models monitor torque on up-to four output shafts. The torque signals are fed back to a PLC that controls a hydraulic servo loop regulating rotary actuators that maintain the desired torque load on each

shaft. Subsequent endurance tests can oftentimes simulate 20 years of operation.

### Condition-based monitoring

Utilizing torque as part of a condition-based monitoring (CBM) strategy is not currently standard practice in the wind industry. Bearing temperatures, vibration, and oil particulates are commonly measured variables relied upon to monitor drivetrain health. Measuring and logging torque data is important to many components, especially as it relates to the gearboxes.

### Summary

The measurement of true mechanical torque is a key parameter for the wind industry in test stand and design validation applications. It may hold promise as a worthy drivetrain CBM variable in the future. As the examples show, torque monitoring systems approved by the National Renewable Energy Laboratory are ideal for continuous measurement.

*Jim Schramski is a field engineer for Binsfeld.*

**Binsfeld** | [www.binsfeld.com](http://www.binsfeld.com)

### References

<sup>1</sup>W. Musial, S. Butterfield & B. McNiff (2007). *Improving Wind Turbine Gearbox Reliability. Presented at the 2007 European Wind Energy Conference, paper preprint, NREL/CP-500-41548: <http://www.nrel.gov/wind/pdfs/41548.pdf>*

<sup>2</sup>Clipper Windpower Plc (2006). *Liberty. Downloadable product brochure: [http://www.clipperwind.com/pdf/liberty\\_brochure.pdf](http://www.clipperwind.com/pdf/liberty_brochure.pdf)*

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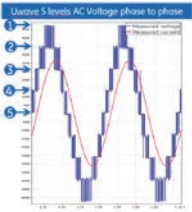


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### Small yet powerful drive

GE's Power Conversion business unveils its new powerful MV7-Series, ultimate waveform, multilevel, high-power drive, the MV7-Series Drive with UWave technology. The water-cooled UWave drive is based on GE's MV7 technology. GE adopted the same MV7 technology and used the same components, but arranged them in a different way, shifting from 3 level to 5 level. The increased number of levels means increased voltage and power output. As an extension of the existing MV7 drive platform, the new UWave drive can operate at up to 13.8kV with a power capacity of up to 40MW in a single thread. The MV7 UWave drive produces clean power with few harmonics. When feeding into motors, it reduces motor stress and can help increase its life expectancy. Higher power quality also results in cleaner electrical signals making the drive more compatible with the grid, allowing smoother grid integration and a more resilient grid network. The smaller filter means a smaller footprint for the entire system, which brings significant benefits across industries. Based on a customer study in the wind industry, the footprint of the system (drive and filter combined) can achieve up to 40% reduction compared to a 3-level drive. Reliability is reinforced by capacitors installed in the drive. An advanced mechanism adopted inside the drive enables immediate isolation of a failed capacitor. Unaffected by this single failure, the rest of the capacitors allow the drive to operate without interruption. The MV7 UWave drive uses standardized component during manufacturing, and is designed to drive induction, synchronous, or high-speed motors (up to 300Hz) for high-voltage and high-power applications. Several configurations of the MV7 series are available—diode front-end (DFE), active front-end (AFE), N+1 redundancy, transformer-less—to adapt different customer and project needs. It also allows easier integration to the fixed frequency system to become variable speed—a key factor to enable energy efficiency.

**GE Power Conversion** | [www.gepowerconversion.com](http://www.gepowerconversion.com)



### Revised aluminum GMAW welding guide

Lincoln Electric has released an updated guide for Aluminum Gas Metal Arc Welding (GMAW). The newest version of the manual features a new, reader-friendly layout with updated information and photos of products and processes related to aluminum MIG welding. The updated welding guide offers a detailed look at filler metal types, filler metal selection considerations for welding, tips for welding on aluminum materials, and a discussion on the causes and cures of defects in aluminum welding. General welding safety guidelines are also included. New sections include information on recent technology advances in welding equipment and processes designed for use on aluminum. New information is included on modern welding power source weld modes and taking advantage of synergic controls like Lincoln Electric's Ultimarc controls. GMAW welding parameters and starting procedures are listed for common alloys and material thickness. The discussion on metal transfer and modes has expanded to include pulsed spray, Power Mode, Pulse-on-Pulse, and AC pulse.

**Lincoln Electric**

[www.lincolnelectric.com](http://www.lincolnelectric.com)



### High-tack acrylic double-coated tapes and transfer adhesives

Mactac has launched a new series of high-tack acrylic double-coated tapes and transfer adhesives. Developed with the company's solvent-free, 100% solids adhesive technology, the product series features Mactac's new high-tack acrylic adhesive –MP410. A high-tack adhesive, MP410 is easy to handle and die-cut and was designed to perform well on a variety of substrates, including: ABS (acrylonitrile butadiene styrene), metals, polycarbonate, most foams, fabrics, and HDPE (high density polyethylene). As Mactac's newest 100% solids, solvent-free, adhesive technology innovation, the MP410 high-tack acrylic adhesive touts low levels of VOCs, migratory compounds and residuals. It also delivers excellent optical properties, adhesion performance, solvent, chemical and plasticizer resistance, UV-resistance, a wide performance range, and it is a versatile option for a multi-purpose tape. When stored in original packaging at room temperature, the new series has an estimated 2-year shelf life.

**Mactac Technical Tapes Products**

[www.mactac.com/technical](http://www.mactac.com/technical)

### Lightning inspection solutions

Frontline enhancements have been made to Schneider Electric's weather intelligence platform, increasing the capabilities of its leading lightning tracking solution. The addition of a user-searchable lightning inspection data archive means that utilities and wind farm operators now have a powerful tool for short- and long-term lightning damage analysis that will save both time and money. Schneider Electric's WeatherSentry solution provides daily reports on potential lightning strikes against a set of critical assets, allowing utility and wind farm managers to pinpoint inspection and maintenance schedules. This reduces maintenance costs while also minimizing the risk that damaged assets will go unnoticed and cause greater issues down the road. Additionally, lightning inspection data archives, with powerful search and filter tools, give users the ability to generate custom lightning data reports filtering a number of variables. Access to this information supports a wide variety of critical business functions, including forensic analysis of past events for insurance claims and long-term analysis of lightning activity for smarter lightning-resilient infrastructure investment decisions.

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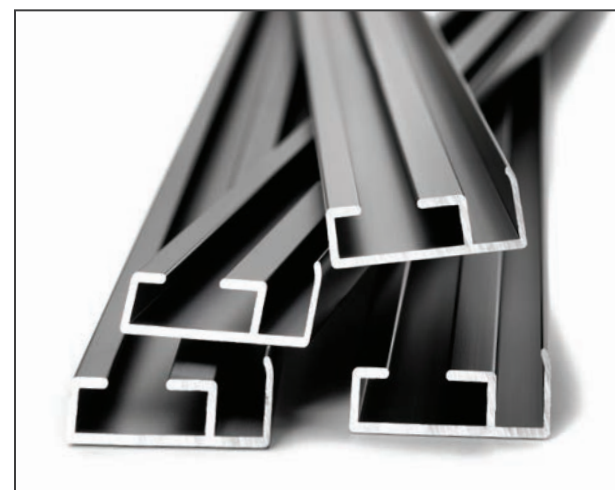
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# Transportation and logistics

With all of the equipment, carriers, size, and specialized handling requirements, getting all of the right turbine components to the right project sites for construction can be a challenge in the wind industry. Safety and efficiency are important keys to ensuring projects and timelines run smoothly. Here we focus on some of the top Transportation & Logistics companies in the industry that provide the specialized services required for getting all of those wind power parts, components, and machinery where they need to be for a successful wind farm.

SEE AD ON PAGE 56



## Logistec

**Services:** A variety of transportation solutions for the wind power industry, including: cargo handling, port logistics, stevedoring, terminal operations management, inventory management, warehousing, transloading, and trucking.

**Min/Max Loads/Tonnage:** Able to accommodate various tonnages and dimensions depending on the port (ranges from break bulk to heavy lift)

**Location/Logistics:** Some 30 ports and 40 terminals throughout Eastern Canada, the Great Lakes and St. Lawrence River, as well as the United States' East Coast and the Gulf Region

**Qualifications:** Founded in 1952, and a member of Green Marine

**Key Features:**

- Provider of value-added cargo handling services for industrial customers in the renewable energy sector, especially wind components;
- Utilizes the latest technologies throughout its network of strategically located facilities; and;
- A partner and team who manage each cargo handling operation to ensure economical and efficient solutions for each project.

[www.logistec.com](http://www.logistec.com)

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## Capps Van & Truck Rental

**Services:** Capps provides box truck, heavy duty pickup truck and crew van rentals. Capps serves large and small businesses in the energy, construction, cartage, logistical, and service sectors throughout the continental United States.

**Min/Max Loads/Tonnage:** Heavy Duty Pick-Up Trucks are equipped for towing and hauling capabilities (receiver hitch and gooseneck). All pickup trucks are all 4 wheel drive vehicles equipped with diesel engines and Allison automatic transmissions. A selection of ¾ ton, 1 ton, and 1 ½ ton crew cab vehicles with regular bed and flat beds are available. All rentals are covered with 24/7 road side assistance. Medium Duty Trucks are available with van bodies including 24 foot box trucks, 16 foot box trucks, 24 foot stake beds, and 15 foot cutaway vans. The 24 foot and 16 foot trucks are equipped with large platform lift gates.



**Location/Logistics:** 15 rental locations in Texas, Oklahoma, and Arizona

**Key Features:**

- Capps offers a large selection of current year model Full Size 12-15 passenger vans, cargo vans, suburbans, 4 x 4 pickup trucks, flatbeds, and box trucks;
- Capps specializes in short to long term rentals to clients in such industries as oil and gas exploration, pipeline construction, renewable energy services, logistics/distribution, church/school rentals, and for family/personal use;
- From clients needing one vehicle for a day to corporations needing hundreds of units to complete a project, Capps has well maintained, current year model units for immediate rental.

[www.cappsvanrental.com](http://www.cappsvanrental.com)



## Port of Wilmington, Delaware

**Services:** 24/7 marine terminal operations and wind project handling experience including; 2 independent stevedores; prompt and efficient State permitting and police escort services, logistics coordination, Class 1 rail, local towing company and ship agencies, onsite CBP and USDA, and FTZ

**Min/Max Loads/Tonnage:** 6 open, project "friendly" berths, heavy lift capacity to 100 MT's, 59 acres outside storage, and immediate access to interstate highway

**Location/Logistics:** Central mid-Atlantic location, and 1st deep water terminal on Delaware River

**Qualifications:** Established 1923, wind turbine components since 2001, C-TPAT, AWEA

[www.portofwilmington.com](http://www.portofwilmington.com)



## DACHSER USA Air & Sea Logistics, Inc.

**Services:** DACHSER provides system logistics through its global transport network with warehousing, customer-specific services, and IT solutions, DACHSER creates an intelligent combination and integration of logistics network competences worldwide.

**Min/Max Loads/Tonnage:** Varies depending on service chosen.

**Location/Logistics:** DACHSER USA is headquartered in Atlanta with branch offices in Atlanta, Baltimore, Boston, Charlotte, Chicago, Cincinnati, Dallas, Houston, Los Angeles, Memphis, Miami, Minneapolis, New York, Phoenix, and St. Louis. Globally DACHSER has 428 offices in 43 countries.

**Qualifications:** Founded in 1972, DACHSER USA Air & Sea Logistics Inc. is the U.S. subsidiary of DACHSER SE.

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**Port Corpus Christi**

**Services:** Port Corpus Christi provides an array of advantages for the movement of break bulk and heavy lift cargo. Facilities include 6 near dock laydown yards; highway and rail accessible; a 45' deep ship channel; dockside rail; three Class-1 rail carriers and a short line railroad; a skilled labor force; open, covered and dockside storage; and state-of-the-art security and safety operations.

**Min/Max Loads/Tonnage:** Port Corpus Christi moves more than 100 million tons of cargo per year. Port Corpus Christi has developed and implemented efficient transportation and logistics solutions for the renewable energy industry and particularly for the wind energy industry.

**Location/Logistics:** Located on the Texas Gulf Coast, Port Corpus Christi has a straight and uncongested ship channel; very few low visibility days, and provides efficient access via three Class-1 railroads and Interstate highways to project sites in the US, Canada, and Mexico.

**Qualifications:** Opened in 1926, Port Corpus Christi started as an agricultural Port and over the past 90 years the Port has developed into a modern Port with a diverse cargo handling capability and home to more than 50 industrial companies. The Port is a major economic engine for the region and attracts US and foreign direct investments for construction of manufacturing facilities. The Port has been recognized for its environmental leadership and has an Environmental Management System that is ISO 14001 certified.

**Key Features:**

- When completed early 2017, the Port's new Nueces River Rail Yard will have 8 tracks each 8,500' long to accommodate 8 unit trains simultaneously;
- Three Class-1 railroads directly connected to the Port's interchange yard and railroad system via short line railroad company;
- Dockside rail loading and truck transfer capability;
- Quick access to US 181 and other highways;
- Direct connector to Interstate 37 via the Joe Fulton International Trade Corridor;
- Home to the strongest open wharf on the Gulf of Mexico

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SEE AD ON PAGE 47



**Landstar**

**Services:** Truckload, LTL, heavy haul/ specialized, expedited, air & ocean freight forwarding, rail intermodal, project cargo

**Qualifications:** C-TPAT, FAST, Licensed NVOCC, IATA, RC14001:2013, ISO 9001:2008, SmartWay Transport Partnership

**Location/Logistics:** North America/ Worldwide

**Key Features:**

- New 199' Windmill Trailers, capable of hauling a 36,000 lb. windmill blade.

[www.landstar.com](http://www.landstar.com)



**Port of Vancouver USA**

**Services:** Provides services for the importing of wind energy components and is a gateway for large modularized components for the oil and gas industry via the Columbia Snake River System into North America. The port has plenty of space for cargo and business needs. It is also a truck and rail gateway to all of North America.

**Min/Max Loads/Tonnage:** The port's two Liebherr mobile harbor cranes can operate at any breakbulk berth at the port and have a lifting capacity of 140 metric tons each. Together, the cranes can lift 210 metric tons. Terminal 2 is equipped with a Paceco multi-purpose crane with a 51-metric-ton capacity and a 115-foot outreach.

**Location/Logistics:** Located on the U.S. West Coast, the port is 106 river miles from the Pacific Ocean on the Columbia River. Transited by BNSF Railway, Union Pacific Railroad, Canadian National Railroad, and Canadian Pacific Railroad have direct unit train access from mainline corridors. Primary freight arterials of the U.S. Interstate Highway network run north, east, and south.

**Qualifications:** The Port of Vancouver USA's five terminals and 13 berths lie at the terminus of the Columbia River's 43-foot shipping channel. 610,000 square feet of waterfront warehousing means ample storage for cargo. Exceptional customer service, including relationships with key resources in the logistics chain, helps them meet any shipping requirements.

[www.portvanusa.com](http://www.portvanusa.com)



**Totran Transportation**

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**Min/Max Loads/Tonnage:** Legal - 350,000lbs

**Location/Logistics:** Canada: Calgary, AB USA: Conroe, TX

**Qualifications:** Alberta Core Certified, C-Tpat certified, Associations: SC&RA, ISNet World, PIC Auditing, Comply Works

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## Wire overmold products

SolarBOS is now offering Overmolds as part of their Wire Solutions product line. They include "X", "Y", "T", and fuse overmolds, with crimp barrel fuses ranging from 2A to 30A. All connections are sonic welded and rated for 1000 or 1500 VDC. SolarBOS Wire Solutions also include wire harnesses, source circle bundles, and combiner box whips. All are custom manufactured to customer specifications. Choice of connector type, number of conductors, conductor length, and custom labels make installations efficient and cost effective.

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**Booth 935**



## Tile replacement mount

Quick Mount PV's Tile Replacement Mount provides a fast and easy way to install solar on tile roofs while protecting against water intrusion. For fast installation, simply remove the tile and replace it with the Tile Replacement Mount, no time-consuming, messy tile grinding or cutting necessary. Works with all standard curved and flat tile roofs, and all standard rail-based racking systems. Flashed at both the deck and top levels, the mount is fully engineered to meet code requirements and industry best practices. The Tile Replacement Mount features Quick Mount PV's patented QBlock Elevated Water Seal technology for optimal waterproofing.

**Quick Mount PV**

[www.quickmountpv.com](http://www.quickmountpv.com)

**Booth 2527**



## Low cost digital secondary class pyranometer

The SR05 digital Second Class pyranometer from Hukseflux offers an affordable high accuracy alternative to low-cost silicon photodiode type pyranometers. Sensor communication and output is via RS-485 RTU (Modbus), or the SR05 can be configured to operate in an analogue output mode: 0 - 1 VDC, or 4-20 mA output (0 - 1600 W/m<sup>2</sup> scaling). An economically priced ball-mount leveling fixture is also available for simplified mounting on any flat surface, or cross-arm tube. Suitable for both POA and GHI measurement applications, the SR05 digital Second Class pyranometer requires no routine desiccant maintenance and is backed by a 5-year factory warranty. Local U.S. ISO/IEC 17025:2005 accredited calibration support is available through ISO-CAL North America, LLC.

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**Booth 642**



## Environmental management

Ecology and Environment, Inc. (E & E) provides a suite of environmental services for the full life cycle of solar projects, from feasibility studies, project siting, and permitting, through pre-construction compliance, environmental monitoring, and operational auditing. E & E recognizes that renewable energy development is as much about building relationships as it is about building infrastructure. Their collaborative approach results in a level of trust with regulatory agencies and the public that provides added credibility during a project's critical early development stages. This approach helps to successfully negotiate realistic permit conditions and mitigation measures, prevents costly delays in the construction and monitoring stages, and helps clients adhere to aggressive schedules that meet critical in-service dates.

**Ecology & Environment, Inc.**

[www.ene.com/markets/solar](http://www.ene.com/markets/solar)

**Booth 469**



## Easy to install, reliable tracker

The DuraTrack HZ v3 from Array Technologies, Inc. (ATI) provides a low overall cost of solar through its easy to install, maintain and reliable tracker design. Its streamlined design allows for flexible tolerances permitting up to 40° off-set in the E-W direction and 15% slope in the N-S plane. The DuraTrack HZ v3 is engineered for long-term durability with only 180 electromechanical components per 100 MW. The tracker requires no scheduled maintenance and has an uptime of 99.99%. DuraTrack HZ v3 features a wind mitigation design which improves yield, eliminates maintenance, and protects against storm survival risks.

