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## **2018 ENERGY STORAGE Buyers Guide**

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## **How to Keep Your Turbine Spinning**

## **Powering the Future with the Winds of Change**

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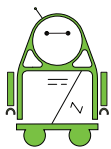
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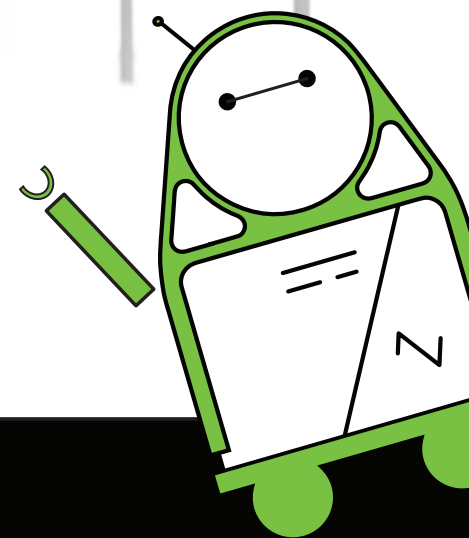
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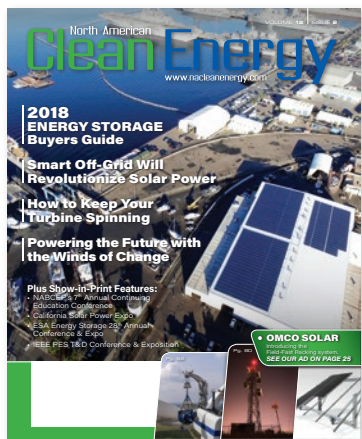


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**PUBLISHER**  
Ian Stuart  
istuart@nacleanenergy.com

**EDITORS**  
Jill Walters  
editor@nacleanenergy.com

Meg Lugaric  
meg@nacleanenergy.com

**ART DIRECTOR**  
Chris Van Boeyen  
production@nacleanenergy.com

**SALES MANAGER**  
Ian Stuart  
istuart@nacleanenergy.com

**SALES**  
Don McIntosh  
dmcintosh@nacleanenergy.com

Quinn Stuart  
quinn@nacleanenergy.com

**CIRCULATION MANAGER**  
James Vail  
circulation@nacleanenergy.com

**ACCOUNTING**  
Alison Bell  
abell@nacleanenergy.com

**255 NEWPORT DRIVE, SUITE 336**  
Port Moody, B.C. V3H 5H1  
Phone: (604) 461-6223

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# Why One Solar CEO is “Unfazed by the New Tariff”

by Scott Cramer



As the CEO of a small solar company relying on foreign imports, what I know to be true of our country and the industry in which I work casts a shadow on any frustration I’m supposed to have over the 201 Trade Case decision.

The solar industry is like America itself: Full of good intentions, strong, enduring, resilient, and willing to fight to improve not just the human condition, but also the most sacred place in our nation’s psyche – the sole item preceding the

white picket fence in the last and greatest components of the American Dream – our homes – which are now powered by solar in larger numbers than ever.

That trend will still continue year over year. I’m unfazed by the new tariff, and I feel many American solar companies relying on foreign imports have reason to feel the same.

In hopes of helping other solar executives understand the opportunity to grow and prosper, in spite of the tariff, I’ve outlined the below principles we must follow and remember if we are to move forward in the way I know we can.

## Unpacking the 201 Trade Case

The first 2.5 gigawatts of foreign-imported solar cells will be excluded from the tariff, giving unprepared companies relying on foreign imported solar cells more breathing room than expected.

Although America imports roughly 80 percent of its solar cells, there are upsides to the decision.

The 30% tariff issued is far less than the 50% tariff advocated by Suniva and SolarWorld. Although 30% seems like a lot, the bulk of American solar companies’ costs aren’t in panel imports.

## The Tariff Will Reveal Which Solar Companies Can be Trusted to Invest in the Customer Experience

The payoff on rooftop solar takes years for customers to receive, and sometimes decades to magnify, so it’s imperative consumers invest their hard-earned money in solar companies that are profitable enough to maintain a positive customer experience.

Given that the tariff will only cause job losses and cut corners in the customer experience for solar companies that have over-leveraged themselves with debt, consumers will be less overwhelmed by the options made available to them, and more likely to make an intelligent decision when going solar.

## History and Economic Structure Make Tariff Manageable

Given the 2.5-gigawatt threshold, financially stable solar companies had plenty of time to import a large number of panels to offset the effect of the impending tariff.

While the tariffs may not mean immediate return for American solar companies who’ve relied on foreign imports, it means a better outcome for solar prospects, which should be the objective of every American solar business.

Additionally, the 201 Trade Case tariff will bring solar companies closer to forecasting how price changes affect the real consumer demand for solar panels.

This becomes increasingly true if the future bodes toward fewer solar tax credits and rebates, which will generate newfound innovation.

## A Proportional Scale Back on Chinese Imported Solar Cells Means Product Diversification and Quality

Over the past decade, many American solar companies, at the expense of their customers, have relied heavily on the cheapest solar panel prices from China to sustain their deeply-leveraged, debt-laden business models.



Despite China taking a harder hit than any other country because of the tariff, JinkoSolar has announced plans to build a solar factory in Florida.

Although roughly 10 percent of all American-imported solar cells came from China prior to the tariff, that’s still a hefty percentage of American solar relying on an imported Chinese product; although low-priced and offering its own unique benefits, this does not expose consumers to the full spread of solar panel features the American market has missed out on over the past decade.

Yes, a tariff on solar panels from China will increase prices, but it will also direct American solar companies and their prospects toward higher quality solar panels.


## Homeowners Will Still be Able to Go Solar for Zero Down

No-cost solar in America is a major misconception, because the phrase is really meant to express that prospects can go solar for zero down, which, although convenient, isn’t going solar for free.


It’s better than free, and will remain better than free because it’s an investment that makes consumers money. Consumers who don’t let the trade case decision keep them from benefiting from the ROI of residential solar, will be glad they remained bullish on their investments.

Simply put, when major trade decisions that impact an entire industry are set forth by a select few, and intended to benefit only a select few, the market will correct these small players’ mistakes, even if many fear the mistakes to be incorrigible.







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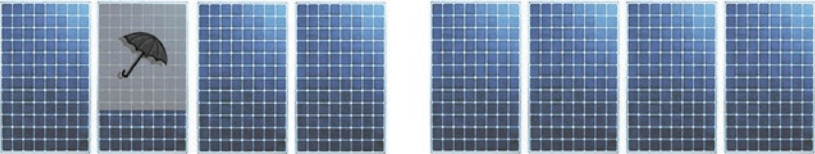
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*Scott Cramer is the CEO, of Go Solar Group, a family-owned, full-service solar company that was founded in Utah after a service mission in Africa. Go Solar Group continues to bring affordable, quality solar products to Utah and Reno, Nevada residents who want to support building a cleaner, healthier Earth.*

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# Smart Off-Grid Will Revolutionize Solar Power

by Miriam Tuerk



**UNTIL NOW, SOLAR POWER HAS BEEN HINDERED BY** one simple truth: the sun doesn't always shine.

If you had an off-grid system such as a street light, and there was bad weather for more than a few days, the battery would drain, and the light would eventually go out. That's it! There was no way to predict how long the battery might last, or change the settings to preserve power. It's like driving a car with no warning light on the dashboard to indicate when you're low on gas.

Today, solar and wind energy are powering critical infrastructure, from streetlights to telecom systems to security cameras and more. This means it is no longer viable for these devices to be unmonitored and unmanaged, or to fail after a few days with no sun or wind.

## Connecting solar to the cloud

Smart off-grid technology is the next stage in the solar power revolution. A smart off-grid controller and a built-in communications network embedded in the solar-powered device, streams critical data in real-time to a cloud-based management system. By connecting these devices to the cloud, infrastructure owners can use a Software-as-a-Service (SaaS) app to remotely monitor, manage, and control the smart off-grid systems in real-time, 24/7, via a smartphone or laptop. This includes automated estimation of energy generation based on current load and local weather forecasts, around-the-clock monitoring, automated alerts and alarms, the ability to remotely change load profiles to extend battery life, and in-depth analysis of solar power generation and consumption performance over time.

In terms of how it works in practice, let's take our example of bad weather. If there's an extended period of bad weather predicted, the amount of sunlight hitting a solar panel will likely be insufficient to keep the batteries charged, and power the lights over that period. With smart off-grid, the person responsible for the lights will receive an alert via text or email from the cloud management system, so they can proactively turn down the luminosity of the lights to preserve battery power and prevent an outage.

The ability to monitor, manage, and control smart off-grid systems makes off-grid devices significantly more reliable. In one case, a smart off-grid system kept a solar-powered street light on for 10 continuous days without sunlight – whereas, typically,

it would have failed in only two or three days. In cases where there is an outage, the infrastructure owner can access the data history to make it easy to troubleshoot the issue; they can then either fix it remotely, or send an engineer with the right replacement part.

Smart off-grid reduces the cost of installing and maintaining off-grid systems by up to 80 percent, often making it considerably more price-competitive than an on-grid system. In one example, a Canadian city wanted to install street lights in a busy district; connection to the grid would have cost \$35,000 per street light -- more than three times the cost of installing smart off-grid power.

## Where smart off-grid will flourish first

In the same way that India leapfrogged the U.S. in the adoption of smartphones, an emerging market, such as sub-Saharan Africa, may become the leader in using solar power for most of its critical infrastructure.

This is because low-cost, reliable solar power has the greatest growth potential in countries where existing electric grid infrastructure is underdeveloped. Sub-Saharan Africa certainly fulfills this criteria: 600 million people lack access to electricity. For those who do have access to electricity, power cuts are frequent; they often have to rely on diesel fuel generators as a back-up when the power grid fails – a noisy, dirty, and expensive solution.

However, according to a report by the University of Michigan, "Although sustainable energy systems are being installed in the region, there is a severe lack of technical expertise regarding the maintenance and repair of energy systems, resulting in inefficiencies and shortened system lifecycles. Without ensuring the productivity of new sustainable energy systems, the region will likely continue to rely on diesel fuel generators."







Miriam Tuerk is CEO and co-founder of Clear Blue Technologies. Clear Blue Technologies, the Smart Off-Grid™ company, was founded on a vision of delivering clean, managed, “wireless power” to meet the global need for reliable, low-cost, solar and hybrid power for lighting, telecom, security, Internet of Things devices, and other critical systems. Today, Clear Blue has over 300 customers and 2,500 systems under management across 33 countries, including the U.S. and Canada.

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Smart off-grid can change this reality for sub-Saharan Africa by making off-grid systems more reliable. Infrastructure owners can ensure that these systems are being installed and maintained correctly, which increases the lifespan considerably. This technology has already been installed in Harare, Zimbabwe, where it controls street lights on one of the city's main thoroughfares. Similar projects are already underway across Nigeria, Rwanda, and Ghana.

### The smart off-grid solar revolution

Smart off-grid will transform the power industry in the same way that wireless communications and smartphones changed the telecommunications industry.

A decade or so ago, everyone had a landline phone. If you were one of the lucky few, you might have a Blackberry. Fast forward to today: the landline is dead - smartphones have taken over our lives. Over 30 percent of the world's population owns a smartphone, and two-thirds of millennials in the U.S. aged 25 to 29, live in a household without a landline.

The same paradigm shift is going to happen to the power industry. In a new digital age of wireless communications and cloud computing, it seems antiquated that we are still tied to power cables and transmission towers. Not only is this monolithic power grid infrastructure costly to install and maintain, it is also inherently vulnerable to systemic failure from cyberattacks, terrorism, and storms - as we witnessed most recently in Puerto Rico.

It is only a matter of time before smart off-grid solar power gains a foothold as a cleaner, cheaper, reliable alternative to grid electricity. We say, viva la revolución!

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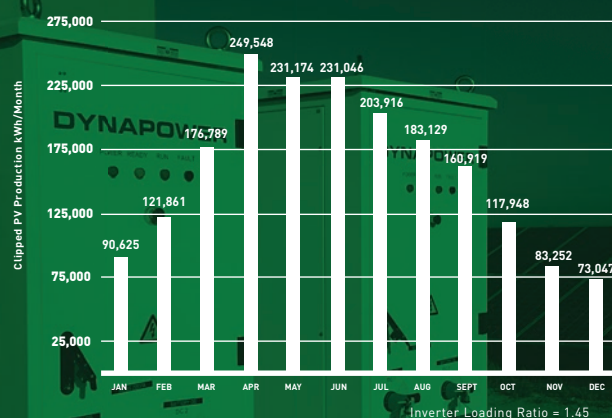
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# 50 by 20

## Standardizing community-scale solar

by Kareem Dabbagh and Joseph Goodman

**THE FORD MODEL T WAS THE FIRST CAR TO BE** affordable for most Americans, thanks to Henry Ford's revolutionary advancements in standardization. Why not apply that standardization to community-scale solar (CSS)? CSS, also called distribution-scale solar, is defined as 1-10 MW solar photovoltaic systems connected to the distribution grid. Currently, CSS projects have a \$0.20/Wp (watt-peak) or more premium, compared to utility-scale solar. This is largely due to custom engineering, high mobilization cost for small projects, and low on-site construction productivity. However, if that cost delta can be narrowed, or even erased, CSS can spur a shift from centralized generation and transmission to a distributed energy resource (DER) model.

Last November, Rocky Mountain Institute's (RMI) Shine™ initiative - which aims to enable a largely untapped 30 GW market potential for CSS - held a design charrette comprised of solar industry professionals and outside experts. Their goal was to develop an ultra-low-cost solar product able to operate in a variety of environments, at fully installed costs as low as \$0.50/Wp. It started with a whole-system design process, requiring a clean sheet and a beginner's mind, then coupled a healthy degree of skepticism that there is plenty of

headroom in the solar industry, and, lastly, considered that other great industrialized industries can lend innovation.

The RMI team has been in development of the product for nearly three years. Though inspiration was initially taken from Henry Ford's standardization, the team also looked to prefab and modular construction, and pre-engineering of gas turbine power plants. After a lengthy socialization process, it was decided that CSS is not only ripe for adopting these proven principles, but can also unlock further cost reduction opportunity with finance and business model innovations. CSS, a true "sweet spot" of solar assets, can become the lowest-cost solar generation, period. The name of the charrette, 50 by 20, is a bold vision for CSS that reaches \$0.50/Wp turnkey capital costs by 2020, a milestone believed to be a mid-point rather than the end.

### Bringing Down Cost through Preassembly

The charrette used RMI's initial product design as a baseline, around which a diverse group of experts could quickly innovate and build commercial aspirations and commitment. Without exception, participants saw standardization and off-site assembly as a strategic necessity. Preassembly of solar packets, or "blocks," was broadly accepted as not only a possibility, but the next logical step for how solar equipment should be sold and delivered. Furthermore, it was generally agreed that streamlining the supply chain of a pre-engineered offering, assembled and shipped from an assembly plant, can unlock \$0.20/Wp of cost reduction in 2018 alone (give or take a nickel, depending on the market). For example, Figure 1 shows how \$0.22/Wp can be eliminated from fixed tilt projects.

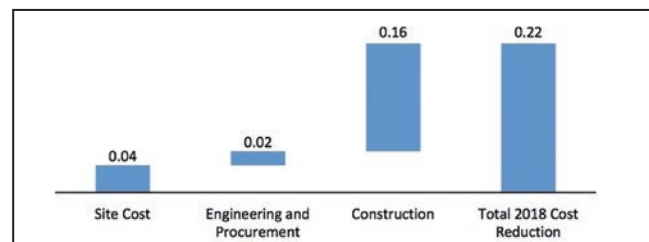


Figure 1: 2018 fixed-tilt cost reduction, \$/Wp

The configuration of each preassembled solar packet will be specified according to a cost-optimized regional design for modules, racking, DC wiring, inverters, and storage. Depending on this regional design, packets could be fifty feet long and weigh near a US ton, and be deployed as fixed-tilt, dual-tilt, or tracking arrays. The packets can be efficiently shipped with flatbed trucks and dropped onto site-installed foundations. In a future product vision, packets are installed at a variety of dual-use sites, colocated with agricultural sites, grazing fields, parking lots, community gardens, and common spaces.

While preassembly requires investments in fixed assets, and adds marginal shipping and handling costs, the benefits of shifting system components and assembly from the field to the factory are manifold. The most significant cost reduction is seen in labor. Preassembly can more than double overall labor productivity, while creating reliable jobs in a safe and controlled environment. Other benefits include reduced warranty and maintenance costs, and reduced project development timelines. Building a regional assembly plant and offering ultra-low-cost solar will allow for a shift from "pop-up" solar markets to more long-term, regional "pull" markets, laying the foundation for a robust and mature industry. Figure 2 shows a possible schematic of the assembly plant, shipping, and field installation process.

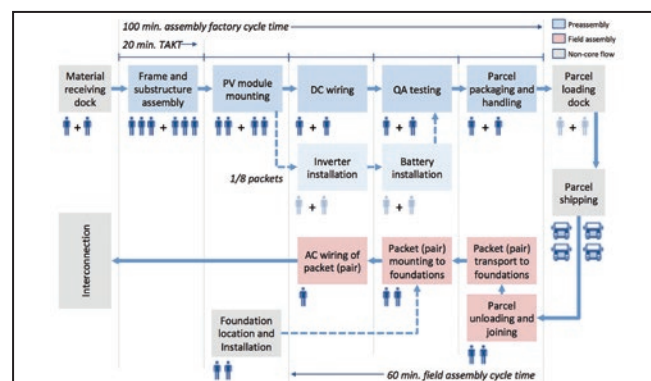


Figure 2: Assembly plant, shipping, and field installation schematic

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*Kareem Dabbagh is a manager of RMI's Shine initiative, focused on bringing ultra-low-cost community-scale solar to market through a whole-systems approach. The Shine team is developing a product and innovation platform to enable subsidy-free solar energy costs that can compete on the wholesale distribution grid, providing clean energy for everyone.*

RMI | rmi.org



*Joseph Goodman is a Principal with Rocky Mountain Institute's electricity practice. He is an energy systems engineer with over 10 years experience in renewables and energy efficiency. He has extensive experience leading multidiscipline design teams, and bringing new technologies to market.*

### Questions Remain

Despite the deep expertise in attendance at the charrette, several questions remained unanswered. What would be the requirements of the solution regarding regional typology selection (dual-tilt/fixed-tilt/tracking), the module and inverter selection (bi-facial, string/central), and the foundation design (screws/piers)? Another open question was the cost and benefit of working with regional vs. national product specifications; performance-minded participants favored a regional product, while finance-minded participants supported a national product. The group quickly uncovered a host of business model questions, such as who the natural owner of a brick and mortar assembly plant should be, how to manage liability across this new delivery model, and which aspects of the opportunity are most defensible in a competitive landscape.

In the face of less-than-favorable market conditions and tariffs, it's time for the U.S. solar industry to take advantage of this opportunity to standardize solar design and installation with a market-based product offering. RMI and the charrette participants are confident that an initial version of the product, along with an assembly plant, can be deployed in 2018. Further afield, the product platform has global potential in places like India and island nations. Existing markets will see positive effects through improved conversion rates and customer satisfaction, while new markets will become accessible via a low-cost, easy-to-understand offering. The product will reduce market volatility and uncertainty, and help us transition to a high-throughput model of ultra-low-cost solar energy, ubiquitous and accessible to all.

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# Large Array Solar Panel Cleaning

by Tom Fredericks

What is the best way to clean large solar panel arrays? What are the main concerns? Whether it's a large commercial community solar garden or utility-grade solar farm, following basic guidelines can increase system output and reduce panel damage.



Prior to cleaning, you should practice the following standard operating procedures:

1. Inspect the entire solar array system to detect loose or broken wires, damaged panels, or improperly functioning apparatus. Make necessary repairs or modifications for electrical safety.
2. Trim or remove any vegetation that may interfere with the system's operation.
3. Schedule panel cleaning early in the day, or at night when it is cool. This minimizes thermal stress on photovoltaic cells and protective glass, which could damage the panels. Cold water can microfracture hot panels. Also, a hot panel can evaporate water too quickly before it has dissolved and lifted contaminants.

Once the array is inspected according to system guidelines, and any adjustments to meet code or specs are done, it's time to clean the panels. What do you need in order to clean them?

Spray systems are one of a variety of equipment available on the market for cleaning solar panels. Automated spray systems, much like irrigation systems, are mounted on or near panels to regularly remove dirt. Small manual systems are available with handheld or back-mounted pack devices that spray water onto panels - O&M personnel then use brushes to scrub the panels prior to a final rinse. Manual systems are useful in remote locations, or where larger machines or vehicles can't navigate tightly clustered rows of an array. Large, automated truck-mounted brush systems and tanker truck operations are generally used on utility grade and larger solar systems. These often employ an assortment of hoses that are connected to the tanker truck reservoir, as well as the support personnel needed to scrub down panels to remove heavier grime.

For years, the industry has recommended using water with this equipment. Unfortunately, plain water just isn't an effective cleaner.


Many solar panel manufacturers have claimed that you don't need to clean panels, or, if cleaning is absolutely necessary, to just use water (more specifically, deionized water to reduce mineral deposits and spotting). However, large-scale solar farms that have been in operation for a few years tend to collect a layer of dirt on their panels; this prevents them from operating at their maximum output, which can cause problems for the owners. Facilities located in dry climates, or near agricultural fields, coastal areas, volcanos, airports, bird flight paths, or industrial areas

have almost immediate output loss due to contaminant accumulation on the panels. Many arrays require more frequent cleaning simply due to their location, and many of the contaminants do not easily rinse off with water alone. What is the best option to effectively clean off bird droppings, jet fuel residue, plant matter, dust, sand, and other contaminants?

Cleaning tough contaminants off panels with water additives is relatively easy. The real challenge is cleaning safely, with a product that does not degrade panel films or the aluminum support rails. Untested products may be effective at cleaning, but can also shorten equipment life. Proven compatibility is paramount. Specialty solar panel cleaners are commercially available. Quality panel manufacturers will have tested cleaning products for compatibility, and are an excellent source for recommendations.

Environmental concerns and worker safety must also be addressed. Cleaning effectiveness is a key parameter, too, as this optimizes power output, saves time and labor, and helps cut water usage—an important consideration in many locations. The goal is to find an approved, low-toxicity, biodegradable product that enhances the cleaning effectiveness of deionized or plain water.








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
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### Surge protection for industrial connectors

HARTING's new Han-Modular Surge Protection Modules make it possible to move surge protection into its most widely used industrial connector series, a space-saving idea that simplifies wiring arrangements. Proper surge protection for Instrumental and Control (I&C) signals usually requires separate, external solutions that add to material and labor costs. When used correctly, the new surge protection (SP) modules will reduce the number of operating faults, increase the service life of the production line, and ultimately increase production uptime for better plant operating performance. There are two types of SP module: a two-channel version for differential signals and four-channel type for signals with common reference potential. Each can transmit nominal 24Vdc and up to 0.5A. The protection level is approximately 50V depending on the type. Transient energy, which can disturb signal circuits and destroy electronic devices, is discharged to the ground via an appropriate spring element and the grounded Han-Modular Hinged Frame. This ensures interference-free transmission of the signal.

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Detergent, or any other product that is added to the water in a panel cleaning system, should meet the following requirements:

1. It must be compatible with the solar panel films, aluminum rails, racking, and epoxy.
2. It should be approved by the solar panel manufacturer.
3. It must be biodegradable with low environmental impact, and contain no VOCs.
4. It should have low toxicity for worker safety.
5. It should be specifically formulated to remove contaminants commonly found on panels.
6. It should rinse off thoroughly, with no spotting or residue.
7. It should be dilutable in water, and suitable for use with either tap or deionized water.
8. It should dissolve and remove dirt, jet fuel residue, and dust off of panels, offering hygroscopic action to achieve this performance enhancement.

If you follow these guidelines for cleaning and maintaining your solar arrays, you will ensure that your system operates at its highest level, at maximum output, and with the longest possible equipment life and ROI.

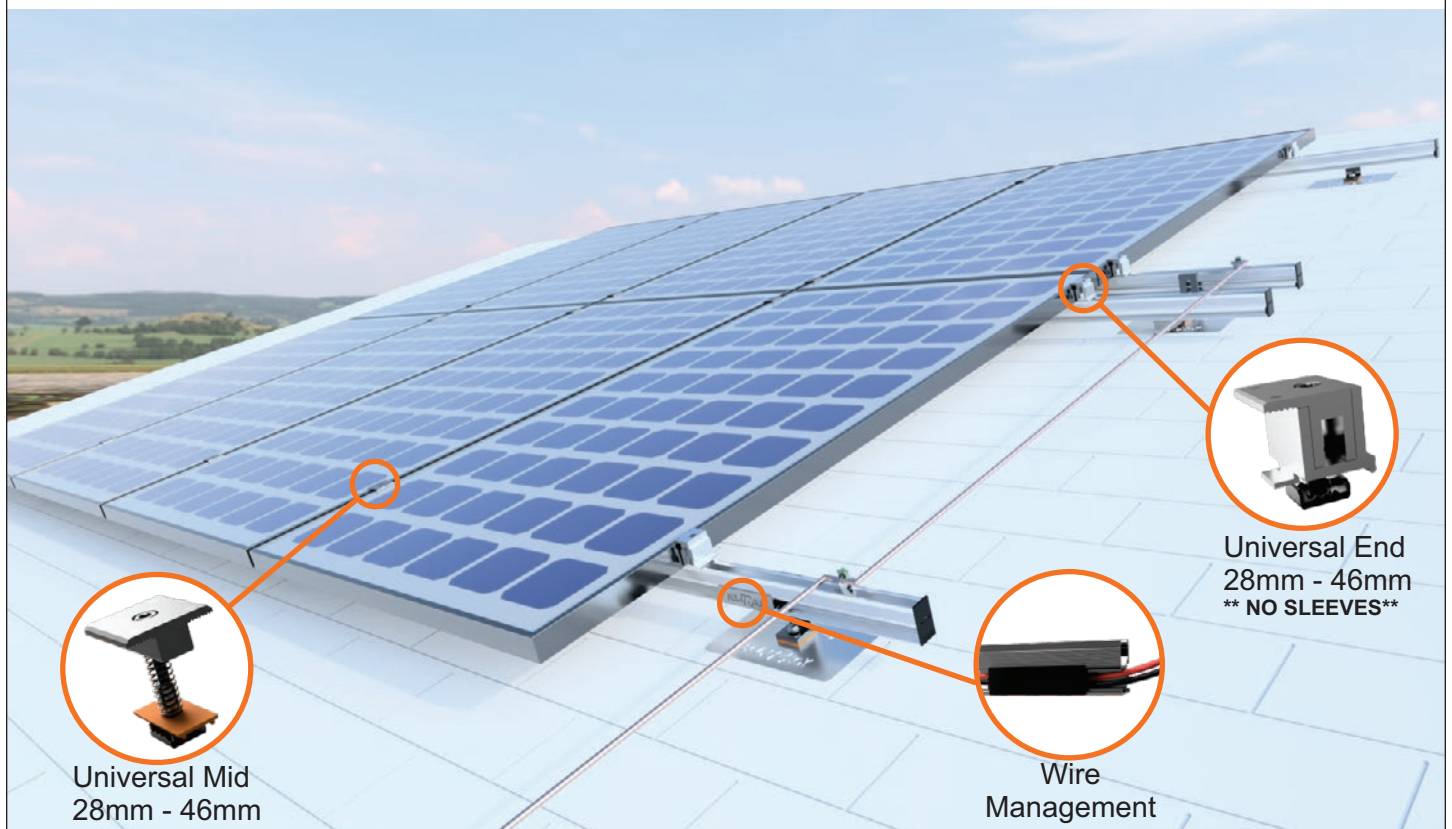
*Tom Fredericks is General Manager/Vice President Electrical Division at American Polywater Corporation.*

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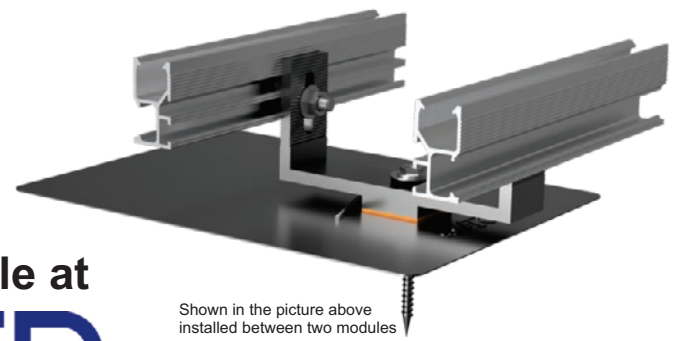
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# Custom-Made in the U.S.A.

by Seth Hansen

**ON JANUARY 22, 2018, MANY AMERICANS LOST HOPE IN A** US solar market that was, by all accounts, on track to continue its decades-long expansion. When the current Administration implemented a 30 percent tariff on solar cells and panels imported into the United States, champions of the clean technology were left saddened, disheartened, and downright angry about the future of solar in the United States.

It's not as bad as it all seems; there are a few less-publicized key advantages that US-based companies have when it comes to the incredibly competitive solar landscape. For any company aiming to move forward in this new environment, the smartest move is to look at this decision not as a barrier, but an opportunity. The key to success lies in offering specific, smaller quantity, and custom solutions to customers. There are many solar manufacturers who can meet the demands of grid-tie applications, but few who are capable, and positioned, to meet the more niche, small-scale, and remote solutions involved in asset tracking, etc.

In order to fully appreciate the advantages US-based companies possess, we need to first understand that these tariffs won't apply to imported cells until after 2.5 GW of solar cells are imported. This threshold may or may not be met, but it certainly won't be met quickly. This allows US companies time to fully realize their place in the solar assembly marketplace before the tariff is truly felt, and market pricing is impacted.

There are less obvious competitive advantages that US-based solar assemblers possess when compared to their Asian-market counterparts.

One advantage is that quality can be controlled in smaller, more focused facilities. These companies can rapidly evolve to meet a different set of challenges; they are geared to provide well-designed product and solid customer service. Many US companies have design, engineering, and manufacturing experts on staff who are dedicated to bringing superior products to both consumers and businesses. Solar authorities on staff ensure that products are inspected, refined, and tested along the way.

Not only do successful companies have professionals controlling the different steps of the solar assembly process, they also have customer service specialists who are ready and willing to ensure that customers have the best possible experience before, during, and after the purchase. You won't find this level of attention to detail or dedication to customer happiness on a less expensive panel from China, or other Asian markets which are geared towards large volumes.

Another advantage that US companies possess is the ability to create custom encapsulation stacks to benefit clients' unique needs. Many would look at the volume that US-based companies can provide and see as a disadvantage, but it can also allow for custom batches of product geared toward a specific demand. China may be considered the solar capital of the world, but when you see a Chinese-made panel, there's a good chance that it's one of a million units that were mass-produced to perform a single, specific use case. Rather than a one-size-fits-most scenario,



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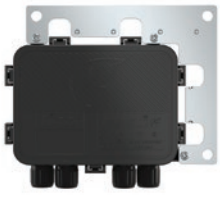
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### Simplified rapid shutdown solution for commercial market

SMA and Tigo have announced a new rapid shutdown solution for the commercial market, which will be available in the second half of 2018. The solution will use technology from SMA and Tigo to provide rapid shutdown only, creating a reliable, economical product focusing on key functions to enable NEC compliance. The new rapid shutdown solution will fulfill UL 1741, NEC 2014 and NEC 2017 requirements, particularly the stricter module-level shutdown requirements coming effective in January 2019. It will be compatible with the power line-based SunSpec Communication Signal for Rapid Shutdown, making it simple and robust. Using the existing DC wires between the inverter and module-level electronics as a communication channel will drastically reduce installation time. Mechanically, it will be compatible with Tigo's existing TS4 platform. The product will offer outstanding system safety thanks to full integration with SMA's AFCI function.

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US plants can produce smaller runs that focus on solving each and every client's specification. Need a stack that maximizes light absorption? Done. Need encapsulation that can withstand hail and keep a truck's GPS system online in severe weather? No problem. Whatever your specific use case, US companies - who will almost assuredly be working in smaller quantities - can meet your needs more readily.

Finally, successful companies aren't sticking to the assumption that solar panels and charge controllers are separate products, and must be sourced from two different companies. When you buy a laptop, it comes with the vendor's tested and vetted charging cable so you can be confident in its performance. Why shouldn't the same be true of a solar company? Engineering expertise can integrate these once separate systems, allowing them to work together to provide the most consistent, efficient, and reliable source of power to consumers and business clients everywhere.

For the foreseeable future, the lion's share of solar manufacturing will likely remain in China and other Asian countries. However, that doesn't mean that US-based assemblers can't win market share as well. With dedication to creating truly custom solutions, delivering fantastic customer service, and engineering products to client requirements, US-based solar assembly is full of opportunity and untapped potential.

*Seth Hansen is the Marketing and Communications Manager for PowerFilm Solar, a global developer and manufacturer of thin-film solar products and modules. The company utilizes a unique and proprietary technology platform, enabling the production of low-cost solar modules on a high volume basis. PowerFilm offers their U.S.-assembled, custom crystalline solar solutions under the brand Soltronix.*

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# PV System Math

## Fewer available sites + poor planning = money down the drain

by Jürgen Schmid, Manfred Karl and Jeremy Scott, P.E.



**Figure 1:** Collage of some structural and geotechnical failures and damages observed at utility scale ground mount solar farms

A scarcity of good utility scale solar project sites, paired with insufficient engineering, can result in heavy financial losses. Ready-to-build sites with good soils are getting harder to come by; in order to take advantage of available farmland, brown fields, abandoned land, and waste deposits, structural and geotechnical engineers need to incorporate diligent, interdisciplinary, and hand-in-hand engineering.

A growing number of solar systems are built on challenging terrain, with difficult and inhomogeneous soil conditions or irregular topography. At the same time, the frequency of failures and damaged utility scale solar plants is rising (see Fig. 1). Regardless of the cause of the damage, there are solutions to help overcome these challenges, thereby safeguarding investments, and improving preparedness for future changes in the challenging environment.

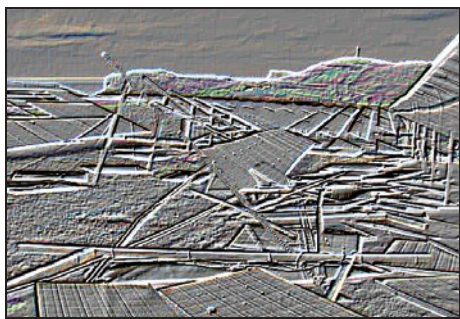
Wind load is the most frequent source of failures, followed by snow load, then dead load combined with seismic loads. Figures 2 through 10 show examples of damage to utility-scale plants due to various failures. Note that in Fig. 4, the snow load damage destroyed not only the mounting structure, but also nearly all of modules of this 5MWp farm. The wooden cable drum served as a temporary support after the damage had already occurred. Also note, as observed on Fig. 9, that dynamic loads can lead to compaction of insufficiently compacted fill soils. Additionally, many contractors may attempt to conceal issues faced during installation by installing wooden wedges - not a durable construction element. This particular weakness was exposed at many foundation points during a subsequent storm.

All of these images illustrate the large variety of reasons for severe damage or complete failure. In order to understand the nature of damages, and to avoid future capital loss, Fig. 11 categorizes the possible range of damages, and distinguishes between which affect the mounting superstructure, the foundation, or both. Furthermore, installation damages are categorized.

Foundation is critical. Incorrect design can affect the entire mounting system, including the PV modules.

The panel mounting system foundation links the solar equipment to the soil beneath the entire system (see Fig. 12). Recently, small steel piles of various configurations have become the most common type of foundation method (see Fig. 13), if the subsurface conditions allow this application. This “mini pile foundation” has to safely transfer loads from snow, wind, dead, and seismic forces into the soil.

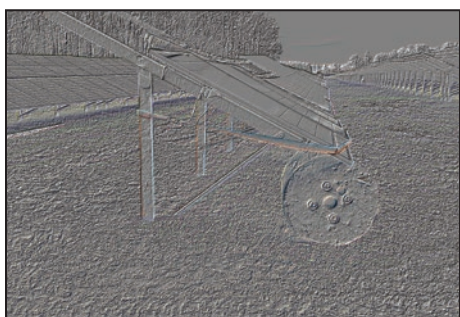
The resulting loads are minimal when compared to forces acting on large building structures. However, the load effect of wind and gust activity is high compared to the dead load (weight) of a solar mounting system. Several thousand foundation elements are usually needed to build even a 10-megawatt utility scale ground mount PV system. Steel mini-piles have proven to be a very economic, quickly installable, and reliable foundation solution for small and large scale solar farms. In addition to a conventional subsurface investigation and numeric modelling, performing load tests at the site to simulate cyclic wind and snow loads, seasonal fluctuations, and soil variability, provides an opportunity to both confirm the sufficiency and optimize the steel mini-pile foundation design.



**Figure 2:** Heavy damage to structural system and foundations due to high wind load at a utility scale ground mount solar farm [Picture embossed to protect source]



**Figure 3:** Significant corrosion damage observed at a utility scale ground mount solar farm



**Figure 4:** Significant Snow Load Damage observed at a Utility Scale Ground Mount Solar Farm [Picture embossed to protect source]



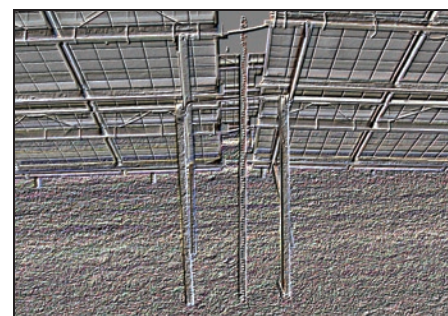
**Figure 8:** Change of soil consistency due to climatic impacts as a potential reason for pile failure



**Figure 9:** Left hand side: Dynamic loads led to compaction of insufficiently compacted Cut & Fill; right hand side: Subcontractor tried to hide problems he faced during installation



**Figure 5:** Damage presumably due to Frost Heave



**Figure 6:** Example for significant differential settlement [Picture embossed to protect source]



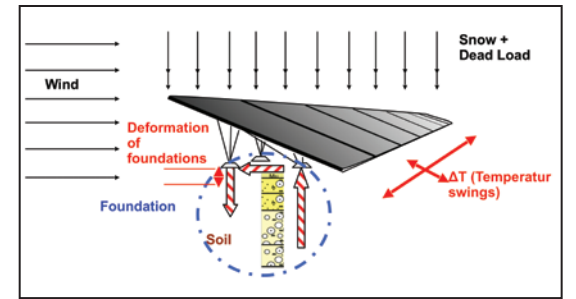
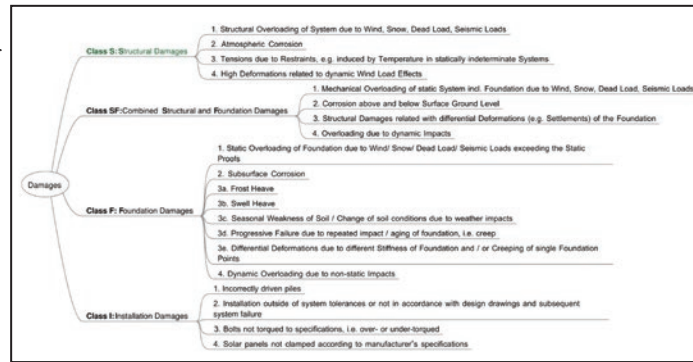
**Figure 7:** Damaged pile foot due to ramming obstructions





**Figure 10:** Severe damage due to insufficient embedment depth of the pile foundation

**Figure 11:** Classification of structural and geotechnical damages observed at utility scale ground mount solar farms



**Figure 12:** Loads acting on mounting systems of solar farms, which must be transmitted to the foundation and the soil

Therefore, system design must be conducted with professional expertise and diligent interaction between the structural engineer, and foundation design engineer.

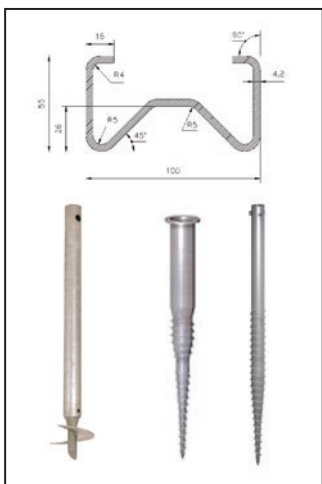
The task of geotechnical engineers is to design safe and economic foundations; these highly specialized civil engineers collect the measurement of the necessary soil parameters at the project site, prepare the design of the foundations, and answer all questions related to the building ground.

*Jürgen Schmid is a Civil Engineer, Geotechnical Engineer and CEO of AquaSoli LLC, an international engineering consultant company which has performed pioneer work with a global experience of more than 11 GWp in geotechnical engineering of renewable energy worldwide.*

*Manfred Karl has been a Civil Engineer at AquaSoli since 2010. From 2006 to 2009, he worked in ARGE Richard-Strauß-Tunnel in Munich. He is based in Munich.*

*Jeremy Scott, P.E., is a Civil Engineer at AquaSoli, with over 17 years of diverse engineering experience worldwide, in design, construction management, and environmental engineering. He is currently based in Bangalore for AquaSoli India.*

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**Figure 13:** Steel "mini pile" product examples from different manufacturers: left side: cross section of a driven pile foundation, right side: examples for ground screw solutions

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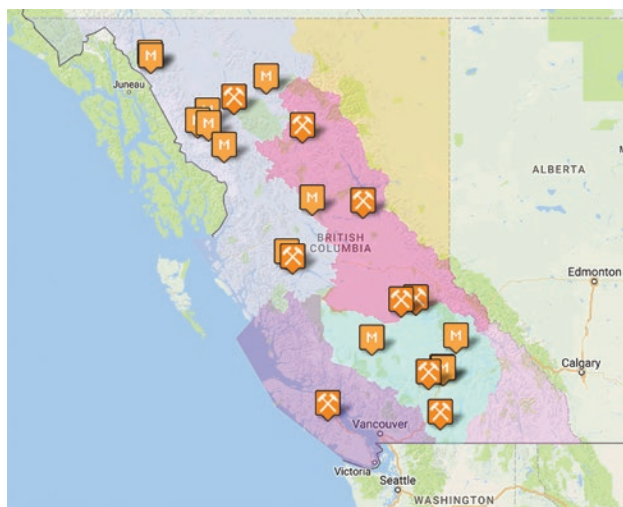




# Global Rise of Solar Power

## Giving Canadian mines a place in the sun

by Bryan Cox



**BRITISH COLUMBIA IS POISED TO CONTINUE TO HELP** lead the world in its transition to a lower carbon future. With reserves of some of the highest quality metals and minerals required for this transition, BC has the opportunity to be at the forefront of this global movement. BC is unique - it has a geology that houses many of the metals required to build clean energy infrastructure, including copper, silver, molybdenum, steelmaking coal and others; these all combine to make BC a very important jurisdiction in this evolution.

We also have an affordable clean energy grid, and a pool of world-class talent in technology, green innovations, environmental science, engineering, and more. We have a robust, world-leading regulatory framework that British Columbians and Canadians can be proud of. We have been change-leaders in our engagement with First Nations and communities, ensuring that the benefits of resource development are shared. British Columbia is, by all measures, well positioned to lead the world towards a cleaner and more inclusive future.

The accelerated growth in global demand for clean energy technologies in recent years has sparked worldwide interest in the Canadian mining industry. One practical example is the important role of our mining inputs in photovoltaic solar sources, or PV Solar Panels.

The idea of solar power has become synonymous with clean energy for a good reason; it's a prime example of a technology that's growing in popularity alongside its capability. PV panels are quickly being adopted worldwide, with countries like India and the US doubling their solar capacity since 2015. In 2016, China increased its capacity to

30 gigawatts—for reference, according to Clean Energy Canada (CEC), that's enough solar panels to cover nearly three soccer fields every hour. That same year, India built the world's largest solar project: 2.5 million PV panels created in 8 months, for a grand total of \$900 million, generating 648 megawatts. That's enough power for 150,000 homes. With this evidence of global advancement in PV capacity, the growth of the solar industry is naturally generating interest in countries that produce the raw materials required for PV solar panels. With the resources to manufacture them, this places Canada in the spotlight.

British Columbia is renowned for mining, and also home to some of the world's most progressive mining companies. For these companies, the growth in clean energy technologies presents a wealth of possibilities, with solar technology emerging as a golden opportunity. BC has the potential to lead the way as a crucial supplier of natural resources for constructing global solar power. As of 2017, there were over 3 million jobs in the solar technology industry globally, and that number is only expanding. CEC reports that, in 2016, the solar industry set a new record with "73 gigawatts (GW) of new capacity coming online. For context, that's more than half the capacity of Canada's entire electricity grid." In addition to this, costs associated with solar dropped by 58 percent between 2010 and 2015, suggesting that it has become a more affordable technology to adopt and advance.

Of the 19 metal and mineral materials required to make PV solar panels, Canadian mines produce 14, including eight of which are considered "critical". The "critical materials" designation means that these products are



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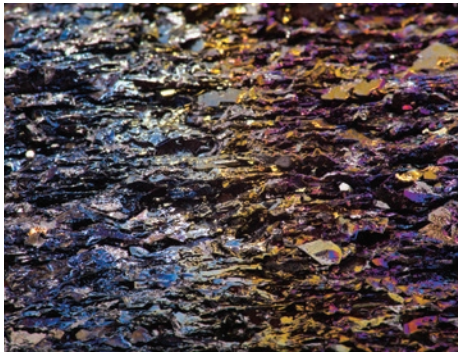
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### Software update includes an inverter heat map feature

Draker's V7 software provides a quick and easy shortcut which helps visualize the production of centralized and string inverter performance data. This enhancement features real-time, automatically mapped inverter status. The inverter heat map displays at the Project Level within Draker's intuitive interface—no need to scroll down in lists or click around. The new inverter heat mapping tool adds to the growing list of V7's enhanced diagnostic abilities. Working alongside remote shutdown and power control features, advanced reporting, hierarchical alarms, and performance dashboards, the inverter heat map is a quick way to identify system impairments.

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“particularly important to the technology and also face supply challenges, which include a small global market, a lack of supply diversity, market complexities caused by co-production, and geopolitical risks,” as described by CEC. Both copper and silver are included in the listing of critical materials; BC is an important source of these materials, which generated a combined \$2.3 billion in 2016. British Columbia is Canada's largest producer of copper, shipping nearly 1 million tonnes in 2016.

The global rise of solar panels has set the stage for BC to power everything under the sun. The International Energy Agency (IEA) has suggested that solar should play a key role in the future of energy in order to avoid extreme climate change. In the scenario outlined by the IEA, PV solar panels are given a lead role in the transition to clean energy; the demand for solar PV capacity could increase more than 17 fold between 2015 and 2050. This increase in growth can't happen without the natural resources that make up PV panels, and several indicators suggest this increase in demand is already underway.

In addition to fueling the economy and job creation, mining companies have an important role to play in a new green economy. Our mines are producing the inputs required to make this transition, and our companies are continuing to invest in these clean technologies for our own operations. In light of the global rise of PV solar panels, the future looks bright for Canadian mines and the Canadian economy, and British Columbia is poised to lead the way.



Bryan Cox is President & CEO of the Mining Association of British Columbia (MABC).

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Source: Mining for Clean Energy 2017; Clean Energy Canada: <http://cleanenergycanada.org/work/mining-clean-energy-2017/>

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# Trade Secrets

## Protecting clean energy technology

by Maximilienne Giannelli, Ph.D., and Kenneth Aruda, Ph.D.

**IN TODAY'S COMPETITIVE MARKETPLACE, IT IS** vital that you have a comprehensive plan in place to protect your intellectual property. While most companies include patents and trademarks as key components of their plan, many overlook the existence, role, and/or value of trade secrets. That mistake can prove costly.

Trade secrets are prevalent in the clean energy sector. In the solar industry alone, the United States has secured convictions of several individuals for economic espionage, e.g., trade secret misappropriation benefiting a foreign government, instrumentality, or agent, with penalties resulting in imprisonment and multi-million dollar restitution awards. Importantly, the vast majority of reported trade secret theft occurs at the hands of current or former employees. And, while a subset of these employees intend to profit from the theft of company secrets, some employees may claim they were unaware of the scope of what they could permissibly disclose. At least with respect to this latter category, some simple steps may help you prevent trade secret misappropriation.



You may wonder whether your company actually possesses enforceable trade secrets. In general, any confidential information that gives your company a competitive edge may qualify as a trade secret, as long as it is not generally known or readily ascertainable by proper means (such as reverse engineering), and provided that you safeguard such information using reasonable measures to maintain secrecy.

Technological trade secrets can develop along two paths. First, you may rationally decide at the outset that trade secret protection would provide greater value than patent protection. This may be the case if a patent would not carve out a meaningful space in the marketplace, if your secret information might provide a competitive advantage for more than a 20-year patent term, if you expect that you can maintain the secrecy of your information, and if you doubt that others could reverse engineer or independently develop your secret. Cost may also be a consideration, as trade secret protection has no upfront costs. However, particularly during early stages of commercialization, it may be difficult to predict when trade secrets will provide greater value than patents.

The second path by which trade secrets develop may be referred to as hindsight recognition. Such trade secrets develop over time, often hand-in-hand with manufacturing experience and the development of technical know-how. These trade secrets may, at times, include combinations of features previously disclosed in patents, provided that the overall trade secret remains valuable, secret, not generally known, and not readily ascertainable through proper means. Particularly if your company engages in commercial manufacture, you may well have trade secrets but not realize they exist. Technological trade secrets often relate to production processes, including chemical reagents, recipes, specialized equipment, process parameters, and/or combinations thereof.

Taking active steps to evaluate and protect your confidential information may help prevent costly misappropriation. First, know your trade secrets. Knowing which information provides you with a competitive advantage will help you devise reasonable steps to protect that information. This may involve a company-wide trade secret audit, resulting in a list of the type of information that may qualify as trade secrets. Importantly, you should balance how broadly you categorize your secrets. Labelling everything “secret” or “confidential” may confuse employees, and devalue the protection of legitimately confidential or secret information. On the other hand, it is important to categorize your secret information broadly enough to ensure that no valuable confidential information falls through the cracks.

Second, once you have a general sense of what type of information needs to be protected, devise a plan for securing that information. Limit disclosure appropriately. For example, limit access to those with a need to know. For facilities where confidential activities like manufacturing occur, restrict access, prohibit photography, and conceal the identities of key components or reagents by using code names. For electronic information, use passwords, encryption, and other appropriate measures. For hardcopy materials, require that employees with access check out materials, and sign and date whenever such information is accessed.

Third, ensure your employees know their responsibilities. This should occur at all stages of employment. Upon hiring, have appropriate terms and conditions spelling out confidentiality obligations; clearly state that the confidentiality of your company secrets never expires. Consider using an employee handbook detailing permissible activities, including whether and/or when employees may work from home, copy company data to personal laptops, or use external emails or memory devices. For anyone with access to confidential information, implement appropriate levels of training and repeat that training periodically. Importantly, for any departing employees, conduct exit

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*Maximilienne Giannelli, Ph.D., represents clients in complex matters involving patents and/or trade secrets and counsels clients on how best to protect and defend their intellectual property. Max focuses her practice on patent and trade secret litigation in federal district courts and at the U.S. International Trade Commission.*

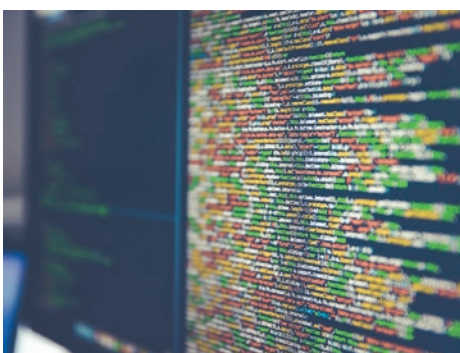


*Ken Aruda, Ph.D., focuses his practice on patent prosecution with an emphasis in the areas of pharmaceuticals, alternative energy technologies, and semiconductor devices. His practice includes drafting and prosecuting U.S. and foreign patent applications, portfolio development and management, and due diligence investigations. Ken has a wide range of technical expertise, including laser optics, semiconductor devices, lithium ion batteries, solar cells, and small molecule synthesis.*

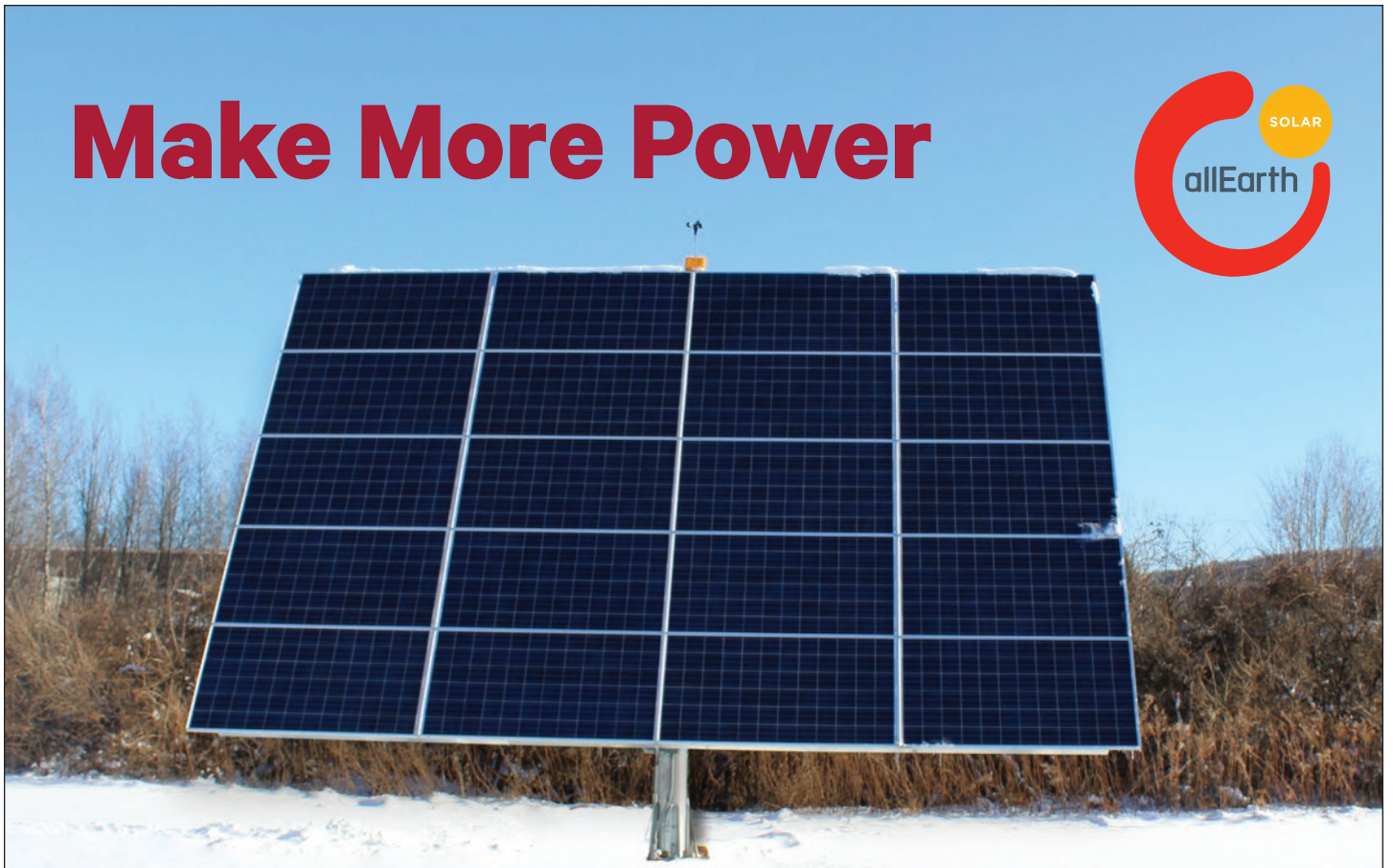
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interviews where you explain all on-going obligations, including at least the obligation not to disclose any company secrets. These issues often confuse employees, so invite discussion, and ask departing employees to contact the company if they are confused about what information they may permissibly tell others. Where an employee has had access to highly valuable information, ask them to formally sign an acknowledgement of their confidentiality obligations prior to their departure. At all times, ensure that employees know what information your company considers confidential, and what steps they need to take to ensure that secrecy is maintained.

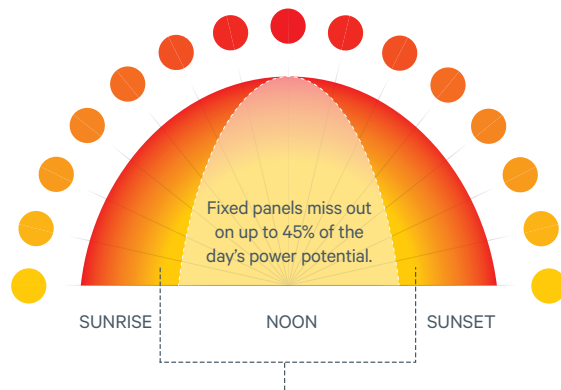
Finally, evaluate your agreements with third parties, including vendors, collaborators, purchasers, and any others. When appropriate, ensure that your agreements have robust non-disclosure provisions. If the identity of equipment, chemicals, or other items gives your company a competitive edge, consider including a provision that prevents vendors from telling others about the existence of your business relationship and/or what was sold; discuss these restrictions with the vendors' sales representatives to ensure that they understand their confidentiality obligations. While it may not be possible to prevent all acts of calculated trade secret theft, these measures may help prevent inadvertent disclosures and thereby help maintain the competitive edge provided by your trade secrets.



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## Will Solar Remain King?

by Matt Ji

The new Tax Cuts and Jobs Act was introduced on November 2, 2017, in the U.S. House of Representatives by the Chairman of the Ways and Means Committee, Texas Representative Brady. After multiple revisions, this major tax reform legislation was signed into law by President Donald Trump on December 22, 2017. The new tax law institutes key changes that may drastically affect the fast growing U.S. solar market.

Analyses have shown that the bill offers two critical changes: the corporate tax rate reduction; and first year full depreciation tax write-off of equipment placed after September 27, 2017. From the perspective of a solar investor, these changes provide even more favorable terms which would spill over to the overall solar market activity.

The decrease of the corporate tax rate from 35 percent to 21 percent, has a paramount effect on the economy by altering the flow and value of goods and services. Fundamental market behavioral changes are expected from the magnitude of these tax cuts. 100 percent bonus depreciation will make infrastructure investments more attractive due to the increased time-value of immediate tax write-off benefits. From a preliminary assessment of supply and demand, we can predict the following outcomes:

### **Total tax partnership investments from corporations will decrease in the short run.**

A tax equity investor, first and foremost, evaluates a project based strictly on the tax benefits. Therefore, when the corporate tax rate falls from 35 percent to 21 percent, the overall tax benefits from depreciable and tax credit eligible assets like solar equipment would decrease substantially, by 40 percent. The sensitivity of even a slight tax rate decrease will impact the tax equity market. This will make these tax-advantaged investments far less economically attractive as a vehicle for corporate tax optimization, which has traditionally pushed effective corporate tax rates down towards 15-22 percent. Now those projected renewable energy investments earmarked for 2018 may be at risk, and will be contingent on core business performance.

### **Infrastructure projects will go small.**

While the larger corporate tax equity retreats, the smaller tax equities will play a larger role in helping finance infrastructure in 2018 and beyond. 100 percent bonus depreciation of equipment, and the trend towards smaller tax equity appetite, will lead to a greater demand for smaller projects. Non-corporate profits are less easily syndicated than corporate profits. Therefore, any unpooled source of tax liability is better matched with smaller and less-costlier infrastructure projects, while barriers for establishing additional syndicate funds are still very high. We can assume that this move towards 100 percent bonus depreciation will counteract the need for syndication to achieve bigger scale projects - making smaller projects efficient on their own in achieving economic objectives.

### **Solar projects: smaller but more of them.**

Solar projects are unique because they generate investment tax credits in addition to the 100 percent bonus depreciation. When the two mechanisms interact, the size of an ideal project for any given tax liability is reduced even further, resulting

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in system sizes and costs 60-80 percent of the current market's. This means that solar project developers should position themselves for smaller projects, as those will better serve the needs of the new market equilibrium between finance and customer demand. This will be the best opportunity for growth, as the inflows and outflows of new and old tax equity investors create price discovery opportunities in the market.

**Projects with tax credits will be the most attractive investments for offsetting tax liabilities.** Tax benefits of depreciation and tax credits are fundamentally different in how they translate to tax benefits. Noting the differences and the subsequent tax reform changes, tax credits will be even more valuable for corporations due to the decrease in corporate tax rate. This means that, dollar for dollar, solar will provide better value for investors than other comparably priced infrastructure projects under the new tax plan.

**Fair Market Value will increase in all revenue-generating assets.** Broad decline in corporate tax rates is a boon to revenue. Third-party owned solar, which is the most popular vehicle for financing solar projects, are long-term revenue generating assets that will appreciate in after-tax value. Passively generated income and long-term energy contracts will appreciate significantly in fair market value, by 14 percent or more.

**Solar prices will continue to decline 10-15 percent per year, citing improving manufacturing technology and efficiency improvements.** While a 15 percent-per-year cost decrease is more heavily cited in the industry and indicative of the past decade of solar PV technological development, silicon solar wafer cells are closing in on the theoretical maximum (Shockley-Queisser limit) for a single junction solar cell. Significant cost-efficiency gains of solar cells are still expected to increase year-over-year until reaching 29 percent, but only at a rate of 10 percent.



**Solar profit margins will increase 25 percent year-over-year, citing combination of cost decline and revenue increase.** This is an important macroeconomic boost and reminder for solar businesses given the shock and scare of the recent tariff and tax reforms. Two major macro-economic trends are positive for the solar industry, technology and revenue. Both contribute to lower costs, greater performance and higher after tax revenue that will help steer the industry for at least another decade. If you are in solar, now is not the time to jump ship.

**Total solar capacity deployed will experience short-term downward pressure.** It's not without doubt that the tax reforms and tariffs present headwinds for the industry. Business relationships will re-shuffle as they always do until the right offer meets the right price. Other factors such as higher operating margins and increased competition will offset, and might even overcome forecasted downturn.

*Matt Ji is a Financial Analyst and Asset Manager for O3 Energy. He evaluates the company's project pipeline for economic feasibility, and performs due diligence. He assists O3 Energy clients and partners with any financial and technical inquiries. He has extensive research experience in meteorology and artificial neural networks and holds a Master's degree in Renewable Energy Management from the University of Freiburg (Albert-Ludwigs Universitaet Freiburg). He also holds a Bachelor's degree in Petroleum Engineering from the Colorado School of Mines with minors in Economics and Public Policy, and is a registered Engineer-in-Training in the State of Colorado. Mr. Ji is a member of O3's editorial team for articles relating to solar industry finance, trends, and predictions.*

O3 Energy | [o3energy.com](http://o3energy.com)



### SunSpec based inverter for module level shutdown

Fronius' Symo Advanced Inverter offers an integrated Power Line Communication (PLC) transmitter based on the recently published SunSpec Communication Signal for Rapid Shutdown. This industry standard is a multi-vendor and multi-device communication specification for inverters, modules, and string combiners to support NEC 2014, NEC 2017, and UL 1741 module-level rapid shutdown requirements.

**Fronius USA LLC** | [www.fronius.com](http://www.fronius.com)



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# Racking & Mounting

Along with quality panels, it's important to ensure a solid base and a supportive structure for a successful solar installation. The following highlights a variety of mounting and racking solutions that are available, along with their key features, to help solar designers and installers find the best option for their project.

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## SolarRoofHook

**Product:** Low Profile QuickBOLT with Microflashing

**Application:** Roof-mount

**Material:** Stainless Steel backed EPDM Washer and Stainless Steel L-Foot

**Angle:** 90°

**Pre- or Post-assembly:** No assembly required

**Certifications/Approvals:** UL Certified, Tensile, Load, and Water Testing (ASTM E331 and E2124)

**Warranty:** 25-year warranty

### Key Features:

- UL Certified Microflashing mounting system;
- The Microflashing is compressed by the collar on the bolt to create a water-tight seal;
- Now available in 4" diameter and a stainless steel L-Foot is coming soon;
- With an installation time of less than one minute, the Low Profile QuickBOLT allows installers to complete more jobs;
- All spec sheets, test results, and installation instructions and videos can be found online.

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

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## Solar FlexRack

**Product:** Fixed Tilt Series G3-X

**Application:** Ground-mount, utility, C&I, community solar

**Angle:** 5° to 45° (custom tilts can be accommodated)

**Material:** Galvanized steel

**Pre- or Post-assembly:** Either pre- or post-assembly

**Certifications/Approvals:** UL 2703, CPP Wind Tunnel Tested, Accutek Structural Connection

**Warranty:** 20-year warranty

### Key Features:

- Adaptable with crystalline or thin film and any pile solution including SmartPost, Round Post, Wide Flange W section, Helical piers and Ground screws;
- All steel construction for competitive cost-per-watt pricing and robust design delivers rugged durability;
- Fast and trouble-free installation with rapid module install design (third-party time study available) and safeguards solar modules from damage during installation;
- Safe and efficient module mounting with direct bolt bonded connection, integrated bonding and wire management;
- Built-in adjustability and tolerances accommodating up to a 20% slope in the east-west direction.

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

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## ILSCO

**Product:** Copper Flex Braid

**Application:** Grounding and bonding

**Material:** Electro-tin plated pure copper

**Pre- or Post-assembly:** Pre- and post-assembly

**Certifications/Approvals:** UL 467 Listed

**Warranty:** One-year manufacturer's warranty

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



## ISA Corporation

**Product:** Solar Racking - Clamp-on

**Application:** Service station canopies, steel roofs

**Angle:** 0° to 10°

**Material:** Aluminum

**Pre- or Post-assembly:** Pre-assembly

**Certifications/Approvals:** Structurally Approved for most areas

**Warranty:** 15-year warranty

[www.isa-corporation.com](http://www.isa-corporation.com)



## SunWize Power & Battery

**Product:** Large Format Side of Pole Mounts

**Application:** Side-of-pole mount

**Angle:** 15° to 60°

**Material:** Aluminum with stainless steel hardware

**Pre- or Post-assembly:** Post-assembly

**Certifications/Approvals:** Certified up to 140MPH Wind Speeds per IBC 2012, ASCE 7-10, Zones B & C

**Warranty:** 1-year warranty

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



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**AP Alternatives**

**Product:** GEO-Ballast

**Application:** Fixed-tilt, ground-mount, commercial, utility-scale

**Angle:** Customizable from 2° to 45°

**Material:** Hot dipped galvanized welded wire, PVC coated

**Pre- or Post-assembly:** 50% pre-assembled, 50% post-assembly on-site

**Certifications/Approvals:** UL 2703, PE stamped and engineered to site parameters

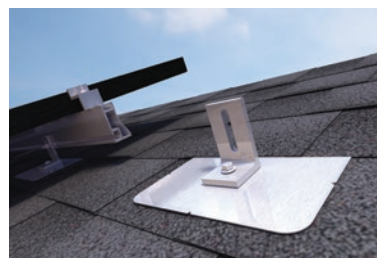
**Warranty:** 25-year warranty

**Key Features:**

- 50% pre-assembled;
- Rapid connection and assembly;
- Uses local 3 1/4 quarry rock and no concrete;
- Continuous table design seamlessly rolls with topography;
- Compatible with all major crystalline and thin-film module types.

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

SEE AD ON PAGE 29



**Quick Mount PV**

**Product:** L-Mount Series

**Application:** Residential composition, asphalt shingle roofs

**Angle:** Sloped roofs

**Material:** Aluminum

**Pre- or Post-assembly:** Pre-assembly

**Certifications/Approvals:** 100% IBC compliant; meets or exceeds tile roofing best practices

**Warranty:** 25-year warranty

**Key Features:**

- Integrated L-foot and mount;
- High level of waterproofing with their patented Elevated Water Seal Technology;
- Cost-effective and super-fast single-bolt installation;
- Available in single- and double-slot options for maximum versatility and works with all leading racks.

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

SEE AD ON PAGE 19



**Structural Solar LLC**

**Product:** Canopy and Ground Mount Structures

**Application:** All parking areas and ground mounts

**Angle:** up to 45°

**Material:** Galvanized and aluminum structures

**Pre- or Post-assembly:** From supply only to fully installed

**Certifications/Approvals:** AISC

**Warranty:** Structures durable for 40-years

**Key Features:**

- Structural design;
- Manufacturing;
- Construction.