**Array Technologies** | [arraytechinc.com](http://arraytechinc.com)

**Booth 2805**



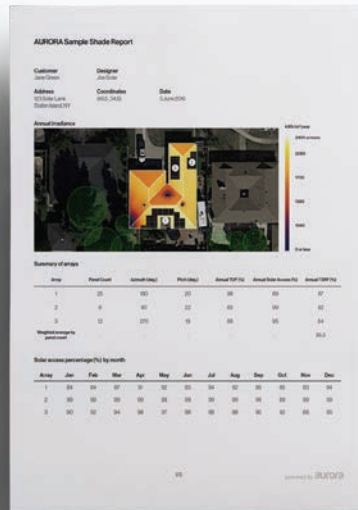
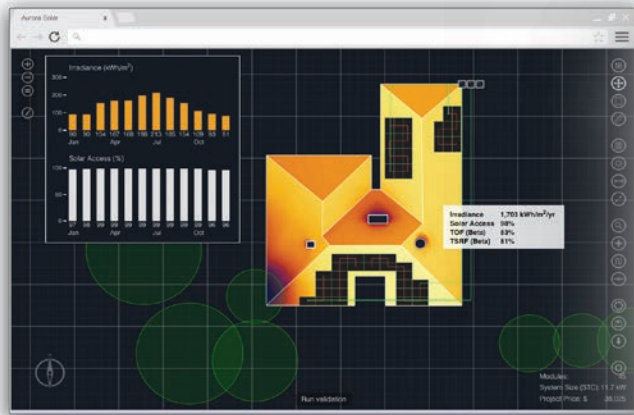
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# One-stop solution for the solar architect



## Remote Shading Analysis

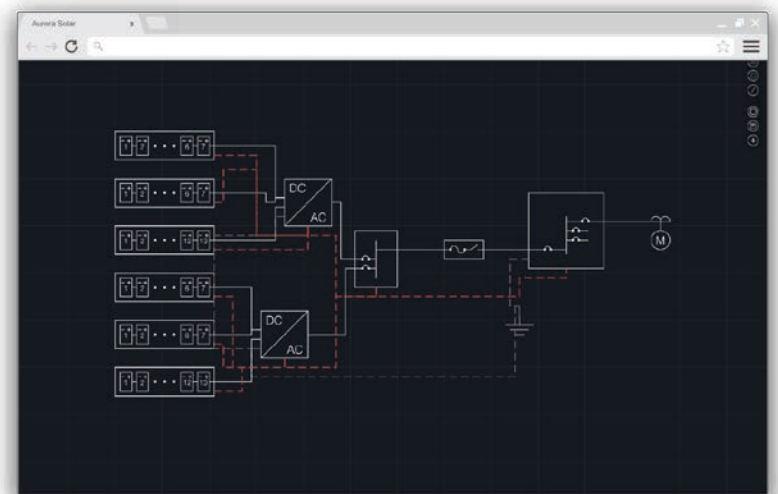
### Save time and money

Generate NREL-validated irradiance maps and save truck rolls. Aurora's shade reports are accepted by rebate authorities and financing providers.

## Engineering and Design

### Always design optimal systems

Automatically generate optimal systems or manually create detailed designs in Aurora's CAD environment. All designs are checked for NEC compliance.



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### Impress customers

Calculate your project's financial returns and present them with dynamic 3D visualizations and customizable sales proposals.

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### Automated PV system design

Aurora is a one-stop application for solar sales and engineering providing powerful tools to streamline the solar workflow, allowing users to generate a full system design, bankable shade reports, sales proposals, and perform financial analysis starting with just an address and utility bill. Aurora is used to create over 6,000 residential and commercial projects a week globally.

**Aurora Solar Inc.** | [www.aurorasolar.com](http://www.aurorasolar.com)  
**Booth WSUA12**



### High-breaking capacity PV fuses

SIBA FUSES are available for protection of PV panels, sub-arrays, arrays, energy storage (ES) systems, inverters, filters and transformers, and switchgear tied to the grid. Fuses for DC side of the inverter are available in the voltage range from 400VDC through to 1500VDC and current ratings from 1A through to 2500A. Fuses developed for energy storage (ES) have a high current breaking capacity and low L/R. On the AC side of the inverter SIBA is capable of meeting voltage applications up to 40.5kV with for bus protection, capacitor filters, PT transformers step-up transformers (SSK fuses specific for wind, solar, and energy storage application), and switchgear with medium/high voltage fuses.

**SIBA FUSES** | [www.siba-fuses.us](http://www.siba-fuses.us)  
**Booth 2273**



### Renewable energy batteries

Crown Renewable Batteries are 99% recyclable and designed from the ground up for renewable energy. Heavy plates, robotic welding, and cast-on-strap manufacturing maximize performance, durability, and lifespan. The CRP Power Module series provides a wide range of Ampere-hour (Ah) capacities, from 710 to 3690 Ah (100-hour rating). CRP Monobloc 6- and 12-volt batteries feature capacities from 130 to 525 Ah (100-hour rating).

**Crown Battery Manufacturing Company**  
[www.crownbattery.com](http://www.crownbattery.com)  
**Booth 3005**



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ISO-CAL North America, LLC. | 36610 N 20th Street, Phoenix, AZ 85086



### Single-axis solar tracker

Exosun's single-axis solar tracker, Exotrack HZ v2, was engineered to deliver high energy output and to minimize CAPEX and OPEX for ground-mounted solar plants. Exotrack HZ v2's straightforward design is reflected in its installation rate of 200 man-hours per MW. No machines are needed to assemble the structure's few and lightweight parts on site. With its short rows, Exotrack HZ v2 smoothly follows flowing topography without land grading. The system's linked-row architecture and grease-free, balanced structure make it a reliable solar tracker. With only 51 key components needed for 10 MW, failure risks and O&M actions are reduced to a minimum for 25 years. Exotrack HZ v2 can be delivered with a smart module cleaning device. With reduced human intervention and its capacity to clean without water, the system offers increased cleaning performance at a low cost.

**Exosun** | [www.exosun.net](http://www.exosun.net)  
**Booth 3013**

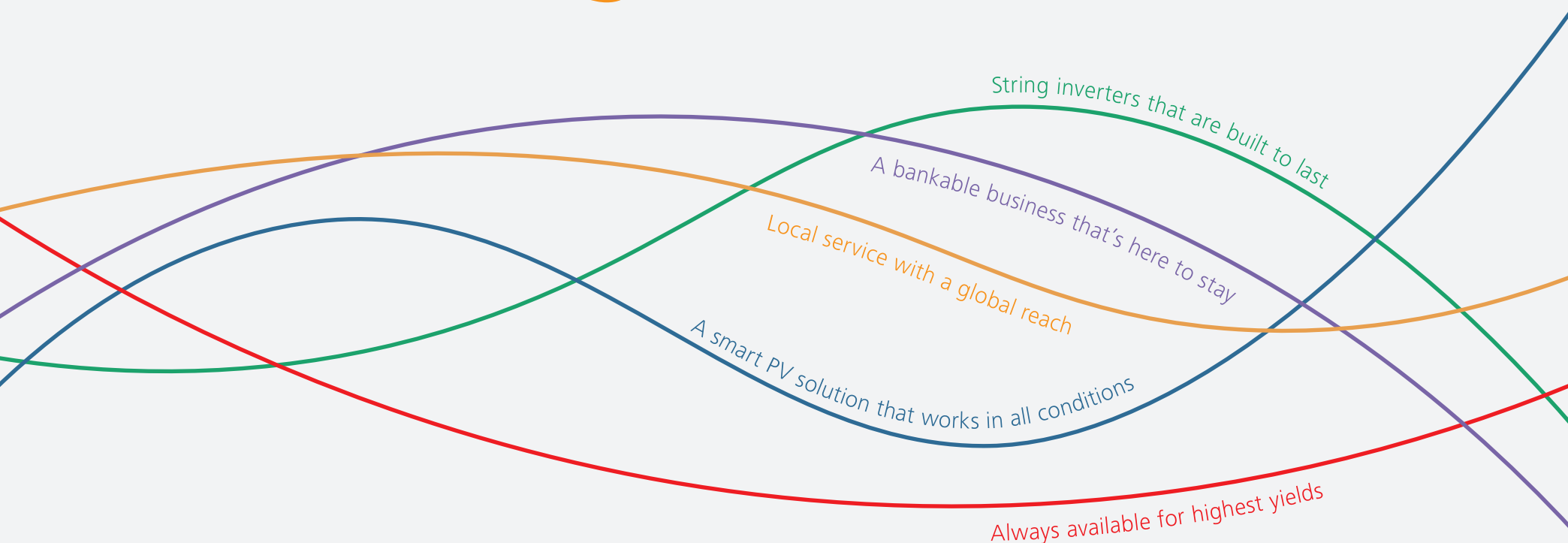


### PV harvesting system

Alencon Systems' String Power Optimizers and Transmitters (SPOTs) are DC-DC optimizers which step-up the voltage harvested from PV arrays to any DC voltage 2,500V+, while performing maximum power point tracking (MPPT) on up to four strings of solar panels. Alencon's patented PV-IoT solution provides granular performance monitoring of a utility scale PV installation. Their Grid Inverter Package (GrIP) scales up quickly to multi-MW level in 2.5MW increments. SPOTs and GrIPs leverage the benefits of the IoT to monitor plant performance with a visual SCADA system, VIEWS, which is connected to a series of sensors embedded into Alencon's hardware; the PV-IoT. VIEWS provides a complete overview of a PV plant, displaying voltages, currents, PV string performance, semiconductor temperatures, and control board temperatures with easy to understand visuals. An accurate model of a PV installation is populated with performance data for use with future demonstrations, diagnostics, and engineering support. By leveraging the PV-IoT, users gain insight into their performance.

**Alencon Systems, LLC**  
[www.alenconsystems.com](http://www.alenconsystems.com)  
**Booth 3023**

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Our SUN2000 string inverters use intelligent software that lets you monitor your solar system from your phone or tablet, so you're always in control of your yields.

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SUN2000-45KTL-US-HV-D0



### Tracking precision and accuracy

Cone Drive's solutions for the solar energy industry help harness the power of the sun, in both an efficient and cost effective manner. For accuracy-critical applications, Cone Drive's solutions are capable of providing tracking precision. With robust construction and maintenance-free operation, Cone Drive's Azimuth Drive is offered in three sizes, with customizable ratios, and is designed to suit any requirements. The Azimuth Drive family has a vast output torque range with a minimum nominal dynamic torque of 150 Nm and a maximum holding survival torque of 15000 Nm.

**Cone Drive** | [www.conedrive.com](http://www.conedrive.com)

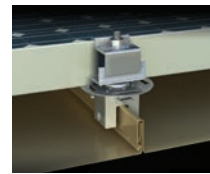
**Booth W1123**

**SIBA Fuses are available for protection of PV panels, sub-arrays, arrays, energy storage (ES) systems, inverters, filters, transformers and switchgear tied to the grid. Our specialized energy storage (ES) fuses are available from 400V to 1500V with the highest breaking capacity and lowest L/R**

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**SIBA**

[www.siba-fuses.us](http://www.siba-fuses.us)  
(973) 575-7422



### Solar module mounting solution

The S-5! PV Kit is one of the first solar module mounting solutions to be listed to the new UL subject 2703, a standard that covers both bonding and mounting, and has gained an ETL listing to UL 1703. This non-penetrating, DirectAttach PV mounting solution for standing seam metal roofs fits the majority of solar panels on the market and can withstand the harshest weather conditions while maintaining electrical conductivity. S-5!'s new EdgeGrab is specifically designed to be used in conjunction with the patented S-5-PV Kit for solar array end conditions. The S-5! PV Kit reduces cost by eliminating the need for inter-module copper wires and lug bonding, and ultimately saves time and materials by providing the entire attachment system.

**S-5!** | [www.s-5.com](http://www.s-5.com)

**Booth 1929**



### Meteorological measurement solutions

Lufft's all-in-one Weather Sensors (WS) provide easy installation, integration, and will maintain into any DAS/SCADA/PLC/Datalogger system. Lufft's robust, no moving parts, pre-calibrated WS meet the needs for temperature, humidity, pressure and wind readings, and also include sensors with embedded Second Class and Secondary Standard Solar Radiation Sensors, reducing maintenance, inventory, and replacement costs. The Lufft portfolio includes products like the WS800; with a maintenance-free precipitation (rain/snow) gauge, along with lighting detection to extend safety to the production team and provide the information needed on insurance claims. Lufft's WS product family fill critical meteorological measurement requirements for any renewable energy installation.

**Lufft** | [www.lufft.com](http://www.lufft.com)

**Booth 2479**

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### Electrical and electronic connectors

As a provider of electrical and electronic connectors using advanced contact technology, Multi-Contact will be showcasing the latest offerings of their PV connectors and junction boxes. The MC4 PV connector system has over 1 billion installed units worldwide and 120 GW of installed capacity. In addition, they will be showcasing their low-profile junction box, the multi-function junction box and will offer on-site training for the assembly of the MC4 PV connector system. Multi-Contact is a solution provider for solar application needs, and offer technical support and provide quality customer service.

**Multi-Contact** | [www.multi-contact.com](http://www.multi-contact.com)

**Booth 2137**



### Large polycarbonate electrical enclosure

Fibox, a manufacturer of non-metallic enclosures, has the largest polycarbonate enclosure available; the ARCA-IEC. Sized up to 32x24x12 inches, the ARCA IEC offers quality performance and security in harsh environments. Molded in robust polycarbonate to answer the demand for larger non-metallic enclosures, ARCA-IEC results in an easy to install, affordable alternative to steel cabinets. ARCA-IEC has the features of steel with the added benefits of polycarbonate, which will not break down and bloom like fiberglass, or dent and rust like steel.

**Fibox USA** | [www.fiboxusa.com](http://www.fiboxusa.com)

**Booth 440**





# POWER ELECTRONICS

## 1500 Volt Central Inverter

Power Electronics leads the world in 1500 Volt inverter technology. Through Q3 of 2016 Power Electronics has already shipped over 200MW of their new UL 1500V HEC-US Inverter with over 900MW of commitments for 2017.

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## Solar energy experts

PV power plant projects often require customer specific solutions. For this reason our clients also have our Engineering and Consulting department at their disposal, which comprise a wide number of highly skilled and experienced engineers that are available to modify our standard product to suit customer demands and ensure our clients get the product they need.



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### Solar inverter solutions

Growatt's 33-40k TL3-US model is an inverter with excellent performance and high reliability. It's dual independent MPPT with wide input voltage range ensure energy harvesting. With string monitoring, comprehensive protection, and remote upgrading, Growatt 40k TL3-US offer a low operating and maintenance cost. Wide MPPT range, max DC/AC ratio of 1.5, and plug and play wiring box provide a flexible design and installation. This new three-phase inverter from Growatt is a global solution for commercial and industrial PV systems.

**Growatt New Energy Technologies**  
www.growatt-america.com  
**Booth 1844**



### Stainless steel cable management

Nine Fasteners, Inc. recently introduced a new addition to their line-up of standard wire management offerings, the NFI-1463. The NFI-1463 is designed to securely fasten a single Enphase Engage trunk cable (or AC cable) to a module frame. The NFI-1463 is produced using 410-grade stainless steel, and is manufactured entirely in the US. Nine Fasteners has continued to use a rolled outer edge on this clip, as is standard across their entire product line. In addition to their standard products, Nine Fasteners offers custom design capabilities for application-specific products in both 300 series and 400 series stainless steel.

**Nine Fasteners** | www.ninefasteners.com  
**Booth 2879**



### Aluminum extrusions for the solar market

Sapa Extrusions, a global manufacturer of aluminum profiles, is a key supplier to the solar industry. Sapa provides solutions to all solar market segments including: PV racking and mounting systems (open field, flat roof, and residential); solar thermal (H2O) applications; module frames and components; concentrated solar power (CSP) collectors; inverter housings and components; and thermal management solutions. Sapa's North American Technical Center (NATC) works with customers to establish finished designs for innovative custom features and improved end-use applications. Sapa's manufacturing capabilities include standard and custom extrusion, finishing (painting and anodizing), as well as full fabrication and logistic services. Sapa supplies critical components for solar applications that help customers optimize the value of their products.

**Sapa Extrusions North America** | www.sapagroup.com/NA  
**Booth 233**



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### Solar carports and ground-mount systems

Powers Solar Frames manufactures and provides cost effective solutions for Solar Carports, 5 Panel Ballast Ground Mounts and posted 5-High Ground Mount systems. All products utilize the Powers patented Super Purlin, that reduces purlin usage and requirements by as much as 42%, reduces install time and saving labor costs. Installation of their Solar Carport systems eliminates the necessity of anyone being on top of the structure, all installation of purlins and panels can be done from a scissor lift. All of Powers racking and mounting components are made in the USA at their facility in Phoenix, AZ.

**Powers Solar Frames**  
www.powersolarframes.com  
**Booth 2545**



### Utility-scale and distributed solar power systems

NEXTracker, a Flex company, advances the power plant of the future with advanced PV system innovations, empowering solar power plants to increase performance while reducing costs. NEXTracker's NX Fusion is a pre-engineered solar power plant component bundle incorporating optimized technologies for seamless system deployment. A complete, repeatable tracker power block, NX Fusion incorporates the NX Horizon tracker (its independent rows, fewer foundations and assembly points minimize geotechnical risk and accelerate project construction schedules), advanced string inverter, high power PV modules, DC wire harness, UPS, piers, and a monitoring and control system – all supported by NEXTracker's services. NX Fusion reduces design and logistics challenges, accelerates procurement and construction, and delivers cost savings, scalability and maximum performance for ground-mounted PV systems. 80 to 90 module rows result in optimal electrical design for a wide range of system voltages.

**NEXTracker** | www.nextracker.com  
**Booth 1123**



### In-line string protection

The Littelfuse SPXI 1500 Vdc solar fuse is designed to integrate into an in-line assembly within a wire harness. The fuse provides string protection that meets UL2579 for photovoltaic applications. The SPXI can be electrically insulated by either over-molding or using approved heat-shrink. Also available in 1000Vdc (SPFI) the products protect solar strings from 2 – 30 amps. Littelfuse offers numerous DC circuit-protection products that are suited to protect the equipment and systems subject to the harsh environments of photovoltaic installations.

**Littelfuse** | www.littelfuse.com/solar  
**Booth 214**

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[www.solarroofhook.com](http://www.solarroofhook.com)



### Asphalt shingle roof mounting system

For SPI, SolarRoofHook has installed their QuickBOLT for Asphalt Shingle Roofs through the middle of an aquarium containing two live fish, Marco and Polo, to prove the flashing-free QuickBOLT is leak-proof. They will also be showcasing the first hooks in their new line of Heavy Duty mounting solutions, the Flat Tile [HD+]. The staff at SolarRoofHook can help figure out a custom solution for any installation problems their customers have faced.

**SolarRoofHook** | [www.solarroofhook.com](http://www.solarroofhook.com)  
**Booth 3265**



### Fast, reliable pyranometer

EKO Instruments recently released the new MS-80 secondary standard pyranometer. This thermopile pyranometer has less than 1 second response times, negligible thermal offsets, and a high level of stability. The MS-80 is a solution for photovoltaic as well as climate science solar monitoring applications. As the only ISO 17025 accredited pyranometer manufacturer, EKO provides a high level of calibrations. As part of the calibration, each MS-80 is supplied with an individual cosine and temperature response report.

**EKO Instruments USA** | [www.eko-usa.com](http://www.eko-usa.com)  
**Booth 222**



### Solar structures

Skyline Solar of AZ is a construction firm which designs, engineers, and installs custom solar structures to fit any location requirement. With over 140 MW of installations throughout the U.S. and Hawaii including over 20 MW on parking garages, Skyline Solar, a division of Skyline Steel, approaches every project with a focus on quality, safety, aesthetics, functionality, cost, and structural integrity. Skyline performs all work with their own equipment and employees, so they can offer low cost and quality, with on-time performance.

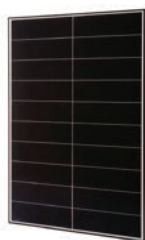
**Skyline Steel, Inc.**  
[www.skylinesolaraz.com](http://www.skylinesolaraz.com)  
**Booth 372**



### Accelerated foundation method

TerraSmart's ground screw patented spiral thread system and pinpoint tip allow it to cut through arduous soil conditions. From bedrock to permafrost to coral, ground screws have an innate ability to penetrate the toughest soil conditions in minutes. Ground screws eliminate the need for concrete and allow foundations to be set within minutes, not hours. This accelerated foundation method has redefined installation times to 150 ground screws per day in medium dense soils. A ground mount project will progress quickly with foundations set in minutes and structures erected instantly.

**TerraSmart** | [www.terrasmart.com](http://www.terrasmart.com)  
**Booth 2145**



### High output solar modules

Solaria's high-efficiency solar PV modules – Solaria PowerXT series – significantly boost energy generation, providing high yield at low cost. With a high power rating, Solaria's 330W and 400W modules are optimized for the rapidly-growing residential, commercial, and utility-scale sectors. Designed for rugged applications, Solaria high-efficiency modules are ideal for trackers and racking systems, reducing the number of modules, project installation time, and balance of system components. Solaria's high-output modules are built on the company's proprietary technology, patented cell cutting, and assembly processes. Through advanced ribbon-less, solder-free interconnection, cells are composed of high density sub-strings. Inactive space between cells is eliminated, providing 18% greater efficiency and ensuring maximum power and profitability.

**Solaria** | [www.solaria.com](http://www.solaria.com)  
**Booth 1123**

# PV Panel Washing Made Easy!

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**Roboklin PV Washer Seen at Hannah Solar - Atlanta, Georgia**

**Wash 12,000 panels in a single shift – 59HP Kubota Turbo-diesel – rubber tracks – 640 gallons water tank – 4 sizes of soft foam brushes – twin joystick controls.**



### NEMA 4X rated inverter

The Huawei SUN2000-45KTL-US-HV-D0 is a 1500Vdc string inverter. Huawei's 8 string inverter provides intelligent monitoring and power line communication technology. With real-time operation monitoring, it offers adaptive edge 4MPPT for fast tracking. The maximum efficiency reaches 99% and CEC efficiency of 98.5%. The DC is AFCI compliant to UL 1699B, and the DC disconnect is integrated, offering safety and convenience for maintenance and ground fault protection with Category C surge arresters for both DC and AC. Its five-level topology can significantly reduce self-power consumption, and directly increase energy yield by more than 0.3%. This reliable inverter has no need for external fans due to its natural cooling technology and rates an outdoor application of NEMA 4X.

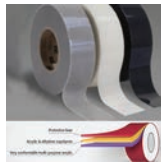
**Huawei America** | [www.huawei.com/solar](http://www.huawei.com/solar)  
**Booth 1145**



### Unlinked single axis horizontal tracker

IdeemaTec's tracking system, safeTrack Horizon, combines the advantages of a central drive unit and an unlinked single axis tracker design. The tracker can be installed on slopes up to 36% without grading, eliminating grading costs. The module surface area of up to 54 ft<sup>2</sup>, combined with unlinked rows, results in less foundations per MW (250), lower O&M costs (half the cleaning distance), and higher GCR (no additional cleaning path needed and optimized shadowing distance). Low installation costs and times were achieved by reducing the number of parts through pre-assembly, a switch to riveting technology, and patented module assembly solutions for frameless modules. The patented synchronous drive technology prevents modules twisting, making it attractive for 1,500 volt glass-glass modules. With offices in the USA, Brazil, Mexico, and Chile, IdeemaTec ensures on-site support.


**IdeemaTec Deutschland GmbH**  
[www.ideematec.com](http://www.ideematec.com)  
**Booth 1435-B**



### Tough, flexible sealing tape

3M Extreme Sealing Tape is a family of single coated, pressure sensitive adhesive tapes designed for difficult sealing applications. The backing on this tape is an ionomer film that is tough, yet flexible and abrasion resistant. The soft and thick acrylic adhesive has excellent sealing properties and good outdoor durability. This single coated tape is designed to seal over an existing joint, seam, or penetration. The adhesive is designed to adhere well to the ionomer film so overlapping tape joints can be made while maintaining a strong seal. This tape sticks on contact to many metals and plastics without dripping, oozing, or clean-up and has no drying time, so it is immediately paintable. It conforms over contours, edges, rivets, and screw heads for a water tight seal and eliminates the need for caulking guns. Available in two thicknesses which offer regular or low profile.


**Mudge Fasteners** | [www.solarfastenerexpert.com](http://www.solarfastenerexpert.com)  
**Booth 1172**



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 513.242.2051



### Solar mounting solutions

RBI Solar offers solar mounting solutions, including ground mounts, roof mounts, carports, and landfill solutions. RBI Solar's next generation utility-scale ground mount solution is specifically designed to make solar installation more affordable and includes a wide selection of component parts that bear loads while using less steel.

**RBI Solar** | [www.rbisolar.com](http://www.rbisolar.com)  
**Booth 811**



### Energy wire and cable

Superior Essex is a U.S. manufacturer and supplier of energy wire and cable products serving the commercial, industrial, utility, and renewable energy markets. Their MV Primary UD 35kV cables are suitable for underground collection systems designed for solar applications. They offer these cables with conductor strand filled, gauge sizes up to 1250kcmil Aluminum, TR-XLPE or EPR insulation, multiple concentric neutral configurations, and LLDPE jacket, meeting the applicable ASTM, ICEA, and AEIC standards, and they are RUS accepted. They also offer low voltage 300V and 600V instrumentation cables for control systems, audio, intercoms, energy management, and alarm controls, low voltage 600V control and power cables for industrial or utility substation circuits, low voltage 600V secondary URD for utility underground power distribution and medium voltage 5kV through 35kV power cables for primary power. All cables are designed, produced and tested in Superior Essex's U.S. manufacturing facilities.

**Superior Essex - Energy Cable**  
[ce.superioressex.com](http://ce.superioressex.com)  
**Booth W1125**



### Labor management and training

IMPACT is a labor management partnership designed to provide a forum for union ironworkers and their contractors to address mutual concerns and encourage reasonable balanced solutions. Their members are committed to increasing the competitiveness and market share of the union ironworking industry. Their primary mission is to expand job opportunities through progressive and innovative labor management cooperative programs, providing expertise in ironworker and contractor training, construction certifications, safety, marketing and construction project tracking, and bidding. The Iron Workers & IMPACT provide training to their growing 130,000 ironworker members at 157 training centers across North America. Thousands of hours of training are provided every year, and certifications are constantly checked and updated to ensure that their labor force is ready and able to deliver immediate manpower.

**IMPACT** | [www.impact-net.org](http://www.impact-net.org)  
**Booth W106**



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### Solar module cable clips

Heyco recently expanded its SunRunner 90° Cable Clip family by introducing a 2-wire version as well as a 4-wire version. The SunRunner 90° Cable Clips are designed to mount at a 90° angle to the original SunRunner. The SunRunner 90° will accommodate a single cable from .20" (5,1 mm) to .30" (7,6 mm); SunRunner 90-2 will accommodate (2) of these cables, and SunRunner 90-4 will accommodate (4) of these cables. The SunRunner 90° Cable Clips are designed to mount on to panels from .06 to .125" thick. The SunRunner 90° Series is designed for use with PV modules mounted in the "landscape" mode. The SunRunner 90° Series will also allow the junction box cables to be run to the adjacent modules across the short side of the PV module frame.

**Heyco Products, Inc.** | [www.heycosolar.com](http://www.heycosolar.com)  
**Booth 3211**



### Maintenance-Free AGM & GEL Batteries

With a full range of capacity options and voltage configurations to choose from, Roll's Battery maintenance-free AGM and GEL valve regulated lead acid (VRLA) batteries offer reliability and heavy-duty construction. Installed in off-grid, grid-tied, or backup float applications, these sealed battery lines require minimal ongoing maintenance and provide a versatile energy storage solution for remote or confined installations, offering superior cycle life and added peace of mind.

**Roll's Battery Engineering**  
[www.rollsbattery.com](http://www.rollsbattery.com)  
**Booth 1777**



### Versatile PV mounting system

Roof Tech, Inc. is introducing the option for third party rail mounting to its self-flashing base. With the understanding that in some rail-less applications, a rail based platform may be a complementary option to some challenging roofing surfaces. This option now allows the installers to combine the versatile, 100% waterproof, and quick to install RT-[E] Mount with a conventional rail system yet utilizing the same self-flashing base integrated with RT-Butyl. The engineering letters from SML (Starling Madison Lofquist, Inc.), who produced the PE reports can be found at the support pages under PE Letters for the RT-[E] Mount.

**Roof Tech, Inc.** | [www.roof-tech.us](http://www.roof-tech.us)  
**Booth 769**



### Reliable single axis tracker

Genius Tracker offers fast install and overall value for low O&M costs. It has completed Black & Veatch technical assessment, CPP wind tunnel testing, is rated 150mph, and ETL / UL 2703 tested. Genius Tracker provides 99.3% panel density on rows. It's linear actuator drive system has a 40-year operating life and is IP 66 rated for operation in harsh environmental conditions. Every drive actuator has its own battery backup and wirelessly linked controllers, eliminating all trenching. Tru3D-Gimbal bearings account for pile installation being out of plumb, out of azimuth, and out of vertical and east-west alignment. Self-powered rows eliminates central drive, allowing for uninterrupted grass cutting and panel washing. GameChange Solar provides free installation training and tracker commissioning for their Genius Tracker systems.

**GameChange Solar**  
[www.gamechangesolar.com](http://www.gamechangesolar.com)  
**Booth 1939**



### Utility-scale solar inverter solution

Power Electronics has been providing quality product and service for over 25 years. Combined with over 6 years of design experience with solar inverters, HEC-US series is a utility scale solar inverter solution designed to provide a reliable plant architecture. Available in both 1000Vdc (HEC-US Plus) and 1500Vdc (HEC-US v1500), scalable between 1MW to 3MW, the modular and redundant design is built on outdoor stainless steel base and air cooled topology that comes with advanced features such as PV Array Transfer Kit and Smart Recombiners to meet requirement for NEC2014, zone monitoring, communication and auxiliary power options, AC close coupling solution, and more to provide a suitable package for every project. All this is backed by 24/7 Power On Support service.

**Power Electronics** | [www.power-electronics.com](http://www.power-electronics.com)  
**Booth 1459**



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### Maintenance-free, deep cycle AGM battery

Fullriver DC Series Deep-Cycle AGM batteries are specifically built for cyclic use in demanding solar applications. The thick plate design and AGM construction combine for a robust battery delivering optimal performance in both fair weather and extreme climate conditions, all in a spill-proof, non-hazardous, and maintenance-free package.

**Full River Battery**  
www.fullriverbattery.com  
**Booth W719**



### All-in-one solar monitoring system

RaZON+ is a system which measures direct, diffuse, and global solar irradiance, all at a high level of accuracy. This new turn-key system for solar radiation monitoring consists of a sun tracking device equipped with GPS and new Smart sensors, and it has built-in data logging. RaZON+ is both innovative and user-friendly. The design of the pyrhelimeter minimizes the effects of soiling, which results in higher accuracy of the measurements.

**Kipp & Zonen** | www.kippzonen.com  
**Booth 2459**



### EPC energy solutions

The Ryan Company, Inc., a wholly-owned subsidiary of Quanta Services, Inc. provides full service engineering, procurement, and construction (EPC) energy solutions. They offer a new approach to traditional EPC models to serve the power generation industry. The Ryan Company provides a flexible and comprehensive suite of services for utility-scale and distributed renewable energy projects, O&M services, energy storage, and integrated solutions ranging from construction-only, to turnkey EPC.

**The Ryan Company, Inc.**  
www.ryancompany.net  
**Booth 1843**



### Watertight flashing

K-Flash is a 100% watertight flashing system made by Kinetic Solar Racking and Mounting. Backed by a 20-year guarantee, the K-Flash kit includes a baseplate that flush-mounts to the roof surface, a 9" x 12" black flashing plate that maximizes coverage of the penetration points, as well as all stainless steel hardware. The baseplates can be secured to the roof with up to two lag bolts and have a separate blind stud on top for L-Bracket attachment, eliminating the through-holes that may cause water leakage and lead to dry-rot. Made from lightweight, malleable aluminum, the flashing can be formed around roof obstructions. The raised channel allows for sealant application on the underside while also diverting water off the top of the flashing. The textured, powder-coated flashing blends well with all asphalt roofs and easily slides under shingles during installation.

**Kinetic Solar Racking and Mounting**  
www.kineticsolar.com  
**Booth 3178**



### Sales and project management software

JobNimbus offers a fully mobile sales and production management software with features including interactive boards, customizable workflows, and photo uploads. Enter new leads and move them through the sales pipeline. Everything in JobNimbus is organized into job folders, including notes, emails, tasks, contracts, photos, estimates, and more. The entire pipeline can be viewed and interacted with in a digital whiteboard to see where everything is and what's up next. With a mobile app (iOS, Android), JobNimbus provides tools in the field to capture lead information, take and upload pictures to a job folder, and create estimates on the spot. The app works in offline mode to provide uninterrupted productivity anywhere. Featuring integrations for canvassing, QuickBooks, and EagleView, JobNimbus is a one-stop solution for managing any solar company from the field or in the office.

**JobNimbus** | www.jobnimbus.com/spi  
**Booth W1111**



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E: usa@ginverter.com

W: www.growatt-america.com



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### Solar racking and tracking

Arctracker, Inc. is a distribution company representing Arctech Solar products in the US. Arctracker, Inc. will be distributing two versions of their ground mount system; the two-high in portrait configuration and the four-high in landscape. The tracking systems are the flat panel single axis tracker, with the tilted panel single axis tracker to soon follow. Both tracking systems have a redundancy design.

**Arctracker, Inc.** | [www.arctrackerinc.com](http://www.arctrackerinc.com)  
**Booth 2971**



### Solar components

With over 40 years of manufacturing experience, Matenaer Energy Products partners with renewable energy OEMs and EPCs to provide the metal stamping, fabrication, CNC machining, and specialty coating products and services. From fabricated welded assemblies to foundation hardware and support structures, they specialize in creating solutions and high quality production. Their offerings include: stamping, welded assemblies, machined components, specialty hardware, geomet and dacromet coating, piles and beams, light assembly and kitting, logistics management, customized Kanban programs, and more.

**Matenaer Energy Products**  
[www.matenaerenergyproducts.com](http://www.matenaerenergyproducts.com)  
**Booth 1724**



### Flexible and efficient three-phase PV inverter

The new generation REFUsol 24K-UL for the Americas is based on the innovative platform of REFUsol 08...23 K inverters which delivers maximum yields with no maintenance. Working hand-in-hand with their customers, REFU Elektronik has improved the devices, making them more future-proof, user-friendly, and reliable. Whether accumulators are added in the future, the PV system is integrated in smart grids, or regulations change, the new software will adapt for the future. Plan and build decentralized PV project flexibly. The simple layout can be rapidly multiplied, particularly with large systems. Partial systems connected to the grid during the construction phase provide early yields.

**REFU Elektronik** | [www.refu-sol.com](http://www.refu-sol.com)  
**Booth W1129**

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### Tubular flooded battery

Discover Energy's 12VRE-3000TF Tubular Flooded battery provides deep cycling performance and reliability in demanding stationary and renewable energy applications. Discover's Tubular Plate Technology offers long life and more runtimes than flat plate battery technologies. The 12VRE-3000TF battery provides performances with lower internal resistance, resulting in better charge acceptance and better overcharge tolerances, and it's constructed to deliver up to 2,500 cycles at 50% DOD and 1,500 cycles at 80% DOD. Battery maintenance and servicing are quick and easy with a translucent Polypropylene container integrated with water level markers and water level float indicators. Available with centralized watering and gassing systems.

**Discover Energy Corp.**  
[www.discover-energy.com](http://www.discover-energy.com)  
**Booth 1701**

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### Self-aligned bearing

The Self-aligned Bearing offers flexibility with ease of installation. Designed to require no greasing, this bearing has zero scheduled maintenance. The inner spherical form (highlighted in blue) allows for flexibility of  $\pm 4^\circ$  to self-align for any type of tolerance. The Self-aligned Bearing is compatible with Sun Action Trackers' Single Axis Tracking systems.

**Sun Action Trackers** | [www.sat-energy.com](http://www.sat-energy.com)  
**Booth 1159**



### Bifacial solar panels

SolarWorld's new Sunmodule Bisun XL bifacial solar panels offer up to 25% more yield, thanks to high-efficiency PERC cell technology applied to SolarWorld duo cells. The Bisun solar panels collect solar radiation from both front and back. When combined with highly reflective surfaces, such as white membrane roofs or white stone, more light is reflected into the module, increasing the energy yield. The installation environment and configuration of a planned solar array can be enhanced to provide the maximum amount of energy harvest possible. This additional boost further reduces energy costs and provides a faster return on investment.

**SolarWorld** | [solarworld.com](http://solarworld.com)  
**Booth 911**



### Intelligence driven electrical products

Koolbridge Solar designs, develops, and sells intelligence driven, solar-ready, electrical power products which automatically select the most economical use of utility, solar, battery, wind, or generator power for homes and businesses. Providing supply reliability on a circuit by circuit basis, the SMART LOAD CENTER is an intelligent breaker box that does not allow for any power interruption if the grid goes down while using solar power, and completes the communications chain from utility to smart grid to smart home to smart appliances.

**Koolbridge Solar** | [www.koolbridgesolar.com](http://www.koolbridgesolar.com)  
**Booth W1009**



### Solar ground-mount earth anchors

American Earth Anchors introduce's the PE46-Hex8 to their line of Penetrator earth anchors. The hex8 has been field-tested to 9,000lbs. of downward pressure and up to 14,000lbs. of pullout strength. It was designed to fit a 2" schedule 40 pipe, making it an option for solar panel ground mount racking. The hex8 can save time and money by replacing concrete footings providing the advantage of no digging, no forms, no pouring, no waiting, and easy leveling by screwing up or down. American Earth Anchors can make custom brackets for any pipe size for any earth anchoring needs.

**American Earth Anchors** | [www.americanea.com](http://www.americanea.com)  
**Booth W730**

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# YASKAWA SOLECTRIA SOLAR



### High power drives

Kinematics HE line are fully-enclosed, vertical drives that do not require other components for mounting. It is most commonly used in the center of single-axis solar trackers to hold the solar array steady in a high wind storm without breaking. The HE drives are a high-power unit that can rotate and accurately position a very long line of panels by themselves to ensure greatest energy collection.

**Kinematics Manufacturing** | [www.kinematicsmfg.com](http://www.kinematicsmfg.com)  
**Booth 110**



### Mid and end clamp assemblies

TRA Snow and Sun introduces their pre-assembled Mid Clamp Assembly and End Clamp Assembly, which clip into the top channel of their Solar Rail Plus and slide along the rail for easy adjustability. Mid Clamp Assembly and End Clamp Assembly allow for variable module heights.

**TRA Snow and Sun** | [www.trasnowandsun.com](http://www.trasnowandsun.com)  
**Booth 1071**

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### 30 amp MPPT controller

MidNite Solar is a US based manufacturer of renewable energy electronics, balance of system components, and small wind turbines. The latest addition to Midnite's family of Wind Controllers is the Wind Kid and Clipper. Similar to its Solar Only sibling, the Kid is a 30 amp MPPT controller able to work with 12V - 48V battery banks, and take a maximum of 150V on the input. The Wind Kid will be able to handle small three phase and DC turbines and comes equipped with a braking system allowing users to shut down the turbine during high wind events. The Wind Kid is fully updatable and as updates become available, they will be released to the public. The Wind Kid with Clipper is a solution for use with small wind turbines in off grid home and cabin applications.

**Midnite Solar** | [www.midnitesolar.com](http://www.midnitesolar.com)  
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### Roof mounting innovation

AceClamp's A2 clamp can now be used with their new micro L foot to install inverter boxes to S.S.M.R. without compromising manufactures warranties. This fully assembled product is just another way to get installers on and off the roof faster. AceClamp's A2 clamp can now be used with their new micro L foot to install inverter boxes to S.S.M.R. without compromising manufactures warranties. This fully assembled product is just another way to get installers on and off the roof faster.

**PMC Industries** | [www.aceclamp.com](http://www.aceclamp.com)  
**Booth 226**



### 50kW and 60kW transformerless string inverters

Yaskawa - Solectria Solar announced the introduction of its PVI 50TL and PVI 60TL inverters adding to its three-phase, 1000 VDC, transformerless string inverter line. These inverters have design flexibility, compliance with NEC 2014, wide MPPT voltage range, 1.5 DC/AC ratio, -30°C to +60°C operating temperature range, and remote diagnostics/firmware upgrades. The new PVI 50TL and PVI 60TL inverters add to the current fleet of transformerless PVI 14-36TL commercial inverters, each designed to maximize return on investment (ROI).