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



**AceClamp**

**Product:** AceClamp A-2 Solar Kit

**Application:** Roof, SSMR

**Angle:** Various

**Material:** Stainless steel, aluminum, brass

**Pre- or Post-assembly:** Pre-assembled

**Certifications/Approvals:** FM approved, UL listed

**Warranty:** 20-year warranty on manufacturer's defects

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



**Unirac, Inc.**

**Product:** SOLARMOUNT Pro Series Universal MID and ENDCLAMPS

**Application:** Roof mount, universal clamps fit module thickness 30-51mm

**Angle:** 0° to 45°, >45° as permitted by code

**Material:** Stainless steel and aluminum

**Pre- or Post-assembly:** Pre-assembled

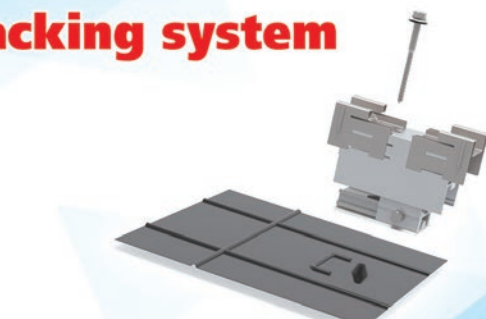
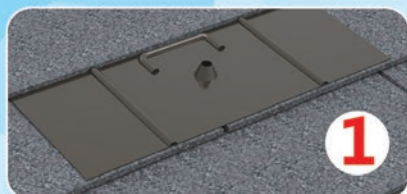
**Certifications/Approvals:** UL 2703 integrated bonding

**Warranty:** 25-year warranty

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

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**AR10-2 railless racking system**



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- 1, Say "bye-bye" to lost bolts and nuts, everything is in the box
- 2, Easy to replace the damaged panel in the middle of an installed array
- 3, Saving on shipping, saving on labor and saving on overall cost







**SunModo Corp.**

**Product:** TopTile Mount

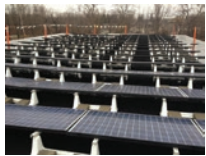
**Application:** Tile roof

**Material:** High grade aluminum and 204 stainless steel hardware

**Pre- or Post-assembly:** Pre-assembly

**Warranty:** 20-year structural warranty, 5-year finish warranty

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



**DynoRaxx**

**Product:** DynoRaxx FR Ballasted Racking

**Application:** Flat roof

**Angle:** 10°

**Material:** Fiberglass

**Pre- or Post-assembly:** Pre-assembly

**Certifications/Approvals:** UL2703

**Warranty:** 10-year limited warranty

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



**Advanced Racking**

**Product:** TRP - Total Roof Platform

**Application:** Roof-mount

**Angle:** 0° to 10°

**Material:** Aluminum and stainless steel

**Pre- or Post-assembly:** High degree of pre-assembly

**Certifications/Approvals:** UL1703, UL2703 Bonding Grounding

**Warranty:** 10-year warranty with 20-year warranty available

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



**Magerack Corporation**

**Product:** MageMount Rail-less Solar Mounting System

**Application:** Roof-mount

**Angle:** Pitched

**Material:** Aluminum alloy and stainless steel

**Pre- or Post-assembly:** Pre-assembly

**Certifications/Approvals:** UL 2703, Class 'A' Fire Rating

**Warranty:** 25-year warranty

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

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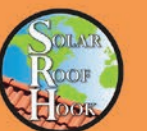
Microflashing™ is a component of the UL Certified QuickBOLT Mounting System.

**Microflashing™ hits the bullseye,  
even when you don't.**



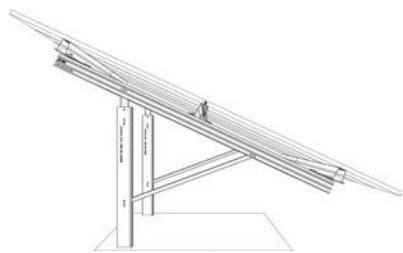
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**SCHLETTER**  
The Solar Mounting Group

**Schletter Group**

**Product:** G-Max Fixed-Tilt Ground-Mount

**Application:** Ground-mount for utility-scale and commercial projects

**Angle:** 10° to 35°

**Material:** Galvanized steel

**Pre- or Post-assembly:** Pre-assembled with only 4 components to be installed in the field

**Certifications/Approvals:** UL 2703 pending

**Warranty:** 20-year standard warranty

**Key Features:**

- Modules can be installed either from top-down or bottom-up creating a safer installation with reduced ladder or scaffolding requirements;
- As much as 20% reduction of piles creates an overall reduction in manufacturing times, improved shipping costs, simplified site deployment, and faster installation time;
- Combined purlin design eliminates fourth purlin in portrait resulting in a 25% reduction in material and handling;
- G-Max includes visual quality assurance measures designed into the system including part identification numbers and embedment depth call-out.

[www.schletter.us](http://www.schletter.us)

SEE AD ON PAGE 42



**PIP** **PREFORMED** LINE PRODUCTS  
The connection you can count on.

**Preformed Line Products**

**Product:** POWER MAX

**Application:** Roof-mount

**Angle:** Flush, Dual Tilt, 5°, and 10° Tilt

**Material:** High impact, temperature and UV resistant

**Pre- or Post-assembly:** Pre-assembled pan and clamp

**Warranty:** 10-year manufacturer's warranty

**Certifications/Approvals:** UL 2703

**Key Features:**

- Corrosion resistant;
- Unique Inter-Row Spacing (7.5" – 19.5");
- Seismic attachment options;
- Handles roof undulations;
- High wind speed options;
- Top down clamping up to 50% faster installation.

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



**MT Solar, LLC**

**Product:** Top-Of-Pole Mounts

**Application:** Ground-mount

**Angle:** Adjustable tilt from 5° to 85°

**Material:** Steel frame with aluminum racking

**Pre- or Post-assembly:** Post-assembly

**Warranty:** 20-year limited warranty

[www.mtsolar.us](http://www.mtsolar.us)

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**EcoFasten Solar**

**Product:** SimpleBlock-PV

**Application:** Roof-mount for metal standing seam

**Angle:** Fixed

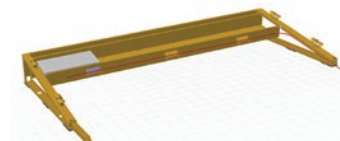
**Material:** Aluminum

**Pre- or Post-assembly:** Pre-assembly

**Certifications/Approvals:** UL 2703 First Edition, UL 2703: First Edition (tested by NRTL TUV Rheinland)

**Warranty:** 10-year warranty

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



**Solar Mounting Solutions**

**Product:** Low Profile Ballasted System

**Application:** Flat-roof

**Angle:** 5°, 10°, and 15°

**Material:** Galvanized steel

**Pre- or Post-assembly:** Arrives pre-assembled

**Certifications/Approvals:** ETL/UL Listed Grounding Components

**Warranty:** 220-year warranty standard

[www.sms.solar](http://www.sms.solar)





## Solar SpeedRack, Inc.

**Product:** HRS160 Hybrid Racking System

**Application:** Residential, commercial rooftop, ground-mount

**Angle:** 0° to 45°

**Material:** High quality aluminum and stainless steel

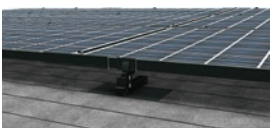
**Pre- or Post-assembly:** Pre-Assembled ready for installation

**Certifications/**

**Approvals:** UL2703, UL1703, UL467, 2012 IBC, ASCE 7-10 and PE Certified. Approved for installation in LA County

**Warranty:** 10-year fit and finish warranty, 25-year limited warranty

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



## SnapRack Solar Mounting Solutions

**Product:** RL

**Application:** Roof-mount

**Angle:** 0° to 90°

**Material:** 6000 Series Aluminum, stainless steel, galvanized steel, and aluminum flashing

**Pre- or Post-assembly:** Pre-assembly

**Certifications/Approvals:** UL Standard 2703 for Grounding/Bonding, Class A Fire Rating Type 1 & Type 2 Modules, UL Certified Modules, Stamped Structural Engineering Reports

**Warranty:** 20-year warranty

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



## Zilla Corporation

**Product:** Electrical Flashing

**Application:** Roof-mount or side entry

**Angle:** Flush mount on composition/shingle, metal roofs, or siding

**Material:** Galvanized steel and aluminum

**Pre- or Post-assembly:** Post-assembly using standard tools and hardware

**Certifications/Approvals:** Passed AC286 evaluation standards using methodology of UL 441

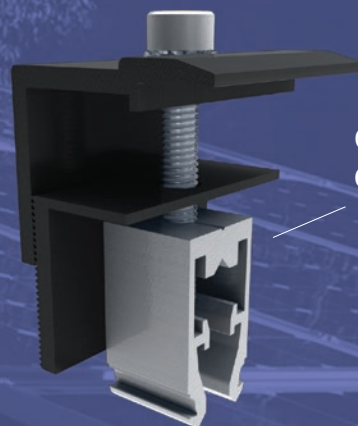
**Warranty:** 20-year limited warranty

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

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SEE AD ON PAGE 43



**Orion Solar Racking**

**Product:** Orion's Belt Mount Solution

**Application:** Ground-mount, commercial, roof-mount

**Angle:** 0° to 15°

**Material:** Galvanized Steel

**Pre- or Post-assembly:** Pre-assembly

**Certifications/Approvals:** DSA Approved, UL 2703, UL1703, Firerated

**Warranty:** 25-year warranty

**Key Features:**

- Suitable for most commercial buildings;
- Suitable for flat roofs, tilt range from 0° to 15°;
- Wind tunnel tested;
- Engineer Certified;
- Ballasted and Non-Ballasted System.

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

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**EJOT Fastening Systems, L.P.**

**Product:** EJOT Solar Flashing

**Application:** Ground-mount

**Angle:** Sloped roofs

**Material:** Aluminum

**Pre- or Post-assembly:** Pre-assembly

**Certifications/Approvals:** 100% IBC compliant, IAMPO ER0308

**Warranty:** 10-year warranty

**Key Features:**

- 100% dry system;
- Seals in 3 layers;
- Simple, secure, fast, and labor-saving installation process;
- Precise defined depth (control) stop;
- Secure transmission of all loads into the substructure.

[www.ejot-usa.com](http://www.ejot-usa.com)

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**OMG Roofing Products**

**Product:** PowerGrip

**Application:** Roof-mount

**Material:** Heavy duty cast aluminum

**Warranty:** Through roof system manufacturer

**Key Features:**

- Reduces or eliminates ballast in commercial solar racking systems;
- Includes a base ring and protective cover plate for waterproofing;
- Transfers load to the structural roof deck and doesn't require membrane welding;
- Less than 5 minute installation time;
- Each unit provides up to 3300 lbs of tensile strength, 2500 lbs of shear strength, and can support compressive loads up to 2000 lbs.

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



**Pegasus Solar**

**Product:** LightSpeed Mounting System

**Application:** Residential composite or tile roofs

**Angle:** Up to 45°

**Material:** Aluminum mounting hardware, powder coated skirts

**Pre- or Post-assembly:** Pre-assembled factory components, field installation, web design tool

**Certifications/Approvals:** UL Sub 2703, ASCE 7-05, ASCE 7-10, and AC286 Rain Test standard with and without Sealant

**Warranty:** 10-year warranty

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

**Kinetic**  
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- Flat roof pitched roof and ground mount

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





**Renewable Energy Holdings, LLC**

**Product:** Genmounts  
**Application:** Roof-mount, ground-mount, utility-scale  
**Angle:** Customizable  
**Material:** Aluminum, high strength galvanized, stainless  
**Pre- or Post-assembly:** Pre- and post-assembly options  
**Certifications/Approvals:** UL467  
**Warranty:** 10-year minimum warranty  
[www.genmounts.com](http://www.genmounts.com)



**AEROCOMPACT, Inc.**

**Product:** AEROCOMPACT + east/west  
**Application:** Flat-roof and ground-mount installations  
**Angle:** 10°  
**Material:** Aluminum  
**Pre- or Post-assembly:** Post-assembly  
**Certifications/Approvals:** TUV certified, UL 2703, wind tunnel tested up to 150 mph  
**Warranty:** 25-year warranty  
[www.aerocompact.com](http://www.aerocompact.com)



**Nuance Energy Group, Inc.**

**Product:** Osprey PowerPlatform  
**Application:** Ground-mount racking system  
**Angle:** 15° to 35°  
**Material:** Galvanized steel  
**Pre- or Post-assembly:** Pre- and post-assembly  
**Certifications/Approvals:** UL 2703  
**Warranty:** 25-year warranty  
[www.nuanceenergy.com](http://www.nuanceenergy.com)



**SunEarth, Inc.**

**Product:** RexRack  
**Application:** Roof-mount  
**Angle:** 15° to 60° (dependent on model)  
**Material:** Corrosion resistant 6063-T6 anodized aluminum

**Pre- or Post-assembly:** Post-assembly  
**Warranty:** 5-year finish warranty, 10-year structural warranty  
[www.sunearthinc.com](http://www.sunearthinc.com)



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GROUND MOUNT

ROOF MOUNT

CANOPY

LANDFILL



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**OMCO SOLAR**

**Product:** OMCO Solar Field-Fast Fixed-Tilt Racking

**Application:** Ground-mount, utility-scale, commercial, municipality

**Angle:** 15° to 35°

**Material:** G235 Pre-Galvanized Steel to ASTM A653, G90, Post-Dip Galvanized Steel to ASTM A123, Hardware: OR Zinc-Coated to 15 Micro

**Pre- or Post-assembly:** Pre-assembly

**Certifications/Approvals:** ISO 9001: 2018, ISO 901: 2015 Standard, UL 2703 Ed1, CPP wind Tunnel Tested, NEC Compliant

**Warranty:** 20-year limited warranty

**Key Features:**

- Racking direct from the OEM reduces installation costs and ensures proper construction;
- Pre-assembly delivers quick installation time, simplifies logistics, and significantly reduces loose hardware;
- High-level customer service, with complete engineering and turnkey project support available;
- 8GW and 10 years of worldwide, utility-scale experience with over 60 years of custom roll form manufacturing across four, strategic U.S. locations.

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

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**ROOFCLAMP**.com

**RoofClamp RC & RCT**

**Product:** Mounting Clamp

**Application:** Standing seam metal roof

**Material:** Aluminum

**Pre- or Post-assembly:** Post-assembly

**Certifications/Approvals:** Tested up to 2,400lbs with 600lbs allowable loading when properly installed

**Warranty:** Lifetime warranty

**Key Features:**

- 2 sizes fit about 95% of today's standing seam panels!;
- Attach solar panels, walkways, satellite dishes, HVAC mounts, etc;
- 3 points of attachment for superior holding strength;
- Anti-seizing, coarse thread set screws allow for re-attachment and re-torquing;
- Tested up to 2,400lbs. with 600lbs. allowable loading when properly installed.

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



**DCE Solar**

**Product:** Contour

**Application:** Ground-mount

**Angle:** 5° to 30°

**Material:** Galvanized steel structural members, stainless steel hardware

**Pre- or Post-assembly:** Pre-assembly of C-beams to angle braces

**Certifications/Approvals:** UL 2703

**Warranty:** 20-year warranty

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



**TRA Snow & Sun**

**Product:** Shadow Power Awning System

**Application:** Commercial, residential fixed

**Angle:** Side vertical walls

**Material:** Aluminum

**Pre- or Post-assembly:** Post-assembly

**Warranty:** 25-year manufacturer's warranty

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

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**KB Racking**

**Product:** EkonoRack

**Application:** Flat roof

**Angle:** 5°, 10°, 12°, 15°, 20°

**Material:** Aluminum, stainless steel fasteners

**Certifications/Approvals:** ETL Certified to UL Standard 2703

**Warranty:** 10-year standard product warranty, extended warranty available

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



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### Solarland USA Corporation

**Product:** Universal Single Panel Pole and Wall Mounts

**Application:** Roof- and ground-mount

**Angle:** Adjustable Pole/Flat Surface

**Material:** Stainless steel hardware

**Pre- or Post-assembly:** Pre-assembly

**Key Features:**

- Designed for Solarland brand solar panels, but easily adaptable to other solar panel brands;
- With different mounting hardware and flexibility of the brackets, they can be mounted on walls, poles, and flat surfaces;
- Durable 20-year lifetime;
- Rugged stainless steel hardware provided with all mounts;
- Aluminum construction.

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

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### Solar Connections International

**Product:** Solar Connection Kit for Standing Seam Roofs

**Application:** Roof-mount

**Angle:** Any roof pitch

**Material:** 6061-T6 Aluminum

**Pre- or Post-assembly:** Post-assembly

**Certifications/Approvals:** UL 1703, UL 2703

**Key Features:**

- UL 1703 and UL 2703 Listed, rail-less solar panel mounting system that can attach to virtually any solar panel frame;
- PushLock Technology secures the cable management disc to the standing seam base clamp without extra nuts or bolts;
- GroundBonding Technology creates a conductive bond from panel to panel without extra tools or parts;
- Cable Management Disc allows for cables to be top loaded and secured, making cable management clean and simple;
- The Standing Seam PowerClamp can attach to virtually any standing seam profile.

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



### Fabrack Solar, Inc.

**Product:** Four Season Variable Racking

**Application:** Ground-mount

**Angle:** 30°, 45°, 60°

**Material:** Aluminum

**Pre- or Post-assembly:** Pre-assembly

**Certifications/Approvals:** Fully engineered

**Warranty:** 25-year warranty

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



### Silverback Solar

**Product:** 60 Series

**Application:** Roof-mount

**Angle:** 3° to 75°

**Material:** Galvanized and stainless steel

**Pre- or Post-assembly:** Post-assembly

**Certifications/Approvals:** UL 1703

**Warranty:** 20-year warranty

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



### Ecolibrium Solar

**Product:** EcoFoot Ballasted Racking

**Application:** Flat-roof

**Angle:** 5° and 10° flat-roof

**Material:** Black, ASA-PC, UL Listed Resin

**Pre- or Post-assembly:** Pre-assembly

**Certifications/Approvals:** UL 2703 (grounding and bonding, mechanical loading, fire type I and II modules), ICC waterproofing, SEAOC seismic compliant

**Warranty:** 25-year warranty

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

## RibBracket™ I-IV

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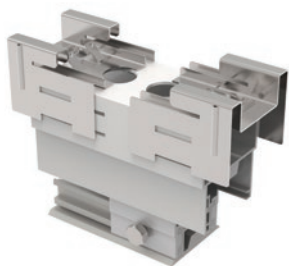
S-5 leads the way in ingenuity and smart design when it comes to attaching anything to a metal roof. That's why we invented the RibBracket I, II, III, and IV products. They are thoroughly tested for strength, have no moving parts, and flexibility to fit various trapezoidal roofs.

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www.s-5.com | 888-825-3432 | A2LA Cert No. 0018.04



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### Atlantic Clean Energy Supply

**Product:** AR10-2 Rail-less Racking system

**Application:** Roof-mount

**Angle:** Up straight

**Material:** 304 stainless steel aluminum

**Pre- or Post-assembly:** Pre-assembly

**Certifications/Approvals:** UL

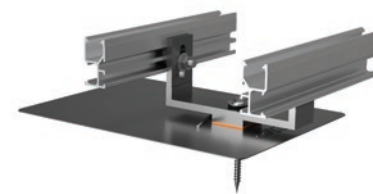
**Warranty:** 10-year warranty

**Key Features:**

- Pre-assembled to save installation time;
- 10 sets (Holder, Flashing, Bolt) in a box, good for 4 pcs panel;
- Box packed shipment, never worried about losing parts;
- Pull & Push makes installation easy;
- Easy to uninstall while doing repairs.

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

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### SolaRack

**Product:** SolaRack Double Composition U Kit

**Application:** Roof-mount

**Angle:** Sloped roofs

**Material:** Aluminum Flashing, aluminum U, UV rated silicon washer, lag screw, and rail attachment T- bolt

**Pre- or Post-Assembly:** Pre-assembly

**Warranty:** 15-year limited warranty

**Certifications/Approvals:** UL 2703 Integrated Grounding and bonding, Mechanical Loading, Fire Rated Class A, B Type 1 & 2

**Key Features:**

- 30% less roof penetrations means less liability and fewer holes in the roof;
- SolaRack Double Composition is installed between 2 solar modules and will support 2 modules with one penetration;
- Made from high quality anodized aluminum 6005-t5 & UV rated silicon;
- Designed to be installed in both landscape or portrait orientation and can accommodate solar module of 60, 72, or 96 cells;
- One lag screw per attachment means fast installation.

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



### Ridged Systems, LLC

**Product:** DOUBLE DOWN

**Application:** Zero penetrations of roof mounting technology

**Angle:** Various configurations available

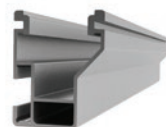
**Material:** Aluminum

**Pre- or Post-assembly:** Post-assembly

**Certifications/Approvals:** Florida Product Approval (including HVHZ): FL 21074 R4

**Warranty:** Standard 5-year warranty with optional terms

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



### Everest Solar Systems, LLC

**Product:** CrossRail 48-X

**Application:** Roof-mount

**Angle:** Flush to roof

**Material:** Aluminum

**Certifications/Approvals:** UL 2703 Listed

**Warranty:** 20-year warranty

[www.everest-solarsystems.com](http://www.everest-solarsystems.com)



### Sollega, Inc.

**Product:** Sollega String Inverter Mount

**Application:** Roof-mount, ground-mount

**Angle:** 20°

**Material:** Ultramid (glass reinforced nylon) and aluminum

**Pre- or Post-assembly:** Pre-assembly

**Certifications/Approvals:** PE Stamp

**Warranty:** 25-year warranty

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

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✉ [sales@solarlandusa.com](mailto:sales@solarlandusa.com)



### PV Racking

**Product:** Clamp-Free Solar Mounting Systems

**Application:** Roof-mount, ground-mount

**Angle:** 9° to 45°

**Material:** Aluminum and galvanized steel

**Pre- or Post-assembly:** Post-assembly

**Certifications/Approvals:** UL 2703

**Warranty:** 15-year warranty

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



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**RBI Solar**

**Product:** GM-BL

**Application:** Ballasted Fixed Tilt Ground Mount

**Angle:** 5° to 35°

**Material:** Galvanized steel

**Pre- or Post-assembly:** Pre-assembly available

**Certifications/Approvals:** UL 2703

**Warranty:** 20-year warranty

**Key Features:**

- Proprietary on-site testing for ballast designing;
- Professional engineers licensed in all 50 states;
- Site specific designs to accommodate variable slopes;
- Precast and Cast-In-Place options;
- National installation capabilities.

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

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**Polar Racking**

**Product:** PRG: Flat ballasted rooftop racking

**Application:** Rooftop

**Angle:** 5°, 10°, 15°

**Material:** Galvanized steel

**Pre- or Post-assembly:** Post-assembly

**Certifications/Approvals:** UL 2703

**Warranty:** 10- to 20-year warranty

**Key Features:**

- Quick and easy assembly, using one tool;
- Build array and lay ballast without PV modules;
- Fewer ballast stones (3-5 psf);
- Simple wire management;
- Single bay modular;
- Competitively priced.

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



**TerraGen Solar**

**Product:** TGR flat roof mounting system

**Application:** Any type of flat roof

**Angle:** 0° to 35°

**Material:** Aluminum and steel

**Pre- or Post-assembly:** Pre-fabrication completed

**Certifications/Approvals:** Tested to UL 2703 standards, Wind tunnel tested in accordance with ASCE 7 Standard, National Building Code of Canada (NBCC) 2005 [2010], International Building Code (IBC) 2006 [2012], Ontario Building Code (OBC) 2006 [2012]

**Warranty:** 10-year warranty

[www.terragensolar.ca](http://www.terragensolar.ca)



**Spice Solar**

**Product:** Spice Built-In Racking

**Application:** Roof

**Material:** Galvanized steel, aluminum

**Pre- or Post-assembly:** Pre-assembly

**Certifications/Approvals:** UL-1703, UL-2703, FSEC, LADWP, CA Fire Codes, System Fire Class Rating A, Type 1 & 2 Modules

**Warranty:** 10-year warranty

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

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INFO@SOLARCONNECTIONS.COM



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**KINETIC Solar Racking and Mounting**

**Product:** K-Flash

**Application:** Pitched-roof, ground-mount, and flat roof

**Angle:** Flush-mount up to 40°

**Material:** Anodized, extruded aluminum

**Pre- or Post-assembly:** Some pre-assembly required

**Certifications/Approvals:** Fully engineered, LCAB, UL 467, CSA-C22.2 No.41

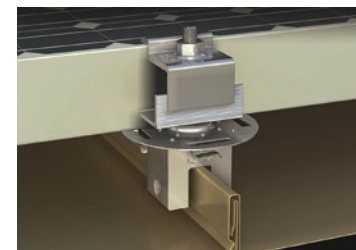
**Warranty:** 20-year warranty

**Key Features:**

- Easy-to-use, quick-to-install;
- Knowledgeable staff;
- 100% watertight flashing;
- Low per-watt price;
- Widely available.

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

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**S-5!**

**Product:** S-5 PV Kit

**Application:** Roof-mount, standing seam, and exposed fasten (trapezoidal and corrugated)

**Angle:** Flush to roof

**Material:** Aluminum 6061 T6

**Pre- or Post-assembly:** Either pre- or post-assembly

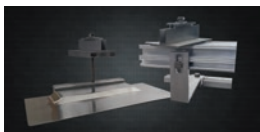
**Certifications/Approvals:** ANSI UL 2703 listed (module mounting), ETL UL1703 (grounding/bonding)

**Warranty:** 25-year manufacturer's warranty against manufacturer defect

**Key Features:**

- Works with all S-5 clamps and S-5 brackets;
- Unprecedented holding strength with S-5 clamps;
- Costs less than .08 cents for mounting hardware;
- Direct attach solution, no rails or racks necessary.

[www.s-5.com](http://www.s-5.com)



**Spider-Rax**

**Product:** Black/Red Widow

**Application:** Roof

**Type:** Fixed

**Material:** Aluminum

**Pre- or Post-assembly:** Post-assembly

**Certifications/Approvals:** UL testing, fire Class A

**Warranty:** 25-year warranty

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



**Allied Tube & Conduit**

**Product:** Mechanical/Structural Steel Tube

**Application:** Racker, tracker, and ground-mounted systems

**Angle:** Round, Square, Rectangular, Oval

**Material:** Galvanized Steel

**Pre- or Post-assembly:** Pre-assembly with capability to fabricate/assemble

**Certifications/Approvals:** UL 2703

**Warranty:** 1-year implied warranty

[www.atc-mechanical.com](http://www.atc-mechanical.com)



**SolarDock**

**Product:** SolarDock

**Application:** Flat-roof and ground-mount installations

**Angle:** Up to 35°

**Material:** Aluminum with stainless steel hardware

**Pre- or Post-assembly:** Post-assembly

**Certifications/Approvals:** TUV Rheinland Certified; tested and passed proposed UL2703 standard; wind tunnel tested up to 150 mph

**Warranty:** 25-year warranty

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

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**Roof Tech, Inc.**

**Product:** E Mount Air

**Application:** Asphalt pitched roofs

**Angle:** 1:12 to 12:12

**Material:** Anodized aluminum

**Certifications/Approvals:** UL2703, ASTM 2140, ICC ESR-3575

**Warranty:** 10-year warranty

[www.roof-tech.us](http://www.roof-tech.us)

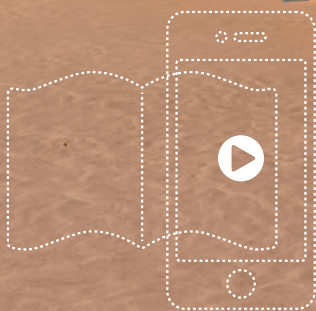
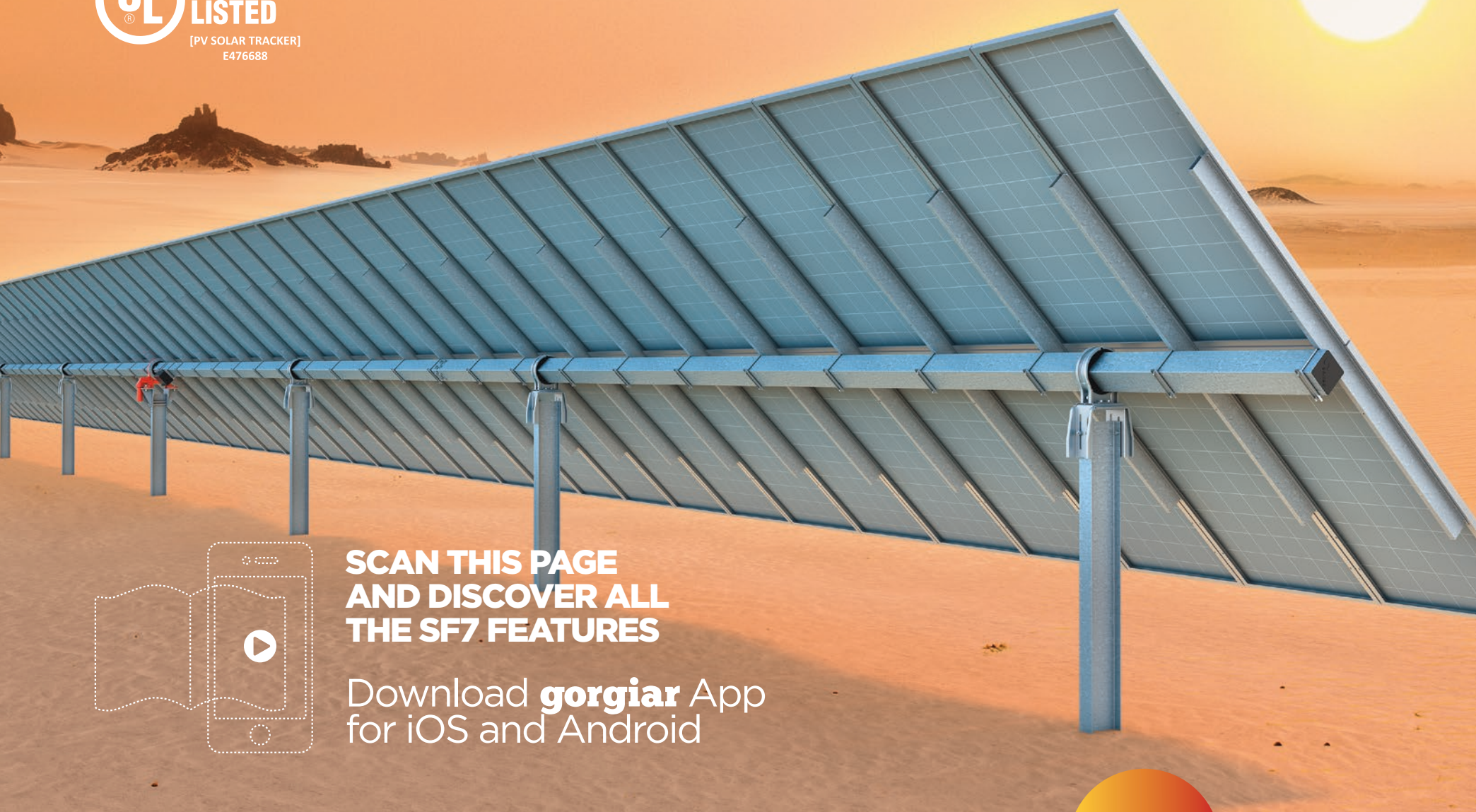


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SF7 enables up to 5% greater MW per acre than other trackers and has the greatest land-use options, ideal for large scale PV tracking projects. Those features, combined with proven cost-effective innovation and operations, have driven Soltec to the top-tier globally.





# Tracking Systems

An advanced mounting system for photovoltaic panels, solar trackers maximize the sun's energy by tracking its progress across the sky. Versatile enough to provide highly efficient solutions for both large and small projects, solar trackers can generate more electricity in the same area as their fixed-tilt counterparts. Below, we explore some of the solar tracking systems available on the market today.

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## AllEarth Renewables

**Type of Tracker:** Dual-axis

**Drive System:** GPS-based tracking powered by a hydraulic power unit

**Tracker Length:** 20' to 25' (6.09m to 7.62m)

**Tracker Height:** 18' to 20' (5.48m to 6.09m)

**Pile Count:** 1; supported on a single pole

**Modules per Row:** 4 panels in landscape orientation

**Module Mount:** Rail and clamp system

**Slope Tolerance:** Maximum 10% grade

**Tracking Range:** Yaw range 0° to 360°. Tilt range 0° horizontal to 60° off horizontal

**Preventative Maintenance Required:** Hydraulic fluid change every 8-10 years. Annual inspection recommended

**Tracker Power Consumption:** Approximately 50kWh per year

**Key Features:**

- American designed and manufactured;
- Individually tested pre-engineered system;
- 120 mph wind rating;
- 10-year limited warranty.

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

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## Soltec

**Type of Tracker:** Horizontal single-axis

**Drive System:** Enclosed slewing drive, DC motor

**Tracker Length:** 147' 12" (45.1m)

**Tracker Height:** 12' 12" (3.95m)

**Pile Count:** 7 piles per 90 modules

**Modules per Row:** 90

**Module Mount:** Omega rails with cinches, rivets, or bolts

**Slope Tolerance:** n/s 17%; e/w unlimited

**Tracking Range:** 120° +

**Standard Configuration:** 2 x 45

**Preventative Maintenance Required:** Yes

**Tracker Power Consumption:** 249kwh/MW-year

**Certifications:** UL 3703, IEC 62817, EN 1090, IEC 61326-1

**Key Features:**

- Limited shadowing, high bifacial performance;
- Best captures early and late day bifacial potential;
- No special parts or installation operations;
- All other Soltec's SF7 cost-effectiveness features included.

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

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Solar Trackers and Fixed Structures

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



## Scorpius Trackers, Pvt., Ltd.

**Type of Tracker:** Horizontal single-axis, tilted single-axis, dual-axis

**Drive System:** Linear actuators (array), gear motor drive (row)

**Tracker Length:** 206' (63m) (n/s row length)

**Tracker Height:** Up to 6' (1.8m)

**Pile Count:** Between 225 to 450, depending on configuration

**Modules per Row:** Up to 126

**Module Mount:** Clamps or bolts and washers

**Slope Tolerance:** e/w 14%, n/s 5%, row tracker

**Tracking Range:** +/- 60° in e/w

**Standard Configuration:** 2 or 1 up in portrait, 2 or 4 in landscape

**Preventative Maintenance Required:** Not required

**Tracker Power Consumption:** self-powered

**Certifications:** Wind tunnel, Independent Engineers Certification

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



## Sun Action Trackers

**Type of Tracker:** Single-axis, dual-axis

**Drive System:** Slew drive, linear actuator

**Tracker Length:** 130' (39.6m)

**Tracker Height:** 5' (1.5m)

**Pile Count:** 42 panels per pole, dual-axis; 6.75 mods per pile, single-axis

**Modules per Row:** Up to 60

**Module Mount:** Direct bolt or clamps

**Slope Tolerance:** 10° e/w, 4% n/s

**Tracking Range:** +/- 60°

**Standard Configuration:** 360 modules per linear actuator

**Preventative Maintenance Required:** Annual

**Tracker Power Consumption:** 800MWh/yr/MWdc

**Certifications:** UL3703

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



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## Array Technologies

**Type of Tracker:** Horizontal single-axis

**Drive System:** Flexibly linked rotating driveline

**Tracker Length:** Variable, average 296' (90m) using standard 360W crystalline

**Tracker Height:** 54" (1.37m) standard, adjustable (46" (1.17m) minimum height above grade)

**Pile Count:** Variable, average 7 modules per pile

**Modules per Row:** Up to 93 modules using standard 360W crystalline

**Module Mount:** Single-bolt module clamp

**Slope Tolerance:** 40° cone flexibility along driveline, 15% grade along the n/s module row

**Tracking Range:** +/- 52° standard, +/- 62° optional

**Standard Configuration:** 90 modules per row, 28 rows per module block (32 rows optional)

**Preventative Maintenance Required:** None

**Tracker Power Consumption:** 400kWh/MW-year

**Certifications:** UL 3703, UL 2703, CE



### Key Features:

- Revolutionary tracking system designed to lower lifetime costs and deliver measurable value to solar power plant owners;
- Flexibly linked row design, with each industrial-grade motor driving up to 1MW, effectively reduces the number of potential failure points to a minimum and allows quality sourcing of key components for long-term reliability;
- Ease of installation and significant upfront cost savings through Array's single-bolt module clamp, material kitting, pre-assembled components, and relaxed installation tolerances;
- Zero scheduled maintenance for 30 years. The DuraTrack HZ v3 drivetrain is lubricated and sealed for life. Array Technologies designs for the full site-specific wind load at full tilt angle without relying on active wind stow or UPS. v3 features a fully integrated, fully automatic wind load mitigation system which mechanically responds to loads on a row-per-row basis, improving tracker performance.