**Yaskawa - Solectria Solar**

[www.solectria.com](http://www.solectria.com)

**Booth 1717**



### C&I dual-axis tracker

PV Booster is a dual-axis solar tracker designed for the commercial and industrial (C&I) market, bringing the economic benefits of trackers from the ground to the rooftop. PV Booster maximizes solar capture throughout the day to increase energy production by 30% and improve system economics by 20%, with especially significant returns for customers in regions with time-of-use utility rates due to improved generation during the late afternoon hours. PV Booster is built for simple, fast installation and features a gearless, brushless design which keeps operations and maintenance (O&M) costs low over the lifetime of the system. Additionally, PV Booster's low profile enables superior wind resistance and its built-in intelligence automatically retracts modules at night and during inclement weather events. PV Booster is the flagship product from Edisun Microgrids, an Idealab company.

**PV Booster** | [www.pvbooster.com](http://www.pvbooster.com)

**Booth W811**



### Standing seam mounting clamp

The Standing Seam Power Clamp is a mounting clamp that can attach to virtually any standing seam profile and provides a strong connection using WaveLock Technology with optional 2, 3 and 5 points of attachment. The top of the Standing Seam Power Clamp can be custom drilled and tapped to fit any bolt configuration. Offering ease of installation, the Silver Bullet set screws include a rounded bullet tip to maximize strength and won't damage the paint finish or pierce the seam. Additionally, the Standing Seam Power Clamp is available in standard mill finish aluminum material, making it an easy-to-stock item. The Standing Seam Power Clamp can be powder coated or Kynar coated to match the color of the roof system.

**Solar Connections** | [www.solarconnections.com](http://www.solarconnections.com)

**Booth 1276**

# The Battery Matters



## The Difference Between Deka Solar and Other Batteries Is Like Night & Day

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MK Battery – An East Penn Manufacturing Co. Subsidiary MADE IN USA with U.S. and Imported Materials



**Ballasted solar racking system**

EcoFoot3 is the next generation ballasted solar racking system from Ecolibrium Solar. Designed for commercial flat roofs of all sizes, EcoFoot3 combines the ease of install and low part count of a modular system, with improved roof loading and lower ballast from increased structural rigidity. The simple base supports the modules at manufacturer recommended support locations, and the unique rear mount clamp design is provided pre-assembled to the racking. Wire management options eliminate expensive auxiliary supports, and easily support conduit or cable tray directly from the racking. Complete UL2703 validation was completed at the Ecolibrium Solar Certified Lab in partnership with TÜV Rheinland PTL, and wind tunnel testing was done at I.F.I. Aachen University in Germany. The resulting system can be optimized with low ballast or minimal penetrations to handle a wide range for roof requirements.

**Ecolibrium Solar** | [www.ecolibriumsolar.com](http://www.ecolibriumsolar.com)

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**Microinverter with LVRT/reactive power control**

LeadSolar Energy provides highly reliable and cost-effective smart solar solutions. Its grid-connected microinverters leverage modern-day communications technology to maximize the effectiveness of solar panels throughout changing environmental conditions. LeadSolar's solution could produce 15-25% more power than conventional methods, and features a warranty matching that of solar panels for maximal ROI. LeadSolar's microinverter, LS1500, can connect to four modules and supports reactive power compensation and LVRT. LS1500 also tracks each module separately with independent MPPTs.

**LeadSolar Energy**

[www.leadsolarenergy.com](http://www.leadsolarenergy.com)

**Booth 447**



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Travelers insures clean energy and technology businesses, effectively delivering and implementing industry-specific insurance products and services. Travelers provides specialized coverages, risk management expertise, and early resolution claim strategies for businesses engaged at all stages of the renewable energy lifecycle, including software developers, R&D, manufacturers, contractors, operations and maintenance services, and power providers. Additionally, through their Lloyd's Syndicate, they offer first party coverage to businesses with global wind and solar exposures.

**Travelers Global Renewable Energy**

[www.travelers.com/energy-practice/](http://www.travelers.com/energy-practice/)

**Booth 2771**



## Electric power meters

Continental Control Systems features the WattNode Revenue meter and the customizable meter module with ANSI 12 accuracy as well as its full line of high accuracy split-core current transformers and its flexible style, Rogowski Coils for difficult to install loads up to 6000A. CCS specializes in low-cost, high accuracy electric power metering and custom inverter monitoring equipment for OEM applications. The company's meters and current transformers are designed to provide bi-directional, revenue-grade electrical measurements including power (kW) and energy (kWh) through a variety of communication protocols including BACnet, Modbus, and LonWorks or as pulse outputs. Applications for the WattNode meter and Accu-CT current transformers include measurement and verification of energy production, measurement and verification of energy consumption as well as net metering.

### Continental Control System

[www.ccontrols.com](http://www.ccontrols.com)

**Booth W1133**



## Rapid shutdown for rooftop PV systems

Phoenix Contact has developed an NEC 690.12-compliant solution for the safe, rapid shutdown of rooftop PV systems. SOLARCHECK RSD (Rapid Shutdown) is based on the intelligent analysis of electrical conditions within solar strings. In the event of an emergency, a fault condition within a string, or a manual shutdown for maintenance work, the system automatically switches the PV system into a safe state. SOLARCHECK RSD modules are integrated directly onto the panels via a smart cabling system. When the system can be safely restarted, SOLARCHECK RSD switches on automatically, triggered by the startup of the inverter, or optionally, via an enable input.

### Phoenix Contact

[www.phoenixcontact.com/rsd](http://www.phoenixcontact.com/rsd)

**Booth 633**



## Corrosion-resistant wire management

Wiley, a product line of Burndy, offers wire management solutions for all types of solar applications. Their newest addition to the wire management family is the ACC-F1-270. It's made of corrosion resistant 304 stainless steel, which makes it a durable, long lasting, and reliable solution for all environments. The ACC-F1-270 is easy to install and can be slid onto module frames of various thicknesses. The ACC-F1-270 accommodates micro inverter trunk cables, AC module cables, and PV cables. The rolled edges help protect cable insulation from damage. When mounted on the module frame the cable compartment always faces up which allows for the cable to be securely held in place by gravity. The 270 feature permits installation of the clip on the top or side portion of the module flange. Designed for rail-less and ballasted roof systems.

**Burndy** | [www.burndy.com](http://www.burndy.com)

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**SkyRail** - Low Slope Roof ballasted support structure is low cost galvanized steel, quickly assembled without bolts, for 60 or 72 cell modules in Portrait or Landscape at 10° tilt angle.



**NEW SkyGrip™** top grounding middle clamp eliminates lay-in ground lugs and copper wire on solar modules. Listed to UL467 self drilling screws or bolted connections to metal rails, available now at competitive pricing.



**NEW SkyBite™** stainless steel- solar module mounting and grounding attachment developed for carports, Listed to UL467, installs from below - reduces safety risk and damage from crawling or walking on PV modules. Coming soon at great pricing!



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**PV testing tool**

HT Instruments introduces their new HT App for Solar I-V measurements. The HT App allows users to add photos, video, and voice notes and share them via the HT Cloud and makes it easy to download panel characteristics. Using the HT App allows a time line comparison of strings to previous tests to monitor performance.

**HT Instruments** | [www.ht-instruments.com](http://www.ht-instruments.com)  
**Booth 373**



**Advanced batteries to reduce PSOC**

Trojan Battery is now shipping the J200-RE, the newest addition to its Premium line of advanced lead acid, flooded batteries with Smart Carbon for renewable energy (RE) applications. The J200-RE is part of Trojan's Premium line featuring Smart Carbon, Trojan's proprietary carbon additive that helps to reduce the effects of Partial State of Charge (PSOC) in renewable energy applications. Deep-cycle batteries used in off-grid and unstable grid applications are heavily cycled at PSOC. Operating at PSOC on regular basis can quickly diminish the overall life of a battery, which results in frequent and costly battery replacement. Along with increased life in PSOC, Smart Carbon provides improved charge acceptance and faster recharge in PSOC applications. The added benefit of Smart Carbon and the eight-year service life, based on the IEC 61427 test, supports Trojan's continued commitment of providing high quality, reliable energy storage solutions for various renewable energy market segments.

**Trojan Battery** | [www.trojanbattery.com](http://www.trojanbattery.com)  
**Booth 1576**

**SOLARPOWER INTERNATIONAL**  
 September 12-15 / Las Vegas  
**Booth #935**

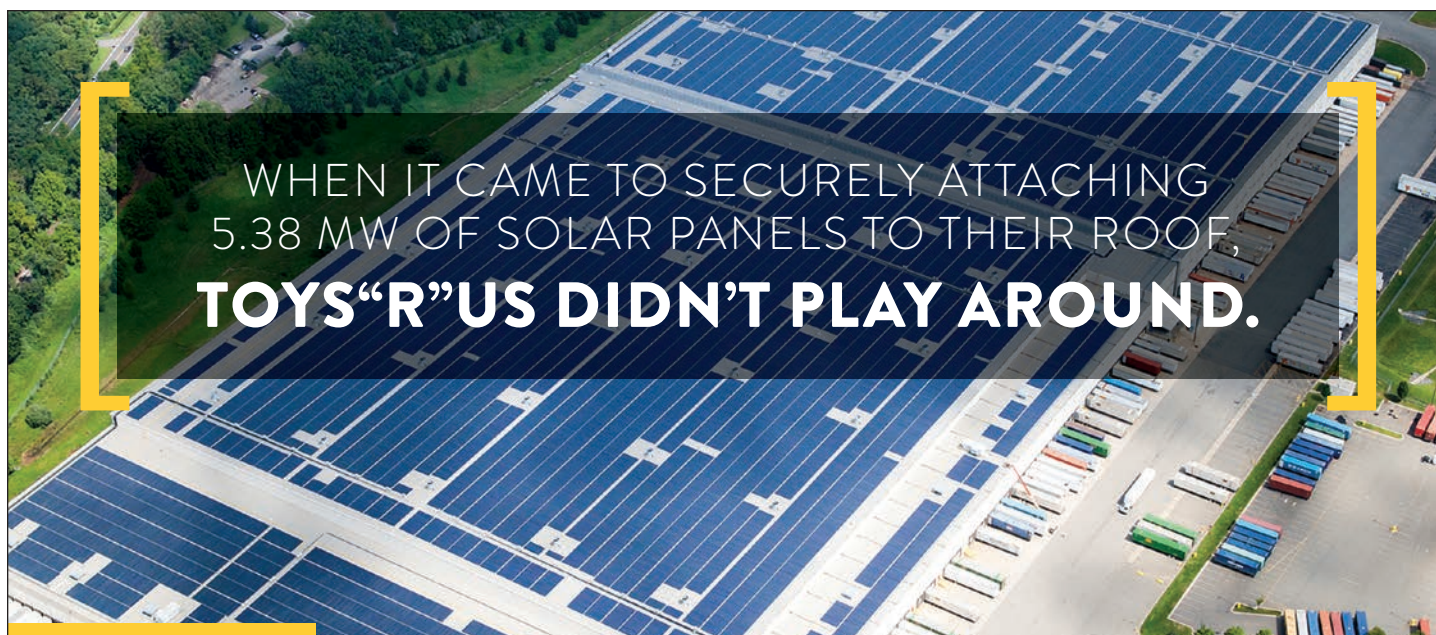
# Connect with us!

Did you know that nearly 25% of all solar electricity in North America flows through a SolarBOS product? Ever wonder why?

We believe it's due to our product quality, flexibility and manufacturing capabilities right here in the US. Not to mention our world-class customer service and wide product range, including everything from AFCI Combiners to Breaker Enclosures to PV Wire Harnesses. Add to this our 2-day shipping to most every jobsite in North America and it's easy to see why so many customers choose SolarBOS.

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**Solar structures & carports**

Baja Construction provides pre-fabricated, pre-engineered, high-tensile, and light-gauge steel structures that serve as the mainframe of a solar energy facility. They design, engineer, supply, and install Solar Support Systems, an integral component of a solar ground-mount, solar carport, and/or solar RV and boat storage solution. Baja's Solar Support Systems are being built at schools, train stations, sports complexes, shopping malls, medical facilities, office buildings—and any place where a parking lot is a location for solar shade that can generate power to offset energy costs or generate revenue from a Feed-in-Tariff. Baja is a nationwide company with its own in-house engineers.

**Baja Construction**  
[www.bajacarports.com](http://www.bajacarports.com)  
**Booth 3017 and SL44**





### Panel washing

The Bitimec- Messersí RoboKlin is a washing machine for large PV arrays, able to wash two megawatt of panels in one day, using only 4500 gallons of water. The system runs smoothly on a rubber track undercarriage. With twin joy-stick controls, a telescoping boom, ultrasonic sensors, and a hybrid foam brush, feather-light mechanized panel washing is done simply and gently. Operators and owners can now avoid losing up to 20% of revenue from soil deposits accumulating on panels. This ability to economically wash solar panels can repay buyers many times their investment.

**Bitimec** | [www.bitimec.com](http://www.bitimec.com)  
**Booth 2471**



### Soiling index datalogger

Soiling, the loss of PV module power output due to accumulation of dirt and/or snow on the panel surface, has become one of the most important operational issues of solar energy power plant performance. The CRSI2 Soiling Index Datalogger provides solar energy professionals who are responsible for managing the performance of a PV power plant with the information needed to evaluate and manage the impact of soiling. The CRSI2 calculates a daily average soiling loss index using industry standard methodologies. The data is available to the solar farm SCADA system and is also stored in on-board memory. The CRSI2 can be used as a stand-alone measurement solution, or integrated with existing solar farm weather stations from Campbell Scientific.

**Campbell Scientific**  
[www.campbellsci.com/crsi2](http://www.campbellsci.com/crsi2)  
**Booth 541**



### Solar tool kits

Transcat Alternative Energy orders, assembles, calibrates, and documents their solar tool kits to meet customers' safety requirements and quality standards. They have multiple types of standard tool kits available, and items can be added or excluded to customize each kit to a user's needs. Alternative energy tools kits available are: technician tool kits, site kits, service and maintenance tool kits, and commissioning tool kits. Items in the kits can be laser etched and Transcat keeps orders on file for future reordering, expansion, or replacement.

**Transcat Alternative Energy** | [www.transcat.com](http://www.transcat.com)  
**Booth 569**

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## Expertise

- Experienced staff from across the cable industry
- Success providing innovative solutions



## Specialization

- Extensive product offering to service the commercial, industrial, utility and renewables market
- Full range of value-added, integrated manufacturing services
- Two U.S. manufacturing facilities



## Service

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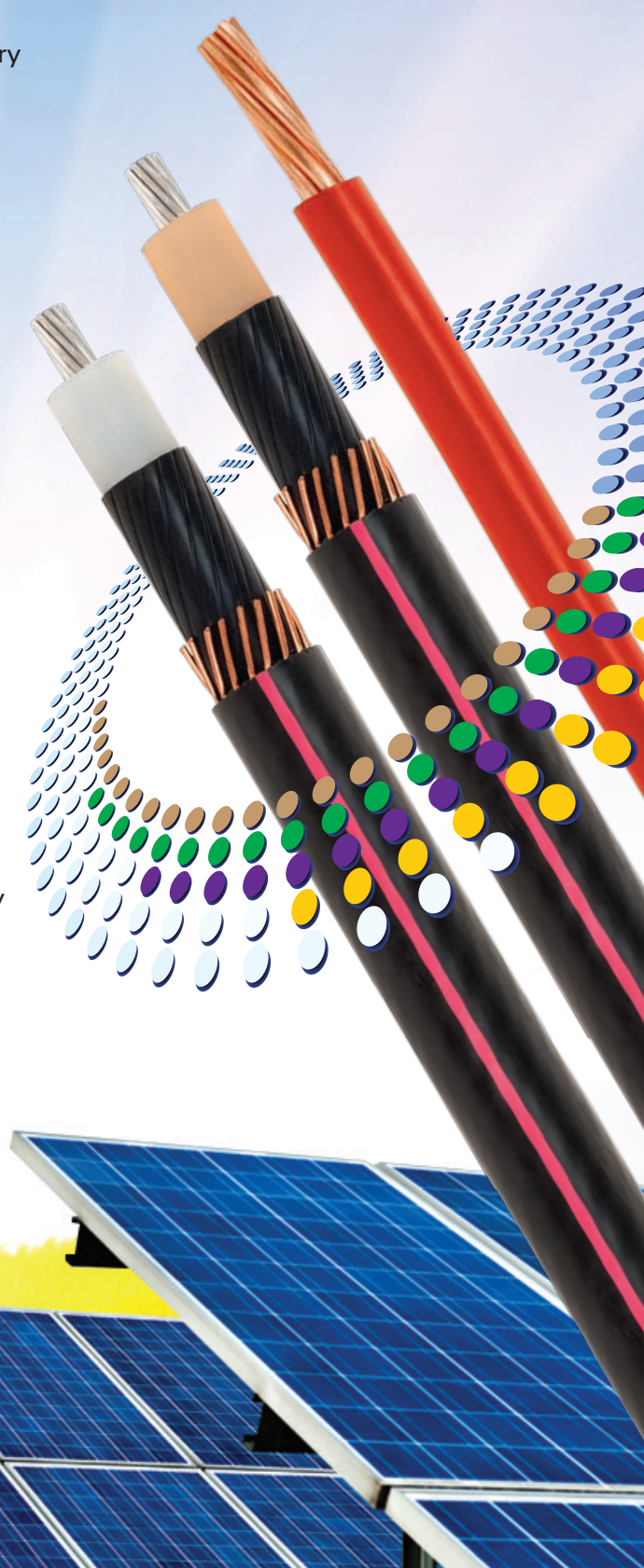
## Innovation

- Robust product innovation and new product development
- Clean Material handling technology for MV cables
- State-of-the-art U.S. manufacturing technology

Come visit us at **Solar Power International** (Booth #W1125) September 12-15, 2016 in Las Vegas. We have the experience and expertise to help you successfully achieve your power needs!



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ESSEX**





### Cellular and WiFi monitoring

The Powered Enclosure Kit (PEK) is designed to protect an installation and provide power to one of several communication protocol devices (WiFi, cellular, etc.). The kit comes with components that complement the eGauge main unit, decreasing installation time and reducing complexity. The PEK can be utilized with 3p/4w, 120/208vac and 2p/3w, 120/240vac services.

**eGauge Systems, LLC** | [www.eGauge.net](http://www.eGauge.net)  
**Booth 1621**



### Solar solutions

Fronius USA will display many high quality solutions, partnerships, and key innovations for solar: the Fronius Primo Hybrid with the Tesla Powerwall, the Fronius Rapid Shutdown solution, the online support tool Fronius SOS, as well as the latest module optimizer technology for Fronius string inverters.

**Fronius USA** | [www.fronius-usa.com](http://www.fronius-usa.com)  
**Booth 1521**

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### Turnkey energy storage system

GILDEMEISTER energy storage's CELLCUBE is a turnkey system solution which includes an integrated power conversion system, double-wall tanks, intelligent sensors and control functions, comprehensive monitoring procedures, and simplified maintenance. The system reacts within milliseconds to deliver clean and emission-free power. Capable of 100% depth of discharge, users can charge and discharge according to their needs. It exclusively uses dissolved vanadium salts. They are not subject to cycle degradation and can be used without limit. Ready for operation in all climatic and weather conditions, the CELLCUBE can also be monitored 24/7, charge level, current power level, operating state, and more can all be controlled online. The CELLCUBE is a solution for behind the meter energy storage applications, C&I demand charge reduction, utility investment deferral, self-generation optimization, renewable firming, microgrids, backup power, and much more.

**GILDEMEISTER energy storage** | [www.energy.gildemeister.com](http://www.energy.gildemeister.com)  
**Booth W436**



### Freestanding, skid-ready auxiliary power enclosure

AMtec's Solar Auxiliary Power Enclosure is a freestanding NEMA 3R enclosure, with vent, filter, and fan. Available with 480 and 240/120Vac circuits for lighting, convenience outlets, and tracker power with room to mount SCADA, meters and weather equipment all in one enclosure. The main transformer is available in a variety of voltages and kVA ratings. The AMtec's Solar Auxiliary Power Enclosure removes the need to install multiple AC panels boards and transformers, and is UL508A listed.