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

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## GP Joule

**Type of Tracker:** PHLEGON Horizontal Single-Axis Tracker

**Drive System:** DC linear electrical actuator

**Tracker Length:** 139' (42.5m) to 195' (59.5m) per tracker

**Tracker Height:** 5'5" (1.7m) top of post; 11' (3.35m) at max tilt

**Pile Count:** 0.1 pile per module; average 310 piles/MWdc

**Modules per Row:** Up to 84 modules per tracker

**Module Mount:** Rail, direct bolting

**Slope Tolerance:** 10° to 15° n/s

**Tracking Range:** -45° to +45°

**Standard Configuration:** 3x4 landscape

**Preventative Maintenance Required:** None required



**Tracker Power Consumption:** 2-3MWh/yr/MWdc

**Certifications:** CE, CSA, UL, RWDI

### Key Features:

- Specifically designed for northern climates, PHLEGON is engineered and validated in Canada and the U.S. to meet any challenging environmental and geotechnical conditions (high snow and wind loads, high range of operating temperatures), while minimizing O&M costs;
- Little to no civil work required;
- Flexible configuration - all modules and string sizes;
- Further improved design - 15% less foundations and reduced material costs;
- Quality manufacturing, NA supply chain, rapid lead time.

[www.gp-joule.com](http://www.gp-joule.com)



## NCLAVE

**Type of Tracker:** One-row single-axis

**Drive System:** Slew drive / linear actuator

**Tracker Length:** 295' (88.9m)

**Tracker Height:** 4.9' (1.49m)

**Pile Count:** 7/8

**Modules per Row:** 90

**Module Mount:** Rails, clamp, rivet

**Slope Tolerance:** Up to 20% grade n/s

**Tracking Range:** +/- 55°

**Standard Configuration:** 2V x 45

**Preventative Maintenance Required:** Minimal; grease slew drive once every 2 years, optional every 10 years

**Tracker Power Consumption:** 50kWh-year

**Certifications:** TUV NORD, ISO 9001:2015, ISO 14001:2015, EN 1090, IEC62817

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



## NEXTracker

**Type of Tracker:** Single-axis tracker

**Drive System:** One slew gear, 24VDC motor and self-powered controller w/dedicated solar panel per row

**Tracker Length:** 283' (85m)

**Tracker Height:** 4.5' (1.4)

**Pile Count:** 11/80

**Modules per Row:** 80-90

**Module Mount:** Shared mounting rails with integrated module frame grounding. Rails pre-align to locating holes in torque tubes.

**Slope Tolerance:** 15% (8°) n/s; unlimited e/w

**Tracking Range:** 120° (+/-60°)

**Standard Configuration:** Portrait

**Certifications: Grounding/bonding:** UL2703; Structural design: ASCE7-10, Tracker: UL 3703

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



## SunLink Corporation

**Type of Tracker:** Single-axis

**Drive System:** Distributed electric motor and slew drive

**Tracker Length:** 304' (93m) 90 module row

Tracker Height: Project specific

**Pile Count:** 11 piles per 90 module row

**Modules per Row:** Up to 90

**Module Mount:** Module rails, module clamps, or direct bolt

**Slope Tolerance:** 3% constant grade and 2% change in grade n/s, any practical e/w

**Tracking Range:** 120°

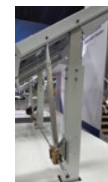
**Standard Configuration:** 1 high in portrait

**Preventative Maintenance Required:** Annual visual inspection. Grease slew drive every 5 years. Tracker performance monitored by Vertex.

**Tracker Power Consumption:** Self-powered

**Certifications:** ETL Listed to 2703, 3703

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



## Axsus Solar

**Type of Tracker:** Horizontal table based single-axis tracker

**Drive System:** Independently driven rows. Each table in the row is connected by a flexible drive shaft which is driven by one 24VDC motor per row. There is one drive on each pile to eliminate dynamic loads and move the table

**Tracker Length:** Standard 12-module table: 39.37' (12m); Standard 180-module row: 593.8' (181m)

**Tracker Height:** 4.54' (1.383m) to pivot point

**Pile Count:** 2 piles per table

**Modules per Row:** Up to 180 modules per row

**Module Mount:** Grounding clip, compatible with all module types, including FSS6

**Slope Tolerance:** +/- 10% within a 12 module table, +/- 5% between tables

**Tracking Range:** 120°

**Standard Configuration:** Dependent on site conditions; 1 module in portrait, tables can be between 19.69' and 39.37' (6m and 12m) long

**Preventative Maintenance Required:** No special maintenance required

**Tracker Power Consumption:** For a 180 module row - Peak 200W, Nom. 30W

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



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### Solar FlexRack

**Type of Tracker:** TDP 2.0 Tracker with BalanceTrac (Single-axis)

**Drive System:** Zero-Maintenance Distributed Slew Drive

**Tracker Height:** Project specific

**Tracker Length:** 304' (90 module row)

**Pile Count:** 7 modules per pile

**Modules per Row:** Up to 90 modules

**Module Mount:** Self-aligning, auto spacing direct bolt

**Slope Tolerance:** Up to 10° n/s

**Tracking Range:** Up to 110° (+/- 55°)

**Standard Configuration:** 1 in Portrait, 2 in Landscape (crystalline); 4 in Landscape (thin film)

**Preventative Maintenance Required:** None

**Tracker Power Consumption:** 31kWh per tracker/year or self-powered

**Certifications:** UL 2703 (2018)

**Key Features:**

- Adaptable with crystalline or thin film, optimized for 1000V and 1500V modules and installation is easy with no prying, adjusting, or special tools;
- Self powered option now available, and independently driven rows provide easy access for mowing, cleaning, and other maintenance;
- Lower per-unit fixed costs for BOS savings;
- Programmable technology to mitigate inclement climatic conditions;
- Independent tables increase design flexibility to maximize land use;
- Smart backtracking reduces row shading to optimize energy production for high power density.

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

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### STI Norland

**Type of Tracker:** Horizontal, single-axis, multi-row

**Drive System:** Worm Gear - Arm/Drive

**Tracker Length:** 200' (61m)

**Tracker Height:** 5' (1.5m)

**Pile Count:** 10 piles per row

**Modules per Row:** 62

**Module Mount:** Bolt, clamp, rivet

**Slope Tolerance:** 5% n/s / 5% e/w (Higher values should be validated)

**Tracking Range:** +/-55°

**Standard Configuration:** 1 Portrait

**Preventative Maintenance Required:** Annual visual inspection and torque verification

**Tracker Power Consumption:** Self-powered

**Certifications:** UL 2703, UL 3703, IEC 62817

**Key Features:**

- Robust design; minimum number of failure points with only 4 actuators per MW. Rows are mechanically linked with simple pin articulated connections;
- Easy installation; no need of specific tools or on-site pre-assembly (no hidden cost on tool investment);
- Number of rows and length can be adjusted to specific site layout and string requirements;
- Self-powered or Parasitic power supply with back-up battery and wireless communication eliminates the need of AC and communications wiring;
- Maintenance free; gear is lubricated and sealed for life.

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



### GameChange Solar

**Type of Tracker:** Single-axis

**Drive System:** Linear actuator

**Modules per Row:** TBD on string size

**Module Mount:** Bolts, nuts, star washer, clamp, or SpeedClamp (no module mounting hardware required)

**Slope Tolerance:** n/s slopes of 7%, e/w slopes of 15%

**Tracking Range:** +/- 45°, +/-52°, +/-60°

**Standard Configuration:** 1 up in portrait

**Certifications:** UL 2703, UL3703 Tested

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



### Ideematec

**Type of Tracker:** Single-axis, horizontal tracking system

**Drive System:** Single row electrical drive unit (AC and DC)

**Tracker Length:** 500' (150m)

**Tracker Height (top of posts):** 13.2' (4m)

**Pile Count:** 16 modules/foundation

**Modules per Row:** 2 modules in portrait or 4 modules in landscape

**Module Mount:** Rivets

**Slope Tolerance:** 36% N/W/S/E

**Tracking Range:** Up to 58°

**Standard Configuration:** 2 modules in portrait on 28-32 rows per table; 5 tables per tracker

**Preventative Maintenance Required:** Recommended but not required

**Tracker Power Consumption:** 1800kwh / MWp per year

**Certifications:** UL, CE, TUV

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

**PHLEGON® SINGLE AXIS TRACKER**

**GP JOULE**  
TRUST YOUR ENERGY.

**Lowest Installed and O&M Costs for the Harshes Conditions**

Visit us in **Minneapolis** (April 30-May 2, November 13-14) **Calgary** (June 20-21) **Anaheim** (September 24-27) **Chicago** (October 19-20) **New York** (December 13-14) **Toronto** (All year round)

GP JOULE is a global renewable energy company with an extensive track record in commercial and utility-scale ground mount PV. Our proprietary PHLEGON® single axis tracker, designed for northern climates and challenging sites, comes with a complete offering of engineering, installation and commissioning services. Learn more at [www.gp-joule.com](http://www.gp-joule.com).



### Krinner Solar LLC

**Type of Tracker:** Krinner Tracking System

**Drive System:** Linked system with screw jack, single drive also available

**Tracker Length:** Up to 325' (99m); standard linked 204' (62m); standard single drive 270' (82.5m)

**Tracker Height:** Center pivot axis 4.26' (1.3m)

**Pile Count:** 400 to 500 piles per MW, depending on wind and soil conditions

**Modules per Row:** Up to 96 (for 1500V strings); standard linked 60 modules; standard single drive 80 modules

**Module Mount:** Standard one row vertical (in portrait); 2 or 3 in landscape possible

**Slope Tolerance:** Rigid pivot axis n/s 6° / 10%; e/w 10° / 17%; pivot axis with universal joint (hinged system) n/s 15° / 26% per joint

**Tracking Range:** -50° to + 50° for linked system (central drive); -60° to + 60° for single drive

**Standard Configuration:** Central drive: 60 to 84 modules (72 cells) in portrait; single drive: 80 to 96 modules (72 cells) in portrait

**Preventative Maintenance Required:** Central drive: no maintenance, only the screw jack once per year; single drive: no maintenance, only the oil-level in the slew gear must be checked (through oil level windows)

**Tracker Power Consumption:** Central drive: 300kWh/MW and year (average); single drive: standard self-powered > 0 consumption

**Certifications:** Designed according to standards DIN, EN ISO; UL, TÜV certifications  
[www.krinner-solar.com](http://www.krinner-solar.com)





## What's in your DNA?

Having grown up on the East coast of the United States, I looked forward to the change of seasons. Reflecting back on my childhood, I was always the most eager for spring and a ray of sunshine to help melt the long, deep freeze of winter. As delightful as the seasons are for us humans who get to experience Mother Nature from the comfort of our homes, solar power plants have to endure the elements – rain, wind, snow, heat and cold – totally exposed for decades.

In the 28 years we have been building solar trackers, Mother Nature still amazes me with her uncanny ability to reveal the slightest oversight or miscalculation in engineering design. She has revealed many flaws over the years, but through a combination of stubborn perseverance, a careful understanding of lessons learned, and perhaps a bit of luck, Array Technologies weathered the storm. We endured a long and gradual learning experience along the way that enriched us just the same.

### EXPERIENCE IS THE TEACHER OF ALL THINGS

This life-long experience reminds me of something my mother used to say to me when I was just a boy, “That which doesn’t kill you makes you stronger.” To this day her words still ring true. Our experience makes us strong. Our history of supplying trackers is backed by almost three decades of building and innovating these systems, many of them 1kW at a time. Prior to the existence of the utility-scale projects we build today, Array Technologies manufactured 1 & 2 kW trackers and delivered tens of thousands of them all over the world, to just about every climate. We have delivered trackers to desert regions, the Arctic Circle, Fiji, Hawaii, Alaska, Minnesota, Africa, the Bahamas, Scotland, Mongolia and the East Coast of the United States. We’ve even built a solar tracker that was suspended below the gondola of a helium balloon attempting to circumnavigate the globe.

We have seen a lot over the years, enough to know we likely have not seen it all, but we generally understand what works and what lasts. We know what to look out for in our new designs, and what to avoid, based on our lessons learned over almost three decades. Hence, this knowledge has manifested itself in a simple motto we live by at Array Technologies: “If it can happen in the field, it will.”

### BREAKING INTO THE UTILITY-SCALE MARKET

When the opportunity presented itself to build trackers for large-scale power plants about 15 years ago, there was resistance to adding moving parts to an inanimate system. I was frequently asked, “Why add a moving element to such a beautifully simple system?” The answer was clear: because it is more efficient, achieves a lower Levelized Cost of Energy (LCOE) and produces a broader, flatter production curve which is more meaningful to the utility grid. All those things are true, but the real driver, like most things in business, is because trackers provide a significantly greater return on investment than fixed-tilt systems.

Breaking into the utility-scale market, the onus was on Array to produce a system that was durable, reliable and delivered the power as promised over the life of the power plant. Our tracker designs were scrutinized by customers, independent engineers and the financial community. They required us to prove performance and reliability, and scientifically demonstrate risk mitigation. With little utility field history at the time, we achieved this through Failure Modes and Effects Analysis (FMEA) and extensive product testing. Over the years, the historical performance of our tracking systems became the proof in the pudding. The evolution of this disciplined approach resulted in tremendous growth for both our company and market share for trackers as a whole in utility power plants. Trackers are now the norm, and no longer the exception.

It is my personal goal to never allow Array to lose the knowledge of our history, and to continue to ensure that our experience informs our innovations. It has been a lifetime of perseverance and growth, both personal and corporate, and I am grateful to the solar industry and all the people who were part of the journey throughout the years. It has served me well and I believe that our company has thrived because our mission has always been to put our customers first, starting foremost with the integrity of our tracker design.

### “EVERYTHING SHOULD BE MADE AS SIMPLE AS POSSIBLE, BUT NOT SIMPLER.” – ALBERT EINSTEIN

Our steady development as a company over several decades set the course for us to design our trackers differently. Inspired by nature and informed from experience, our trackers are built to withstand the wind intrinsically through simple and elegant design, much like a palm tree that moves with the force of the wind to alleviate its powerful effect. We don’t rely on the failure-prone, complex electronic interaction between anemometers, weather reports, controllers, radios, electric motors or batteries to keep your solar investment safe. We also believe that a tracker should work for thirty years with minimal maintenance. Why? Because “if it can happen in the field, it will.”

We derive maximum value for our customers by finding the optimum balance of cost, durability and performance over the long haul as defined by LCOE. It is our DNA. Unfortunately, the lowest LCOE rarely coincides with lowest upfront CAPEX cost. LCOE is the metric upon which all power plants are valued. Now that trackers have become ubiquitous, a new phenomenon has emerged, mostly spawned from the intense competition over PPAs and sometimes exacerbated by cutthroat auction processes. Our Executive Chairman, Brad Forth, calls this the “Greater Fool Theory”.

### FOISTED!

The hypothesis is that some developers believe they can incorporate low priced equipment for their project and have it signed off by an Independent Engineer (IE) without considering the ownership cost, performance or risk. This will in turn enable them to foist their completed projects to the “Greater Fool” at the same price as if they had selected higher-value and more reliable components, allowing them to pocket the difference. How is this possible? Surely buyers of utility scale power plants are more sophisticated than this would suggest?

After all, modules are scrutinized, tier rated, continually quality monitored and ultimately regarded as investment grade or not. Inverters are similarly scrutinized. Tier rating of these suppliers has evolved over time, mostly through costly learning experiences that will continue to haunt the unfortunate owners of sub-standard equipment for decades to come.

Most, if not all of those sub-standard equipment suppliers are long-gone and their warranties have no value, which begs the question: what are long-term warranties worth, if there are broad repeated deficiencies in a product of an inherently flawed design or made from poor quality materials? Solar trackers have not yet received the similar scrutiny that modules and inverters have. In the early days, when we were pioneering the tracker market, there was intensive scrutiny on reliability,

but where did that focus go? Our recent experience is that many of the IE’s (and subsequently the project owners) treat the performance, cost of O&M and risk profiles associated with ALL tracking systems the same in their LCOE models – I say, “Big Red Flag!”

### A GREATER UNDERSTANDING

There are very few tracker manufacturers that have field experience of more than two or three years. Despite the risks, large volumes of new, unproven technology has been deployed in the field in a very short period of time and is expected to perform perfectly for the next 30 years. Operating in an open intellectual property space, most of the new market entrants have followed one another with the same design approach, developing individually-motorized row designs with a proliferation of electronics and batteries. The reliability and performance effects of this gold-rush mentality are now beginning to emerge as these systems get a year or two under their belts and Mother Nature reveals their shortcomings.

What do the FMEA of these systems look like? What can be gleaned from their short field experience? Are any of the IE firms compiling data and advising on this? Are the O&M and risk assessment models getting updated? Well, all too frequently, the answer is no. The Greater Fool Theory might just be alive and well – at least for now.

On the bright side, I guess we can consider ourselves lucky if we are always learning. It may not be easy, but one thing I can say for sure is that, What you haven’t learned or forgot to consider, Mother Nature is sure to reveal.

### Ron Corio

Founder and CEO, Array Technologies, Inc.





# Solar Structures & Carports

Solar power carports and structures take full advantage of large areas, such as parking lots, for the purpose of producing electricity while, at the same time, providing shade and a covered area for users. Gaining popularity over recent years, these solar structures are ideal for generating renewable power without sacrificing valuable real estate. The following listing offers details about some of the more popular options available on the market today.

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## SCHLETTER

The Solar Mounting Group

### Schletter Group

**Product:** Park@Sol Carport

**Roof Inclination:** Compatible with most module types, orientations and inclinations up to 20°

**Height Clearance:** Variable, dependent upon design

**Depth:** Variable, dependent upon design

**Space-to-Column ratio:** Variable, dependent upon design

**Configuration:** Customized for the customer and considers local conditions such as ground conditions, wind, and snow loads

**Options:** Customized foundation including cast-in-place concrete ballasts, concrete pillars, and micropile integrations

**EV Charging:** Compatible with most EV charging stations

**Panel Type:** Compatible with most module types

**Power Generated:** Several hundred megawatts of installed PV system for both commercial and residential applications

**Certifications:** 100% IBC 2006, 2009, 2012 code compliant systems, with PE wet stamps available in most states

**Key Features:**

- Park@Sol Carport allows customers to use real estate wisely with a multi-functional solar structure. Maximize space to create a usable surface for solar energy while also providing shade for parking or pedestrian areas;
- The Park@Sol system is a versatile solar carport solution offering different design options for both single and double rows of parking;
- Schletter can accommodate any site situation with customized foundation options including cast-in-place concrete ballasts, concrete pillars, and micropile integrations;
- Achieve longer spans between foundations, reduce costs, and simplify the installation process with Park@Sol.

[www.schletter.us](http://www.schletter.us)

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### Baja Construction Co. Inc.

**Product:** Custom designed and engineered solar support structures

**Configuration:** Many configurations available. Fast Port SSS carport offers solutions to give customers a very cost-effective option for their solar carport project

**Options:** Direct solar panel attachment to purlins, concrete bollards, field painting, fascia, standard and custom, and racking system

**Panel type:** Neutral, can design/engineer to any panel size

**Power generated:** Based on module selection, orientation, layout and location. Baja can accommodate proposed PV layout, improving integration and implementation of solar to canopy structures

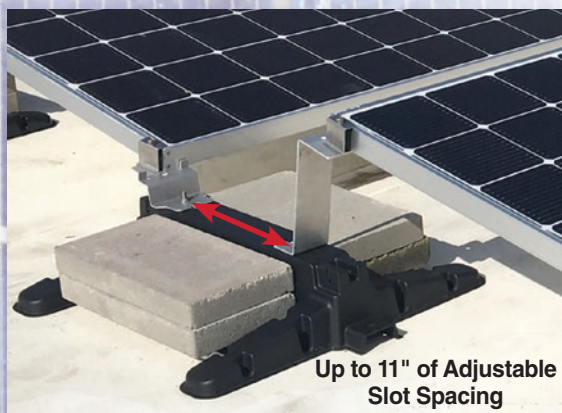
**Certifications:** NABCEP Technical sales/installation, certified fabricators, general contractor, licensed engineers, and certified welders. Baja is licensed in more than 27 States, plus Puerto Rico

**Key Features:**

- Fully designed, supplied, and installed by Baja Construction crews;
- Pre-fabricated, pre-engineered, all-galvanized, and custom engineered to site-specifics, soils, geotechnical report recommendations, local building codes;
- Customized design-build solutions with industry partnerships facilitate and improve project schedule timelines.

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

PREFORMED LINE PRODUCTS



# BOOST YOUR ENERGY with POWER MAX™

The new racking system that maximizes the number of solar modules and energy production on flat roofs.

- Unique Inter-Row Spacing Maximizes Design Flexibility
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- Factory Pre-assembled Bases and Hardware

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### Quest Renewables

**Product:** QuadPod long span solar canopy

**Roof Inclination:** 0° to 10° tilt

**Height Clearance:** 9' to 16'

**Depth:** 14' to 46'

**Space-to-Column ratio:** Varies

**Configuration:** Long span, double cantilever

**Options:** Battery storage, inverter mounting, lighting, marine environment coating, rain water collection

**EV Charging:** Yes

**Panel Type:** 60-cell, 72-cell, framed or frame-less

**Power Generated:** Varies

**Certifications:** UL

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



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**Structural Solar LLC**

**Product:** Solar Carports, canopies, pavilions, ground-mounts

**Roof Inclination:** 0° to 25°

**Height Clearance:** Unlimited

**Depth:** up to 60'

**Space-to-Column ratio:** Columns typically on 27' centers

**Configuration:** All types

**Options:** Architectural options, roofing, lighting, charging stations

**EV Charging:** Yes

**Panel Type:** All types of modules including bi-facial frameless modules in water management system

**Power Generated:** No limit

**Certifications:** AISC certified fabrication and coating

**Key Features:**

- Licensed across the USA;
- Module-ready structures;
- Durable for 40 years.

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



- **Cost-effective Design:**
  - Eliminates welding reduces construction time & need for welding inspections
- **Design available in all 50 states**
- **All galvanized framework; no painting required**
- **Carport clearance: 8'-6" (higher clearance available)**
- **Compatible with all solar module styles and manufacturers**
- **Aesthetically pleasing**
- **Installed at commercial locations, including universities and corporations**
- **Inclination: -10° to +10°**
- **DSA APPROVED**



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**RBI Solar**

**Product:** CP-Tee, CP-Truss, CP-LS, CP-G, DSA-PC

**Roof Inclination:** Various options

**Height clearance:** 10' and 14' standard, various options available

**Depth:** Site specific

**Space-to-Column ratio:** Site specific

**Configuration:** Portrait standard

**Options:** Finishing (Galvanized, Paint, Powder Coating), Raised Pier Foundations, Underdecking, Gutters/downspouts, Flashings

**EV charging:** Available options

**Panel type:** Compatible with all commercially available module type

**Power Generated:** Site specific

**Certifications:** UL 2703 options available, EOR services for all 50 states in-house

**Key Features:**

- Maximizing parking functionality;
- In-house design, engineering, manufacturing, installation teams;
- No on-site welding;
- Customizable to project specific requirements.

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

G-Max

**Pre-Installed Connection Points**  
Reduces touch points, installation time, and margin of error in field

**40% Span Increase**  
In purlins

**30% Pre-assembly**  
Girder, head, and strut unfold in field allowing for single person installation

**On-site QC**  
Factory printed ID # and description for improved quality control

**Revolutionizing Utility-Scale Fixed-Tilt Market with G-Max™**

- Reduced component count
- Highest level of pre-assembly in the industry
- Single person installation of girder, head adapter, and strut
- Components optimized for strength, safety, and fast installation
- 20 year limited warranty

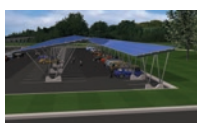
Contact us at **1-888-608-0234** or visit online to watch a video—just one person to install girder, head and strut in a few simple steps.

Schletter Inc., Tel: (704) 595 - 4200  
E-mail: [mail.us@schletter-group.com](mailto:mail.us@schletter-group.com)

Schletter Canada Inc., Tel: (519) 946 - 3800  
E-mail: [mail.canada@schletter-group.com](mailto:mail.canada@schletter-group.com)

**SCHLETTER**  
*The Solar Mounting Group*

www.schletter.us/gmax | www.schletter.ca/gmax



**Inovateus Solar**

**Product:** Solar Carport

**Roof inclination:** 7°

**Height clearance:** 14' 6"

**Space-to-Column ratio:** 18'

**Configuration:** East/West Facing V-Shaped

**Options:** Architectural options, roofing, lighting

**EV Charging:** Available

**Panel type:** Canadian Solar including bi-facial frameless

**Power generated:** 15516 MWh/year

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



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**Kinetic Solar**

**Product:** Solar Carport

**Roof Inclination:** 10°

**Height Clearance:** 7.2'

**Depth:** 20'

**Space-to-Column ratio:** Single carport occupies 2 parking spots (min 8.8' parking spot width)

**Configuration:** 24 Panels, landscape

**Options:** Off-grid with battery, grid-tied with FIT (non-roof), and net-metering

**EV Charging:** Level I or II EV chargers to charge up to 2 vehicles

**Panel Type:** Can accommodate any panel

**Power Generated:** 6.85kW system size. The installation is an off-grid setup with batteries from Canadian Energy.

**Key Features:**

- Level III fast DC chargers with battery option can be integrated with larger carports;
- Durable, modular, easy installation;
- Engineered to withstand over 150mph winds;
- No loss of parking spots;
- Innovative foundation solution with no excavation.

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

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**Orion Carport Systems & Construction, Inc.**

**Product:** Orion's Carport Design

**Roof Inclination:** -10° to 15°

**Height clearance:** 9' (higher clearance is available)

**Depth:** Determined by structural engineer

**Space-to-Column ratio:** Determined by structural engineer

**Configuration:** Semi-Cantilever, T-Structure, Custom Canopy

**EV charging:** Optional

**Panel type:** Compatible with all modules

**Power generated:** Dependent on module

**Certifications:** DSA Approved

**Key Features:**

- Cost effective design that eliminates welding, the need for welding inspections, and reduces construction time;
- All Galvanized framework; no painting required;
- Aesthetically pleasing;
- Installed at commercial locations, including universities and corporations;
- DSA Approved.

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



**S:Flex, Inc.**

**Product:** Solar carports and canopies

**Roof Inclination:** 0° to 15° tilt

**Height Clearance:** 8.5' to 15' minimum clearance

**Space-to-Column ratio:** Columns are typically spaced at 27' on center

**Configuration:** Carports can be individually designed and engineered to meet all space requirements and site conditions

**Panel Type:** Structures can be designed for all types of panels

**Power Generated:** 50kW minimum

**Certifications:** DSA Approved

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



**M Bar C Construction**

**Product:** Design/Build Solar Carports and Canopies

**Roof Inclination:** 0 to 7°

**Options:** Module installation, underside decking, top side decking, concrete bollards, paint, hot dip galvanizing, aesthetic features

**EV charging:** Optional

**Panel type:** Any

**Panel type:** Based on project size

**Certifications:** General Contractor, Structural Steel Contractor, Certified Welders

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

**ECO**  
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THE GROUNDSCREW SPECIALISTS

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Just screw it!

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The best screw you will have in the dirt™

**46" Penetrator™**  
Field-tested to 9,000 lbs downward pressure

**REPLACES CONCRETE FOOTINGS**

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- No forms
- No waiting

**EASY LEVELING** Screw down, screw up

2" Schedule 40 pipe fits over  
Custom brackets for any pipe size

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**Skyline Solar of AZ**

**Product:** Solar Carport Structures

**Roof Inclination:** 0° to 15°

**Height clearance:** 7' to 25'

**Depth:** 10' to 50'

**Space-to-Column ratio:** 2:1 to 6:1

**Configuration:** Landscape or portrait

**Options:** Single or double cantilevered, double post and beam, straight or tapered beams, exposed piers, deck, painted or galvanized

**EV charging:** Charging station can be attached to the columns

**Panel type:** Specified by integrator

**Certifications:** AISC Certified fabrication shop, OSHA Certified / CPR trained crews, Certified field welders

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





## YOU'RE A PROPERTY OWNER OR INVESTOR WHO ALREADY

operates or is interested in building RV and boat storage. There's an easy way to maximize the return on your investment and generate additional profit. It can even help the developer make faster headway through the approval process. What is it? The addition of solar panels to your RV and boat storage facility.

Adding solar to your facility increases both the revenue from the solar installation and shaded parking. This concept calculates the revenue from the solar income from either a feed-in tariff or net metering project as well as the shaded parking revenue.

Let's examine the advantages of building a solar RV and boat storage project. First it allows you to reduce your tax liability and increase your net operating income. Solar creates a secondary revenue source to bolster your storage rental income, again, increasing your NOI. A solar installation allows you to enrich the value of your real estate with a capital improvement that can be depreciated over five years rather than the standard 30. You can also receive a tax credit from the federal government equal to 30% of the costs associated with solar. Finally, when solar canopies are installed, it supports the production of solar power, while generating revenue from the shaded parking the solar modules provide above. All the power produced is being sold back to the utility, on a 20 year fixed rate contract.

The layout, design and engineering are extremely critical in the creation and success of a solar project. Generally, the project includes both solar and non-solar canopies. The goal is to maximize rentable space while erecting canopies that can support the weight of the solar components. These structures have no roof deck, and the reason they have no roof deck on them is so they qualify for the Federal tax credit and accelerated depreciation. There are other factors you need to consider when you decide to use solar for the roof shade rather than the roof decking. The solar structures require more purlins and it requires a dead load of 3 pounds per square foot, that's what the solar panels weigh. You have to design that into the structures. Most all projects are designed so that all the of the structures can support solar at some time in the future. The parking spaces are 13 feet wide and angled at 60°. Perhaps the most important element in the design of the project, the orientation of the canopies. The structures are positioned to maximize the production of solar power. The slope of the roof maximizes your production. You want to keep water off of the panels and create drainage at a 10° angle.

Modules are attached directly to the purlins of the fixed elevated structure specifically engineered to support their weight. Again, the solar arrays double as the shade structures under which boats and RVs are stored. With the deadweight of 3 pounds a square foot for the panels, you have to design the structures to support the extra deadweight with additional purlins being installed. Solar panels have to be attached in a very precise way so that their warranty is not voided and no damage to the module is incurred during or after installation. The panels generate DC wholesale power that is fed directly back into the utility grid under a small generator feed in tariff program. This translates into automatic monthly revenue for the facility owner.

There are some obstacles that could affect the budget of an RV boat or any self-storage project. Solar helped surmount some of the obstacles. In many cases the city is not overly excited about the prospect of adding another RV and boat storage facility to the already crowded market in many areas. At times the project owner is faced with a good deal of opposition and several attempts to sidetrack the project.

A few of the major obstacles I've seen are easily taken care of with solar.

-No drainage to the property. The city wanted the owner to drain the surrounding 90 acres at the cost of 1.5 million dollars. They also wanted the owner to put in 500 feet of sewer which would cost another half million dollars. SOLUTION- The city allowed a retention pond instead of installing a drainage system, that allowed the plans to include a septic tank instead of sewer.

-There was no gas, electricity or water to the property. SOLUTION- After playing around with different options of trying to get the city behind the project, the owner prevailed over many of these red lights by adding the solar component to the site design. The water district even ran water to the facility for no charge.

All of a sudden everything opens up and began to move forward. When the city is opposed to a traditional boat RV storage facility, adding solar

quickly turns the red light green. It is like a magic wand is waved and all of a sudden the negativity surrounding the project turns into a great idea.

The other primary obstacle for an RV and boat storage project is financing. Funding is challenging to find for a new project in a fairly depressed community and economy. Again, the solar components save the day. Once a project secures a 20 year guaranteed revenue stream from the public utility company, the money from lenders began to flow.

In a successful Solar RV and boat storage project, the property owner purchases, installs, owns and operates the photovoltaic system at the storage location, contracting with the utility to sell all of the energy produced at a fixed rate, paid monthly for a 20-year period. By entering a feed-in tariff contract with the utility company, the owner creates a bankable annuity that he can take to the bank to secure financing. A good example is a solar feed in tariff contract with PG&E. In this example the utility is paying the property owner \$0.13 a watt over a 20-year timeframe. Basically every kilowatt produced is fed to the electric company and they pay the owner for it. It's turned out to be way better than what the owner thought it was going to be. Having had no idea of the amount of power that were producing and the way it's being paid monthly basically covered all of the owners' debt service within 18 days. This project was cash flowing in the first 18 days. The first check from PG&E was for \$34,000. The payment to the bank was \$32,000 so the project was cash flowing from day one.

So how does this solar system work? The panels produce the power in DC and the electricity feeds into an inverter which then converts it to AC. Each inverter has a capacity of 500 kW. There are a half a million watts feeding into each inverter. The inverters then send the AC power over to the interconnection site at the utility power pole. The closer you are to the interconnection point of the utility, the better off you are.

To see and project how much energy the solar site is and should be producing, the owner can use an online monitoring program like Draker, which is the one used by Oakley Executive RV and Boat Storage. When you sell power back to your utility they're going to require a monitoring system. With the Draker system you can go online and see real-time exactly how much power you're producing per inverter. The monitoring system gives you a ton of information, way more than most people are able to read, but you can tell whether or not it's producing power and how much it's producing. There's also alarms, if for some reason there's a problem, it will send you an alarm instantaneously. The metrics also make great selling points to storage consumers.

How do you know if your property is suitable for this kind of operation and how might it compare to the general proof of concept? A good candidate would be someone that owns property in a medium demographic, average middle-class and above, around the \$57,000 average income and being near a large city or on the way to recreation is ideal. From there you can look into two of the criteria that would apply. Is there a large energy need or usage on that property that we could offset? And/or Does your particular utility and state have a feed-in tariff opportunity? Your construction team can help you identify those issues and whether they will allow you to pass the first tier. Then look at things like interconnection and the viability of current power into the grid and whether the utility is willing to receive it in. Your facility's solar options are based on your ability to secure a reservation from your local utility company for a feed-in tariff



or for net metering. The incorporation of solar to an RV and boat storage project also opens financial avenues that might not otherwise be available to you.

The differentiating factor between a traditional storage facility and a solar RV boat storage facility, is that solar allows you to debt service the entire project and that makes it very comfortable for the bank to get a 20-year contract with the utility company, guaranteed payments. As long as they can feel comfortable with that utility company and/or the AAA creditor, the business risk of starting a solar storage facility is minimized. That's what we found and that's what the bank has reinforced in asking us to find more projects that include solar with RV and boat storage.

Finally, incorporating solar into your storage project will improve the value of your real estate while creating significant tax advantages. A solar project allows you a 30% federal tax credit and that tax credit comes right off of what you owe Uncle Sam. You should consult with your accountant about how to best use the 30% tax credit and five-year depreciation schedule. If you have a tax liability, you'll like what your CPA has to say about solar. There's a whole host of ancillary benefits as well for example, the positive public perception and general goodwill a green project attracts.