**AMtec** | [www.amtech1.com](http://www.amtech1.com)  
**Booth 3117**



### Ballasted roof mount

The Aurora Ballasted Roof Mount is a non-penetrating flat roof mount system designed for ease of installation at a low price point. The mount is available in 5° and 10° tilt angles, and mounts panels individually allowing for arrays to circumvent rooftop obstacles while maximizing the utilization of roof top space. The mount is shaped for convenient shipping and handling and includes port holes for North/South conduit runs. The Aurora also features integrated panel-to-panel grounding with the UL 467 grounding mid clamps. The lightweight aluminum design maintains a low weight for shipping and deployment to the roof has been wind tunnel tested up to 150 m.p.h.

**Patriot Solar Group**  
[www.patriotsolargroup.com](http://www.patriotsolargroup.com)  
**Booth W830**

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**Solar Power International  
 Las Vegas • Booth W1133**

**Continental Control Systems, LLC**  
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### Digital training solution

InterplaySolar delivers a training solution for solar companies looking to improve company performance by making their employees more efficient, more dedicated, and more effective at their job. Interplay's online software platform features 3D simulations, gamification, and a smart system of learning to drive new hire productivity for immediate on-the-job results. Interplay's training platform also integrates a manufacturer training portal to deliver simulation-based training on specific equipment. This scalable learning helps installers provide an accurate install on all types of equipment.

**Interplay Learning**  
www.interplaysolar.com  
**Booth 2974**



### Lithium-ion battery systems

Saft develops and industrializes lithium-ion (Li-ion) batteries and provides project management and delivery of complete, fully tested and qualified systems. Saft provides Li-ion energy storage systems which offer a combination of performance, reliability, and safety for projects in energy services and renewable energy integration. Saft's Intensium Max is a ready-to-install containerized solution designed for today's electricity grids and for the smart grids of tomorrow. It provides a complete, fully integrated energy storage system at the megawatt scale comprising Li-ion battery modules, power management and control interfaces, air conditioning, and safety devices.

**Saft America** | www.saftbatteries.com  
**Booth 1579**



### Crimp tool for solar contacts

For 30 years, Rennsteig has been manufacturing tools. Their top of the line tools are engineered for the wires and terminals specific to the solar industry. Rennsteig now offers a new Crimp Die Set and Locator for Amphenol UTX solar contacts (UTXCF, UTXCM, UTXFE, and UTXFM) as well as many other Crimp Die Sets available for terminals by all major manufacturers. With stock in NJ, Rennsteig can respond quickly to installer needs.

**Rennsteig Tools, Inc.** | www.rennsteig.us  
**Booth 2777**

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**Custom cost-efficient solar solutions**

KRINNER Solar delivers fully integrated EPC solutions. From the manufacturing of foundations and racking solutions over project planning and project management to the optimized installation process utilizing their own installation robots. The KRINNER Solar team achieves up to 4MWp per day. Their GPS-based work-flow allows permanent tracking and documentation of the project via the Krinner Cloud. This provides a high degree of security and insight into the project.

**KRINNER Solar** | [www.krinner-solar.com](http://www.krinner-solar.com)  
**Booth 2745**



**Residential and commercial grid**

The POWERGRID is now available to both residential and commercial customers to create an independent system combined with solar that can replace the power grid. The new LiFeMnPO4 battery system takes up a small 2 sq.ft. foot print and is safe for indoors, with no fumes or toxic chemicals of any kind. Built to last 20 years with no maintenance, Clean Energy Storage systems are easy to install, come with online monitoring, and offer tools to help customize any system within minutes.

**Clean Energy Storage**  
[www.cleanenergystorage.net](http://www.cleanenergystorage.net)  
**Booth W428**



**Fast, easy financing**

Salal Credit Union has provided millions in loan funding to help dealers close more sales. They partner with businesses of all sizes to provide their customers with attractive financing for everything from solar panels to heating systems to roofs. They offer an online application with fast credit decisions (subject to credit approval), and have a high approval rate on loans from \$1,000 to \$50,000 with terms to fit any budget. There are no dealer fees on standard programs but they also have a deferred program offering 0% financing for 6 or 12 months (dealer fees apply).

**Salal Credit Union**  
[www.salaldealerdirect.com](http://www.salaldealerdirect.com)  
**Booth W630**

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**Single axis utility tracker**

Soltec's SF Utility single-axis independent-row tracker design and project supply is a land-use enabler providing built-in tolerances for irregular land, including its steep-slope tolerance of 17% grade North-South. SF Utility is a yield enabler providing configurations to achieve the highest yield per acre. SF Utility provides low-cost installation with low piles-per-MW, reducing pile-driving expenses and environmental impact.

**Soltec** | [www.soltec.com](http://www.soltec.com)  
**Booth 609**

**INTRODUCING THE SOLAR CONNECTIONS KIT**  
 Solar Panel Mounting System For Standing Seam Roofs  
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**Commercial grade microinverter/optimizer mount**

Solar Clam-P's O Clam-P is the 2nd generation of their microinverter mount, the Mi Clam-P. The O Clam-P is UL2703 Listed to be optimized with SolarEdge Optimizers. The O Clam-P comes pre-assembled and mounts any microinverter or optimizer in less than 6 seconds.

**Solar Clam-P** | [www.solarclam-p.com](http://www.solarclam-p.com)  
**Booth W1105**



### String inverter mount

Sollega, Inc., introduces their FastRack String Inverter Mount (FSIM) It can be adapted to mount most string inverters and makes the installation of an inverter, combiner box, or disconnect easy and quick. With ballast and mechanical attachment options, flexible Strut configuration, 20° tilt, and optional shade cover, the FSIM fits every roof requirement. Founded in 2009, Sollega designs, tests, and manufactures solar mounting solutions. The FastRack510 is a patented, one-piece, injection molded solar racking system designed for both commercial low-pitch roofs and ground-mount installations. It is quick to ship, stage, and install, with no assembly required.

**Sollega, Inc.** | [www.sollega.com](http://www.sollega.com)  
**Booth 832**



### Watertight solar roof mounts

EcoFasten Solar designs, engineers, and manufactures patented, watertight solar roof mounts for all roof types. Their product line includes GreenFasten, the rail-free Rock-It System and Rock-It System 2.0, SimpleGrip for low-slope applications, Tile Flashing Systems, CorruSlide for metal roofing, QuikFoot for slate or comp shingle, conduit mounts, a SIPs solution, and more, including solar snow management options. The company provides quality mounting solutions that are easy to install, cost-effective, and rugged in fabrication. EcoFasten Solar products are precision-designed with the installer in mind.

**EcoFasten Solar**  
[www.ecofastensolar.com](http://www.ecofastensolar.com)  
**Booth 3071**



### Mechanical tubing

Lock Joint Tube introduced large diameter steel tubing for the solar industry in 2014. LJT manufactures over 350 different sizes of mechanical tubing to choose from. Their size range options go up to 6.375" round, 4" square, 3 x 6, and a number of special shapes for the solar industry. They also produce a wide variety of galvanized and non-galvanized coatings. They can manufacture custom tubing to meet individual specifications.

**Lock Joint Tube** | [www.ljtube.com](http://www.ljtube.com)  
**Booth W306**



**Wiley ACC Cable Clips are a high-quality wire management solution**

# Clipping Right Along

## Long-lasting, Customizable Wire Management Clips

Wiley Cable Clips simplify wire management and create a cleaner look to solar PV arrays. Able to last a lifetime, the corrosion resistant 304 stainless steel clips are a durable solution for all environments. Coined edges prevent damage to cable insulation. The design is easy to install and no tools are required. Clips can be used in a wide variety of mounting configurations (including 90-degree) for module and rail applications. Custom designs are available upon request.

# wiley



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### Surge protection device

CITEL's M50 Series is a UL96A listed surge protection device composed of hybrid technology for enhanced TOV protection with no leakage current. All single and three phase configurations from 120 to 600Vac and real-time diagnostics include an LED per phase and audible alarm. CITEL's M50 Series can be used in industrial, commercial, or residential applications and is UL listed for standalone or integrated applications.

**CITEL** | [www.citel.us](http://www.citel.us)  
**Booth 1774**



### Microrail pitched roof system

SUNFRAME MICRORAIL (SFM) is a hybrid racking system including a structural front Trimrail for fast array alignment and improved aesthetics. Minimize total labor with pre-assembled parts, integrated bonding hardware, and one tool installation. Compact packaging lowers logistics costs from the warehouse to the roof. Patented mounting components provide post-install height adjustment and allow for removal of individual panels for maintenance.

**Unirac** | [www.unirac.com](http://www.unirac.com)  
**Booths 2117, MR8, and SL38**

### Tracking the Sun. From dawn to dusk.

End-to-end tracking solution : hardware, tracker controller & structure designs.



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India's largest 10 deg TILT, Auto E-W tracking plant



- Awarded 'Solar Trackers Company of the Year' for 2015 and 2016 at the Global Solar EPC Summit.
- Several MW class installations currently under operation in **India, USA, Africa, Middle East, Japan.**
- **Global** product & design **patents.**
- Proven tracker technology that **enhances energy generation by upto 25%.**
- **In-house facilities** and instrumentation that enable **research, validation & testing.**
- **Project pipeline of over 500 MW** for FY 2016-17.

#### About Scorpius Trackers

Scorpius offers the best in Tracking Technology; from maintenance-free bearings for the lifetime of the plant, to electronics and actuators that are self-powered. Truly, world-class bankable technology at very competitive upfront CAPEX and minimal O&M costs.

#### Contact

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 T: +91 20 2565 9413  
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### Rail-less PV Mounting System



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### Solar powered lifestyle products

Founded in 2013, BirkSun manufactures solar lifestyle products and accessories. Their products are designed to carry belongings while simultaneously keeping smartphones and portable devices charged on the go. Combining the emergence of solar power with the increasing popularity of wearable devices on the market, BirkSun provides a solution to portable power struggles. BirkSun was created to inspire, motivate and encourage users to charge their passion. By harnessing the power of the sun, they believe in changing the way the world is powered.

**BirkSun** | [www.birksun.com](http://www.birksun.com)  
**Booth WSUA11**



### Japanese-made PV modules

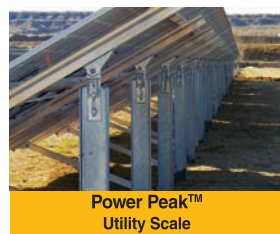
Japan Solar offers both poly/mono, 60/72 cell modules for residential, commercial, and industrial applications. They can offer a complete Japanese-made solar system plus inverter and energy storage as well as racking.

**Japan Solar** | [www.japansolarus.com](http://www.japansolarus.com)  
**Booth 551**



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### Improved temperature coefficient modules

LG's new 60-cell module, NeON 2, adopts Cello technology, which replaces 3 busbars with 12 thin wires to strengthen power output and reliability. Compared to previous models, the NeON 2 has been designed to increase output efficiency even in limited spaces. It features an enhanced warranty, durability, aesthetic design suitable for roofs, and superior performance under real environment due to its improved temperature coefficient.

LG | [www.lgsolarusa.com](http://www.lgsolarusa.com)

Booth 1447



### Single-axis, turnkey tracking solution

Solar FlexRack's TDP Turnkey Trackers are the next generation, single-axis tracker solution, complete with comprehensive services and support. This tracking solution has an updated tracking technology bundled with a full suite of services and support for commercial and utility-scale solar customers. The TDP Turnkey Tracker offers a low total cost solution by including full design, installation, commissioning, and support services bundled in one contract. Solar FlexRack's TDP Tracker also offers a flexible design allowing for close packing on odd-shaped lots and maximizes land usage. The TDP solution is supported by an in-house team of experts including mechanical, structural, civil, electrical and geotechnical engineers, and geologists.

SolarFlex Rack

[www.solarflexrack.com](http://www.solarflexrack.com)

Booth 923



### High cycle rechargeable batteries

The ECO R SLR1000-2 is one of the newest additions to the GS Battery "Pyramid of Power" energy storage lineup. These Advanced Lead-Carbon batteries feature a patented nano-carbon enhancement which allows the battery to achieve long cycle life, deliver partial SOC performance and provide fast charging rates. These 2-volt mono-block batteries are rated at 1000ah (10hr) and tested to deliver 5000 cycles at 70% DOD. The SLR1000-2 is a non-spillable, sealed VRLA offering minimal maintenance requirements in an inherently safe and environmentally friendly format.

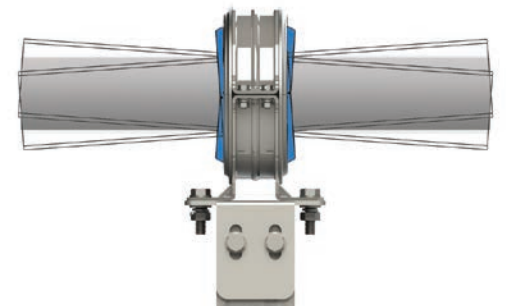
GS Battery (U.S.A.), Inc. | [www.gsbattery.com](http://www.gsbattery.com)

Booth 1675



## MORE FLEXIBILITY EASE OF INSTALLATION

Sun Action Trackers' Self-aligning Bearing offers flexibility with ease of installation. It is designed to require no greasing, and have zero scheduled maintenance. The inner spherical form (highlighted in blue) allows for flexibility of  $\pm 4^\circ$  to self-align for any type of tolerance. The Self-aligning Bearing is compatible with Sun Action Trackers' Single Axis Tracking systems.



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[sales@sat-energy.com](mailto:sales@sat-energy.com)

We invite you to join us at:

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INTERNATIONAL  
Booth 1159



### Solar ground-mount system

The second generation Power Peak GS is a cost effective, utility scale mounting system manufactured from high strength galvanized steel. The design features factory preassembled clamps that align anywhere along the rail without holes. Power Peak systems feature fewer parts, easy field adjustable components, and bottom access clips to ensure fast build rates. Wind tunnel optimized and code compliant, Power Peak racks assemble over pile driven "H" or "C" posts and quickly adjust to changes in terrain. Power Peak mounting systems are manufactured in the United States and are backed by Preformed Line Products, a company founded in 1947 and a pioneer in energy infrastructure solutions.

**DPW Solar** | [www.dpwsolar.com](http://www.dpwsolar.com)

**Booth 717**

# SOLAR CLIPS



#### NFI-1306-V90

90° oriented clip intended to secure two USE-2 wires, up to .20" diameter, to standard module frame.

#### DCS-1306

Designed to secure two USE-2 wires, up to .20" diameter, to module frame.



#### DCS-1307

Designed to secure two PV wires, up to .30" diameter, to module frame.



#### NFI-1461

Designed to secure two Enphase trunk cables to module frame.



#### NFI-1462

90° oriented clip designed to secure two Enphase trunk cables to module frame.



#### NFI-1463

NEWLY designed clip to secure a single Enphase trunk cable to module frame.



#### DCX-2452A

Designed to secure two Enphase trunk cables on to most rail/racking systems.

**For FREE product samples, please reach out to Vin Marino**  
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### Modular solar racking solution

AP Alternatives modular solar racking utilizes a shallow helical foundation system allowing for flexibility and installation ease in even the most adverse site conditions. Sandy soils, high water tables, low laying bedrock, extremely soft soils, and landfill sites are no issue for these flexible foundations. APA's recent hardware addition, the Advanced Modular system, includes an offsite prepanelization process to take expensive man hours out of the field and streamline the installation process in high wage environments.

**AP Alternatives**  
[www.apalternatives.com](http://www.apalternatives.com)  
**Booth 533**



### Custom PV structures

M Bar C Construction provides custom design/build for Photovoltaic carports, canopies, ground-mounts, and trackers in commercial, government, school, and military construction projects. Their aesthetic, sturdy, functional structures are manufactured in light- and heavy-gauge steel which harness the sun's energy for all types of applications.

**M Bar C Construction**  
[www.mbarconline.com](http://www.mbarconline.com)  
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### Balance on tracker solution

Shoals' Balance on Tracker is a full PV utility-scale solution, which includes all necessary electrical and mechanical components to move panels and transport electricity to the inverter. The SAH tracker, all electrical harnesses, the BLA, and wireless string monitoring have been designed and optimized at the system level.

**Shoals Technologies Group**  
www.shoals.com

**Booth 2205**



### Branch fuse connector

BizLink's new Sunbolts DC Branch Fuse Holder consists of an overmolded, hermetically-sealed branch connection with a Sunbolts fuse-connector terminating each of PV cable ends. With strong over current protection, this RoHS compliant and UL recognized connector simplifies in-field module installations and maintenance with the easily replaceable fuse. Their low-resistant, IP67 branch cables take the hassle out of stripping and crimping to make branch connections, reducing labor costs and improving workmanship.

**BizLink** | www.bizlinktech.com

**Booth W930**



### Three-phase 25kW solar inverter

Known as the "Tabuchi workhorse," their three-phase 25kW commercial inverter is capable of 480V AC output, remote monitoring and setup, and scalable for larger projects. 6 MPPTs allows for flexible and easy design, greater utilization of roof space for panels, and high production despite shading or panel malfunction. The 25kW commercial inverter is a ground, rooftop, and rack mountable inverter.

**Tabuchi Electric** | www.tabuchiamerica.com

**Booth 2933**



### Fully bonded flashing

Solar Speed Rack has developed a fully bonded flashing using a metal to metal sealing system. In addition to bonding, this system will have a longer life as there is no rubber to degrade over time and cause leakage. The flashing system will be available for both composition and tile roofs, will include a slider which provides adjustability for tile roofs and, in addition to the normal rafter penetrated, a "floating" flashing.

**Solar Speed Rack, Inc.** | www.solarspeedrack.com

**Booth 825**

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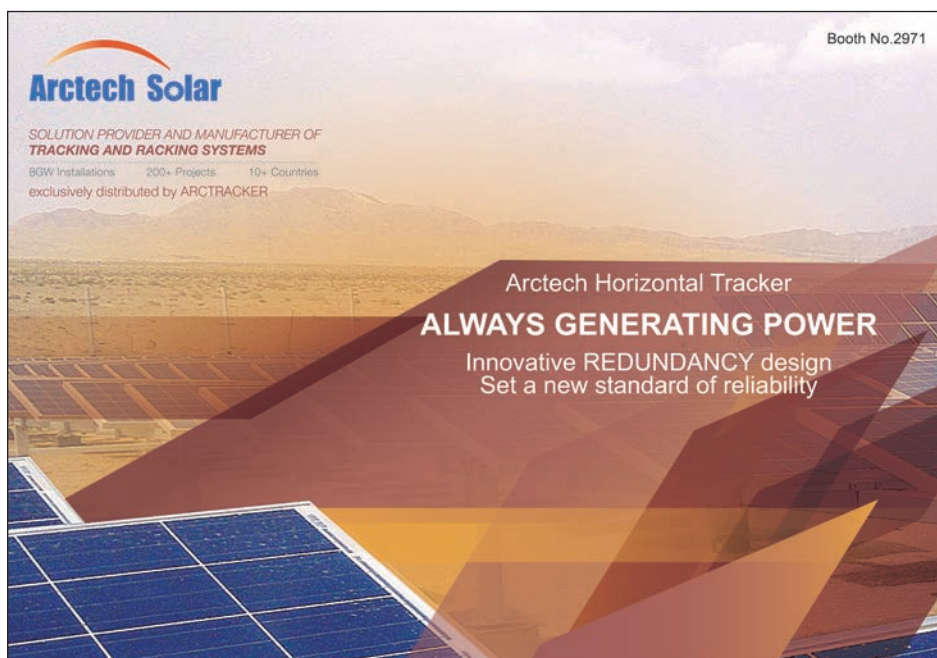
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Booth No.2971

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### Energy storage inverters

Dynapower introduces the Generation 2 MPS-100kW and MPS-250kW energy storage inverters. In addition to being able to parallel in microgrid applications, the MPS family features Dynamic Transfer, Dynapower's proprietary algorithm which provides backup power from the energy storage system to behind the meter customers. The MPS family has a low acoustic footprint which simplifies the permitting process. Its Real Time Controller features a Modbus TCP interface for ease of integration. The MPS line reduces installation time and expenses with factory installed switchgear, integrated AC Breaker and DC Disconnect. The MPS family is ETL listed to UL 1741, seismic certified, and FCC Part 15 Compliant.