The benefits of building a solar project is that it makes life easier. No one wants to be in an adversarial relationship with an alternative energy project. Everybody wants to be for Mother Earth, everybody wants to be green. I've been installing carports for over 30 years. People used to ask me, "what you do for living?" I always replied, "steel carports." They looked at me puzzled. Nowadays they ask what you do for living and I say, "I build solar carports." Their eyes light up! That's the difference. We are emotionally and politically correct when we build solar projects.

I was at a Starbucks the other day and a neighbor came over to me and said, "oh my, I just saw your commercial for the solar RV and boat storage facility. That is the coolest thing I've ever seen!" I can guarantee you if I had a commercial about an RV boat storage facility they would not have had the same reaction, because the soul element of solar makes it really cool. It makes it interesting and makes you want to learn more about solar. We're seeing that's the norm with the tenants and people interested in building a facility. It's a wow factor.

Storage operators obviously generate revenue by renting parking spaces for boats, RVs and other vehicles. They can make even more money when they add solar shade structures creating a second revenue source. It will not only take profit to the next level but will also create real tax savings, reduce tax liabilities and allow accelerated depreciation opportunities.

What is the key to all of this? A solid business partner. One who can make the dream a reality. Pick a partner that has installed many of these same structures all over the United States. Find a partner that has over 30 years of experience, they have the most knowledge and expertise about the structures. They also know the best partners as far as solar goes, nationwide. Some carport installers have worked with over 50 different solar integrators throughout the United States. They can tell you who the good guys are and who the bad guys are in my opinion. Another value of choosing a veteran installer is the way they can design and optimize production, so it's not just about fitting the most spaces at a project site. It is also about orientating the panels and aligning the canopy so that you can get the best production. With a great PV optimization tool, you should be able to give them a site plan, they can produce a layout of the support structures that will optimize solar.

So are you interested in generating additional revenue with your boat and RV storage investment? Your next step is to reach out to the professionals and find out if your existing or planned project is a good candidate to make money from the sun.

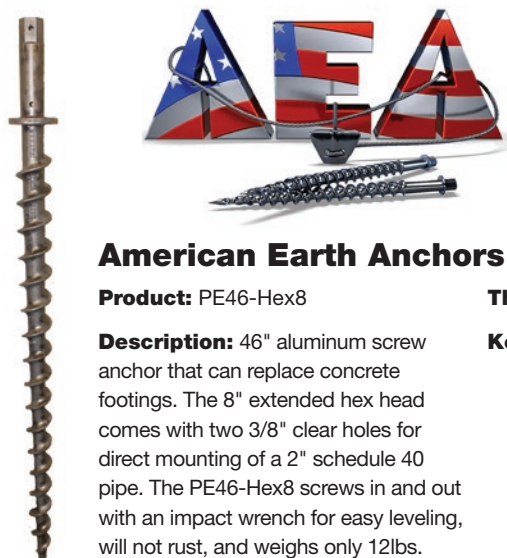




# Ground Screws

Ground screws are becoming the choice in foundation methods. They eliminate the need for concrete and allow foundations to be quickly set. The following highlights a variety of available options to suit different applications and soil conditions.

SEE AD ON PAGE 44



## American Earth Anchors

**Product:** PE46-Hex8

**Description:** 46" aluminum screw anchor that can replace concrete footings. The 8" extended hex head comes with two 3/8" clear holes for direct mounting of a 2" schedule 40 pipe. The PE46-Hex8 screws in and out with an impact wrench for easy leveling, will not rust, and weighs only 12lbs.

**Material:** Heat treated aluminum

**Thickness:** 1.75" (4.45cm) shaft

**Length:** 54" (137cm)

**Flange Size:** 4" (10.16cm)

**Thread Width:** 3" (7.62cm)

**Thread Pitch:** 2.25" (5.72cm)

**Threads:** 17

### Key Features:

- Replaces concrete footings, no digging, forms, pouring, or waiting;
- Tested for up to 14,000lbs of pull out and 9,000lbs of down pressure;
- Aircraft quality 356 alloy, heat treated cast aluminum;
- Fast installation with 1 3/4" socket and impact-easy leveling by screwing up or down;
- Made for temporary or permanent application.

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

SEE AD ON PAGE 47



## Williams Form Engineering Corp.

**Product:** Micropiles

**Description:** Williams offers right-hand threaded Grade 75 All-Thread Rebar in #14 to #28 along with a selection of reducer couplers that can adapt to any smaller size. Williams also offers Grade 80 and Grade 90 All-Thread-Rebar and 150 KSI All-Thread-Bar as alternatives for micropile design applications upon request.

**Material:** Grade 75 All-Thread Rebar

**Thickness:** #28

**Length:** 50' (15.25m)

**Thread Pitch:** 2.75" (6.98cm)

### Key Features:

- In larger micropile designs, casing diameter is minimized;
- Effective net area available for reinforcement is optimized with a single large bar;
- Increased rate of production by installing a single large bar.

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

SEE AD ON PAGE 44



## ECO Foundation Systems

**Product:** Ground screws

**Description:** Groundscrews are a replacement for concrete pier footings. They offer an extremely fast and strong foundation system in almost any substrate, including rock, and can be installed quickly, with racking being installed simultaneously. Double ground mount production with no increase in overhead.

**Material:** Hot dipped galvanized structural steel

**Thickness:** Sidewalls 0.12" to 0.20" (3mm - 5mm) thick

**Length:** 3' to 10' (0.91m to 3.05m)

**Flange Size:** Various sizes depending



on application

**Thread width:** 1/2" (1.27cm)

**Thread Pitch:** 2" (5.08cm)

**Threads:** 10 to 20

### Key Features:

- Groundscrews work in any terrain;
- Double ground mount production with no increase in overhead;
- Less manpower required;
- On-site testing easily performed;
- Turn 4 days into 4 hours.

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



## TerraSmart

**Product:** TerraSmart Ground Screw

**Description:** TerraSmart Ground Screws are made with quality materials and finished with a corrosion resistant, hot-dipped galvanized coating for long-lasting foundations. The spiral thread design minimizes embedment depth that increases installation efficiency. It has a forged chisel-tip for insertion into soil, including rock, and has a 20-year limited warranty.

**Material:** Steel tube with a hot dipped galvanized finish

**Thickness:** 0.145" (0.368cm)

**Length:** 82" (208cm)

**Thread Width:** 0.5" (1.27cm)

**Thread Pitch:** 2" (5.08cm)

**Threads:** 15-20

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



## Milspec Earth Anchors

**Product:** Solar Helical Pier

**Description:** Solar pier with helical plate is a foundation alternative to cement or driven H-beam. Milspec's solar helical pier allows for greater loads and has an extremely high pullout resistance. With a 50-year minimum lifespan, they are easily removed and can be reused.

**Material:** API pipe

**Surface Treatment:** Hot-dipped galvanized

**Diameter:** 2 3/8" (6.03 cm), 2 7/8" (7.3 cm), 3 1/2" (8.89 cm), or larger if needed

**Thickness:** .190w to .337w

**Length:** 5' to 10' (1.5m to 3m) as needed

**Flange Size:** As required

**Thread Pitch:** 3" (7.62cm)

**Threads:** 1 to 3 helices

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



## Almita Piling, Inc.

**Product:** Helical Pile Foundations

**Description:** Almita Piling offers engineered helical pile foundation designs, fabrication and installation, and supplies and supports renewable energy solar, and wind projects.

**Material:** Steel, galvanized, pipe, and helix

**Thickness:** Variable

**Length:** Up to 328' (100m)

**Flange Size:** Variable

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



# Metal Fabrication for Solar Structures

Customized shapes and formed structures designed to mount, secure, and support solar panels are a significant component to any reliable solar power project. This is where processes such as roll forming and extrusion come into play. The following highlights some of the main companies involved in metal fabrication processes for solar components and related support structures.



## Hynes Industries

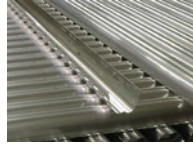
**Process/Technology:** Hynes Industries brings more than 90 years of experience to the solar manufacturing industry. With 75 roll forming lines, four facilities, coast-to-coast service and more than 500,000 square feet of production space, Hynes is prepared to service solar panel mounting needs as a single-invoice solution. From finite element analysis to assembly and finishing capabilities, Hynes offers full-service fabrication solutions to reduce solar mounting production costs through a stable and high volume roll forming process.

**Materials:** Steel, stainless steel, galvanized steel, aluminum, brass, copper, lead, composites.

**Sizing:** C-section: 2.0", 2.5", 3.0", 4.5", W-section, Z-section.

**Shapes/Structures:** Ground mount racking, ground pilings, module rails, panel support channels, PV framing, roof mount racking.

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



## Samson Roll Formed Products Company

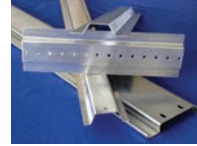
**Process/Technology:** Over 40 production lines offering custom roll forming services including a fully integrated service to develop, engineer, produce, and package component parts or finished products. Additional services provided include: pre- and post-punching/notching, secondary stamping, assembly, and Run and Ship Programs

**Materials:** Pre-coated, painted, anodized, embossed, galvanized, or laminated metals

**Sizing:** Range for finished profiles: 0.005" to 0.250" Thickness, 3/4" to 12" Slit Width, 6" to 480" Length, Up to 4" Maximum Part Depth

**Shapes/Structures:** Parabolic shaped channels, C, U, and hat channels, in a range of different coating weights, for use as brackets, photovoltaic array supports, or solar panel framing/trim, and other custom shapes for the solar industry.

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



## Johnson Bros Roll Forming Co.

**Process/Technology:** Modernized equipment and tooling designed to offer roll forming services with the latest automated technology, including: pre-notching; pre-punching; cut-to-length; and post-fabricating, combined with the cut-length operations

**Materials:** All metals, including: ferrous and non-ferrous in either plain or pre-anodized; pre-painted; pre-laminated; pre-embossed; perforated; duplex; special alloy; pre-hard tempers; and more

**Sizing:** 0.005" to 0.150" thickness, and coil widths up to 20" wide before forming; maximum height of profiles 5.25" in the vertical axis

**Shapes/Structures:** Profiles; panel frames; reflectors; trim; support structure framing; Hat shapes; C-channels; U-channels; Zees; rings; and many other custom shapes for solar components

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



## RPM Rollformed Metal Products Ltd.

**Process/Technology:** Rollformed steel

**Materials:** Steel: Galvanized CRS, HRPO, galvalume, galvalume and stainless, aluminum, brass, zinc, and copper

**Sizing:** Material 0.008" min, 0.168" max (future expansion: 0.250"); strip width 24"; length capabilities 12" min, 60' max

**Shapes/Structures:** Custom shapes, Z purlins, C channels, U channels, punching, notching, cut-to-length, pre-galvanized steel up to 7 gauge

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



## Matenaer Energy Products

**Process/Technology:** Stamping, machining, laser cutting, bending/forming, manual welding, robotic welding, coating.

**Materials:** Low carbon steel, high carbon steel, stainless, aluminum.

**Sizing:** .0149" - 1" thickness.

**Shapes/Structures:** coil, sheet, plate, angle, castings, channel, beam.

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

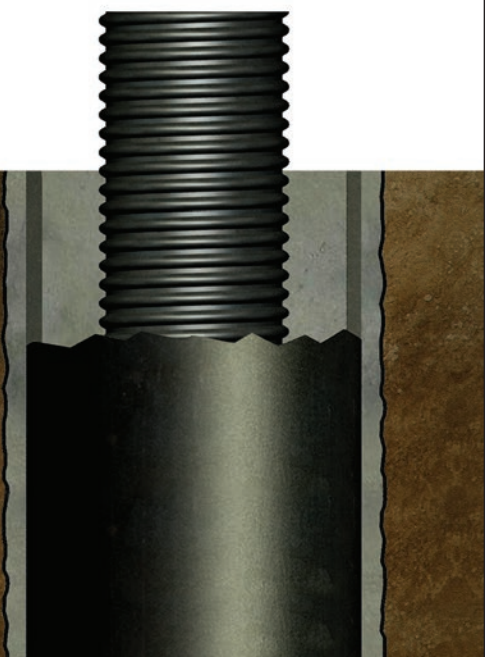


Solar panels require a strong foundation to resist compression, tension and lateral loading. Owners, developers and contractors want a cost effective solution to this foundation requirement. Williams' micropiles provide both! Micropiles are small diameter, drilled and grouted cylindrical piles with center steel reinforcement and provide substantially more load capacity than driven pipe piles or helical anchors. Williams' Grade 75 and Grade 150 KSI All-Thread-Bars are the reinforcing steel element of the micropile. Our engineers can design customized brackets to attach Williams bars to any solar panel support. Williams' Geo-Drill Injection Anchor System can be used for lightning fast installation rates in caving soils, which otherwise would require installation using extractable casing. Trust Williams with your next solar panel foundation!



## Micro Piles

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

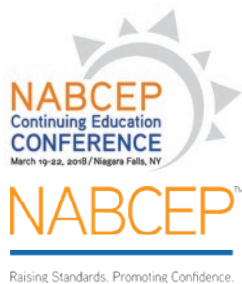


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## NABCEP'S 7<sup>TH</sup> ANNUAL CONTINUING EDUCATION CONFERENCE

March 19<sup>th</sup>-22<sup>nd</sup>, 2018  
Niagara Falls, NY

The North American Board of Certified Energy Practitioners (NABCEP) is the most respected, well-established and widely recognized national certification organization for professionals in the field of renewable energy. NABCEP offers credentials for skilled professionals, specialists and those new to working in the areas of photovoltaics, solar heating and small wind technologies. NABCEP's mission is to develop and implement quality credentialing and certification programs for practitioners by supporting and working closely with professionals and stakeholders in the renewable energy and energy efficiency industries.

[www.nabcep.org](http://www.nabcep.org)

show in print

Features just some of the companies and technologies attendees will see at this year's show.



### Inversion technology with design flexibility

The Fronius SnapINverter line offers integrated Wi-Fi and SunSpec Modbus interfaces, NEMA 4X rating, wide voltage windows, multiple MPP trackers, and easy installation in 15 minutes or less. With the identical look and feel, the Fronius SnapINverters reduce cost for training and servicing. Power classes range from 1.5 to 24.0kW. Additionally, the unique O&M solution of the Fronius Solutions Provider program eliminates the need for inverter exchanges, providing a fast service solution.

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



### Corrosion resistant wire management

BURNDY, a manufacturer and provider of wire management solutions to the Solar PV industry, announces the addition of the new ACC-FPV180 wire management clip to the WILEY line. The ACC-FPV180 wire management clips are made of corrosion resistant 304 stainless steel, which makes them a durable, long lasting, and reliable solution for all environments. The ACC-FPV180 is easy to mount and can be installed straight on or at 180° on to module frames of various thicknesses. The ACC-FPV180 accommodates 1 to 2 PV cables up to 8mm in diameter. The rolled edges are designed to help protect cable insulation from damage. ACC-FPV180 clips are a solution for keeping the PV installation neat, clean, and free from ground faults.

**BURNDY** | [www.hubbell.com/wiley/en/](http://www.hubbell.com/wiley/en/)



### R-Panel metal roof attachment

Solar Connections' PowerMount for R-Panel Metal Roof Systems offers ease-of-installation and provides an aesthetically pleasing system. The 6061-T6 PowerMount features a fully EPDM Gasketed Mount to help form a water-tight seal with the roof. Cross Stitch Attachment Technology secures the system with 4 custom screws angled to provide strength and uplift. The stainless fastener w/ EPDM washer provides an additional layer of water protection. The PowerGlide Adjustment Technology provides 2" of adjustment. The 6061-T6 Universal PV Cube features a robust design and is compatible with all PowerMounts. Go rail-less and utilize the Solar Connection Kit with GroundBonding Technology which is UL 1703 and UL 2703 listed and approved.

**Solar Connections**

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



### Three-phase solar inverter

Yaskawa Solectria Solar (YSS) is set to launch the new XGI 1000 and XGI 1500 – the company's next-generation 3-phase solar inverters for the commercial and utility markets. YSS' new American solar inverters are engineered at YSS in Lawrence, MA and manufactured by their parent organization, Yaskawa America, Inc., at its facilities just north of Chicago, IL. The XGI 1000 inverters feature 60kW and 65kW models, and the XGI 1500 inverters come in 125kW and 166kW power levels. These advanced inverters offer wireless HMI and connectivity, reducing the cost of installation and commissioning, and include a companion line of string combiners that include fused inputs and PV connector options. With Yaskawa quality throughout, the XGI 1000 and XGI 1500 are designed to achieve quality and reliability.

**Yaskawa - Solectria Solar**

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



### Custom solar racking solutions

As a single-source provider for solar racking systems, RBI Solar provides customized and cost effective solutions for their clients. For solar mounting projects, RBI Solar has dedicated in-house experts that design, engineer, manufacture, and install efficient solar mounting solutions. RBI Solar collaborates with their customers from project conception to completion to ensure jobs are finished on time and within budget.

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



### Dependable, long lasting batteries

Rolls deep cycle 4000 Series flooded batteries offer dependable, long-lasting energy storage capacity in a variety of versatile voltage and capacity options. Rolls line-up of 2V and 6V L16 models deliver 375AH - 1445AH capacity (20 Hr AH rate) per string, offering extended cycle life in a durable and manageable case size with limited footprint design and company backed warranty, for a range of small grid-tied and backup to residential-scale off-grid applications.

**Rolls Battery Engineering**

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



### Accurate residential or commercial energy meter

The eGauge Core is a 15 channel energy meter with 0.5% revenue grade accuracy compliance and the ability to measure residential or commercial circuit panels, up to 3-phase 277/480VAC and 6900A. The meter has HomePlug AV powerline communication, an Ethernet port, and 2 USB ports for additional communication options, like WiFi and cellular. Users can access energy data using the free user interface, or with other systems using a published XML API, Modbus, or BACnet IP. The embedded web server allows users to connect to the interface over the internet or on a local area network. Each meter has a data logger that stores up to 64 data points for the lifetime of the hardware.

**eGauge Systems** | [www.egauge.net](http://www.egauge.net)



### Rail-less mounting system

POWER DISK is a rail-less mounting system that can attach anywhere on residential rooftops. It does not need to be secured to rafters and arrives with a pre-applied butyl mastic sealant. POWER DISK provides design layout flexibility by allowing installers to set the modules in portrait or landscape by simply turning the disk. Fitting most framed 60- and 72-cell modules, POWER DISK is pre-assembled and quick-to-install with built-in electrical grounding clips and optional flashing and perimeter skirts. POWER DISK is UL 2703 code compliant and easily handles roof undulations by spinning the disk to adjust the module height. The POWER DISK design tool provides optimal residential roof layouts, built-in code compliant engineering, and simple user interface.

**Preformed Line Products**

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



## CALIFORNIA SOLAR POWER EXPO

March 27<sup>th</sup>-28<sup>th</sup>, 2018  
San Diego, CA

Solar and storage are booming in the Golden State. With new energy storage subsidies and over 5,000MW of installed solar capacity in 2016, California is a cornerstone for the solar and storage markets. The California Solar Power Expo is the first opportunity in 2018 to tap into this on-demand market and get hands-on demonstrations led by solution providers and industry leaders.

[events.solar/expo](http://events.solar/expo)

show in print

Features just some of the companies and technologies attendees will see at this year's show.



### Cost-effective, strong, and reliable mounting system

POWER PEAK systems offer a cost-effective, high-strength, and reliable solution for large utility-scale ground mount applications. Featuring pre-assembled components, unique field adjustability, and easy-access PV module clamps, the POWER PEAK mounting systems offer installers both labor and time savings on every project. The POWER PEAK mounting system is customizable, providing five optimized structure designs for specific ground conditions and environments, including a new ballasted version for rocky terrain or landfills. To further reduce BOS costs and labor, POWER PEAK mounting systems are designed and manufactured to match specific module string counts and site conditions. POWER PEAK systems also include integrated equipment grounding and are certified to UL 2703 requirements.

**Preformed Line Products** | [www.preformed.com](http://www.preformed.com)



### Wireless, plug and play BLA harness

Shoals' combiner-less BLA harness has helped streamline installation while creating between 20 and 60% material savings. The newest addition to this is the introduction of BLM which adds current and voltage monitoring along with autonomous I/V curve measurement. I-V curve measurement provides more information about the performance of a PV module or array than any other measurement method and is coupled with the fastest possible measurement tools. The entire system is plug and play and completely wireless - allowing for maximum functionality.

**Shoals Technologies Group**  
[www.shoals.com](http://www.shoals.com)



### Heavy duty, long lasting battery

Rolls deep cycle 5000 Series 2 KS 33P flooded battery model is specifically designed to offer extended cycle life in a heavy-duty, dual-container case design, using thick plate construction for added durability and extended cycle life. Delivering 1766 AH capacity in a versatile 2V cell, the 2 KS 33P is suitable for residential and large-scale energy storage applications and is backed by a 10-year warranty.

**Rolls Battery Engineering** | [www.rollsbattery.com](http://www.rollsbattery.com)



### UL listed stainless steel clip

Nine Fasteners NFI-1307-V90 solar wire management clip is a 90-degree oriented, module mounted, PV wire clip designed to secure up to two PV wires, or equivalent. As with all of Nine Fasteners' clips, the NFI-1307-V90 is manufactured in the U.S. with a rolled outer edge for maximum wire safety. Recently, Nine Fasteners has upgraded this clip's status with UL from Recognized to Listed, ensuring an added level of assurance for installers using Nine's clips.

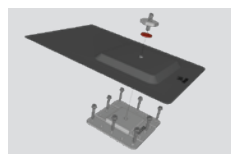
**Nine Fasteners, Inc.** | [www.ninefasteners.com](http://www.ninefasteners.com)



### Customizable medium voltage solution

Ingeteam's Medium Voltage Inverter Station is a compact, customizable, and versatile plug & play solution that can be configured to suit each customer's requirements. This brand new medium voltage solution integrates all the devices required for a multi-megawatt system, customized up to 3.6MVA. With high adaptability and power density of 5.2 W/in<sup>3</sup>, not only does Ingeteam's Inverter Station offer low CAPEX, but also low OPEX, thanks to its long-lasting design, ease of access and serviceability, and maximum protection. The high-performance design uses electronic conversion topologies capable of achieving efficiency values of up to 98.9%. Its dual channel air cooling system makes it possible to increase the ambient operating temperature for maximum enhanced functionality, thus maximizing return on investment. The INGECON SUN PowerMax B Series is certified in compliance with UL 1741 SA contributing to the quality and stability of the grid.

**Ingeteam, Inc.** | [www.ingeteam.com](http://www.ingeteam.com)



### Fast, safe, and easy mounting solution

Zilla's Double Stud XL Flashing attaches directly to sheathing or structural members making installations on composition/asphalt shingle roofs fast, safe, and easy. The Double Stud XL features a patented base plate design with multiple attachment points to provide maximum speed and flexibility in the field. It also features Zilla's patented low profile flashing design that incorporates a metal-to-metal compression zone to create a complete water tight seal while ensuring the integrity of the structure during expansion and contraction. Compatible with all Zilla rail systems or any other solar mounting system, the Double Stud XL installs with standard tools and hardware and is also the foundation for the Zilla Phantom Rail-less mounting system. Zilla's Double Stud XL Flashing provides solar professionals with flexibility in the field allowing for more cost-effective and aesthetically pleasing mounting installations.

**Zilla Corporation** | [www.zillarac.com](http://www.zillarac.com)



### Waterproof rail-less roof-mounting system

Attaching solar panels to an asphalt shingle roof is easy with the newest product from Solar Connections International. They've packed numerous features into their Shingle PowerMount Kit. Starting from the base, the PowerPlate is made from durable 0.032" aluminum and includes reference marks for easy alignment. It also features their ButylSeal Technology which utilizes a fully customized butyl pad and features an easy peel-and-stick installation to form a water-tight seal. The 6061-T6 PowerMount secures to the roof with Cross Stitch Attachment Technology - 2 custom screws positioned diagonally to provide maximum strength and uplift. The Fully EPDM Gasketed Mount provides an additional layer of water protection. Installers will appreciate the PowerGlide Adjustment Technology which provides 2" of adjustment. Solar Connections' Solar Connection Kit with Ground Bonding Technology is UL 2703 listed and approved and makes going rail-less quick and easy.

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



### Robust wire management solutions

One of the most underrated conversations when talking about PV system safety is wire management. Damaged wire insulation can lead to ground-faults, system downtime, and fire. PV systems are installed in various environments, conditions, and by different processes so having accurate information to create a solid wire management strategy is essential. BURNDY has an extensive wire management product portfolio. Everything from UV rated nylon 6/6, nylon 12, 304 stainless steel cable ties and clips. The Wiley ACC Clips are all constructed of 304 stainless steel. They have performed extensive testing on these clips including, but not limited to a 500 hour salt spray and UL 2703 temperature (200 cycles cycling between -40°C and 90°C) and humidity cycling (10 cycles between -40°C and 85°C at 100% humidity). The combination of material construction and extensive testing shows that the Wiley ACC clips are robust wire management solutions.

**BURNDY** | [www.hubbell.com/wiley/en/](http://www.hubbell.com/wiley/en/)



# How to Keep Your Turbine Spinning

by Jesse Shearer



**THE DESIGN AND MANUFACTURING OF A SLIP RING** component is imperative to the overall function and efficiency of a wind turbine.

Wind turbines require reliable transmission of power and data signals from the nacelle to the control system for the rotary blades – none of which happens without the slip ring. A slip ring is used to transfer electric current from a stationary to a rotating unit. It's a small component compared to gearbox bearings or generators, but if it's defective, it can make or break the performance of a turbine.

When a slip ring fails, power and communication data cannot pass through to pitch mechanisms, and other controls in the hub and top box; this can cause a wind turbine to shut down. This is also why manufacturers have devoted a great deal of engineering and research to developing wind turbine slip rings that last longer, and require less maintenance.

Over the years, engineers have seen many different types of failures in hub slip rings, as it is a difficult environment. Once such problem they have encountered is under-designed circuits for the amperage they are carrying. This is particularly common in “wire brushes” where they have been burnt back due to excess current. Over time, excess current will greatly weaken the contacts, and eventually lead to failure.

From external factors (such as harsh environments) to internal mechanisms (like using solid brushes and rings stacked to save space), there are many factors to consider when choosing a slip ring for your wind turbine.

Regardless of the design, it is important to consider the quality of the materials used, the annual maintenance required, and the overall life expectancy.

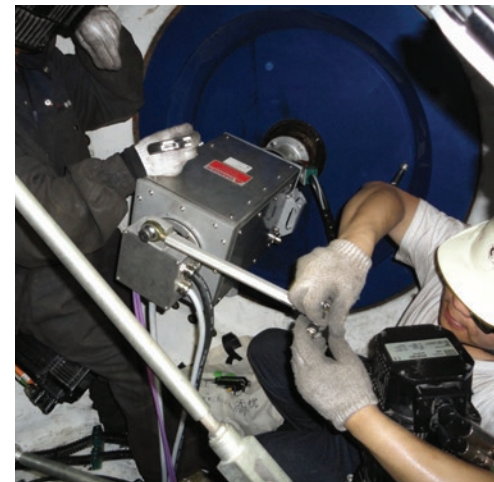
## Ensuring Efficiency

A wide selection of circuitry is available depending on the power requirements, with many combinations of amperage and voltage (ac or dc). Today's advanced designs can transfer higher wattage with decreasing power loss. High quality slip rings have handled over 55 kW for pitch control motor use with circuits rated over 100 amps and 690 VAC.

Wattage transfer capacity and power losses may be affected by various factors, which is why custom designed slip rings are often recommended for wind turbine applications in order to ensure proper capacity and function.

## Reducing Operations & Maintenance (O&M)

Most wind-turbine operators would agree that the fewer up-tower maintenance trips, the better. Replacing slip ring brushes is time consuming and costly. Extending the maintenance intervals saves money in the long run.



Traditional slip rings need frequent maintenance to avoid degradation of the rotating electrical connection caused by regular wear and debris. In some cases, failures occur for simple reasons such as technicians not cleaning and lubricating some designs.

By using solid metal brush slip rings, manual cleaning is minimal, and lubrication is eliminated. A higher spring pressure than that on conventional slip rings can also help clean the ring as it rotates.

Fortunately, there are more advanced designs that allow for slip ring assemblies to achieve 100+ million revolutions before brush replacement, again reducing maintenance and downtime. These designs typically come with built-in, lifelong lubrication, reducing the amount of maintenance required to about five minutes per year. Some turbine operators say that they have eliminated annual maintenance altogether.

## Material Consideration

Material considerations are important for reducing O&M. In a hostile environment, such as that common to remote wind turbine locations, high-grade slip ring materials are important to reduce surface degradation. For instance, you may think that gold automatically translates into a better product, yet some wire-brush slip rings wear down their gold plating, resulting in lost conductivity and transfer capacity. That's why it's important to understand this essential component in your overall wind turbine performance. If you try to save money by cutting down on quality, you risk losing long-term productivity of the whole unit.

*Jesse Shearer is Sr. Application/Design Engineer at United Equipment Accessories, Inc., which designs and manufactures slip rings, hydraulic swivels, shift controls and cable reels for a wide variety of industries and customers around the globe.*



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# The Wind Industry Goes Craneless

by Thomas Lamberth Sandbjerg and Jon Valdivielso García

**ARE WE, AS AN INDUSTRY, GETTING CLOSER TO** eliminating the need for mobile cranes entirely?

The market for the installation, operation and maintenance of wind turbines continues to grow globally. In order to keep pace with generation capacity, we need to rethink processes and technologies across the industry.

We're seeing plenty of developments in the fields of preventive maintenance and small corrections; it's the areas of installation and major corrections that pose the greatest continuing challenges. In a bid to provide operators with options that have major economic and environmental advantages, more and more companies are brainstorming solutions that aim to remove mobile cranes from the equation altogether.

Anyone in this business will tell you that crane rental fees can be hefty. Less known, yet just as relevant, are the many

indirect costs that frequently follow; bridges and roads may require reinforcement to allow passage of the trucks carrying the crane, the site itself may need elaborate preparation to provide a level area big enough for the large crane structure, and special permits may need to be obtained.

Turbine height is another cost-inflating factor. Current turbine developments are nearing 10 MW capacity. These systems require increasingly taller towers, many of which already reach above 150 meters - adding to the headaches facing the corrective maintenance field.

Finally, availability presents a separate challenge. Until the crane reaches the wind farm and performs the necessary operation, turbine downtime and the resulting loss of production may last for days or weeks, depending on the number of cranes needed and the distance to the site.

With all this in mind, the industry has potential for huge savings on mobilization, installation, and maintenance. If we managed to eliminate the need to use mobile cranes with smarter solutions, it would have a major impact on both the economic and environmental cost of energy, ultimately reducing the bill for the end consumer while sustaining our natural resources.

The outlook for the coming years is intriguing. Public entities across Europe recognize the incentive to secure their position as world leaders in this segment of the industry, and are awarding funding support to companies that prioritize innovation and investment in R&D.

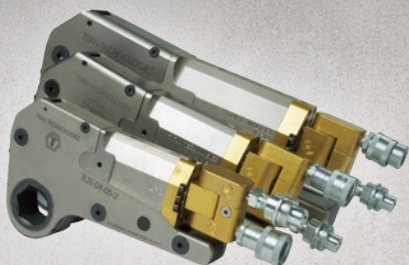
The advance of craneless systems includes:

- In Spain, an engineering company has been recognized as a benchmark in the construction of concrete tower sections and foundations worldwide. The company has been refining solutions for self-elevating tower sections since 2014, and has received support from the Eurostars Programme.
- A relative newcomer to the industry has won several patents, including one for its technology for self-erecting towers based on a lattice structure. The solution promises to save 30 percent of total tower costs, while reducing the assembly time by up to 50 percent, and has won support from the European ERDF fund.
- A Dutch manufacturer of direct-drive wind turbines has developed a climbing crane for installing turbines. The crane scales the turbine, from base to the top, by means of a series of steps installed in each tower section. This setup allows the crane to install the full tower, section by section, climbing upwards in the



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## Battery-powered torque wrench for industrial bolting applications

The VOLTA Battery-Powered Torque Wrench is the newest addition to TorcUP, Inc.'s extensive line of industrial bolting tools. Power-driven by a Lithium Ion 6.2Ah re-chargeable battery, the VOLTA combines current technology with the freedom and flexibility of cordless operation. The VOLTA's precision-engineered, brushless motor delivers efficiency, long run-time, and extended durability, while its configurable torque range capabilities ensure ease of use and repeatability. The tool's internal brushless technology also allows the wrench to run cooler, providing bolting application safety and versatility in harsh environments. Additional features include digital display, torque memory settings, automatic reaction arm release, and ft/lb to Nm conversion. The VOLTA is available in two drive sizes (3/4" and 1") and four models with a torque ranges from 120 ft/lbs to 3,000 ft/lbs.

**TorcUP, Inc.** | [www.torcup.com](http://www.torcup.com)



## Stainless steel retained-tension ball-lock cable ties

Ty-Met stainless steel retained-tension ball-lock cable ties, from Thomas & Betts (T&B), a member of the ABB Group, feature specially formed spring crimps which help maintain consistent tension on the tie after installation. Consistent tension enables the cable tie to remain in position, even under high-vibration conditions. The formed channel provides a path for trace wire that protects against crushing and short circuits. Other features include the ball-lock fastening mechanism that is easily assembled and adjusted for tension. Ty-Met stainless steel retained-tension ball-lock cable ties are available in Type 304 stainless steel and marine-grade Type 316 stainless steel. Ty-Met stainless steel retained-tension ball-lock cable ties can be installed with T&B DAS-250 application tools.

**Thomas & Betts Corporation** | [www.tnb.com](http://www.tnb.com)

process. It can even be used to install the rotor without incurring the costs of mobilizing a large crane.

- Denmark boasts a pioneer in the field of independent craneless technologies. In 2013, this company introduced a self-hoisting crane for replacing gearboxes and generators, and recently unveiled a new technology for replacing single blades and pitch bearings. Both technologies require either one or two 40-foot containers to mobilize, and rely on a set of hoists installed up-tower to perform corrective operations, with no mobile cranes involved. EUDP has supported both solutions; the crane has received funding support from Horizon 2020, while the blade replacement design has been backed by the Market Development Fund.

More craneless innovations exist, and it is going to be an exciting trend to watch in 2018, and for years to come. The future is very promising, as more solutions address key challenges faced by operators industry-wide. The technologies highlighted here represent more environmentally responsible solutions to common problems. After all, we all want to reduce emissions, encourage the installation of renewables in hard-to-access areas, and further reduce the cost of energy.