**Dynapower** | [dynapowerenergy.com](http://dynapowerenergy.com)  
**Booth W120**



### Solar PV testing instrumentation

Seaward's new PV210 is a multi-function solar PV tester that combines accurate I-V curve analysis with essential electrical tests for roof top and ground mounted solar PV systems. Alongside the electrical tests required by IEC 62446:2016, the PV210 also undertakes I-V curve measurements in accordance with IEC 61829:2015 to determine if the measured curve deviates from the expected profile, highlighting the need for any further analysis or fault finding. For detailed analysis, measured data can be transferred instantly from the test instrument to an accompanying PVMobile Android App to create high definition color displays of the I-V and power curves for individual PV modules or strings.

**The Seaward Group**  
[www.seaward-groupusa.com](http://www.seaward-groupusa.com)  
**Booth W824**



### Off-grid water pumping

Franklin Electric's new Photon SolarPAK system utilizes Franklin's solar technology with the Photon solar drive which features a smaller modular design, providing flexibility and simple maintenance for the installer. The new Photon solar drive features a robust IP66, NEMA 4 enclosure that protects against wildlife, insects, dust, and weather. The system is available in a variety of flow rates from 2.5 to 90 gpm and power ratings of 0.75 and 1.5 hp. Franklin Electric has a network of water systems professionals available, for solar installers looking to partner with a driller.

**Franklin Electric**  
[www.franklinwater.com](http://www.franklinwater.com)  
**Booth 1136**



### Valve-regulated stationary batteries

The Absolyte GP line is a VRLA stationary battery for photovoltaic and energy storage applications. Made in the USA, Absolyte combines long duration and deep discharge performance in a modular steel tray design accommodating a wide variety of configurations. These two-volt batteries feature a capacity range from 120 Ah to 5460 Ah (based on Ah @ 20hr rate) and a cycle life range from 1200 cycles @ 80% depth-of-discharge to 5000 cycles @ 20% depth-of-discharge. 34 available models scale to meet small, medium, and large requirements. Absolyte batteries and trays are tolerant of freezing temperatures, do not require watering maintenance, and meet IEEE and IBC seismic codes without the need of independent racks.

**GNB, a division of Exide Technologies** | [www.gnb.com](http://www.gnb.com)  
**Booth 3179**



### Touchless snow and dust removal

Buffalo Turbine has been manufacturing turbine style blowers since 1945, and use high-precision machined components resulting in long-lasting dependable products. These turbine units are used worldwide in a variety of applications. The diverse product line provides its customers with the ability to choose a product best suiting their application and budget. Buffalo Turbine's stacked hydraulic solar blower has been used for touchless snow and dust removal in the solar industry for the past 3 years. The two machines work together for fast removal of snow or dust resulting in less energy lost and more energy gained. Standard and high speed options are available.

**Buffalo Turbine** | [www.buffaloturbine.com](http://www.buffaloturbine.com)  
**Booth W1118**



### Intelligent, dynamic single-axis tracker

SunLink's TechTrack Distributed single-axis tracker introduces a dynamic design, site flexibility, and reductions in total project costs. The system reacts intelligently to real-time conditions to increase generation and reduce the risk of harm to the power plant. Dynamic Stabilization provides damping when unlocked, secures the structure during critical events, and increases system natural frequency. In addition, by reducing the maximum torque in the system by 67%, the system is stronger, lighter, and cost-effective. Continuous tables and 120° tracking yield a high power density and generation. Fieldwork is reduced with 10% grade N-S and any practical E-W terrain following plus flexibility for up to 5% change in grade post-to-post. PowerCare installation, O&M services, SunLink's VERTEX project intelligence platform further enable cost reductions and maximum energy production for the life of the system.

**SunLink** | [www.sunlink.com](http://www.sunlink.com)  
**Booth 2037**



### Durable AGM series batteries

U.S. Battery Manufacturing's line of AGM Series batteries provides sealed low maintenance and deep-cycle performance for RE applications. U.S. Battery's AGM products are tough, durable, and provide peak performance in harsh conditions. Utilizing advanced paste and plate technology, U.S. Battery's AGM products produce long life-cycles and low self-discharge rates. Built with high-quality case and cover materials, as well as rigidly mounted plates, all of the AGM Series products are designed to withstand shock and vibrations, and feature low hydrogen gas emissions allowing them to be used safely in tight compartments.

**U.S. Battery** | [www.usbattery.com](http://www.usbattery.com)  
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**Unified battery management system**

MK Battery now distributes the Deka Solar Fahrenheit advanced AGM battery HT200ET, specifically designed for energy storage in grid-tied backup systems in high heat applications. Engineered for power, their IPF Technology enhances energy capacity, cell consistency, and long-term reliability. The Deka Fahrenheit battery case is constructed of THT Plastic, specifically designed to resist heat and optimize compression, and the TempX Alloy helps inhibit corrosion under high temperature extremes. Epoxy-sealed posts eliminate leaks while the case and cover are heat sealed and 100% tested to prevent overall leakage. To further mitigate thermal buildup and cell dry-out, the Microcat Catalyst is utilized to lower float current and maximize the efficiency in high-heat applications. The Deka Fahrenheit's front access design allows for easy installation and maintenance. All batteries meet or exceed IEEE recommended practices and UL recognition requirements.

**MK Battery** | [www.mkbattery.com](http://www.mkbattery.com)  
**Booth A2173**



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**OMG Roofing Products**  
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**Booth 137**



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**CG** | [www.cgglobal.us](http://www.cgglobal.us)  
**Booth 321**

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### Powerful microinverter for large PV modules

The Darfon G320 microinverter handles up to 350WDC of power for larger PV modules. It offers great flexibility with operating voltage range of 22 to 60VDC and MPPT range of 24 to 45VDC allowing the use of high voltage 60- or 72-cell modules. The G320 comes in 208, 120/240, or 480 grid tie voltages, making the microinverter flexible enough to use in residential, commercial, or utility designs. The G320 carries an efficiency rating that qualifies for rebates throughout the country. It can be tied to 10-gauge trunk cables for 30A circuits, allowing more modules on each circuit, a reduction in the number of circuits, and a lower BOS cost on larger systems. Darfon's G320 comes with a 25-year warranty in the USA.

**Darfon** | [www.darfonsolar.com](http://www.darfonsolar.com)

**Booth 2817**



### Complete solar tracking solution

Scorpius Trackers is a tracker solution supplier and has an aim to accelerate wholesale grid parity for the IPP's. The Scorpius tracking solution features a patented IP including 25 year maintenance free bearings and Storm Detection. Scorpius trackers have been wind tunnel tested and are currently being certified by Black & Veatch. Scorpius offers a 10° tilt for higher latitudes and also has designs for different wind speeds. Scorpius' advanced end-to-end tracking solution requires minimal installation time and its self-powered system design is flexible to varying site conditions and requires no additional maintenance costs.

**Scorpius Trackers Pvt., Ltd.**

[www.scorpiustrackers.com](http://www.scorpiustrackers.com)

**Booth W929**



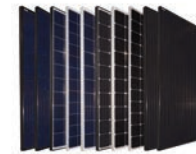
### Flexible, lightweight PV products

Solopower Systems, Inc., located in Portland, Oregon, manufactures flexible, ultra-lightweight CIGS photovoltaic products which are suited for PV applications that cannot be addressed by conventional glass PV panels including: rooftops of low-load bearing structures, buildings located in high wind or seismic areas, BIPV applications (roof types: SSM, TPO, EPDM, BUR), LED street-lights, utility poles, micro-grid, off-grid, as well as transportation applications and structures of special architectural design.

**Solopower Systems, Inc.**

[www.solopower.com](http://www.solopower.com)

**Booth 501**



### PERC solar modules

Boviet Solar USA introduces its new line of PERC (Passivated Emitter Rear Contact) solar modules. PERC technology promises to deliver more efficient solar power at a reduced cost. PERC technology improves conversion efficiency by adding a dielectric passivation layer at the rear of a solar cell, helping maximize the electrical gradient across p-n junctions for a steadier flow of electrons, hence greater efficiency.

**Boviet Solar** | [www.bovietsolarusa.com](http://www.bovietsolarusa.com)

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# The State of Solar Financing

by John Berger



The solar industry continues to go through the growing pains and huge successes typical of any groundbreaking industry. From state net metering battles, to companies declaring bankruptcy, to rooftop solar's 1 millionth installation, solar has been making big headlines this year. One critical part of the story is the decline in corporate financing, which includes venture capital funding and public market and debt financing.

According to a solar funding report published by Mercom Capital Group, a research and market intelligence company located in Austin, Texas, the second quarter of 2016 saw total corporate financing for solar fall to \$1.7 billion – the lowest level seen in the past three years. The drop was a 41 percent decrease from the \$2.8 billion achieved in the first quarter of this year, and a sharp decline from the \$6.9 billion raised in fourth quarter 2015. The global solar venture capital funding segment, which includes private equity, saw a significant decline in the second quarter of 2016 with \$174 million in 16 deals, compared to the \$406 million in 23 deals in the first quarter.

However, there are bright spots in this story. Mercom Capital Group reported downstream solar companies led the venture capital funding category with \$112 million, while solar public market financing reached \$179 million.

In addition, the residential and commercial solar sector experienced a solid second quarter. \$1.3 billion was raised in 11 deals, representing a 36 percent improvement over the \$1 billion achieved in the first quarter, with \$800 million going towards the lease model and \$555 million directed to loan funds.

This strong showing is due, in part, to the fact that the residential and commercial solar sector has an established history with corporate financiers dating back to 2009: almost \$20 billion has been invested in this segment of the market. It is also important to remember two of the top three fundraisers in this sector are privately held companies that have achieved financing successes comparable to their publicly traded counterparts.

As the solar industry continues to become more established and more companies start to enter the market, capital is harder to come by, particularly for small-to-midsize players. That said, investment opportunities are still available for solar companies willing to take advantage of the profitability business model. This model is preferred by investors over the growth-at-all-costs model, which has wreaked havoc on some solar companies in the past six months, and led to lagging stock performances and bankruptcies.

## Financial discipline foundation for financing success

As of 2015, there was 233 GW of solar installed globally, with growth of 38 percent year over year, according to BP's Statistical Review of World Energy 2015. It is clear that solar is no longer just an alternative form of energy, it has gone mainstream. No longer in its infancy, the solar industry is growing quickly. That growth has come with an increased need for credit and capital, both of which carry risk and must be managed. If done properly, the companies that manage risk without inhibiting growth, particularly those occupying the distributed energy resources space, will emerge as winners in the race for America's next energy revolution.

However, the poor performance among some companies has cast doubt on solar in ways that can make investors wary of financing a volatile market. The annals of history carry the obituaries of companies that embraced a "grow at any cost" mentality, as witnessed by the recent turmoil across the industry. To overcome these challenges, solar companies will need to embrace financial discipline and solid risk management to ensure growth strategies do not harm their financial health. Like in any industry, solar companies need to make sure they don't overpay for assets, don't spend too much on overhead, and don't overleverage themselves.

The old saying, "cash is king", is particularly true for the solar industry. However, an influx of cash and other capital means companies must follow thorough and approved accounting practices. The accepted best practice is to follow Generally Accepted Accounting Principles (GAAP)—a measurement of success through cash flow. These are the principles top companies, both private and public, across the world, use when reporting on financial health. This accounting method will help bring a healthy balance sheet and assure investors that solar companies are being transparent with their shareholders and private equity partners, which will be critical in building the foundation of future financing success.



*John Berger is the CEO of Sunnova.*

**Sunnova** | [www.sunnova.com](http://www.sunnova.com)

# Solar Ownership Comes Full Circle

## Trends in financing amidst solar's next growth phase

by Mark Colby

As solar energy freely moves towards large-scale adoption, the path of how to finance solar energy systems has come full circle. At its onset, solar's emergence promised a new way for home and business owners to participate in clean energy production. But in this early adopter phase, limited financing options restricted market adoption to those who could afford to purchase the systems, and their associated benefits, outright.

This pain point became a burgeoning market opportunity for organizations nimble enough to create no money down financial vehicles, which, in turn, gave birth to the popular solar leases and PPAs. These third party system ownership models broadened access to solar technologies, and provided those unable to pay high upfront costs, an affordable way to go green.

Leases and PPAs have reigned as an easy way to go solar, and have been instrumental in scaling the industry, if somewhat limited in their optionality. As a result, the industry has evolved new financial tools that build on the strengths of both the earlier purchase and third party system ownership models. Home and business owners are able to assume the responsibility of owning solar in its entirety, while receiving all the benefits the technology has to offer.

### Driving the trend: Beyond leases and PPAs

As the economic advantages of solar increase and consumers and business become more savvy about the benefits, more people are willing to assume the risks associated with ownership, like labor costs and maintenance, in exchange for a greater portion of the payback. Home and business owners are shying away from "escalator pricing" typically associated with solar leases and PPAs. In most third party ownership models, the repayment terms escalate year-over-year, and can even become costlier than the savings generated after the first few years. With outright ownership, there is no escalator pricing, so as soon as the solar panels are paid for, electricity becomes essentially free for the consumer. Traditional third party ownership models have been instrumental in scaling solar technology. Now that the industry has moved well beyond the early adopter phase, however, people are looking for a new way to purchase solar: a safe, flexible financing mechanism that maximizes consumer benefits.

### A financing revolution vs. evolution: The emergence of PACE

Even with sliding technology costs, most people are still unable to afford the up-front, out-of-pocket cost of solar; however, they still prefer ownership to leasing. Enter PACE: Property Assessed Clean Energy financing. PACE sits at the intersection of renewable energy and finance to establish clean, renewable energy for all. Unlike previous financing mechanisms, PACE was built from the ground up, to address the critical need to scale clean energy in order to meet climate goals, while also providing a tool that is beneficial to consumers and with more favorable terms to property owners than its lease and PPA predecessors.

Like a personal loan or HELOC, PACE provides no money down, 100 percent financing, and allows property owners to make clean energy upgrades, all while avoiding the pitfalls of traditional consumer financing options. Approval for PACE is based on available property equity, not the owner, which means it is unaffected by FICO scores, and applications are usually approved in under 30 minutes. In addition to a seamless application process, repayments are made through the property tax and can be scheduled for up to 18 months later, allowing the property owner to accumulate the savings well before having to make a payment. This financing revolution allows homeowners to go green and free up their current capital for other investments.

### PACE in action

Today, PACE has unlocked billions in financing for renewable energy, energy efficiency, water conservation, and climate resiliency upgrades across the United States. The program has found broad-based recognition from consumers, as well as bipartisan support from elected officials in the 32 states that have PACE enabling legislation and the 16 states with active PACE programs. Recently, President Obama announced his administration's unequivocal support for PACE, and highlighted the program as a key pillar of his Clean Energy Savings for All Americans Initiative. By democratizing access to both new and proven clean energy technologies, national PACE providers are bringing cutting edge financing to cutting edge technologies, building resilient, revitalized communities, creating jobs, and generating value for property and business owners.

From California to Florida, communities are turning to PACE to help with their clean energy transition. Speak to any PACE customer or certified contractor, and you will hear stories detailing the cost savings that solar ownership has brought to a home, the sense of safety that hurricane protection has brought to an at-risk community, or the uptick in business a family-run solar and roofing contractor has experienced, all because of PACE. Now PACE, always on the leading edge, looks to enable the approaching solar plus storage revolution by financing storage technologies. Already a proven success in energy efficiency and climate resiliency, PACE is now poised to reach mass-market status, and serve as the backbone to the coming renewable energy revolution.

As we look to the future of solar, we can be certain that with this new breed of financing options, the opportunity for going solar is stronger than ever before.



Mark Colby is general manager of Solar & Storage at Ygrene Energy Fund. At Ygrene, he is charged with rolling out a new generation of tools, solutions, and financial instruments designed to accelerate the adoption of solar and storage technologies while providing the highest quality safeguards and customer service for property owners to affordably make improvements to homes and businesses, reduce CO2 emissions, and protect our planet for future generations

## Energy Storage North America

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Energy Storage North America 2016 is the 4th North American grid-connected energy storage market development and deal-making event. This year it focusses on building the ecosystem for priority applications of energy storage in North America. Attendees will have the opportunity to learn which energy storage applications are profitable and bankable today, strategize with other professional on how energy storage can enable market opportunities and profitability, engage with other key implementation partners and actively shape the market for grid storage applications in North America.

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### Project Development and O&M

EDF participates extensively in the distributed energy market, currently operating in excess of 330 megawatts (MW) / 824 megawatt-hours (MWh) of battery storage worldwide. An additional 100 MW of energy storage systems (ESS) is in development in the U.S. market. EDF Renewable Services provides 24/7 remote monitoring and basic trouble shooting from its Operations and Control Center (OCC). The facility is staffed around the clock, 365 days a year, with trained and experienced EDF Renewable Services operation technicians. With 11 GW of energy under contract, EDF Renewable Services is a provider of third-party operation and maintenance.

**EDF Renewable Energy**

[www.edf-rs.com](http://www.edf-rs.com)



### Grid-tied and microgrid inverters

Dynapower has a complete line of inverters from 100 KW to 2,200 KW for grid tied and microgrid applications. For utility scale energy storage applications, Dynapower offers its Compact Power Systems family of utility grade ESS inverters. Dynapower's flexible and highly modular CPS inverters optimize the transfer of energy between a DC energy storage system and a 3 phase grid. CPS systems feature integrated AC breakers with shunt trip, DC disconnect and input fuses, as well as a cooling system. CPS units also feature Black Start and Dynamic Transfer, Dynapower's proprietary algorithm which, upon sensing a grid stability issue, will seamlessly disconnect from the grid and transition to stand alone mode on the load connection.

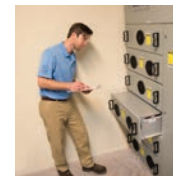
**Dynapower** | [dynapowerenergy.com](http://dynapowerenergy.com)



### Sustainable long duration energy storage

The value of long duration (> 6 hours) energy storage is increasingly recognized by regulators, utilities, and thought leaders for its flexibility in addressing multiple energy storage (power and energy) applications with a single energy storage asset. Utilizing earth-abundant iron, salt and water for its electrolyte, and simple materials for battery components, make the Iron Flow Battery (IFB) from ESS Inc. a durable, environmentally safe, long-duration storage solution that is suited for time-shifting renewable energy on a daily basis, managing a facility's demand or TOU charges, and smoothing the intermittency of renewables on a constrained grid. The ESS team has developed this all iron electrochemistry allowing the IFB to operate at high efficiency over an unlimited number of deep charge and discharge cycles, with absolutely no degradation or capacity fade over a 25 plus year operating life with minimal annual Operations & Maintenance (O&M).

**ESS, Inc.** | [www.essinc.com](http://www.essinc.com)



### Behind-the-meter control system

EnSync Energy Systems is a technology solutions company providing integrated energy management systems. Whether part of the grid transmission and distribution network, or located behind the meter in commercial, industrial and multi-tenant buildings, EnSync technology brings vital power control and energy storage solutions to micro-environments. The Matrix Energy Management system is EnSync's behind the meter control system targeted at C&I and multi-tenant buildings. Matrix utilizes "Auto-Sync" DC-Bus modular controls that enable simple integration of all AC and DC system inputs, and automatically routes electricity in the most efficient and cost effective manner. Matrix is modular and configurable, designed to meet the building owner's needs today, and a "future proof" solution for applications tomorrow. Matrix enables complete DG asset-to-utility communication for "smart export" and can be clustered in a secure network as a set of assets that enable real-time spot market electricity sales.