*Thomas Lamberth Sandbjerg and Jon Valdivielso García are both with Liftra and are based in Denmark and Spain, respectively. Founded in 2003, Liftra designs and manufactures special lifting and transportation equipment for the global wind turbine industry.*

**LIFTRA** | [www.liftra.com](http://www.liftra.com)



## Low cost rotary drive

Festo's rotary drive ERMO is a low-cost, high performance axis for rotating and aligning parts and work pieces or for swiveling tasks, even for heavy loads. It's also suitable for simple rotary indexing table applications often past of assembly processes. Its rugged design gives it a long service life of more than five million cycles. The ERMO drive is part of Festo's Optimized Motion Series (OMS) of cost effective electrical axes. A complete OMS package for ERMO is comprised of the electromechanical actuator with permanently mounted motor and drive system (motor controller) and matching connecting cables for an integrated web browser technology for fast and easy configuration. The package can be ordered with one order code and everything comes preassembled in one box, ready for fast installation and commissioning. The ERMO actuator itself is comprised of an integrated electric rotary drive with stepper motor boasting a robust rotating plate bearing, with backlash-free ball bearings. It has excellent axial and radial run-out properties and is specially designed for absorbing high lateral forces and torques. Smooth surfaces - the Festo CleanLook - make it less susceptible to contamination. ERMO is available in four sizes. Closed loop operation with an encoder is available as an option. Festo also offers mounting interfaces to connect ERMO to other drives, like slides and gantries.

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# Powering the Future with the Winds of Change

by Mike King

Wind power is one of humans' earliest sources of energy. As nations and industries across the world step up the fight against climate change, it's also one of the most vital for our future.



One of the major barriers to the widespread adoption of clean energy sources like wind is the perceived uncertainty. Governments want to invest in trusted, proven technology, and wind – at least in North America – is in its infancy (compared with traditional energy sources like oil and gas).

But the tide is turning; sea levels are rising, and across the Atlantic there is mounting evidence of the transformative potential of wind energy – both on the environment, and on the modernization and future proofing of the sector.

In the United Kingdom, offshore wind has been a major success. Over the last five years, the UK has become the world's largest market for offshore wind investment and deployment. The number of wind farms increases every year, and the rate of progress in the technology's efficiency and scale of use continues to rise.

Technological improvements mean that the latest generation of sleek and powerful turbines offers far more than the first iterations, which gained a reputation for being nothing more than a costly nod to the environmental lobby. Recent advances have led to the doubling of turbine power output over the last five years – this output is anticipated to double again in the next five years, faster than nearly any other tech sector.

The key to their uptake and success in the UK is the parallel development of new infrastructure, in order to support and encourage the continued spread of these projects.

With several proposed offshore wind developments in the pipeline, North America is beginning a similar journey to that of the UK, which provides a compelling case study of how this support framework is integral to the industry's success.

Those looking for lessons on how to replicate the UK's successful model need look no further than Liverpool, a city in the north west of the UK which is known around the world as the home of The Beatles and Liverpool FC. It boasts a long maritime heritage, and an ultra-modern, deepwater port infrastructure. It also happens to be home to one of the world's largest concentrations of offshore wind turbines, and offshore wind business clusters.

From its high-capacity port that provides the necessary space for construction vessels and transfer of project cargo, to the Cammell Laird shipyard (which has diversified to support large-scale energy projects, specializing in modular construction, repair, and assembly) Liverpool has built an ecosystem for wind energy to grow.

The expansive Cammell Laird site on the city's waterfront is the hub. The wider wind energy infrastructure in Liverpool City Region includes The University of Liverpool, Liverpool John Moores University, and the National Oceanography Centre, where some of the UK's leading academic experts in wind energy are based. It also includes

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## SMART BATTERY STORAGE FOR POWERFUL GRIDS



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the Engineering College, which is dedicated to developing programs that support the offshore wind industry.

The region boasts a strong supply chain, thanks in no small part to the scale of activity taking place in the Liverpool bay; it's home to over 270 turbines, with supply chain companies exporting their services and solutions to global markets, including the USA and Asia. It also features the first deployment of the world's largest wind turbines, the MHI Vestas V164. These make up the Ørsted Burbo Bank Extension wind farm, an array of 32 640ft (195m), 8MW turbines, which is capable of supplying power to almost a quarter of a million homes. Ørsted has also recently established a multi-million pound state-of-the-art O&M Centre on the banks of the River Mersey.

Liverpool Bay is the first location in the world to deploy an innovative Battery Energy Storage Solution (BESS) linked to the 90MW Burbo Bank offshore wind farm. Developed by ABB, who have their UK headquarters in Liverpool City Region, this BESS solution enables the integration of clean energy without compromising grid stability and power quality.

A multi-million pound, state of the art, Operations and Maintenance Centre has also recently been established on the banks of the River Mersey.

The combination of industry and academia living side-by-side, positive national and city region support, and investment in the physical infrastructure, facilitates the sharing of information and expertise to accelerate progress. Liverpool City Region has established itself as an industry leader and cornerstone of the wind sector in the UK and further afield, supporting and consulting on the development of wind farms right across Europe.

North America is primed to see the same expansion of wind energy that is already taking place in the UK, with many willing developers, and a growing understanding of wind's vital importance to our future energy mix. But funding the technology itself is only the first step. In Liverpool, and the wider UK, the infrastructure available to developers has made it easier than ever for new wind farms to sprout up all along the coast. If North American cities want to truly realize the environmental and economic benefits of a booming offshore wind industry, they need to ensure that the local infrastructure, and support for the sector, matches their ambition.

*Mike King is the Investment Manager for Energy & Maritime at Invest Liverpool and Chair of the Energy & Maritime Place Marketing Sector Group. An Environmental Science graduate from Newcastle University, Mike has been involved in economic development and inward investment for over 13 years, supporting foreign direct investment, industry initiatives, research projects and growing the business base in Liverpool and England's Northwest.*

**Invest Liverpool**  
www.investliverpool.com



### Software solutions suite for power tools

Cleco Production Tools has launched Cleco Software Solutions, a new streamlined production management software suite for Cleco brand power tools.

Cleco Software Solutions is a scalable software suite which equips managers with critical production data and application management tools, allowing them to make informed decisions and take corrective actions quickly while ensuring quality and avoiding costly errors. The three components to the Software System include TorqueNet, Tightening Parameter Server (TPS), and Dashboard module. TorqueNet is a data acquisition and archiving system that makes local plant floor data visible anywhere. All data is sent to a single source making critical production information accessible by all roles working with the tightening process on the assembly line. The Tightening Parameter Server (TPS) is a central application management system enabling customers to effectively and efficiently manage their tightening applications from a central location while providing real-time change management. The Dashboard, an add-on-module interconnecting with TorqueNet, allows managers to dive deeper into data. The user specific views enable quick navigation, identification of trends and issues, and transformation of data into actionable information.

**Cleco Production Tools**  
www.clecotools.com



### North American approved cable gland

With the new cULus approval for its brass and polyamide cable glands, Rittal is now making it easier for system suppliers to meet the high demands placed on enclosures. Cable glands allow cables and wires to be introduced safely into enclosures and housings. They are used when a high level of protection against dust, dirt, and liquids (such as rainwater) is needed. Rittal cable glands made of brass or polyamide not only provide IP 68 protection in accordance with IEC 60529, they are now also suited for the high safety requirements of North American applications, thanks to their additional cULus approval. Rittal cable glands made of brass meet the NEMA / UL Type 4x requirements as well. The polyamide version is also cCSAus approved by the Canadian Standards Association. All the cable glands are also available as CAD models for efficient planning in line with the concept of Industry 4.0 (the Internet of Things) and they are stored in the Eplan Data Portal. The cable glands are available in sizes ranging from M12 to M63 and achieve IP 68 protection category.

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### Aftermarket gearbox replacement

SPX Cooling Technologies, Inc. introduces a new model to its expanding line of gearboxes, the M Series Geareducer. The expansion, the M1311 model, is a direct drop-in, aftermarket replacement for Amarillo 1311 gearboxes, eliminating the need for adaption materials. The entire M Series Geareducer line is designed and manufactured to directly and easily replace other OEM gearboxes in field-erected cooling towers. The new M1311 model Geareducer gear drive incorporates the same differentiating features as the Marley Series 32.2 Geareducer; including the Inpro input shaft oil seal to eliminate grooving and extend life. It is available in ratios from 7.89 to 14.64. The gear drive's primary function is to reduce the speed of the electric motor to optimize fan performance. The Marley Geareducer gear drive goes beyond the American Gear Manufacturers Association (AGMA) requirements to maximize air movement through the cooling tower and to minimize maintenance. It provides primary support to the fan, anchors it against lateral movement, withstands shock loads at start-up and during speed changes, and minimizes power transmission losses, as well as sound generation. The M Series features gears of high-strength, case-hardened alloy steel machined to AGMA Quality Class 9 and above. It is designed to fit into non-Marley cooling towers for easy replacement and has heavy-duty double-row interstage bearings for 100,000 hours of life or more. The M Series gear drive operates without need for add-on oil pumps, oil filters, or oil coolers. It runs with two-stage gear reduction for efficient power transmission; external cooling fins maximize the surface area for cooler operation.

**SPX Cooling Technologies** | [www.spxcooling.com](http://www.spxcooling.com)



### Heavy duty encoders for severe environmental conditions

POSITAL's heavy-duty IXARC incremental and absolute rotary encoders are built to stand up to extreme environmental conditions. Based on a housing design with a 25-year track record of surviving tough conditions, these devices are suitable for marine vessels, off-shore facilities, mines, cranes, wind turbines, and other challenging locations. These sensors feature rugged impact-resistant Type 316L stainless-steel or aluminum housings with seals rated to IP67. Other features include bearings that can stand up to 250 N axial, 350 N radial mechanical shaft loads and the ability to stand up to high shock (200g) and vibration (20g) impact. A special shaft-lock mechanism protects the internal components of the encoder from damage due to extreme thrust loads on the shaft. An optional mechanical overspeed switch provides an additional level of safety for equipment and operators by sending a warning signal to a motor control if the rotational speed of the shaft exceeds a pre-set limit. The operating temperature range for the heavy-duty IXARC encoders is -40° to 80°C. The heavy-duty IXARC encoders are available in a wide variety of configurations. Incremental versions have resolutions (pulses per revolution) of up to 2500 PPR, while absolute versions are available with 16-bit resolution (.005°). Multi-turn variants of the absolute encoders have measurement ranges as high as 16,384 revolutions (14 bit). Other resolutions are also available for both incremental and absolute encoders. Incremental variants are available with Push-Pull (HTL) or RS422 (TTL) communications interfaces, while absolute models can be provided with either CANopen or SSI interfaces. Dual-function models are available that provide both incremental and absolute outputs.

**POSITAL** | [www.posital.com](http://www.posital.com)



### Expanded guide describing custom components, engineering process

Bal Seal Engineering, Inc. has published an expanded guide describing the form and function of its custom-engineered seals, springs, and electrical contacts, as well as the benefits of its engineering process. The 12-page guide, titled Sealing, Connecting, Conducting, and EMI/RFI Shielding Solutions, uses photorealistic application images and descriptive insets to give readers a detailed look at where and how Bal Seal spring-energized seals, Bal Spring canted coil springs, and Bal Contact electrical contacts work in aerospace and defense, analytical, automotive, energy, and medical equipment. A graph in the guide's spring technology section compares the deflection of canted coil springs with other seal energizer types, including V-springs, ribbon springs, and o-rings. The guide also provides information about the company's collaborative engineering approach, which forges partnerships with OEMs and tier suppliers who want to make their products faster, stronger, lighter, or more functional.

**Bal Seal Engineering, Inc.**  
[www.balseal.com](http://www.balseal.com)



### Diamond-coated insert grades offer high-performance aluminum drilling

Sandvik Coromant has unveiled its CoroDrill 880 CVD diamond-coated insert grades, GCN124 and GCN134. The super-hard properties of the diamond coating provide long tool life and combine with innovative chip breaker and geometry designs to guarantee high performance when drilling materials such as aluminum. GCN124 and GCN134 diamond-coated insert grades are designed to offer a low cost per hole in most ISO N materials thanks to long lasting insert tool life. Increased productivity could be gained from elevated cutting data and less machine downtime from fewer insert changes. Further advantages include easy handling in production due to the reliability and long life of the inserts as well as enhanced surface finish inside the hole, which results from the ability to resist BUE and smearing effects. Reduced insert consumption also helps lower stock levels and environmental impact. GCN124 and GCN134 complement the existing H13A, uncoated insert from Sandvik Coromant, which is recommended in applications involving shorter production runs and/or difficult interrupted cuts. The standard CoroDrill 880 range features indexable insert drills from 12 to 84mm (0.472-3.307") in diameter, with drill lengths of 2, 3, 4, and 5 x D. Sandvik Coromant's Tailor Made offer allows intermediate diameter and length combinations as well as different connection types and sizes such as HSK, Coromant Capto, or cylindrical shank. Another Tailor Made option includes customized step and chamfer drill designs for specific components.

**Sandvik Coromant** | [www.sandvik.coromant.com](http://www.sandvik.coromant.com)



### High yields and increased performance

Senvion launched its new products, the 3.7M144 EBC and 3.6M118 NES turbines, which are especially well suited for low and high wind sites respectively and feature the Senvion Next Electrical System (NES) to meet the grid requirements in all Senvion target markets. The 3.6M118 features an optimized rotor design for very high yields and is mounted on a steel tower with a standard hub height of 91 meters, with project specific hub heights also available. The 3.7M144 is designed to be one of the quietest systems in its class with its strengths at low wind speeds due to aerodynamically optimized blades and serrations at the blade edges. With a nominal output of 3,700 kilowatts and a larger rotor, the new turbine leads to a yearly energy yield 6.7% higher than its sister models. The Next Electrical System (NES) features a gearbox-based concept with an asynchronous generator and a fully rated converter that permits stable grid feed-in and meets the grid requirements in Senvion's markets.

**Senvion** | [www.senvion.com](http://www.senvion.com)

# TP & L

Management Solutions

## Making Logistics Easy



By providing logistics management services through every step of the supply chain, **TP&L** ensures your shipments arrive at project sites economically, safely, on time and to the quality standards set by the manufacturer. We currently are storing and maintaining 14,769 components in our yards.

### Services and Capabilities:

- Distribution Services
- Inventory Management
- Rail Logistics
- Trucking Logistics
- Indoor/Outdoor Storage
- Maintenance



Check out our distribution centers:

Casper, WY | Garden City, KS | Enid, OK | Grand Forks, ND | O'Neill, NE

**tpandl.com • 307-262-6748**





## Pneumatic module metal built for lasting performance

With robust metal contacts that can be plugged and unplugged at least 10,000 times, the new Han Pneumatic Module Metal from HARTING presents a cost- and space-saving opportunity to use connectors to streamline flexible production processes with high mating cycles. The Han Pneumatic Module Metal can withstand pressure up to 10 bars, covering the entire low pressure range. With pneumatic modules, users can route compressed air feed through the same connector along with power and signal lines rather than having to set up and maintain a separate compressed air connection for drive units, control units, brakes, holding and unloading units, and much more. The Pneumatic Module Metal is available in variants with two (for hose  $\varnothing = 6$  mm) or three plug slots (for hoses with  $\varnothing = 1.6$  to 4mm). The female contacts are available with or without a shut-off function – a spring-loaded valve that closes over an O-ring when the connector is opened, preventing compressed air from escaping. The Han Pneumatic Module Metal can be employed in a wide range of HARTING connector series that take Han-Modular inserts, including Han-Yellock and Han-Eco.

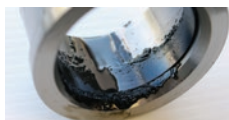
**The HARTING Technology Group**  
www.harting.com



## Flexible, efficient, and comfortable anchoring

Working at height requires movement. Workers need to connect and reconnect their snap hooks dozens – or even several dozens of times – a day. The new 3M DBI-SALA Comfort Grip Connector from 3M Fall Protection improves connecting and disconnecting while providing flexibility to anchor efficiently and comfortably in multiple orientations. Designed and certified to arrest a fall when loaded in multiple orientations, the Comfort Grip Connector helps provide a 5,000-pound tensile strength as well as up to 3,600 pounds in transverse and gate strengths. When connected to a vertical or transverse application, such as a pipe, the hand-guard pin shears in the event of a fall to allow the connector to align with the direction of the fall and remain securely anchored.

**3M Fall Protection**  
www.3m.com/workersafety



## Seal failure guide book

System Seals Inc., a research-based seal manufacturer focused on hydraulic cylinder optimization, has released the second edition of its Seal Failure Analysis Guide – a 30-page trouble-shooting manual for common seal failure modes. The book is free to the public upon request. Over the past two years, System Seals has been overwhelmed by requests for the popular guidebook, which has become a shop staple in many of its customers' facilities. This year, System Seals updated the guide with more photos, charts, graphs, and research from the System Seals' lab. This expanded edition now includes more than 100 images illustrating real-life examples of seal problems and potential failure modes. The guide also details System Seals' new Cylinder Optimization Process – a new modeling tool which predicts and prevents seal failure before it occurs.

**System Seals** | www.systemseals.com



## ADVANCED BOLTING TECHNOLOGY

- Light** – Unsurpassed power-to-weight ratio
- Accurate** – Designed to provide a high degree of accuracy (+/-2.8%) and repeatability (+/- 2%)
- Fast** – Decreased tightening times by up to 300%
- Quiet** – Operates at 75 db reducing noise level

With torque ranges up to 15,000 Nm, the E-RAD BLU uses a patented gearbox design and the precision of an electric AC Servo motor. These tools deliver smooth continuous torque and are capable of torque and angle sequence. They also feature enhanced traceability with data collection.



WWW.RADTORQUE.COM

1.800.983.0044

E-RAD BLU



# Bolts and Fasteners

Reliable tools and components are important in any industry, but particularly in wind power, where efficient turbine and blade construction and operation are essential to safety and project success. This issue, we're highlighting the latest in bolts and fasteners from various companies in the industry.

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## Williams Form Engineering Corp.

**Product:** Anchor Bolts

**Key Features:**

**Description:** Williams Form Engineering Grade 75 and 150 KSI threaded bars offer heavy-duty, rugged thread forms and concentric thread design. The wide thread pitch allows for fast hex nut engagement while still allowing precise adjustments when necessary.

**Application:** Reliable support of wind tower turbines.

- Extensive quality control and manufacturing program produces high quality bolts;
- Eight manufacturing plants throughout North America allow an efficient distribution network and timely deliveries;
- Anchor bolts have been cold temperature tested to assure full load retention and reliability in harsh environments;
- Laboratory test results for all Williams anchor bolts show less than 2% load relaxation loss under tension;
- Advanced engineered components maintain strict tolerances to ensure high product standards.

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

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## Heico

**Product:** HEICO-Lock Wedge-Lock Washers

**Description:** Heico's certified bolt-fastening system works safely in dry and lubricated conditions, can be reused consistently without loss of function or quality, and costs up to 50% less than identical fasteners. Wedge-Lock Washers are suitable for use as high-tensile bolts of 8.8, 10.9, and 12.9, with their respective nuts, and are available in standard or enlarged outside diameters of M3 to M130.

**Application:** A wedge-locking system that delivers high-quality, anti-vibration security, for demanding bolted joint applications, such as for wind turbines.

**Key Features:**

- HEICO-LOCK Wedge-Lock Washers lock bolts tight without any loosening;
- Supplied as a pre-assembled pair that is easy to install and remove;
- Washers will not rust, break, or vibrate - ever; and
- Available in steel or stainless steel, with narrow or wide bearing surfaces.

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



## Lightning Bolt and Supply

**Product:** Nacelle and ISO-DIN-EU Fasteners

**Description:** Lightning Bolt offers a wide selection of ISO-DIN-EU fasteners that are commonly used in the wind turbine industry.

**Application:** Nacelle fasteners, blade bolts, anchor bolts, and tower bolts

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

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## ITH Engineering

**Product:** IHF Fasteners

**Description:** IHF fasteners are designed for use with ITH tensioners to achieve maintenance-free bolted joints. The optimized design eliminates the need for washers and allows high utilization of the yield point, small bolt dimensions can be used with the same tensioning force.

**Application:** IHF fasteners are generally used in steel construction, especially on flanges. Available standard dimensions are: M36 to M64 (1 3/8" to 2 1/2")

**Key Features:**

- DIBt approved;
- Maintenance-free;
- Substitute common bolts and nuts;
- Highest accuracy and repeatability in clamp loads;
- Flanges can be designed more compact and reduce costs.

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

## HEICO FASTENING SYSTEMS



The best value to secure bolts.

## HEICO-LOCK® WEDGE LOCKING SYSTEMS

The HEICO-LOCK® wedge locking system is the reliable solution to the problem of securing bolted joints in high vibration assemblies against self-loosening by rotation!



[WWW.HEICO-GROUP.COM](http://WWW.HEICO-GROUP.COM)

## Cooper & Turner Industries, Inc.



**Product:** Large Diameter, High Strength Threaded Fasteners

**Description:** Cooper & Turner is a manufacturer and supplier of high strength, safety critical large diameter (M16 <> M100) hex bolts, double ended studs, and thread rod. Employing automation (including in process NDT inspection and automatic zinc flake coating) and robotics results in high quality and consistent products, having full lot traceability, for global customer needs.

**Application:** For high strength, safety critical fastening on wind turbines; from foundations, to tower flange bolt sets, to nacelle/hub/rotor fastening, blade hardware kits, and spares/service.

[www.cooperandturner-usa.com](http://www.cooperandturner-usa.com)





OH BABY! We have cut the cord on RAD Extreme Torque Machines. Come check it out at AWEA Windpower Expo Booth 3730.



- Range from 250 to 3000 ft/lbs
- Torque and angle feature
- Automatic 2-speed gearbox
- Programmable preset torque settings
- Latest Li-ion 18V battery
- High accuracy +/- 5%



## WIND ENERGY SOLUTIONS

- ACCELERATED TORQUE AND TENSION SERVICES
- TURNKEY BOLTING SERVICES
- COMPLETE OEM TORQUE AND TENSION SYSTEMS
- BOLTING CONSULTATION SERVICES
- ISO 17025 ACCREDITED CALIBRATION SERVICES
- REPAIR SERVICES FOR MOST TOOL MODELS
- DBRAD DIGITAL TORQUE CONTROL SYSTEMS
- ELECTRIC GEAR TURNING SYSTEMS
- WTG SPECIFIC BOLT TENSIONING SYSTEMS
- HYDRAULIC WRENCH SYSTEMS
- WTG SPECIFIC SELF LOAD INDICATING FASTENERS

info@torkworx.com

888.502.WORX

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*extreme bolt working solutions*

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engineering



# Tensioners and Torque Systems

The proper alignment of a bolted joint can be achieved by using either torque or tension methods of bolting. Proper bolt loads must be realized during installation or the integrity of the joint will be compromised, leading to misalignment and, if left unchecked, the ultimate failure of the joint. In this issue, we look at some of the tensioners and torque systems available today.

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## Torkworx, L.P.

**Product:** Multi-schedule Base Bolt Tensioner

**Description:** Multi-schedule Tensioning Systems can accommodate #9, #10, #11 75Ksi, and 90Ksi plus 1-1/4" and 1-3/8" 150Ksi Grade Base Bolt hardware.

**Bolt Diameter:** #9, #10, #11, 1-1/4", and 1-3/8"

**Stud Protrusion:** 10" (254mm)

**Max Stroke:** 0.7" (18mm)

**Max Load:** 140,000lbs (622kN)

**Hydraulic Pressure Area (in<sup>2</sup>) & (mm<sup>2</sup>):** 6.74" (4350mm)

**Outside tool diameter:** 5.19" (132mm)

**Overall height:** 8.74" (222mm)

**Overall distance between stud CLs:** 4.37" (111mm)

**Weight:** 25 lbs (11.38kg)

**Key Features:**

- Elliptical design fits very narrow applications;
- Built in Stroke Limiting Valve - No over-stroking;
- Built in Cycle Counter for accurate usage tracking;
- Dual purpose aluminum handle serves as an ergonomic handle for moving the tool and protects the hydraulic connection from damage. In case of failure, the hose cannot eject from inside handle.

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



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## ITH Engineering

**Product:** ITH Bolt Tensioning Cylinder

**Description:** ITH bolt tensioning cylinders are designed for tightening large diameter bolts of all major OEM wind turbine applications including: foundation rods, tower bolts, bearing bolts, and more. High accuracy and repeatability ensures consistent even loads throughout bolted joints. Combine with the Micro-MAX pump for a lightweight and compact bolting system.

**Bolt Diameter:** M16 and larger

**Key Features:**

- Designed with OEMs for all turbine applications;
- Lightweight and compact designs;
- Patented safety features;
- High load accuracy and repeatability;
- Fast operation using one or multiple tensioners simultaneously.

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



## Hydratight

**Product:** Elliptical Base Bolt Tensioner

**Description:** The Elliptical Base Bolt Tensioner eliminates any potential thread fit problems by utilizing the existing hex nut on the stressing bar in order to induce the required load. The tool has a 20% reduction in width, which allows fit on all applications including the limited clearance inner bolts.

**Bolt Diameter:** #10 or #11 Williams or Dyson rebar (up to 1.5" diameter)

**Stud Protrusion:** 77" (1970mm)

**Max Stroke:** 0.393" (10mm)

**Max Load:** 104,821lbf (466.3 kN)

**Hydraulic Pressure Area (in<sup>2</sup>) & (mm<sup>2</sup>):** 4.82" (3108mm)

**Outside tool diameter:** 32" x 55" (820mm x 1420mm)

**Overall height:** 58" (1470mm)

**Overall distance between stud CLs:** 14" x 27" from stud center (380mm x 710mm)

**Weight:** 17.8lbs (8.1kg)

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



## Alltite, Inc.

**Product:** 700 bar tensioners

**Description:** Alltite has a full line of tensioners that operate at 10,000 psi / 700 bar for safety and speed. This tensioner can be operated from a hydraulic torque wrench pump, saving time and money.

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



## TorcUP, Inc.

**Product:** VOLTA Battery-Powered Torque Wrench

**Description:** The VOLTAs 18V lithium-ion re-chargeable battery provides enough power to take on hundreds of fastenings without the restrictions of cords or hoses. Its internal brushless technology delivers longer run-time, extended durability and 100% repeatable accuracy. Additional features include digital display, torque memory settings, ft/lb to Nm conversion and more.

**Power System:** 18V lithium-ion re-chargeable battery

**Drive Size:** 3/4" and 1"

**Torque:** 120 ft/lbs to 3,000 ft/lbs; 175Nm to 4045Nm

**RPM:** 0.5 RPM @ min. torque; 20 RPM @ max. torque

**Weight:** 14.5lbs (6.6kg) based on the VT-1000 model

**Noise Level:** 82db

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



### Tension & Torque tools for Wind Turbines

- Bolt Tensioning Systems
- Torque Wrench Systems
- Nut Runners (Torque Multipliers)

**Micro-MAX**  
The compact, lightweight tensioner pump



**Type CX**  
Ultralight, high-speed torque wrench



[www.ITH.com](http://www.ITH.com) • [sales@ith.com](mailto:sales@ith.com) • (815) 363-4900



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### RAD Torque Systems

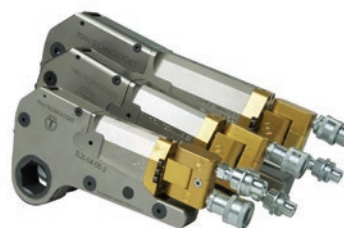
**Product:** E-RAD Blu Torque Wrenches  
**Description:** The E-RAD Blu precision torque wrenches are designed to provide a high degree of accuracy (+/- 2.8%) and repeatability (+/- 2%). These advanced electronic pistol grip torque wrenches combine the legendary RAD gearbox design and AC Servo motor technology to reduce bolting time up to 300%, as compared to conventional hydraulic wrenches.  
**Power System:** Electric 120V or 230V  
**Drive Size:** 3/4" to 1.5"  
**Torque:** 100 to 7500ft/lbs; 135 to 10,000Nm

**RPM:** up to 30 RPM  
**Weight:** 11.9lbs to 33lbs (5.4kg to 15kg)  
**Noise Level:** 75db  
**Key Features:**

- High accuracy +/- 2.8%;
- Data collection;
- Interchangeable handles per controller;
- Password protection;
- Bluetooth connectivity with RAD Smart Socket.

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

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### Chicago Pneumatic Tool Co.

**Product:** Titan Hydraulic Torque Wrenches  
**Description:** Titan's hydraulic torque wrenches are powerful, accurate, durable, robust, and efficient. They are cycle tested under load and then calibrated and certified with trace ability.  
**Power System:** Hydraulic (powered by electric or pneumatic)  
**Drive Size:** 1/2" to 3 1/2" square drive, 7/8" to 6 1/8" hex drive  
**Torque:** 197 to 43,000 ft/lbs; 267 to 59,308Nm

**Weight:** 5.65lbs to 120lbs (2.56kg to 64.3kg)  
**Key Features:**

- Certified torque accuracy of +/- 3%;
- The Titan WIDE TRACK ratchet is crafted from high quality aircraft-grade material;
- Low nose and flat design for extremely tight application accessibility;
- Versatile and light-weight.

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



### Ingersoll Rand

**Product:** QX Series Cordless Torque Multiplier  
**Description:** Transducerized, programmable cordless precision bolting tool with full data recording and wireless capabilities

**Power System:** 20V power platform with brushless motors  
**Drive Size:** 3/4" to 1"  
**Torque:** Up to 1,475ft/lbs (2000Nm)  
**Weight:** 8lbs to 15lbs  
**Noise Level:** <70 dB(A)  
[www.ingersollrandproducts.com/QXM](http://www.ingersollrandproducts.com/QXM)



### alki TECHNIK GmbH

**Product:** alkitronic EFCip / ECWip Electric Torque Multipliers  
**Description:** alkitronic EFCip / ECWip Electric Torque Multipliers from 60 to 6,500Nm. Consistent torque accuracy on all international power supplies. Precise shut-off with on-site voltage-controlled portable generators. Models ECWip angle tools low height for restricted access applications.

**Power System:** Electric  
**Torque:** 45 to 4,795 ft/lbs (60 to 6,500Nm)  
**RPM:** 70 to 3 RPM  
**Weight:** 20lbs to 40lbs (9kg to 18kg) without DMA  
[www.alkitronic.com/en](http://www.alkitronic.com/en)



### Enerpac

**Product:** ETW-Series Electric Torque Wrenches  
**Description:** ETW-Series Electric Torque Wrenches are well suited for complex jobs which demand precision and traceability. This tool features an easy to use touch-screen control box and easy to access controls on the back of the wrench. All are shipped with a calibration certificate.  
**Power System:** Electric  
**Drive Size:** Square drive range 1" to 1 1/2"  
**Torque:** Min. Torque of 200ft/lbs (270Nm) to 1200ft/lbs (1625Nm); nominal torque of 1000ft/lbs (1355Nm) to 6000ft/lbs (8135Nm)  
**Weight:** 18lbs to 42.1lbs (8.2kg to 19kg)  
[www.enerpac.com](http://www.enerpac.com)

## VDH/GSMI®

### 34.5 kV Vacuum Circuit Breaker and High Speed Grounding Switch for Wind and Solar Power Substations



Ema Electromechanics is the designer and manufacturer of model VDH/GSMI® combined 34.5 kV vacuum circuit breaker and high speed, mechanically interlocked grounding switch (aka "grounding breaker"), a unique and patented system specifically designed for switching and grounding of wind and solar feeder circuits.



16 Industrial Drive, Sweetwater, TX 79556  
 Tel: 325 235 8000  
 Email: [contact@emaelectromechanics.com](mailto:contact@emaelectromechanics.com)  
[www.emaelectromechanics.com](http://www.emaelectromechanics.com)



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**ITH Engineering**

**Product:** Hydraulic Torque Wrench type CX

**Description:** ITH type CX is an ultralight wrench system that maximizes speed and versatility. The ultralight housing and TWIN swivel hose connection make handling easy. The quick-release reaction arm has an asymmetrical shape and can be flipped to shorten or lengthen its reach in addition to 360° rotation.

**Power System:** Hydraulic

**Drive Size:** 3/4" to 2 1/2"

**Torque:** 1475 to 29,500 ft/lbs (2,000 to 40,000Nm)

**Weight:** 4.6lbs to 75lbs (2.1kg to 34kg)

**Key Features:**

- High-speed dual-hose operation;
- Ultralight housing;
- Quick-release reaction arms and drive inserts;
- Asymmetrical reaction arm can be flipped and rotated 360°;
- TWIN swivel hose connection.

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

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**Torkworx, L.P.**

**Product:** DBRAD3000-2

**Description:** Digital B-RAD powered torque wrenches are digital, cordless, and lithium-ion battery tools. With advanced, patented technology containing digital display and single increment torque settings, they also offer a torque and angle option.

**Power System:** Battery

**Drive Size:** 1"

**Torque:** 250 to 3000 ft/lbs; 350 to 4000Nm

**RPM:** 13

**Weight:** 13.6lbs (6.2kg)

**Noise Level:** 80

**Key Features:**

- Programmable preset torque settings;
- Latest lithium-ion 18V battery technology;
- High accuracy of +/-5%;
- Automatic 2-speed gearbox;
- Torque and angle available.

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



**Atlas Copco**

**Product:** Revo HA

**Description:** The Revo HA is a swiveling transducerized tool. It uses traceability, angle control, and monitoring to assure perfect joint quality. These high torque models can operate at comparatively high speeds. With multi torque setting buttons and operator feedback on the display, the tightening process is shortened greatly.

**Power System:** Electric

**Drive Size:** 3/4" to 1 1/2"

**RPM:** 10 to 65

**Weight:** 14lbs to 29lbs (6kg to 13kg)

**Noise Level:** <70db

[www.atlascopco.us](http://www.atlascopco.us)



**Stahlwille Tools, LLC**

**Product:** Stahlwille Manoskop 730 Quick

**Description:** A time proof torque wrench with long term accuracy and no need to reset to zero due to the wear resistant mechanism design. This torque wrench now comes with improved features such as an ergonomic handle, and provides quick and easy setting of required torque. Quick adjustment from outside, no disassembly needed.

**Power System:** Manual

**Drive Size:** 1/4", 3/8", 1/2", 3/4"

**Torque:** 5 to 812ft/lbs; 6 to 650Nm

**Weight:** 1.8lbs to 7.2lbs (0.8kg to 3.3kg)

**Noise Level:** 75db when click of torque wrench is triggered

[www.stahlwille-americas.com](http://www.stahlwille-americas.com)



**Norbar Torque Tools, Inc.**

**Product:** EvoTorque 2

**Description:** The EvoTorque 2 has the ability to memorize multiple targets, work IDs, user IDs, and readings. The tool has three modes of operation: Torque, Torque and Angle, and Torque Audit. The unique Audit Mode is a sophisticated feature for testing pre-tightened bolts with minimal impact on the original fastening torque.

**Power System:** Electric

**Drive Size:** 1"

**Torque:** 295 - 3000ft/lbs, 400-4000Nm

**RPM:** 6

**Weight:** 28lbs (12.85kg)

**Noise Level:** <70db(A)

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



**Proto Industrial Tools**

**Product:** Proto Precision 90 Micrometer Torque Wrench

**Description:** The new PROTO 1/4" and 3/8" Drive Precision 90 Micrometer Torque Wrenches feature a 90-tooth ratcheting head and a torque range of 40-200 in/lbs. These torque wrenches are designed to reach 1/4" and 3/8" drive fasteners in obstructed areas as its 90 tooth ratcheting head allows for a mere 4° arc swing. Built in Dallas, TX, the PROTO Precision 90 Micrometer Torque Wrenches meet stringent industrial specifications and are calibrated for reliable accuracy.

**Drive Size:** 1/4" and 3/8"

**Torque:** 40 to 200in/lbs

**Weight:** 2.7lbs (1.22kg)

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



**Snap-on Industrial**

**Product:** Hydraulic Torque Wrench

**Description:** Lightweight, heavy duty, ergonomic, +/- 3% accurate, uni-body hydraulic wrench with 360° adjustable, push-button reaction arm and uni-swivel hose couplings. The dual pawl, anti-backlash mechanism provides smooth, equal load operation and a quick release square drive allows for simple change of direction.

**Power System:** Electric or pneumatic over hydraulic

**Drive Size:** 3/4", 1", 1 1/2", 2 1/2"

**Torque:** 120ft/lbs to 37,000ft/lbs; 1100Nm to 50,000Nm

**Weight:** 2.7lbs to 77.5lbs (1.22kg to 35.15kg)

**Noise Level:** 75 to 80db

[www.snapon.com/industrial](http://www.snapon.com/industrial)



**Norwolf Tool Works**

**Product:** Missing Link

**Description:** The Norwolf Missing Link torque multiplier fits into tightly confined areas and has become a solution in the wind industry for generator feet and yaw pucks. The newly re-designed 6:1 Missing Link fits in the narrowest of confines while maintaining a high power to weight ratio.

**Power System:** Manual

**Drive Size:** 1/2" and 3/4"

**Torque:** 250 ft/lbs input;1000ft/lbs output

**Weight:** 4lbs (1.8kg)

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





Stem | [www.stem.com](http://www.stem.com)

# ENERGY STORAGE BUYERS GUIDE

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### BATTERIES

- AGM
- All Iron Flow
- Lead Acid
- Li-Ion
- NiCd/NiMh
- Redox Flow

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### CHARGING TECHNOLOGY & DEVICES

### COMPONENTS

### CONTRACTORS | EPC

### CONTROLLERS

### COOLING | THERMAL MANAGEMENT

### DESIGN AND BUILD INTEGRATOR

### ELECTRICAL ENERGY STORAGE

### ENERGY STORAGE METERING

### ENERGY STORAGE SYSTEMS

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- Grid-Connected
- Off-Grid
- Residential

### ENGINEERING CONSULTANT

### EPC SERVICES

### FINANCIAL SERVICES

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### PROJECT DEVELOPER

### PROTECTIVE RELAY

### SOFTWARE SUPPLIER

### STORAGE PRODUCTS AND SERVICES

### THERMAL ENERGY STORAGE

### VALVES & SYSTEM COMPONENTS

### WIRE & CABLE

### OTHER

- Energy Recovery
- Fire Suppression
- Higher Education



**Batteries - AGM**



**Maxdura Battery**

The DCS series is newly developed deep cycle battery for solar systems. Its key benefits include high specific power, long cycle life, high large current discharge performance, and fast charging performance. It's a solution for household energy storage, solar and wind energy, emergency, and other cycling systems. Larger capacity can be obtained when connected in parallel.

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



**Sun Xtender Batteries**

Sun Xtender 12 Volt Group 31 and 30HT batteries, manufactured by Concorde Battery Corporation, now include a flat top cover and lifting handles. This eliminates the need to modify hold down apparatus or revise cable routing as the terminals are now more accessible.

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

**Batteries - All Iron Flow**



**ESS Inc.**

ESS Inc.'s 50kW/400kWh Energy Warehouse (EW) iron flow battery is a long-duration (4+ hours) energy storage system providing energy and power solutions for C&I, utility, and microgrid/off grid applications. The EW is capable of up to 8 continuous hours of energy delivery with a 20+ year operating life and no capacity degradation. Composed of iron, salt, and water for its electrolyte, the EW is a safe, long-lasting solution with a low leveled cost of storage per kWh.

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

**Batteries - Lead Acid**



**Crown Battery Manufacturing Company**

Crown Renewable Batteries are heavy weights with dense plates that use more active lead material, increasing battery performance and longevity. Crown batteries contain more lead content per ampere-hour of rated capacity. Their two-volt 2CRP3690 Power Module combines ampere-hour capacity availability to renewable energy system users. The battery delivers application flexibility, while providing an ideal solution for temperature management and electrical isolation.

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



**EnerSys**

EnerSys provides stored energy solutions for industrial applications. They manufacture and distribute reserve power and motive power batteries, battery chargers, power equipment, battery accessories, and outdoor equipment enclosure solutions to customers worldwide.

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



**Fullriver Battery**

Fullriver Deep Cycle AGM batteries use more lead in creating strong connections between cells, heavy plates which increase the reserve capacity in order to maximize life cycles. Their batteries feature a fully sealed, maintenance-free, corrosion-free package, and are an investment in making sure the battery pack enhances the quality of their customers machines.

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



**MK Battery**

MK Battery now distributes the Deka Solar Fahrenheit advanced AGM battery HT200ET which is specifically designed for energy storage in Grid Tied backup systems in high heat applications. Engineered for high power, their exclusive 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.

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



**Narada**

**Narada**

Narada, established in 1994, is a battery manufacturer and global battery supplier of Lead Acid and Li-Ion Industrial batteries. Narada provides long-cycle life OPzV, REXC (Lead Carbon) VRLA series batteries, and LiFePO4 lithium battery systems, packaged with advanced intelligent battery management system technology. Narada offers solutions from large-scale, up to MW, containerized energy storage systems (ESS), to residential solutions.

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



**Newmax Battery**

Newnan Battery's thixotropic nano GEL technology provides for a true maintenance-free GEL battery. Their enhanced AGM VRLA battery is an energy storage and power backup solution.

[www.newmaxbattery.co.kr](http://www.newmaxbattery.co.kr)

**Energport Battery Energy Storage System**  
Driven By *Sinexcel*

**AC RACK L3060**

- 30kW Sinexcel PCS
- 64.5kWh Battery
- LFP Li-ion Battery
- Small footprint
- Easy install
- EMS included
- Remote monitor
- 480V 3p
- ETL Certified
- CA SGIP Approved

- Demand Charge Bill Savings
- PV Self-Consumption
- Backup Power for Emergency
- Turnkey Solutions
- In Stock Now in Bay Area
- Dealer / Installer Wanted
- 10 Year Warranty

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**Storage Inverters 30~500kW**

- cETLus listed according to UL9540/UL1741SA/CSA22.2
- HECO CGS/CSS listed
- CPUC listed
- Grid-interactive & Grid-forming

**Outdoor Commercial & Industrial Battery Energy Storage Solutions**

30kW

50-150kW

250-500kW

**Sinexcel Inc.** <http://www.sinexcel.us/>  
henry@sinexcel.us

**Energport Inc.** <http://www.energport.com/>  
info@energport.com



**Rolls**  
BATTERY ENGINEERING



**Rolls Battery Engineering**

Constructed with heavy duty, thick plate construction and dual-container design, Rolls 5000 Series 4 volt 4 KS 25P offers reliability and high Amp-Hour capacity for small to large-scale energy storage applications. Rolls 5000 Series Renewable Energy battery lineup is backed by a 10-year warranty.

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



**Storage Battery Systems**

SBS Battery's tubular positive plates and lead selenium alloy provide significant corrosion resistance in lead acid battery technology. Their lead selenium alloy virtually eliminates intergranular corrosion, having all the advantages of lead calcium and lead antimony cells but none of the disadvantages. The positive plate's grid does not require horizontal bars, virtually eliminating plate growth. For long service life applications, tubular batteries provide reliable power.

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



**Trojan**  
BATTERY COMPANY  
*Clean energy for life.*

**Trojan Battery Co., LLC**

The Trojan Battery Solar product line features true deep-cycle AGM and flooded batteries which are specifically designed for solar and other renewable energy applications. Trojan Solar AGM features a non-spillable, maintenance-free design which enables installers to customize the use and position of the batteries in various applications. Trojan's Flooded Solar batteries leverage their 90 years of deep-cycle flooded technology expertise and are engineered to provide high cycling.

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



**U.S. Battery Manufacturing**

U.S. Battery Manufacturing has been building flooded lead acid batteries since 1926 and manufactures deep cycle batteries specifically for many industries, worldwide. The company's RE Series batteries are designed to provide high peak capacity, long cycle life, and reliability for use in industrial or residential renewable energy applications. RE Series batteries utilize the company's XC2 formulation and Diamond Plate Technology to create an efficient battery plate, delivering high watt-hours per liter and watt-hours per kilogram.

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

# TWO PEAS... ONE POD

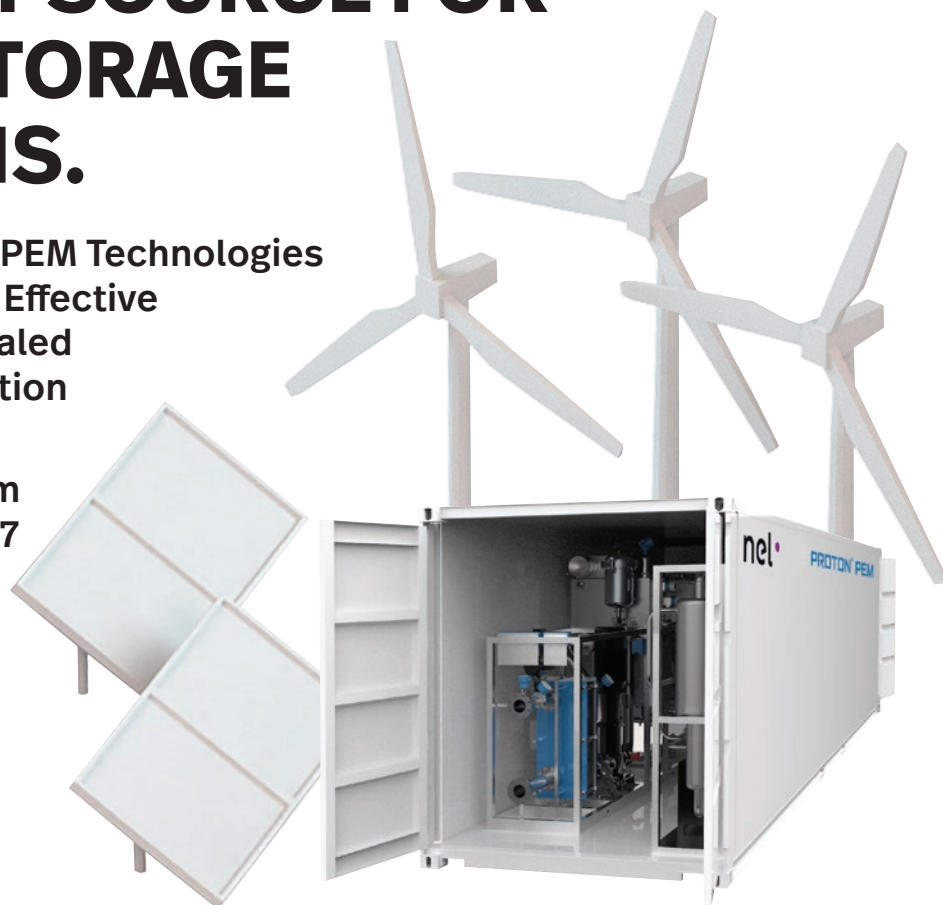
**Nel Hydrogen and Proton OnSite® Merge – Now the World's Largest Electrolyser Manufacturer**

## YOUR BEST SOURCE FOR ENERGY STORAGE SOLUTIONS.

- Alkaline and Proton® PEM Technologies
- Safe, Clean and Cost Effective
- Grid Management Scaled to Match Any Application

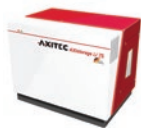
Visit us on-line at [www.NelHydrogen.com](http://www.NelHydrogen.com) or call +1-203-949-8697

**nel**  
number one by nature™





**Batteries - Li-Ion**



**AXITEC**  
AXITEC provides solar modules and photovoltaic storage systems. The flexible and expandable high-performance Li-ion storage is suitable for all photovoltaic systems from home to industry. The AXITEC storage system AXIStorage is manufactured in Germany and combines performance, safety, and longevity.  
[www.axitecsolar.us](http://www.axitecsolar.us)



**Leoch Battery Corp.**  
Leoch manufactures lead-acid and lithium-ion batteries for all sizes of energy storage systems and for use in all types of applications including, renewable or distributed energy, remote site, telecom, UPS, data center, and more. Designs include Pure Lead Punched Grid + Carbon, Deep Cycle AGM, Tubular Plate in both GEL (OPzV) and Flooded (OPzS), hybrid AGM-GEL, and 48Vdc Lithium Iron Phosphate in convenient, easy-to-install modular units. Engineering support and inventory available around the globe.  
[www.leoch.us](http://www.leoch.us)



**Valence Technology**  
Valence Technology, manufactures lithium ion batteries that can be arranged in systems between 12V-1000V, from kWh to MWh. As a result of the stable, high-quality chemistry, Valence's U-Charge family of 12V, 24V, and 36V modules have an extended cycle life and float life, suited for energy storage markets such as renewables and UPS. Through this design, lithium ion batteries can act as a "drop-in" replacement for lead-acid batteries or be easily assembled into larger systems of any voltage and capacity. The lithium iron magnesium phosphate batteries are fast-charging and safe energy storage solutions.  
[www.valence.com](http://www.valence.com)

**Batteries - NiCd/NiMh**



**Nilar, Inc.**  
The Nilar 48kWh modular energy storage is available as a standard solution with rack, battery control cabinet, all switchgear, inverters, and BMS software. The system can typically support fast charge of electric vehicles or efficiently store energy from solar panel systems. For larger applications, the modular system can be easily scaled. A stacked 96kWh unit takes the same floor space as a 48kWh unit. This makes the 96kWh units suitable for container solutions.  
[www.nilar.com](http://www.nilar.com)

**Batteries - Redox Flow**



**ViZn Energy Systems**  
The GS200 Energy Storage System is a self-contained, modular storage system delivering cost-effective and safe energy storage. The zinc/iron flow battery incorporates an efficient and worry free non-toxic chemistry. The flexible GS200 modules can be interconnected for higher power and energy requirements.  
[www.viznenergy.com](http://www.viznenergy.com)

**Battery Management Systems**



**Nuvation Energy**  
Nuvation BMS is a highly configurable and MESA/Sunspec conformant off-the-shelf battery management system that can be used in both small- and large-scale energy storage systems. With over 1000 configurable settings, Nuvation BMS drastically reduces an energy storage project development effort with a BMS that has been designed from the ground up to utility-grade standards. Product options range from an 11- 60VDC BMS for low-voltage applications, to a modular 1250VDC battery management system that can manage megawatt-scale containerized storage.  
[www.nuvationenergy.com](http://www.nuvationenergy.com)

**Capacitors**



**Cornell Dubilier Electronics**  
Next generation inverter designs for renewable energy demand reliable DC link capacitors with higher capacitance values, voltage, and current ratings. Available in new case sizes and ratings, Cornell Dubilier's Type 947D power film capacitors offer high bulk energy storage, ripple filtering, and life expectancy for wind and solar power inverter designs, as well as electric vehicle applications. Clients can select from hundreds of standard catalog listings, or connect with CDE engineers to develop special designs to their requirements.  
[www.cde.com](http://www.cde.com)

**Charging Technology and Devices**



**SolarEdge**  
Based on patent-pending technology, SolarEdge's inverter-integrated EV charger charges by supplementing grid power with PV power via a single inverter. Offering a solar boost mode, SolarEdge's Level 2 EV charger offers charging 6x faster than a standard Level 1 charger. SolarEdge's HD-Wave inverter with an integrated EV charger provides management and monitoring of solar production, while enabling EV charging from a single inverter and dashboard.  
[www.solaredge.com/us](http://www.solaredge.com/us)

**Components**



**Gigavac**  
All GIGAVAC Power Products are designed and manufactured at GIGAVAC in Carpinteria, California. GIGAVAC's Advanced Switching Solutions includes patented EPIC hermetically sealed contactors and GIGAVAC MiniFACTORS switching high currents at voltages from 12Vdc to 1500Vdc. GIGAVAC's patented manual disconnects are hermetically sealed with ratings to 400A.  
[www.gigavac.com](http://www.gigavac.com)



**HARTING, Inc. of North America**  
HARTING is a connectivity solution provider for critical applications. Providing connector and cabling solutions for getting power, signal, and data quickly and reliably from point A to B, their expertise also includes board level and backplane development and manufacturing, network components, complete RFID systems for asset control and management, and, most recently, an edge computer to connect already existing devices to the IIOT.  
[www.harting-usa.com](http://www.harting-usa.com)



**Mersen**  
With the continuous growth of demands for DC battery-related applications such as Energy Storage facilities and Electric Vehicles, comes the need for better operation management and fault clearing of such loads. Mersen offers a wide range of DC overcurrent protection solutions based upon incumbent technology (DC fuse) enhanced by two new disruptive hybrid devices. These three product families are designed to safely clear both high and low DC fault currents for today's demanding DC systems.  
[www.ep.mersen.com](http://www.ep.mersen.com)



**Babcock & Wilcox MEGTEC**  
Babcock & Wilcox MEGTEC is a global turnkey supplier of custom single-side or simultaneous two-side coating lines, drying systems, and environmental solutions. B&W MEGTEC has developed solutions for applications in lithium-ion battery electrodes, fuel cells, advanced composites, battery separators, solar films, membranes, clean room processes, and others. Its GigaCoater wide-web coating line for lithium-ion battery electrodes provides high-volume production of battery electrodes, with each GigaCoater capable of producing up to 3GWhr of electrode capacity per year on average. B&W MEGTEC has also developed an easy-to-use laboratory coating line designed for short production runs. In addition, they offer a complete range of pollution control equipment consisting of oxidizers, solvent recovery systems, and distillation and purification systems.  
[www.babcock.com/megtec](http://www.babcock.com/megtec)



**Iron Edison Battery Company**  
The Iron Edison Battery Company offers Lithium Iron (LiFePO4) and Nickel Iron (NiFe) batteries for solar and off-grid. 48V compatible with all major inverter brands. Iron Edison provides free system design, free setup, and technical support and a 10-year warranty. Capacity from 10kWh up to 250kWh at 48V.  
[www.ironedison.com](http://www.ironedison.com)



## Contractors | EPC



### Black & Veatch

Black & Veatch provides comprehensive bankability, planning, siting, design, and full EPC and also construction only services for all types of renewable resource development. Black & Veatch also brings expertise in all energy storage technologies, including batteries, compressed air, flywheels, and pumped storage hydro. From utility to small-scale projects, their services span the life cycle from planning and development to installation and grid integration.

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

## Controllers



### Eaton

Eaton's Power Xpert Energy Optimizer controller helps simplify and expedite deployment of complex microgrid and energy storage systems. Designed for critical applications, the solution is engineered to help customers deploy stand-alone power systems using existing and new assets with the adaptability to easily meet future needs. The system provides a modular, scalable approach to microgrid control in military, campus, utility, healthcare, commercial, community, and other applications.

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



### Morningstar Corporation

For 25 years, Morningstar has been a supplier of solar charge controllers and inverters for off-grid systems. This includes PWM/MPPT controllers, pure sine wave inverters, and many accessories to support remote monitoring, ground fault protection, and system control functions.

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

## Cooling | Thermal Management



### Stäubli Corporation

Stäubli non-spill quick-release couplings are suited for use in thermal management circuits and ensure reliability over long periods of time. Compact design means they can be incorporated seamlessly into an installation. With a variety of coupling material options and numerous seal types available, they are compatible with a wide range of coolants and temperatures. Built-in misalignment compensation on several styles makes Stäubli couplings a solution for blind mate rack connections.

[www.staubli.us](http://www.staubli.us)

## Design & Build Integrator



**Sabre Industries**  
Building Systems by CellXion

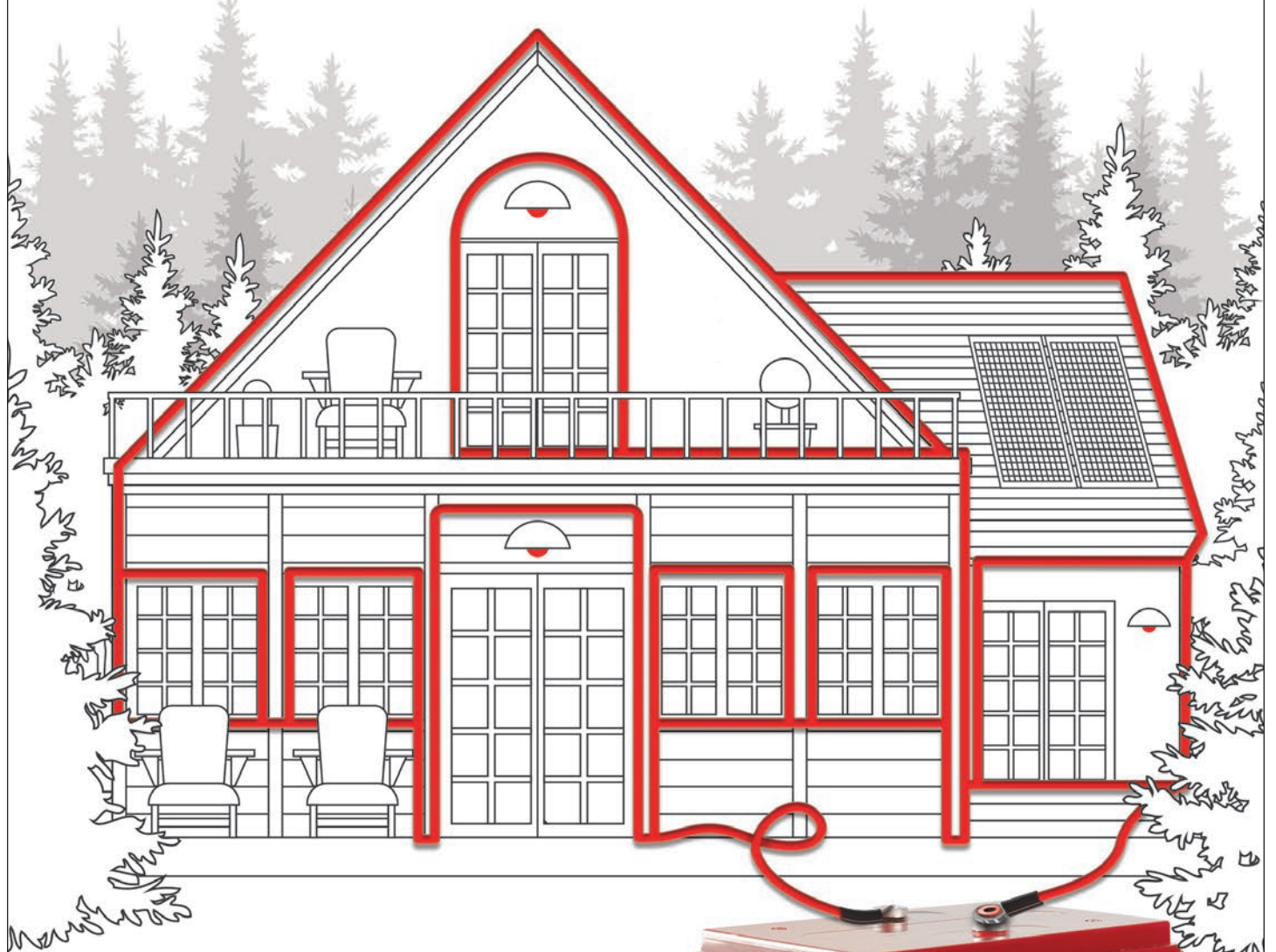
### Sabre Industries Building Systems by CellXion

Sabre Industries Building Systems Division manufactures integrated equipment enclosures, skids, and buildings for utility substations including: Control houses, Power conditioning stations, Battery systems enclosures, Metering and protection skids, Relay cabinet enclosures, and Switchgear skids. With their engineering expertise, breadth of enclosure products, and integration craft, they can support a variety of requirements.

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

CALIFORNIA  
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# THERE'S A LOT OF LIFE IN ONE BATTERY.



# Rolls

BATTERY ENGINEERING

**YOUR RELIABLE OFF-GRID SOLUTION.**

PREMIUM DEEP CYCLE FLOODED AND MAINTENANCE-FREE AGM & GEL

[ROLLSBATTERY.COM](http://ROLLSBATTERY.COM)







### SunWize Power & Battery

SunWize Power & Battery designs and builds reliable, stand-alone industrial power solutions and electronic assemblies for integration into OEM products and off-grid field applications. Their solar, battery backup, and hybrid power systems are pre-engineered, assembled, and tested for easy installation and minimal maintenance.

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

### Electrical Energy Storage



### NantEnergy (Fluidic Energy)

NantEnergy delivers low cost power solutions enabled by its proprietary energy storage technology and integrated intelligent controls system. The company has delivered its Zinc-air breathing cell in over 120,000 batteries installed in demanding environments around the world over the past 6 years. The company's power solution can replace lead-acid batteries and diesel generators. Customer sites include communication towers and solar microgrids providing clean power to remote communities. Most installations are outdoor (no cooling required) and vary in size from 10KWh to +1MWh, although there's no size limitations. In 2017, the company began delivering complete vertically integrated solar/storage solutions, which can be paired with its energy-as-a-service business model so customers pay a monthly fee (rather than investing in capital equipment). The company's turnkey power solutions are reliable for communication, critical back-up, and microgrid applications when customers require continuous discharge capability of 4 to 72 hours.

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



### SIBA FUSES, LLC

SIBA FUSES has introduced PV fuses and developed special wind farm SSK fuses for Switch-Fuse combination, providing minimal breaking current at low dissipation and can be used on transformers rated up to 3150KVA. Their energy storage fuses feature a high breaking capacity specifically designed to meet stringent energy storage requirements.

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



### Sinexcel, Inc.

Semi-integrated BES solution driven by SINEXCEL is not limited to battery technologies, and supports most batteries including Lead-acid, Lithium-ion, Flow battery, and Super Capacitor. The standard electric room benefit from modular and ETL/CPUC/HECO listed PCS offers maximum space for battery. The built-in transformer, switches, fire suppression, and local controls reduce complications and cost of installation. They offer NEMA 3R rating cabinets and 10/20/40ft containers for different power and energy applications in community, commercial, and industrial settings.

[www.sinexcel.us](http://www.sinexcel.us)

### Energy Storage Metering



### Continental Control Systems, LLC

Continental Control Systems provides economical and high accuracy measurement of electrical production and consumption, and has designed a new meter module for mass production, customizable for OEM metering design-in. The WattNode Meter Module is a bidirectional networked energy meter offering energy measurement parameters such as energy (kWh), power (kW), voltage, current, demand, kVAR, kVARh, power factor, frequency, etc. These energy values are communicated using the Modbus RTU communication protocol over RS-485. Revenue-grade accuracy is obtainable using the CCS Accu-CT family of current transformers, (Class 0.6 or Class 0.3 accuracy), otherwise the meter module utilizes any externally mounted or PCB mounted 0.333 Vac current transformers. Available as single and three phase modules, the meter is externally (instrument) powered from 12 to 24 Vac or 6 to 24 Vdc.

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

### Energy Storage Systems



### Atlas ESS

Atlas Energy Storage Systems are inexpensive, high performing lithium ion based systems. All Atlas ESS products have approvals from nationally recognized test labs. Atlas products comply with the new provisions for energy storage systems in the 2017 edition of the National Electric Code (NEC). Professionals and DIYers alike can assemble NEC compliant Energy Storage Systems using Atlas components. Cabinets, BMS, and controls are available separately or in pre-assembled systems.

[www.atlas-ess.com](http://www.atlas-ess.com)



### Younicos, Inc.

Y.Cube is a fully integrated plug-and-play energy storage solution that supports all storage applications, while ensuring maximum system effectiveness and efficiency. Every component has been designed to deliver optimum performance and minimize operating costs. The Y.Cube uses a modular architecture and is available in different container sizes. Single units can be easily combined to deliver the power and capacity required for any application.

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

### Energy Storage Systems - Commercial



### Atlantic Clean Energy Supply

ACES' Battery Energy Storage System (BESS) is a commercial PCS system offered in 30kW/50kW/100kW/150kW or larger. They also provide a variety of affordable batteries, including lead-acid, AGM, Gel, and Li-ion. They can also provide less than 10kWh on/off-grid system solutions.

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



### Baker Electric

Baker Commercial Solar is the solar energy arm of Baker Electric. They design and install commercial and utility solar and storage systems, helping their customers save money and increase profitability. They analyze electric usage to design a new system or add to existing systems. They recommend what works best for specific project needs; roof, ground mount, canopy, and carport. Their on-site staff includes engineers, designers, estimators, project managers, and LEED and NACEP Certified employees. Their expertise includes, but is not limited to small and large commercial buildings, non-profits, education facilities, and government/military installations.

[www.baker-electric.com](http://www.baker-electric.com)



### Canadian Energy

Canadian Energy provides batteries, stored energy solutions, DC power solutions, and renewable energy solutions all across Canada and all over the world.

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



### Delta Products Corporation

Delta has released its scalable outdoor Power Conditioning System (PCS) and new scalable Energy Storage Solution (ESS) allowing up to 500kW and eight hour energy storage capability. The scalable Li-Ion Battery Cabinets support two, four, and eight hour energy storage when coupled with Delta's scalable 125kW to 500kW PCS. The paralleled ESS battery cabinets have a scalable capacity from 84kWh to 1.32MWh, making it a solution for medium to large scale commercial and industrial deployments.

[www.delta-americas.com](http://www.delta-americas.com)



### Draker Energy and Inaccess

Draker/Inaccess Power Plant Controllers for Energy Storage Systems (S-PPC) maximize revenue, providing scalable code-compliant control solutions to transform renewable generation facilities into dispatchable assets. Their S-PPC integrates with battery management systems and storage inverters from any vendor so plant owners can capitalize on delivering frequency regulation, peak shaving, spinning reserves, ramp rate control, and capacity firming from hybrid renewable generation and storage facilities.

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





### Dynapower Company

Dynapower's fully-integrated BTM-250kw/500kWh energy storage system is available in 2, 4 and 6-hour configurations. The units couple Dynapower's UL 1741 MPS-250 smart inverter with Samsung SDI E2 batteries. Multiple skid-mounted systems can be paralleled. The BESS features Dynapower's patented Dynamic Transfer technology which monitors the grid and seamlessly transitions the facility from grid-tied to battery backup power upon detecting a disturbance. IEEE 1547 compliant.

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



### Global Equipment & Manufacturing

GEM specializes in high access/high payload ISO shipping containers, high voltage/high amperage DC controls and combiners, and specialized, high performance cooling solutions for demanding stored energy systems. They can also provide products in life safety, fire detection and suppression, racking, and electrical support products such as battery management systems (BMS), inverter/converter technology, transformers, and auxiliary electrical.

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



### JLM Energy

JLM Energy has created a fully-integrated software platform and energy ecosystem that optimizes energy use and maximizes savings for customers. The ecosystem includes a plug-and-play energy storage product, monitoring devices, algorithms, and load controllers which are all unified via a single software platform.

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



### Kratos Modular Systems Division

Kratos provides engineering, manufacturing, integration, and commissioning of modular energy storage solutions. Kratos' prefabricated enclosures provide a secure, scalable, and rapidly deployable environment for housing mission critical electrical, power, and cooling equipment. Whether the need is for a custom enclosure, externally accessible module, or ISO container-based platform, Kratos can provide a solution.

[www.kratosmsd.com/commercial](http://www.kratosmsd.com/commercial)



### NEXTracker

NX Flow is a turnkey solar-plus-storage solution combining a solar tracker, vanadium flow battery, inverter, and software control technologies to deliver maximized return on investment. DC-coupled with the PV array to improve round-trip inverter efficiency, NX Flow features Digital O&M control software for complete system analytics, preventive maintenance and monitoring, and can discharge 100% of stored energy with little to no degradation, even under extreme duty cycles.

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

# The Battery Matters



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

When it comes to solar power systems, don't settle for just any battery and be left in the dark. For energy storage and power when you need it, always choose Deka Solar, the long-life, reliable battery for on and off-grid power needs in even the harshest conditions.

Deka Solar Gel, AGM or flooded batteries are the proven choice for all your renewable energy applications.

- Competitive Warranty • Quality systems certified to ISO9001
- U.L. recognized components • Available through MK Battery distribution centers across North America, Europe and the Asia Pacific region.



### Deka Solar Saves The Day



Find your new Deka Solar battery

[mkbattery.com](http://mkbattery.com) © MK Battery 2016



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





**Solect Energy**

Solect Energy provides commercial-scale solar, delivering customized design and installation solutions, operations and maintenance services, and energy storage systems.

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

**Energy Storage Systems - Grid-Connected**



**Enphase Energy**

Enphase Energy's new Enphase AC Battery provides intelligence and value, with its low cost of entry and long lifetime value. It pairs seamlessly with Enphase microinverters and other solar technologies. The Enphase AC Battery is simple to install, safe, reliable, and provides low lifetime energy cost for both new solar customers and retrofit customers.

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



**NEC Energy Solutions**

NEC Energy Solutions designs, manufactures, and integrates smart energy storage solutions for the electric grid and applications with critical power needs. Its megawatt-scale energy storage and control systems provide stability to the grid while maximizing renewable generation. In telecom, datacenter, and other industrial applications, its high performance lithium-ion battery systems provide value in tough, critical power applications.

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



**Powin Energy**

Powin's Stack products are modular, purpose-built DC strings ranging in size from 106kWh to 175kWh, which easily and cost-effectively scale from kilowatt to megawatt applications. It is available in both indoor and outdoor models, each of which is engineered to maximize energy density and minimize system footprint. All Stack products are operated by Powin's proprietary bp-OS software which is patented in both the United States and China.

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



**Stem**

Stem pairs artificial intelligence with energy storage to help organizations automate energy cost savings and adapt to changing rates. Stem's Athena—the first AI for energy storage—uses big data and machine learning to optimize the timing of energy use, saving customers 10 to 25% off electricity bills. Athena links facilities into a powerful network that can instantly form virtual power plants which allow customers to earn demand response revenue and participate in grid modernization.

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



**Go Electric**

LYNC DR is a turnkey battery energy storage system that delivers uninterruptible power to facilities, lowers energy costs, integrates renewables and other DERs into a resilient microgrid, and provides grid-stabilizing services to utilities and ISOs. LYNC DR's AutoLYNC proprietary microgrid controller offers quick response time to deliver stable power. LYNC DR is an energy storage system that seamlessly keeps PV running when islanded as validated by NREL in 2017.

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



**Nel Hydrogen**

Nel Hydrogen provides Alkaline and Proton Exchange Membrin (PEM) electrolyzers and electrolyser plants, built-to-scale to store excess electricity from renewable energy sources as hydrogen. This technology allows energy suppliers stable and flexible delivery of electricity. When required, New Hydrogen also integrates equipment components from other global suppliers into a customized Nel solution.

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



**Renewable Energy Systems Americas, Inc. (RES)**

With their in-house engineered systems, a technology-agnostic approach, and over three decades of renewable energy construction experience, the RESolve energy storage systems maximize revenues, optimize performance, and increase asset longevity. The functions include-time shifting of energy, frequency services, renewable integration, upgrade deferral, micro-grid/off-grid, and grid support services. RESolve energy storage systems are customized to meet the demands of any customer.