**EnSync Energy Systems** | [www.ensync.com](http://www.ensync.com)



### Power conversion systems

Rhombus Energy Solutions supports the Renewable and High Efficiency Energy Conversion and Storage markets by providing Power Conversion Systems (PCS), inverters, regenerative DC load banks, and battery test systems from 30kW to over 1MW. Rhombus also offers contract engineering services. The Rhombus DC-Series 125kW PCS is now UL certified. It supports bi-directional grid-tied operation, and comes with an integrated grid-side isolation transformer and liquid cooling system. Their patented Power Management Technology produces quality grid power with low common mode noise (THD). The DC-Series PCS has ultra-fast step response to rapidly follow grid utility power delivery demands. Multiple units can be paralleled for higher power requirements. The Rhombus UPC-60kW Multiport Bi-Directional PCS has two 30kW power stages which can be configured to work with both Battery and/or PV input into a single system. With its wide DC Input Voltage range, it can accommodate most any size system. The UPC is air-cooled and comes with an integrated grid-side isolation transformer making this system quick and easy to install.

**Rhombus Energy Solutions** | [www.rhombusenergysolutions.com](http://www.rhombusenergysolutions.com)



### Distributed energy network optimization system

Demand Energy's DEN.OS platform was architected to deliver intelligence and analytics to the integration and aggregation of distributed energy storage and the optimization of other Distributed Energy Resources (DER's). Based on control and economic optimization technology, this cloud-based Energy Management System (EMS) maximizes the economic returns of behind the meter (BTM) storage systems alone, or in combination with distributed generation (DG). The DEN.OS platform was engineered to facilitate the design, integration, and operation of energy assets/services, to deliver high financial re-turns across a range of energy storage applications, utility rate structures, and economic use cases today and in the future. The DEN.OS software platform was designed as an end-to-end solution delivering differentiated value across the entire project life cycle and can support both Utility and BTM projects. The DE platform and cloud based analytics deliver continuous optimization of economic returns, future proofing storage assets over their 20-year lifecycle.

**Demand Energy** | [www.demand-energy.com](http://www.demand-energy.com)



### Solar + storage system

Tabuchi Electric offers a residential solar + storage energy solution that combines a 5.5kW solar inverter with a 10kWh Lithium-ion battery optimized for energy management and cost performance. Features of this 3 MPPT system include solar, battery, and self-consumption monitoring, dynamic demand response, internal battery charge controller, and an automatic transfer switch. The storage battery discharges at a continuous 2kWh. Four operational modes help end users optimize energy use and maximize savings.

**Tabuchi Electric**

[www.tabuchiamerica.com](http://www.tabuchiamerica.com)





# Storage Solutions in Residential PV Systems

by Lior Handelsman

## DISTRIBUTED PV OFFERS MANY POTENTIAL BENEFITS, FROM PRODUCING CLEAN ENERGY

and giving homeowners energy independence, to offering the utility multiple energy sources. However, there is an inherent problem with solar energy because solar energy production does not match typical residential production patterns. This means that storage technology can be particularly useful and profitable to residential PV systems. By combining PV with a storage solution, homeowners gain from a variety of possibilities to increase self-consumption, improve system profitability, and get backup power.

A particularly important functionality of storage solutions in the US market is backup power, which can offer superior convenience when the grid is down. The increasing severity and frequency of natural disasters caused by climate change and grid instability (due to our insatiable energy use combined with aging networks) are leading to more blackouts and load shedding events. These can have severe consequences, such as frozen water pipes, dark nights, spoiled food, no temperature control, no means to charge mobile communication devices, and more. After Hurricane Sandy, New York utilities restored power to 95% of customers 13 entire days after peak outage. During such scenarios, backup power can be supplied day or night by a combination of PV and battery, to enable families to receive basic needs until full power is restored. During such outages, PV power can both supply the house with energy and charge the battery during the day, so that the battery can supply energy to backed-up loads during the night.

Besides supplying backup power, batteries can maximize self-consumption. This is accomplished by shifting the energy generated by the PV system during the day, to times of high consumption, such as mornings and evenings. The storage system is set up, through the inverter, to maximize the amount of solar energy used by the homeowner. The inverter diverts unused PV power to a battery so the energy can be used when needed. The inverter is also responsible for providing transparency into system production, consumption, self-consumption, and energy fed into the grid. This type of monitoring provides homeowners insight into their usage patterns and the effectiveness of the storage solution.

Another motivation for storage systems is in markets with an export limitation. Storage systems are designed to generate power for on-site use while limiting power feed to the grid beyond a set limit, and then storing the clipped excess power in the battery. This type of solution is particularly useful in more mature solar markets, such as Hawaii.

In markets with varying electricity price structures, storage systems can be programmed according to time-of-use pricing in order to increase system ROI. Time-of-use pricing promotes energy consumption when electric demand is low (off-peak), and lower consumption when demand is high (peak), in order to help decrease power consumption during peak periods and reduce utility bills. However, it also creates an opportunity for storage systems. The storage system can be set to react to each specific tariff. For instance, during low tariffs, the battery can be charged by the PV system or from the grid, if allowed. During medium tariffs, only the clipped PV power would charge the battery and during high tariffs, the battery would be discharged to satisfy the loads. The battery can even be discharged to the grid as an additional revenue stream, where allowed. In markets with net metering structures, PV can still be fed into the grid while rates are high. These type of storage solutions allow homeowners to create day-by-day profiles based on personal consumption analysis.

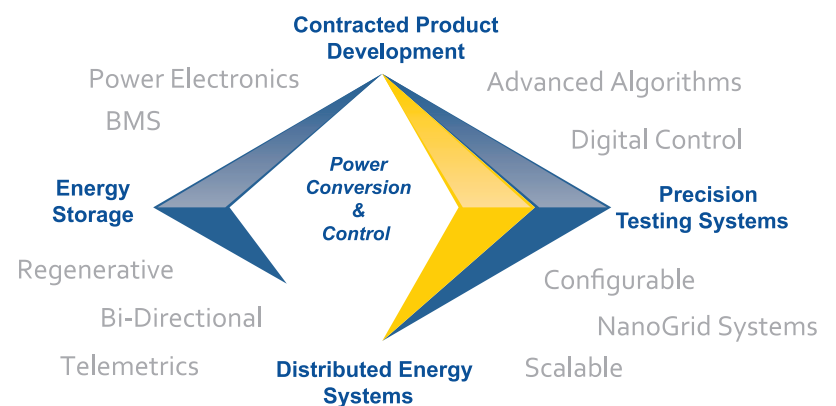
While homeowners can benefit from storage solutions, the real future of storage is the many possibilities that are opened up for the utility when energy production and storage are placed at the same location as the load. This enables a decentralized model of mini-power stations, versus the traditional network of a single source of power generation. The traditional model requires costly energy transmission over an aging network. This potential network of mini power and storage stations would allow a much more dynamic and responsive system that could unlock solar energy's grid parity potential.



Lior Handelsman, VP of marketing and product strategy, founded SolarEdge in 2006 and is responsible for SolarEdge's marketing activities, product management, and business development. Prior to founding SolarEdge, Mr. Handelsman spent 11 years at the Electronics Research Department ("ERD"), one of Israel's national labs, which is tasked with developing innovative and complex systems. At the ERD he held several positions including research and development power electronics engineer, head of the ERD's power electronics group, manager of several large-scale development projects, and he was a branch head in his last position at the ERD. Mr. Handelsman holds a B.S. in Electrical Engineering (cum laude) and an MBA from the Technion, Israel's Institute of Technology in Haifa.

SolarEdge | [www.solaredge.com](http://www.solaredge.com)

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## Sonoma Microgrid Proves Ideal Fit for Long-Duration, All-Iron Flow Battery

by Bill Sproull

*An IFB is operating as part of an advanced microgrid at Stone Edge Farm, Sonoma, CA. The system was easily sited in an environmentally sensitive area, given its small footprint and non-toxic, non-flammable chemistry.*

The owner of Stone Edge Farm (SEF), a premier boutique winery in Sonoma, California, wanted to develop a microgrid with assets that could not only bring its carbon footprint down to zero, but go beyond that to become a net generator of zero-footprint energy to its neighbors. Their goal was to demonstrate what was possible.

SEF was looking to implement multiple battery technologies in ways that would be ideally suited to the optimal microgrid use cases for each chemistry. As part of that vision, they installed an All-Iron Flow Battery (IFB) on the property. The IFB was a cost-effective choice for the long-duration energy storage needs at SEF, as well as an environmentally safe one, with an electrolyte of iron, salt, and water.

The IFB can be operated in many different modes, demonstrating the flexibility of either time shifting bulk energy or delivering short power bursts for smoothing solar or load ramps that occur with pumps starting. Many leading microgrid technologies are being integrated into Stone Edge Farm, including the energy management

system. This application made it possible for the IFB system to interface with, and be controlled by, a leading grid-operable energy control system.

In addition to the IFB, the SEF microgrid contains a control system, a micro-turbine CHP, an hydrogen generator, fuel cells, solar panels, switchgear, a Li-ion battery, a Lithium Iron Phosphate battery and a saltwater battery.

Sonoma Clean Power, the local Community Choice Aggregator (CCA), was supportive of this plan to export clean energy. As a result, Stone Edge Farm can now not only cover their own facility loads with clean power, but export the excess 24/7 to their neighbors through Sonoma Clean Power.

Generally speaking, ideal locations for All-Iron Flow Batteries include microgrids with intermittent renewables, as well as diesel generators, where the IFB can ensure they run at peak efficiency, with a fluctuating load, and minimize fuel consumption. Behind-the-meter C&I applications also are excellent uses for long-duration IFBs, where the storage can manage demand charges and shift bulk solar energy to a different part of the day to minimize energy costs. This enables businesses that might be constrained by low net energy metering caps to put in more solar to cover a bigger percentage of their annual energy consumption with low-cost solar energy.

Long-duration storage will enable more effective use of solar or wind as a baseload generation source, by smoothing the intermittencies and shifting substantial amounts of renewable energy for use at other times of the day. In addition, greater amounts of solar or wind can be deployed on both sides of the meter if a low Levelized Cost of Storage (LCOS) storage technology is incorporated. Long-duration energy storage, at an attractive cost, adds the flexibility to make solar more of a baseload solution for C&I behind-the-meter use cases, as well as for utility-scale solar, thus avoiding or deferring major T&D investments.

Making the decision as to which type of battery to select completely depends on the application. The bottom line is that the best energy storage solution should be the one that has the lowest LCOS, in the intended uses, over the life of the project. The All-Iron Flow Battery is one of the lowest LCOS solutions for renewables+energy storage integration over their 25+ year project lifetimes – and this value is now being demonstrated at Stone Edge Farm.

*Bill Sproull is responsible for business development, sales, and go-to-market strategies for ESS. Having held executive roles and founded startups in both high tech and emerging clean energy spaces for the last 20 years, Bill's passion centers on bringing new technologies to markets where gaps exist.*

ESS Inc. | [www.essinc.com](http://www.essinc.com)

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### Maintenance-free, reliable backup power

Saft's Uptimax nickel battery systems guarantee reliable and safe operation without the need for regular maintenance visits. Saft's Uptimax can provide up to four days of backup power, has minimal maintenance requirements, and a long shelf-life. In the event of an interruption to the main power supply, the batteries are designed to deliver peak power for essential safety systems for an initial period of eight hours, followed by a further 88 hours of low power. Each battery is rated at 24V and has energy storage capacity of 150Ah or 390Ah. They require no topping-up for their entire 20-plus year lifetime. The batteries can also operate successfully after a long period in storage while fully charged.

**Saft Groupe SA** | [www.saftbatteries.com](http://www.saftbatteries.com)



### Sustainable solution for off-grid applications

Aquion Energy, Inc. has introduced the Aspen 24S, a 24-volt version of its Aqueous Hybrid Ion (AHI) battery. The new product is designed for energy-intensive applications that use solar panels, such as off-grid solar-powered LED lighting, as well as small pumps and motors. It is also an ideal drop-in replacement for existing systems using 24V lead-acid batteries. Aquion's Aspen batteries offer a clean, sustainable, and long-lasting alternative that does not degrade from partial state of charge cycling. Aspen batteries have an environmentally friendly electrochemical design. They contain no heavy metals or toxic chemicals and are non-flammable and non-explosive, making them safe batteries, designed for use in pristine environments, island locations, homes, and businesses.

**Aquion Energy** | [www.aquionenergy.com](http://www.aquionenergy.com)



### High power in small volumes

Vishay Intertechnology, Inc. introduced a new series of ENYCAP electrical double-layer energy storage capacitors for energy harvesting, power backup, and UPS power source applications. Available in power and energy versions with high stability, Vishay BCcomponents 220 EDLC ENYCAP series devices deliver high power density and capacitance values in small case sizes ranging from 16mm by 20mm to 18mm by 31mm. For the industrial, telecom, and PC markets, the polarized energy storage capacitors offer power density to 4.1Wh/kg, capacitance values from 15°F to 40°F, and a max. rated voltage of 2.7V. 220 EDLC ENYCAP series devices feature low internal resistance and rapid charge and discharge performance. The through-hole capacitors offer long leads and are RoHS-compliant.

**Vishay Intertechnology, Inc.** | [www.vishay.com](http://www.vishay.com)



### All-in-one solar battery solution

In order to meet the rapidly growing demand for storing solar energy, sonnen announces the launch of the sonnenBatterie eco compact. The streamlined eco compact is designed to increase grid-tied solar consumption and is available at up to 40% the cost of sonnen's other products. The sonnenBatterie eco compact is an all-in-one residential solar battery solution and represents the latest evolution of the company's smart energy management products. Using sonnen's self-learning software, the eco compact provides various grid-tied functions - increasing household solar self-consumption, managing time-of-use and supporting grid services, not including backup power. sonnen's fully-integrated 4kWh eco compact system includes the inverter, the durable battery modules with a 10,000 cycle lifetime, the smart energy manager, and the measurement technology. The modular design allows the product to be easily expanded in 4kWh increments up to 16kWh hours in a single compact unit.

**sonnen, Inc.** | [www.sonnen-batterie.com](http://www.sonnen-batterie.com)



### Flooded, deep-cycle battery

Trojan Battery's J200-RE is the newest addition to their Premium line of flooded, deep-cycle batteries, with Smart Carbon for Partial State of Charge (PSOC) applications. Specifically engineered to withstand the rigorous conditions of renewable energy applications, Trojan's NEW J200-RE is the first 12V battery in their Premium line and offers 2V 200AH @C20 rate and 1,600 cycles @ 50% DOD. Ideal for backup power and renewable energy, J200-RE with Smart Carbon, which improves battery performance when operating in PSOC, is certified IEC 61427 for an 8-year battery life, and comes with a 5-year warranty.

**Trojan Battery** | [www.trojanbattery.com](http://www.trojanbattery.com)

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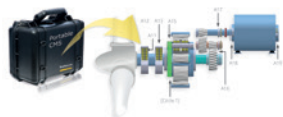
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The Annual Canadian Wind Energy Conference & Exhibition offers an opportunity for all members of the wind energy industry to come together and address the key issues facing the industry today. Exhibiting companies will present their cutting-edge technology and innovations that will help solve the industry's biggest problems and pave the way for a more efficient, effective, and sustainable energy future. This year's conference will host close to 1,500 attendees representing a wide range of interests, including project developers, manufacturers, federal, provincial and municipal governments, utilities, consultants, communities, and students.

[www.canwea.ca](http://www.canwea.ca)

show in print

Features just some of the companies and technologies attendees will see at this year's show.



### Portable condition monitoring

The Bachmann Portable Condition Monitoring System (CMS) delivers wind turbine diagnostics with complete coverage of the drivetrain from the main bearing to the generator, all from a single inspection. Vibration-based condition monitoring technology is a critical asset to the wind industry, providing a quick return on investment and placing extensive maintenance savings into the hands of wind site operators everywhere. Bachmann's Portable CMS allows wind site operators to assess the health of the major drivetrain components for each turbine, with minimal setup and no major investment. The use of a CMS helps to detect damage early, avoid unnecessary maintenance, identify issues prior to end of warranty, reduces risk of secondary damage, and extends total asset life.

**Bachmann electronic** | [www.bachmann.info](http://www.bachmann.info)



### Flexible data logger

Purpose-built for renewable energy professionals, Renewable NRG Systems' Symphonie-PRO data logger brings upgrades in capability and flexibility to their series of user-friendly loggers. Each of the 26 channels' statistical values are calculated from continuous 1-second data samples and averaged over a user-selectable interval (10-minute default). Collected data are stored as binary \*.RLD files on internal Flash memory with a redundant copy on an external SD card. Communications options include SMTP email data delivery, as well as remote, real-time connection capability over RNRG's MetLink protocol for tasks like automated or manual data download, firmware upgrade, live data viewing, or configuration changes. The easy-to-use SymphoniePRO Desktop Application enables users to process raw data files, preview data files in time series format, and configure and communicate with both the SymphoniePRO logger and iPack communications devices.

**Renewable NRG Systems** | [www.rnrghsystems.com](http://www.rnrghsystems.com)



### High-definition videoscope

HD RVI has arrived with Olympus' high-definition IPLEX NX videoscope. Some features include, brilliant laser diode illumination; 8.4-inch touch screen displays vivid images for detailed inspections; PulsarPic image processing intelligently adjusts illumination, reducing glare and white-outs during up-close inspections; super wide field stereo measurement measures flaws from 2X farther away; and multi-spot ranging provides real-time measurement of the surface's shape and condition. The rugged IPLEX NX videoscope is IP55 and MIL-STD 810 rated for resistance to dust, rain, fog, and drops for maximum uptime. The videoscope's flexible form factor adapts and positions itself to the working environment. TrueFeel articulation offers precise scope control, while a crush- and abrasion-resistant, waterproof TaperedFlex insertion tube provides maneuverability in tight corners. Interchangeable 3.5-, 5-, and 7.5-meter scopes are available in 6 mm diameters. A 4 mm diameter scope is also available in 3.5 or 5 meters.

**Olympus** | [www.olympus-ims.com](http://www.olympus-ims.com)

## VDH/GSMI®

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Ema Electromechanics LLC is the designer and manufacturer of model VDH/GSMI® combined 34.5 kV vacuum circuit breaker and high speed, mechanically interlocked grounding switch, a unique and patented system specifically designed for switching and grounding of wind and solar collection circuits.

**EMA** ELECTRO MECHANICS

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Tel: 325 235 8000  
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### Renewable energy consultant

DNV GL is the largest, global provider of independent renewable energy advice. A recognized authority in onshore wind energy, DNV GL is also at the forefront of the offshore wind, wave, tidal, and solar sectors, providing independent technical and engineering services, products, and training. Customers include: renewable energy developers; investors; lenders; manufacturers; construction firms; owners; operators; insurers; nonprofit/government organizations; and large-scale, utility firms. DNV GL is present in all major and emerging global markets for renewable energy.

**DNV GL** | [www.dnvgl.com/renewables](http://www.dnvgl.com/renewables)



## Project Development and O&M

EDF EN Canada develops and builds wind and renewable energy projects which harness the earth's renewable resources, helping to drive the green energy economy and industry. With over 1,370 MW throughout Canada, they have experience in all areas of project development, including: site selection; procurement; financing; permitting; project planning and construction; long-term management; operations and maintenance (O&M); as well as project de-commissioning and repowering. Their O&M affiliate, EDF Renewable Services, ensures ongoing profitability for project owners and investors by providing a full range of expertise and O&M services. With 11 GW of energy under contract, EDF Renewable Services is a provider of third-party operation and maintenance services in North America.

**EDF EN Canada**

[www.edf-en.ca](http://www.edf-en.ca) | [www.edf-rs.com](http://www.edf-rs.com)



## Public participation and stakeholder engagement

Land and Stakeholders are integral to the successful execution of Renewable Energy projects. There is a growing importance in identifying public concerns and values, and developing a broad consensus on planned initiatives and long-term solutions. For over 35 years Canada West Land Services has been providing solutions in supporting land access and acquisition, and working with stakeholders to ensure projects are not only compliant, but in the best interest of all affected parties. It is vital to understand the importance of engaging landowners and project stakeholders so they recognize the importance Renewable projects play in their communities today, and their communities of the future.

**Canada West Land Services Ltd.**

[www.canadawestland.com](http://www.canadawestland.com)



## All-in-One lighting solution

TWR Lighting, Inc. introduces the FAA Compliant L864 LED/IR/VWS RADAR, "All-in-One Solution". The L550-864-G-IR fixture incorporates a Red LED L864 Beacon with Infrared (IR) LEDs, and is ready to connect to a VWS Radar system, if required. The design of the L550 enables the beacon to operate reliably under the harshest conditions and minimizes both the capital costs and cost of ownership over the 20-year system design life. The L864 LED/IR/VWS RADAR "All in One Solution" integrates the benefits of advanced LED and control technologies for the quick-est reactive on time for hibernating lights. TWR can also provide an optional radar system Ethernet Interface Control.

**TWR Lighting** | [www.twrlighting.com](http://www.twrlighting.com)



## Aerial work platform

The PALFINGER-built P 1000 is engineered for assembly and maintenance on wind turbines and other towering structures. With a working height of 337 feet (103 meters), the P 1000 provides access to tall, difficult-to-reach jobs. Equipped with a five-axel all-terrain mobile crane chassis and four different stabilizing configurations which allow the P 1000 to work in tight conditions, the working capabilities of the platform aren't hindered by its large size. Additionally, electronics and safety features, including telescopic stabilizers, guarantee stability and allow for safe operation in wind speeds up to 12.5 m/s.

**PALFINGER** | [www.palfinger.com](http://www.palfinger.com)



## Renewable energy wire and cable solutions

General Cable provides wire and cable for the generation, transmission, and distribution of electricity from wind energy globally. From the nacelle and tower of the wind turbine, to the step-up transformer and the collection system, and from the substation to the power grid, they provide a broad range of traditional and next-generation renewable energy products for the terrestrial and offshore wind markets. A complete cable solution—from optical fiber and grounding wires for SCADA systems, low-voltage DC and AC connections, and medium-voltage distribution, to high-voltage overhead, underground, and submarine transmission lines, is engineered to withstand the demands of entire wind power system.

**General Cable** | [www.generalcable.com](http://www.generalcable.com)



## Combined breaker & grounding switch

EMA Electromechanics' VDH/GSMI combined 34.5 kV outdoor vacuum circuit breaker and high-speed, mechanically interlocked grounding switch is specifically designed for application with wind energy collection units. This patented system for switching and grounding of wind collection circuits replaces traditional use of oil insulated grounding transformers combined with conventional circuit breakers in every feeder of a wind power substation, making green energy greener.

**EMA Electromechanics, LLC**

[www.emaelectromechanics.com](http://www.emaelectromechanics.com)

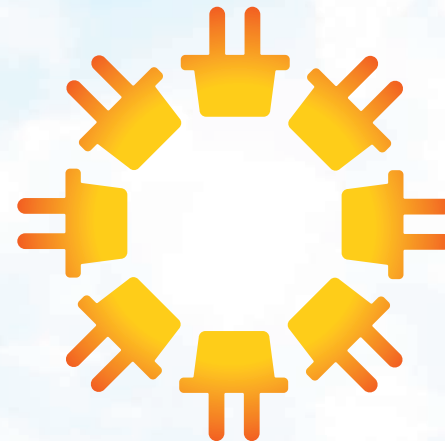


## Fire suppression system

The Firetrace automatic fire suppression system is a solution for the unique environment in a wind turbine unaffected by vibration, dust, airflow, and temperature. Their systems can protect the control panels, capacitor cabinets, braking system, transformer, and other at risk areas of the turbine, without requiring power or excessive space usage.

**Firetrace International**

[www.firetrace.com](http://www.firetrace.com)



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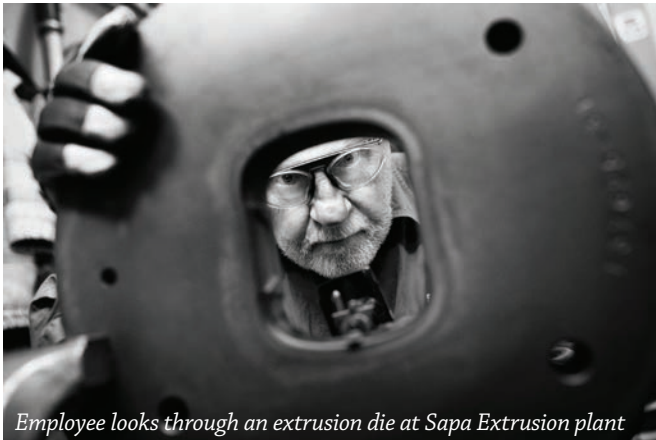
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*Employee looks through an extrusion die at Sapa Extrusion plant*

# Solving Thermal Management Challenges in Electric Vehicles

## Advantages of using aluminum extrusion

by Stephen Jackson

**ALUMINUM IS QUICKLY BECOMING A MATERIAL OF CHOICE IN THE SEARCH FOR SOLUTIONS TO REDUCE WEIGHT** in passenger and other vehicles. Solving the engineering challenges of creating lighter vehicles has led to a portfolio of material solutions working in concert. Sheet and extruded aluminum have made an important contribution to the cause.

In the case of electric vehicles, the choice of extruded aluminum brings additional advantages, given the thermal challenges inherent in these vehicles. Repeated cycling of large amounts of stored energy means significant heat generation must be dissipated. Aluminum's high level of thermal transfer makes it an excellent option for removing heat from the vehicle. Coupled with extrusion's ability to produce complex shapes very efficiently, the extruded aluminum industry is poised to offer highly effective solutions to electric vehicle manufacturers.

Extruded aluminum offers solutions for a range of electric vehicle needs including structural and thermal support of the electric battery pack, electric motor thermal control, thermal management of LED lighting systems, and power electronics systems cooling.

### Designing thermal extrusions for automotive cooling

Heat is the enemy of electronics, and a lack of strength in the vehicle part will create unacceptable potential for failure. Extruded aluminum cooling can solve both these problems with a strong, lower-cost solution offering high thermal conductivity. Extrusion is low cost, and extruded aluminum offers a high strength to weight ratio along with aluminum's useful thermal properties. Heat can be moved away from the required areas with a minimum of individual parts involved.

### Questions to ask when designing an extruded solution for thermal management in a vehicle include:

- What space is available? How will the solution fit into the required location?
- What geometry will achieve the required thermal transfer? What is the required surface area to accomplish the task?
- What other nearby devices are generating heat? What is the overall thermal load?

This data contributes to the calculations for creating a solution, whether it be a high-fin-ratio heat sink, liquid cooler, or another device such a battery enclosure which achieves both structural support for the battery and thermal management combined.

In all cases, the primary goal should be designing for manufacturability. Creating an extruded aluminum design that can be efficiently produced allows for a 'win-win' solution between the extruder and client. Some of the cost factors considered during the design process include profile type, whether solid (low cost), or complex hollow (high cost). Also important are the circle size (diameter), which defines the extrusion press required for the part, and other extrusion aspects like wall thickness and required tolerance.

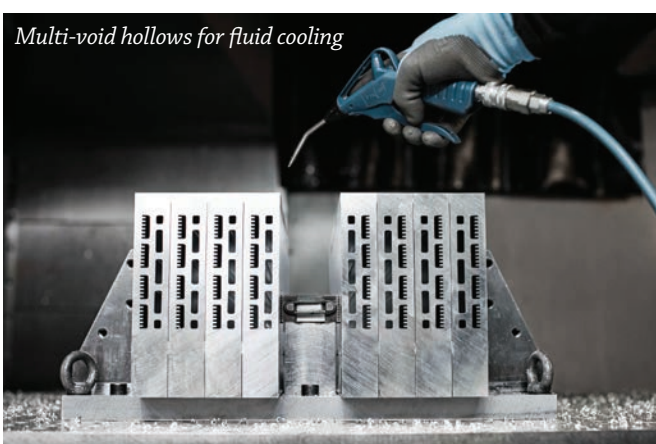
### Friction Stir Welding of extrusions

A typical extrusion press provides a product 10-12 inches in diameter. In the automotive industry, thermal management needs often exceed that dimension, what is the solution for this? Friction Stir Welding (FSW) was developed in 1991 by the Welding Institute in Cambridge, UK. In essence, FSW aluminum is stirred to just below melting temperature by a rotating probe, which mixes the material together to create a weld with no filler material, and a fully re-crystallized fine-grain micro structure at the nugget area (due to the intense plastic deformation). No filler material is required, and FSW can be a much more automated operation than MIG and TIG welding, which are often done manually.

By using FSW to join shorter widths of extruded aluminum, large-scale assemblies for cooling solutions can be manufactured with a higher degree of efficiency.



*Sample crush test of aluminum alloy*



*Multi-void hollows for fluid cooling*



*Machined aluminum for cooling*



*Closeup of one half of an extrusion die for hollow extrusion*

**Advantages of FSW Include:**

- Increased joint strength with high tensile, fatigue, and bend properties;
- Improved sealing with completely leak-free joints;
- Reduced thermal distortion and shrinkage;
- Improved repeatability- FSW is a highly consistent process;
- The ability to join two different alloys or metals;
- No filler material means the parent material conductivity is retained;
- More cost effective process.



Friction Stir Welding tool

Steve Jackson is the business development manager for Thermal Management at Sapa Extrusion North America. He holds a B.S. in Mechanical Engineering, Materials Science from WPI, and has worked in the thermal management industry for more than 20 years.

**Sapa Extrusion North America** | [www.sapagroup.com](http://www.sapagroup.com)

**Modular heat sinks**

An excellent example of FSW for vehicle thermal management is the FSW heat sink, which provides for a very high fin-ratio (up to 40:1), welded with FSW to create a thermally uniform base and fins. Unlike bonded fin heat sinks, which use an extruded or machined base plate with fins bonded manually using thermal epoxy, the FSW heat sink can be up to 8% more thermally efficient than a bonded fin. With proper design, there is no limit to the width of a FSW heat sink. The FSW process can penetrate the base material up to 20mm in depth, producing a very efficient thermal path for the removal of heat.

**Extruded cold plates - liquid cooling**

Another useful electric vehicle application for extrusion and FSW, is an extruded cold plate for liquid cooling. Liquid cooling provides an alternative for vehicles where forced air and natural convection cannot achieve the required cooling. Unlike other solutions, which use copper pipes welded to a base, an extruded aluminum block can be easily machined for channels, and then sealed with FSW to produce an integral solution without separate tubes. This is a highly affordable solution for customers, and can be designed to their specifications for a multitude of cooling solutions. Such a friction stir welded cold plate can withstand up to 90 bar burst pressure, making it an extremely robust option.

In summary, extruded aluminum is making rapid inroads with vehicles, and is especially effective for electric vehicles. The combination of aluminum's good thermal conductivity, coupled with a high weight to strength ratio, provides options for robust vehicle components that also dissipate the heat generated by an electric vehicle. The possibilities for thermal solutions in extruded aluminum are expanding each year, as new technologies increase the efficiency and reduce the cost of extruded aluminum designs.



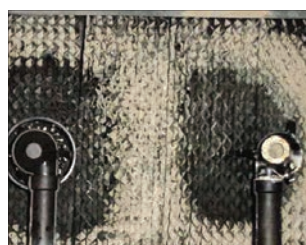
**Sulfur Deposit Plus Biofilm Control in Geothermal Cooling Towers and Distribution Systems**

Sulfur formation begins with the hydrogen sulfide which is present at both low and high levels in geothermal systems. The hydrogen sulfide converts to sulfur solids by both aerobic and anaerobic processes. Sulfur fouling of the cooling water distribution nozzles is a key step in biofilm formation in the tower fill. Sulfur buildup results in cooling tower channeling, blocked piping, control equipment malfunctioning, tower fill collapse, etc..

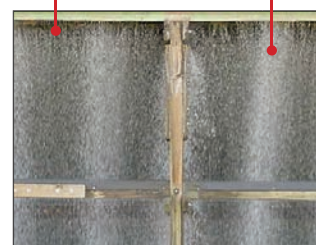
**Poor sulfur deposit control is the beginning of a vicious cycle** of microbiological issues, acidic pH swings, cooling efficiency loss, increased down time for servicing/cleaning, steam waste and power production loss.



Sulfur deposit accumulation in flow-lines.



Sulfur fouling in the fill diverts water flow to less fouled zones.



Uneven sulfur deposition results in channeled flow through the cooling tower fill.



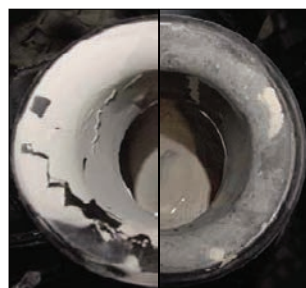
**Sulfur deposition is not your only problem, because it causes this!**

**The Solution:** BCP™ 5030 was proven initially in Cerro Prieto (CP IV) in Mexico and today is a cornerstone of programs used in the Philippines. BCP™ 5000 series products effectively remove pre-existing hard elemental sulfur deposits and prevent the formation of new sulfur deposits.

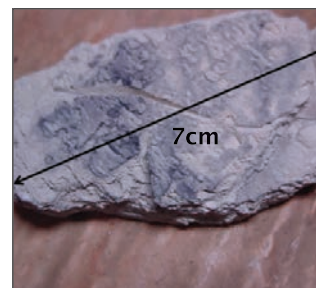
**How it Works:** In a system in which elemental sulfur deposits have formed, BCP™ 5030 attacks the deposits causing disaggregation and release as well as control of organic deposits (including biofilm).



Sulfur cylinder from a flow-line, expelled through a nozzle orifice onto the upper surface of the tower fill.



**Before/after BCP™ 5000** product treatment comparison of a nozzle orifice



A piece of sulfur deposit detached from the tower structure.



**BCP™ 5030 program results!**

To learn more about AMSA's sulfur deposit/biofilm solutions visit:

**Booth 335** at the **GEA GEO Expo!**  
**October 23-26**, Sacramento, CA

Patent pending and patents issued



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# Portable Generator Usage

## Important safety considerations

by Mark Carpenter

⚠ DANGER



SHOCK

Generator voltage is deadly.

There is a danger of electric shock.

Use only undamaged electrical cords.

DO NOT touch bare wires or receptacles.

DO NOT operate generator in wet weather or in wet conditions.

DO NOT touch generator or cords if hands or feet are wet.

Your generator is equipped with a ground fault circuit interrupter (GFCI) and it should always be used.

Use only approved transfer equipment to attach generator to your power system. Only a qualified electrician should install this.

DO NOT plug your generator directly into home or garage sockets (a practice known as backfeeding).

Every year, unfortunate carbon monoxide incidents occur as a result of improper outdoor use of generators. All generators display warning labels that explain the risk of death if operated inside a home or garage. Despite this, more than 400 deaths occur in the United States every year, according to the Consumer Products Safety Commission (CPSC).

In order to fully understand the safety precautions they should take, owners must read the manual before operating. Never run a generator inside, including garages (even with the garage door open). Keep the generator at least 20 feet away from windows, doors, and vents. Failure to do so can result in poisoning from carbon monoxide.

However, carbon monoxide poisoning isn't the only danger posed by generators; electrocution is a concern as well. During power outages, many people turn to portable generators as a means to back up the lost utility. Generators should never be run in wet weather, as they can cause serious electrocution, or be damaged. Some people will try to create "dog houses" for their generators to keep them covered in the rain, but this is hazardous and can put the user at risk. Generators produce a lot of heat and, if enclosed on all four sides, will run too hot. Furthermore, if a generator is in a closed space alongside flammable materials, fire or serious injury can result.


If you need to run a generator while it is raining or snowing, it is important to keep it shielded from moisture. A safe way to do this is to use one of the new generator tent products. These products allow the generator to exhaust properly and stay cool, while also covering the outlets and control panel to reduce the chance of electrocution. They can be used in any wet weather, and are even tested to withstand gale force winds.

Refueling a generator seems simple, but there are still things that can go wrong. Make sure to use the right type of fuel. Fuel type will be listed on the generator or in the Owner's Manual. It is important to make sure the generator is off and has cooled down before refueling. If gasoline spills on the hot surface, flames could ignite. Also, don't store the fuel canister too close to a running generator; the heat produced by the generator could cause any spilled fuel to ignite.


⚠ DANGER

**Using a generator indoors CAN KILL YOU IN MINUTES.**

**Generator exhaust contains carbon monoxide. This is a poison you cannot see or smell.**



**NEVER use inside a home or garage, EVEN IF doors and windows are open.**




**Only use OUTSIDE and far away from windows, doors, and vents.**

extension cord that is rated at least equal to the sum of the connected appliances. Also, never plug the generator into a wall outlet. This is known as "backfeeding", and can severely harm the line workers trying to restore power.

It isn't recommended to run a generator during hurricane force winds, since they could move the generator around. Also, never run a generator in wet weather, and don't run it in flood waters, either.

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## Dynamic window technology

New Visual Media Group, LLC (NVMG) has introduced a novel environmentally-efficient dynamic window technology enabling a six-fold increase in energy efficiency while costing approximately 90% less than the most comparable window alternatives on the market today. ElectroPolymeric Display (EPD) technology, which is a tightly wrapped polymer foil hidden inside any standard double-pane window. The shade, which can be almost any color or design, is covered in ink and can keep the heat out in the summer and in during the winter, significantly reducing energy usage and cost. The shade can be electronically lowered and raised with a TV-like remote control, smartphone app or pre-set program designed to recognize temperature shifts or sense when a room is in use.

**New Visual Media Group** | [www.newvisualmediagroup.com](http://www.newvisualmediagroup.com)

According to the Portable Generator Manufacturers' Association's (PGMA), "Take it Outside" campaign, it's vital to know the symptoms of carbon monoxide poisoning. These include headache, nausea, shortness of breath, dizziness, and fatigue. The best way to stay alerted to the presence of carbon monoxide, is to have working detectors throughout the home. However, if a generator is running and someone begins to feel any of the above-mentioned symptoms, evacuate the structure immediately.

When the power goes out, generators can be a lifesaver. However, generators also come with several consequences: carbon monoxide poisoning, electrocution, and fire. It is very important to not take these consequences lightly, and to make sure that all of the appropriate precautions are taken when running a generator.

There are plenty of great resources available to answer any questions. They can be found through the local utility companies, The American Red Cross, PGMA, the CPSC, and the local fire department. Even with these resources, it's important to always read the Owner's Manual first, and to ensure all carbon monoxide detectors are operational.

*Mark Carpenter is the CEO, president and owner of GenTent Safety Canopies.*

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OCTOBER

- 03-05 LAC CORE Finance Summit**  
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Washington, DC; [www.greenroofs.org](http://www.greenroofs.org)
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Capital Hilton – Washington, DC; [www.sgip.org](http://www.sgip.org)
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Hilton Chicago – Chicago, IL; [www.events.solar/pvchicago/](http://www.events.solar/pvchicago/)
- 14-16 Renewable Energy from Waste Conference**  
Westin Long Beach – Long Beach, CA; [www.rewconference.com](http://www.rewconference.com)
- 14-17 Power Systems 103 for Relay Commissioning**  
Austin, TX; [www.powergridengineering.com/seminars](http://www.powergridengineering.com/seminars)

DECEMBER

- 05-06 Solar Canada 2016**  
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- 11-13 Power Generation Week**  
Orange County Convention Center – Orlando, FL; [www.powergenerationweek.com](http://www.powergenerationweek.com)

MAY 2017

- 22-25 AWEA Windpower 2017 Conference & Exhibition**  
Anaheim Convention Center – Anaheim, CA; [www.awea.org](http://www.awea.org)

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- 19-21 tcbiomass 2017**  
Radisson Blu Aqua – Chicago, IL; [www.gastechology.org/tcbiomass](http://www.gastechology.org/tcbiomass)

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  - Peak Shifting
  - Non-export
  - Power Backup
- ▶ 3 MPPT 5.5kW Hybrid Solar Inverter
- ▶ 9.89kWh Lithium-ion Storage Battery
- ▶ Automatic Transfer Switch



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