[www.res-group.com](http://www.res-group.com)



**Sargent & Lundy LLC**

**Sargent & Lundy LLC**

For 127 years, Sargent & Lundy has provided broad-scope services on battery energy storage projects, including engineering, consulting, construction support, and EPC services. Their experience spans the spectrum of markets, applications, interconnection requirements, and technology types. Clients include utilities, developers, financial institutions/lenders, constructors, and manufacturers.

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

**POWER.PLANT.**



**When you're going off-grid you become the power plant.**

And when you need a battery to provide your power needs, depend on the best: **Crown Battery**. Thick energy-dense plates. Heavy-duty construction. More active lead materials. Proven low-maintenance performance. It all adds up to one **World Class Battery. Crown.**

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**socomec**  
Innovative Power Solutions



**Socomec, Inc.**

Socomec offers their 33kW to 1MW On-grid Storage Solution certified UL 9540 (US Standard for Energy Storage Systems). This solution includes: bidirectional power converters (UL 1741 SA), batteries, AC distribution cabinet, and string battery coupling panel (SBCP). A solution for industrial and commercial applications, this compact system enables peak shaving, load shifting, and photovoltaic self-consumption.

[www.socomec.us](http://www.socomec.us)

**Energy Storage Systems - Residential**



**simpliPhi**  
POWER  
Power. On Your Terms.™

**SimpliPhi Power**

SimpliPhi's plug-and-play, all-in-one AccESS streamlines equipment and costs by integrating power storage into new/existing on/off grid solar installations. AccESS combines SimpliPhi's cobalt-free, non-toxic LFP batteries with inverter charge controllers, power electronics, and system management in a NEMA 3R outdoor-rated box. Available in 10.5 or 6.8kWh, AccESS can scale up and be safely installed indoors or outside in temperatures from -4° to 122° with no risk of thermal runaway or fire.

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

**Energy Storage Systems - Off-Grid**



**Discover**®  
Innovative Battery Solutions

**Discover Battery**

Discover Battery's Advanced Energy System LiFePO4 batteries offer a low per kWh cost of energy storage. Deep cycling, fast recharge, >95% round-trip efficiency, 1C continuous charge/discharge, 5C peak current, and a 10-year warranty combined with zero maintenance provide performance and total cost of ownership savings.

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

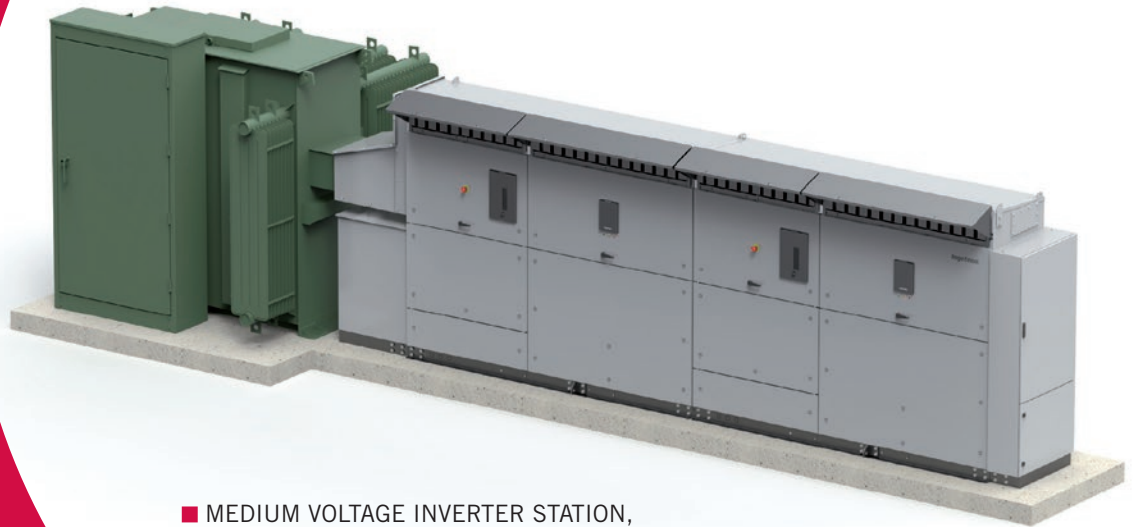


**simpliPhi**  
POWER  
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**SimpliPhi Power**

SimpliPhi's PHI 2.7 and PHI 3.5Wh non-toxic, cobalt-free LFP chemistry poses no risk of thermal runaway and offers top performance: full operation from -4° to 140°F, 98+% efficiency, 10,000 cycle life, deep depth of discharge, integration with all standard inverter charge controllers, and no need for cooling or thermal monitoring equipment to protect the warranty. Ideal for on- and off-grid commercial, residential, military, and humanitarian deployments. Field proven for 15+ years with a 10-year warranty.

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



■ MEDIUM VOLTAGE INVERTER STATION, CUSTOMIZED UP TO 3.6 MVA

# Maximize your Investment with Ingeteam's MV Solar PV Inverter Station

**Lowest CAPEX:**

Plug & Play Technology  
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**With so many advantages, it's no wonder why Ingeteam's inverter MV skid solution was selected for the 1.17GW largest single PV site in the world!**

**Ingeteam**

READY FOR YOUR CHALLENGES





**sonnen, Inc.**

The sonnenBatterie eco systems help residential customers use solar + storage to meet up to 100% of their energy needs. Sonnen's intelligent energy management system provides customers with greater energy control through increased solar self-consumption, reduced peak energy usage, and reliable backup power during outages, contributing to a cleaner and more reliable energy future. Sonnen's fully integrated, intelligent battery storage systems integrate with new and existing solar systems and are scalable from 4kWh - 16kWh in a single unit.

[www.sonnen-batterie.com](http://www.sonnen-batterie.com)



**Tabuchi Company of America, Limited**

Tabuchi America, a solar inverter manufacturer, offers an all-in-one solar+storage system that supports grid-tied and micro-grid energy needs. EIBS is easy to install and is equipped with a bi-directional DC/DC converter, automatic transfer switch, and a built-in battery management system. The EIBS system is a solution for balancing home energy management. Currently, they are working with partners in Puerto Rico to restore power to the area.

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

**Engineering Consultant**



**Electric Power Engineers, Inc.**

EPE Consulting provides the following services; transmission and distribution planning and design, energy market analysis, project/system design, interconnection testing and commissioning, NERC compliance services, integrated resource planning, smart grid modeling, and power system studies.

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



**POWER Engineers**

POWER Engineers provides technical expertise in energy storage and renewables interconnection and integration, system studies, site selection support, distributed generation, substation protection and control, and microgrid engineering and design. They also support the non-technical needs of storage programs, such as financial and economic analysis, and program management. This ranges all the way from tendering to project execution, resulting in cost-effective and reliable projects.

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

**EPC Services**



**Blattner Energy, Inc.**

Blattner Energy is a diversified engineering, procurement, and construction (EPC) contractor providing construction solutions for the power delivery industry and expertise in renewable energy. Blattner provides complete EPC services for utility-scale energy storage projects, and PV, CPV, and CSP solar projects as well as wind energy projects. Blattner has installed more than 32.5GW of renewable energy in North America. Their project management skills and self-performance allow them to deliver high levels of safety, quality, schedule, and productivity.

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



**Mott MacDonald**

Grid-connected battery storage projects are becoming commercially viable for many applications: reducing system and peak demand, providing standby power, improving frequency response, and more. Mott MacDonald has the full range of skills required to plan, engineer, implement, and manage commercially successful battery storage projects across a wide range of applications. Grid-connected battery storage projects are becoming commercially viable for many applications: reducing system and peak demand, providing standby power, improving frequency response, and more.

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



**Signal Energy, LLC**

Signal Energy Constructors is a design/build general contractor providing EPC services. Their experienced engineering and project teams have produced more than 8,000MW of utility-scale projects. Signal Energy Constructors possesses the expertise to build stand-alone energy storage projects or integrate energy storage into the design and construction of renewable power projects.

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



**Trimark Associates, Inc.**

Trimark is a reseller of NEC's distributed storage solution (DSS) — a pre-configured, fully integrated energy storage platform empowering the delivery of advanced energy services at the grid edge. The NEC DSS reduces enterprise energy costs by optimizing how and when energy is supplied from the grid. By combining Trimark's T1-S Vantage control platform with DSS, owners can align multiple generation sources, control charge and discharge events, track power characteristics at the point of interconnection, trend asset performance for predictive maintenance, and automatically produce and distribute scheduled reports. The combined DSS/T1-S platforms support smoother intermittent distributed renewable generation and shaving of peak demand.

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



**Wanzek Construction, Inc.**

Wanzek Construction, Inc., is a general construction contractor and industrial services company in North America. They partner with their clients to provide solutions through their commitment to safety, planning, execution, and teamwork. Wanzek serves many industries including Renewable Energy Construction and Services, Power, Oil & Gas, Infrastructure, Crane Services, Agriculture, and Industrial Services.

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

**Financial Services**



**CleanView Capital, LLC**

CleanView Capital's Clean Energy Ownership Program is for companies seeking optimal value from clean energy systems within capital budget constraints. The program uses an operating lease to replace upfront capital investment with 100% tax-deductible, fixed payments to create a low-cost path to ownership at an affordable purchase option price. In this way, the program could be considered a de facto method of financing.

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



**Rodman CPAs**

Rodman CPAs provides tax advisory, accounting, and business strategy services to small and mid-sized emerging and established businesses. The Rodman "Green Team" provides renewable energy producers and businesses that pursue energy efficiency initiatives with expertise in renewable energy tax accounting and business strategy. They offer tax advisory, financial, and accounting services for companies involved in solar, wind, biomass, waste-to-energy, and energy efficiency projects.

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

**Hybrid Systems**



**Darfon America Corp.**

The H300 series is a solution for those with a limited budget, a light load to support, and minimal floor space. The H300 series of hybrid storage systems are wall-mountable pre-configured solutions consisting of a H5001 hybrid inverter and 5kWh Lithium batteries (LNMC). In this series, the H301 has a storage capacity of 5kWh and the H302 has 10kWh. And if the need arises, the H301 can easily be upgraded into the H302.

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



## Inverters



### Analytic Systems

Analytic Systems makes Pure Sine Inverters from 300-3600W and Battery Chargers from 100-1500W for all environments. All are filtered for low EMI, and new products are DSP controlled. Their products can be customized with added functionality, rugged options, RoHS compliance, MIL STD testing to MIL461/MIL810, CSA/UL inspection, and Water Resistance/Water Proofing. Analytic Systems also offers 100A MPPT Solar Charge Controllers for solar arrays up to 230V, and open circuit and battery banks from 24 to 72Vdc.

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



### Canadian Power Conversion, Inc.

COTEK SR1600 - 1600 Watt Telecom Series Pure Sine Wave Inverter provides parallel connection of up to 32 modules, supporting maximum output power 51.2KW and AC/DC Auto-Switch converts positive or negative 24Vdc and 48Vdc power to continuous AC power for telecom, IT, and industrial applications. The unit delivers clean power from a 1U, 19" rack-mountable package. User friendly, fast and easy installation, and modular design allows for expandable system capacity.

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



### Fronius

Fronius introduces the Fronius Smart Solution, the next generation of solar systems. The Fronius Smart Solution, for residential and commercial systems, provides flexible system design, shade mitigation, NEC compliance, high performance, and monitoring while keeping the number of components low and the installation easy. The Fronius Smart Solution consists of cell-string optimized modules, the Fronius Rapid Shutdown Box, a Fronius SnapINverter, the Fronius Smart Meter, and the Fronius Solar.web monitoring portal.

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

# Ingeteam



### Ingeteam

Ingeteam's INGECON SUN STORAGE PowerMax is a three-phase bidirectional battery inverter for both grid-connected and stand-alone systems, certified according to UL9540 and UL1741(\*March 2018) standards. This inverter offers a high power density in a single power block, providing different configurable operating modes. It is available in two different series, 1000Vdc and 1500Vdc (610kVA to 1,640kVA), and features highly advanced battery control technology which extends the maximum life of the storage system. The ISS PowerMax is 100% compatible with Ingeteam's PV inverters and employs the same technology, ensuring reliability and facilitating the supply of spare parts. Furthermore, the DC input and AC output connections are integrated into the same cabinet, to simplify maintenance work.

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

# Narada

## Energy Storage Solutions for Grid, Off-Grid, Micro-Grid and Home Energy



When you need long term reliable batteries, Narada RexC-series Lead Carbon and Intensive Cycling series batteries deliver. Engineered and manufactured in state of the art facilities, Narada provides solutions to meet your renewable power energy storage needs.

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Tel: 800-982-4339





### Rhombus Energy Solutions

Rhombus Energy's Power Converter Systems enable batteries to be optimally used by converting power from AC to DC to charge batteries, and from DC to AC to use the energy stored in the batteries. Every Energy Storage System (ESS), depending on type of batteries, operates at different voltage ranges and charge/discharge rates. Rhombus Power Converters are an essential and core part of an ESS, and are tuned to optimize each ESS.

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



### Siemens

SINACON HC is a modular, flexible, and easy-to-use hybrid converter that integrates distributed resources to the grid. It processes energy from three different generation/storage technologies simultaneously to provide three-phase AC power to a public grid and/or a microgrid, eliminating the need for other gear. The wide DC voltage range allows flexibility in source and storage technologies of today and the future. It is certified to UL1741, CSA 22.2 107.1 and other international standards.

[usa.siemens.com](http://usa.siemens.com)



### SMA America

The UL listed Sunny Boy Storage 3.8-US/5.0-US/6.0-US inverter is SMA's solution for residential energy storage and management. The Sunny Boy Storage-US offers intelligent residential energy management, and is equipped with features and functions to maximize ROI. Using an AC coupled architecture, the Sunny Boy Storage 3.8-US/5.0-US/6.0-US offers a simple, flexible platform for new and existing PV systems that is compatible with many high-voltage battery brands.

[www.sma-america.com](http://www.sma-america.com)

## Maintenance



### Powering America (NECA & IBEW)

The Powering America Team consists of craftsmen from the International Brotherhood of Electrical Workers and their signatory contractors, including those who are members of the National Electrical Contractors Association. Their expertise provides assurances to electrical teams that accidents, injuries, and costly delays will be reduced, callbacks and limit change orders will be eliminated, and budget busting emergencies and incidents that can turn into legal issues will be avoided.

[www.powering-america.org](http://www.powering-america.org)

## Non-Battery Energy Storage Methods



### Highview Power

Highview Power's proprietary liquid air energy storage (LAES) technology is based on the principle of air liquefaction, enabling the storage of gases in cryogenic liquid form. The process involves a 700-fold expansion in volume from liquid back to gas, which releases the stored energy, powering turbines, and generating electricity. This enables Highview's system to store energy in increments measured in days rather than hours, at half the cost of lithium-ion, and with no siting constraints.

[www.highview-power.com](http://www.highview-power.com)

## Power Electronics for Storage Systems



### Chroma Systems Solutions, Inc.

Chroma is a global provider of power conversion test instrumentation and automated systems including Battery Test Systems, AC/DC Power Sources, Electronic Loads, Power Meters, and ATE for diverse bench-top, R&D and design verification of EV/PHEV, Solar, LED, Battery, Medical, and Power Supply applications.

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



### Ideal Power, Inc.

The Stabiliti Series is Ideal Power's latest 30 kilowatt power conversion system for project developers and system integrators seeking to efficiently connect distributed energy resources to the grid and reduce demand charges. The grid-resilient Stabiliti Series is available in two versions: dual port AC-DC bi-directional and multi-port AC-DC-DC bi-directional. Both products are microgrid-enabled with multi-port conversion technologies and are fully certified to the latest UL 1741 SA Smart Inverter standard, creating energy resilience and reducing reliance on backup generators.

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



### MORNSUN

MORNSUN PV Series (CE approval) offer a wide input voltage range of 100-1500VDC and a temperature range of -40° to +70°, which enable the control systems to get power from the solar panels directly and ensure reliable operation. 4000VAC isolation voltage, multiple protections output over-voltage protection, short circuit protection, and anti-reverse connection protection ensure the stability of the circuit. They have multiple packages including, PCB mount, DIN-Rail mount, and Chassis mount.

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

## Project Developer



### EDF Renewable Energy

EDF Renewable Energy brings together a thorough understanding of energy storage and solar energy in local markets, with the global procurement and financial wherewithal of an international energy firm. In North America, EDF RE has developed 9.5GW of renewable energy projects. EDF RE leverages its utility-scale experience to provide commercial scale project development, engineering, procurement, construction, and long term operations and maintenance for distributed generation and storage.

[www.edf-re.com](http://www.edf-re.com)

## Protective Relay



### Day Ahead Instrumentation

Day Ahead Instrumentation (DAI) provides turnkey multifunction relays for utility interconnection requirements. Typical systems include solid state relays, test switches, mini-station batteries, and NEMA 1/3R/4 enclosures. Assemblies can be configured for DTT, MPLS, or SCADA interface with wired, fiber, or wireless coms. PV real time monitoring and reporting of power generation is available. Lead times as low as 20 business days from receipt of basis of design and NTP.

[www.day-ahead.com](http://www.day-ahead.com)



### NEO Virtus Engineering, Inc.

NEO Virtus Engineering specializes in programming protective relays/RTUs for PV interconnections, including Schweitzer/Beckwith/Eaton/Bazler relays, SEL 3530 RTAC, and NovaTech Orion RTU. They also offer programming for DNP, Modbus RTU/Modbus TCP/IP, Ethernet, Serial, Mirrored-Bit, and IEC 61850, etc. NEO designs wireless P2P and P2MP radio communication and programs radio transceivers like SEL-3031, SEL 2505, and industrial routers, for MPLS line (DDS and T1/E1) coms between the utility EMS and RTU.

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

## Software Supplier



### JobNimbus

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 business from the field or in the office.

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



### Sighten

Sighten offers a comprehensive software platform for solar, covering the entire workflow from lead to install. Sighten can accelerate sales, access integrated financing, and streamline operations. Sighten's powerful, solar-specific feature set includes utility bill and usage evaluation, system design with automated shading analysis, proposal and contract generation with e-signature, and post-sale operations management. The software also offers unlimited users and proposals.

[www.sighten.io](http://www.sighten.io)



## Storage Products & Services



### Destin Power

The All-in-One for 100kW PCS and 220kWh battery is provided as an integrated product of PCS, LiB, and switch gear. It can be configured for the various needs of energy storage application fields like peak cut and renewable energy connections. They work closely with clients through turnkey based ESS projects. This product is easy to install and maintain. Its round-trip efficiency is 91.5% by applying Hybrid SiC IGBT. The turnkey ESS is also available with large 20ft or 40ft containers.

[www.destin.co.kr](http://www.destin.co.kr)

## Thermal Energy Storage



### Ice Energy

Ice Energy's Ice Cub is a compact, home-optimized, solar-compatible HVAC system comprised of an ultra-high efficiency compressor and ice tank with heat exchanger. The Ice Cub compressor can cool the home like a conventional AC unit, or store energy by freezing water in the ice tank to later provide up to four hours of cooling to an entire home. When heating is required, the circuit reverses and the compressor operates as a heat pump to provide all the heating required for a home.

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



### Sun Bandit by Next Generation Energy

Sun Bandit by Next Generation Energy, is the first solar PV water heating solution to be ICC-SRCC certified, representing a paradigm shift in the way solar energy is captured, stored, and used to heat water. Sun Bandit requires no net-meter connection and uses solar PV modules that simplify installation, operation, and maintenance making it easy to reduce utility costs and provide consumers with a simple, clean, and dependable on-site energy storage solution.

[www.sunbandit.us](http://www.sunbandit.us)

## Valves and System Components



### GEMU Valves

GEMU Valves High Purity products are developed and produced for use in process equipment, ultra-pure water, chemical manufacturing, and distribution systems for electrolyte filling and separation of various media. The High Purity products are produced under strict cleanroom conditions at the manufacturing site in Switzerland. GEMU develops, produces, and supplies CleanStar, iComLine, Hydraline, SmartLine, PurePlus, FlareStar, SonicLine, and Controls.

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

## Wire & Cable



### Southwire Company, LLC

Southwire's Super Sunlight Resistant (SSR) Type PV cables feature enhanced UV stability, color permanence, and aged physical properties. The cable is available in sizes 6 AWG through 1000 kcmil and is approved for use in solar power applications per the NEC article 690. Individual conductors are stranded aluminum alloy with a cross-linked polyethylene (XLPE) insulation and is rated for direct burial. The cable is sunlight resistant, RoHS compliant, passes -40°C cold bend, and is VW-1 rated.

[www.powergen.southwire.com](http://www.powergen.southwire.com)

## Other - Energy Recovery



### DDI Heat Exchangers, Inc.

DDI Heat Exchangers' energy recovery system is a solution for recovering energy from a building's wasted grey water, city sewage pipes, industrial, or Waste Water Treatment Plants (WWTP). This approach in energy recovery works via rectangular patented heat exchangers, featuring no baking (wide gaps), no plugging (fast flow), and a possible double wall due to rectangular plates.

[www.ddi-heatexchangers.com](http://www.ddi-heatexchangers.com)

## Other - Fire Suppression



### Firetrace USA, LLC

Firetrace provides automatic fire suppression solutions for energized battery storage protection.

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

## Other - Higher Education



### The University of British Columbia

The Master of Engineering Leadership (MEL) in Clean Energy Engineering is an intensive one-year degree (January to December) for engineers and environmental science graduates who want to make their sustainable vision a reality and advance their careers in the in-demand field of clean energy. Graduates of this program will have the skills to boost their career: tackling complex engineering challenges in this in-demand field while confidently leading collaborative teams.

[mel.ubc.ca](http://mel.ubc.ca)

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## ESA ENERGY STORAGE 28<sup>TH</sup> ANNUAL CONFERENCE & EXPO

April 18<sup>th</sup>-20<sup>th</sup>, 2018

Hynes Convention Center — Boston, MA

For decades, energy storage technology has continued to advance towards integrating electricity from any source into a more resilient and reliable grid, creating jobs, lowering energy bills, and helping to secure our energy future. Now, energy storage is proven and ready for business and the 28<sup>th</sup> Annual Energy Storage Association Conference and Expo (#ESACon18) is where that business happens. Here, network to make those connections to grow your business. Here, access premier education from the energy storage industry's best and brightest. Here, collaborate with stakeholders across the full spectrum of energy resources. And here, directly support the association's mission to transform and expand energy storage markets in the United States. With leading industry speakers, dozens insightful education sessions, site tours to advanced energy projects, multiple workshops led by renowned experts, over 70 exhibiting companies, and nearly 2,000 attendees from 30+ countries, ESA is the go-to for energy storage education and a vital gathering place for the industry.

[esacon.energystorage-events.org](http://esacon.energystorage-events.org)

show in print

Features just some of the companies and technologies attendees will see at this year's show.



### Behind the meter battery energy systems

For smart buildings and cities wanting to increase renewable integration and reduce the impact of increases in the electricity retail price, Socomec has developed SUNSYS XTEND ESS. This smart storage solution maximizes the energy self-consumption for industrial and commercial applications. Any energy surplus is stored in the battery system, and the energy is used later to supply the load. When the retail cost of electricity is low, the batteries are charged and used to supply the loads during peak demand when prices are high. Available from 33kW to 1MW, Socomec's solution is UL 9540 certified. **Socomec** | [www.socomec.us](http://www.socomec.us)



### Optimized and efficient large-scale storage solution

Y.Station is a solution for large-capacity grid-scale storage projects from a few megawatts to many. It is pre-designed and pre-engineered to provide an optimized system layout while minimizing system losses, as well as facilitating efficient project planning and faster project deployment. Because operating efficiencies deserve as much attention as installation efficiencies, Y.Station prioritizes reducing auxiliary losses, cost-effective system redundancies, and robust communications across high numbers of battery racks. Real-time operation of the Y.Station is monitored and controlled by Y.Q, a powerful integrated software platform and the brains behind every Younicos energy storage solution. **Younicos** | [www.younicos.com](http://www.younicos.com)



### Turn-key battery energy storage solution

LYNC DR is a turnkey battery energy storage system that delivers uninterrupted power to facilities, lowers energy costs, integrates renewables and other DERs into a resilient microgrid, and provides grid-stabilizing services to utilities and ISOs. Built into LYNC DR is AutoLYNC, a proprietary microgrid architecture and controller which offers quick response time to deliver stable and resilient power when it's needed the most. LYNC DR is capable of islanding/grid forming and can seamlessly keep PV running during an islanding event. This ability was third-party validated by NREL in 2017. LYNC DR is Open ADR 2.0b enabled, allowing any utility or end-use customer to directly communicate with and control the energy storage system, has an aggregation portal built right into the control panel, and a customer-friendly, web-based interface for 24/7 monitoring. **Go Electric, Inc.** | [www.goelectricinc.com](http://www.goelectricinc.com)



### DC-coupled solar-plus-storage

The DPS-375kW DC to DC converter is designed for coupling both existing and new utility-scale solar installations with energy storage. Installing DC-coupled utility-scale solar-plus-storage with a DPS-375 eliminates the need for costly switchgear and other equipment, significantly reducing the cost to install energy storage compared to doing so with an AC-Coupled or Hybrid inverter. The use of the DPS-375 and its patent pending technology also increases energy production and revenues for utility-scale solar installations by way of clipping recapture and low voltage harvest, both of which are only available through DC-coupled solar-plus-storage. The use of a DPS-375 when adding energy storage to utility-scale installation is efficient and ITC eligible. Multiple units can be paralleled together and Dynamapower offers the DPS-375 with fully-integrated systems as well. **DynamapowerCompany, LLC** | [www.dynapower.com](http://www.dynapower.com)

## SOLAR, WIND & ENERGY STORAGE

**SIBA FUSES LLC**  
WEST CALDWELL, NJ  
PHONE: (973) 575-7422 FAX: (973) 575-5858  
EMAIL: [INFO@SIBAFUSE.COM](mailto:INFO@SIBAFUSE.COM)  
WEB: [WWW.SIBA-FUSES.US](http://WWW.SIBA-FUSES.US)



SIBA Fuses ES fuses have been 100% specifically designed and tested for the stringent requirements of (ES) Energy Storage applications and have been utilized by large OEM's globally. We're very confident you will appreciate our efficiency, product knowledge, superior technology, and the imaginative solutions that we can offer. Call or email us today; we'd love to have you as one of our many satisfied SIBA FUSES customers.



### Semi integrated BES

The semi-integrated BES solution, driven by SINEXCEL, is not limited to battery technologies, and can support most batteries including lead-acid, lithium-ion, flow battery, and super capacitor. The standard electric room benefit from modular and ETL/CPU/HECO listed PCS offers maximum space for battery. The built-in transformer, switches, fire suppression, and local controls reduce many complications and cost of installation. There are NEMA 3R rating cabinets and 10/20/40ft containers for different power and energy requirements in community, commercial, and industrial applications. **SINEXCEL** | [www.sinexcel.us](http://www.sinexcel.us)





## ***Powering Forward to Reach NEW HEIGHTS***

The U.S. industry closed 2017 strong, delivering **7,017 megawatts** (MW) of new wind power capacity. That new capacity represents **\$11 billion** in new private investment. The wind industry is powering forward to continue growth into 2018 and beyond.

WINDPOWER is where the industry comes together to plan for the future and keep this success story growing.

### **2018 HIGHLIGHTS**

- Hundreds of exhibitors & meeting rooms make it easy to meet new customers and discover the latest products and services
- Opening reception is open to ALL attendees at Navy Pier, a Chicago landmark
- Additional informal meet-ups added to increase networking opportunities
- Opportunities to meet current and future customers - grow your business
- General sessions & meeting rooms will be on the show floor again
- The 2018 registration list is already live - start planning your meetings now!

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### Circuit protection fuses and accessories

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### Electrical and integrated solutions

WEG Transformers USA provides electrical products and integrated solutions for the T&D, industrial, and renewable markets. Their products and solutions include: distribution, substation and power transformers, multi-winding (3, 4, or 6) step-up transformers for wind and solar applications, generator step-up transformers, voltage regulators, shunt reactors, and furnace transformers. They have been serving the N.A. renewable market for more than 20 years from their local manufacturing plants in Washington, Missouri with installed base of more than 12,000 wind and solar step-up transformers (24GW).

**WEG Transformers USA** | [www.weg.net](http://www.weg.net)



### Anchors and micropiles

Williams Form Engineering Corporation has been providing threaded steel bars and accessories for rock, soil and concrete anchors, post-tensioning systems, and concrete forming hardware systems in the construction industry for over 95 years. Their rock and soil anchor product line includes Spin-Lock mechanical rock anchors, polyester resin anchors, multiple corrosion protection anchors, soil nails, strand anchors, Manta Ray soil anchors, Geo-Drill Hollow-Bar anchors, and micropiles. For concrete anchoring, they offer Spin-Lock anchors, undercut anchors, reusable anchors, and cast-in-place anchors. They also have a full line of All-Thread Rebar for tiebacks, micropiles, and post-tensioning.

**Williams Form Engineering Corporation** | [www.williamsform.com](http://www.williamsform.com)



### Inspection services

Preformed Line Products provides safe and reliable unmanned aerial system (UAS) inspection services for utility assets, including transmission and distribution lines, generation facilities, and substations. Their services include comprehensive visual and IR inspections, as-built audits, preconstruction surveys, storm damage assessments, and vegetation management. Backed by over 70 years of industry experience, PLP and their partner, AUV Flight Services, provide the expertise, knowledge, and skilled flight operators necessary to efficiently capture, analyze, and assess the condition of utility equipment. PLP's aerial inspections also provide value-added services, including higher rates of anomaly detection and delivery of all-inclusive imagery. Inspection results are presented with asset condition classifications, GIS-mapped attributes, detailed engineering reports, and actionable data.

**Preformed Line Products** | [www.preformed.com](http://www.preformed.com)



### Power delivery services

Sargent & Lundy brings the experience and resources to help clients tackle transmission grid projects. Their multidiscipline project teams offer comprehensive services to successfully execute each project. From cross-country bulk power transmission to enclosed gas-insulated substations tucked into constrained urban locations, Sargent & Lundy helps their clients meet complex challenges. Working in collaboration with their client partners, teams are staffed with the specific resources to fulfill each project need and achieve budget and schedule commitments. Projects span new installations and existing facility improvement, from economic/technical assessments to detailed engineering, construction management, and commissioning. Sargent & Lundy also provides in-depth consulting services and project support, battery energy storage facility design, and IPP grid interconnection, including wind and solar installations. Serving power clients for 127 years.

**Sargent & Lundy** | [www.sargentlundy.com](http://www.sargentlundy.com)



### A wide-open landscape

Fibox announces the enhancement of the ARCA IEC enclosure series, with a new landscape hinge configuration. The ARCA IEC is a large UL listed NEMA 4X Polycarbonate Enclosure on the market. After offering the initial portrait orientation, the decision was made to offer a landscape orientation to give Fibox's clients and partners more options. Made in the European IEC standard sizes, this enclosure is available up to 31.5" x 23.5" x 11.5". The ARCA IEC cabinet enclosure is an enclosing alternative to steel. This watertight, impact resistant polycarbonate enclosure will not dent, rust, crack, or bloom like steel or fiberglass and weighs less and is much easier to modify. The ARCA IEC is available with either landscape or portrait orientation.

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



### Meter pedestal/box pad combination

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# Blockchain's Promise to Revolutionize the Energy Sector

by Peter Bronski



**IN EARLY FEBRUARY, TESLA AND THE** government of South Australia announced what was being billed as the world's largest virtual power plant. Combining rooftop solar PV and behind-the-meter batteries, the 250 MW system would ultimately include roughly 50,000 households. Meanwhile, that same week, the European Union announced formation of an observatory and forum, alongside €100 million (\$124 million) in funding, dedicated to researching uses for blockchain technology. Also that week, Bloomberg New Energy Finance released a report highlighting \$143 million in investment by 135 companies supporting blockchain applications for the energy sector specifically.

These seemingly unrelated anecdotes signal two mega trends on a potential collision course for electricity systems around the world: 1) the accelerating decentralization, decarbonization, and democratization of the grid, and 2) the rise of blockchain applications beyond cryptocurrencies and payments, including for energy-sector applications, from distributed energy resource (DER) integration to renewable energy certificates of origin to peer-to-peer energy trading networks (and many other use cases).

## From Bitcoin to Blockchain

Bitcoin, the popular digital cryptocurrency, is the best-known application of blockchain technology. Blockchains are a form of distributed ledger. Unlike centralized cloud computing (which are often proprietary, closed systems), blockchains are heavily decentralized, with identical copies of the ledger residing on many independent computers around the world. Those computers must cross-validate blocks of transactions and agree to add them to the ledger, making blockchains especially secure against corruption via cyberattack or bad actors.

Such an immutable, secure ledger enables participants to agree on a record of information (without the same needs for independent third parties), automate previously cumbersome processes, and lower transaction costs. While Bitcoin's value and energy use have dramatically increased over the past year, and captured many headlines, the underlying blockchain technology is the real story.

Cryptocurrencies such as Bitcoin are but one use of blockchain technology, which also has tremendous potential to transform a variety of industries. The energy sector—with its myriad participants, resources, markets, and regulations—is particularly ripe with opportunity. Blockchain is poised to support and accelerate the transition to a decentralized, democratized, decarbonized electricity grid.

## The Rise of DERs and Smart Devices

It's no secret that electricity grids across North America and globally are undergoing a fundamental transformation via:

- **Decarbonization:** the rise of renewable energy, including wind, utility-scale solar, and commercial and residential rooftop solar;
- **Decentralization:** the rise of customer-sited distributed energy resources such as rooftop solar, energy storage systems, smart thermostats, electric vehicles and EV charging, smart appliances, etc.; and
- **Democratization:** the ability for customers to provide value to the grid, trade among themselves in peer-to-peer exchanges, and/or participate in various existing retail and wholesale electricity markets

But are these mega trends poised to "break" the electricity grid, so to

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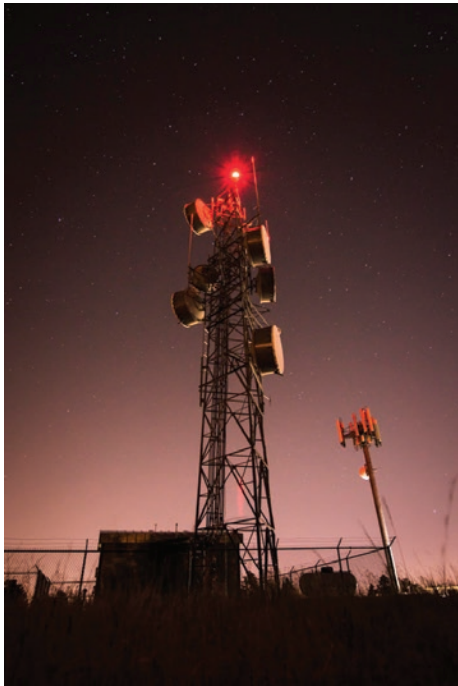
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computing energy consumption lean; allowing open access for market participants at all scales; and ensuring sufficient governance and oversight to address regulatory concerns.

Whether Bitcoin's volatile value surges back up to its December peak by the time you're reading this article is anyone's guess. As for blockchain in the energy sector, there's much to watch and be cautiously excited about.

*Peter Bronski leads marketing and communications for Energy Web Foundation, a nonprofit cofounded by Rocky Mountain Institute and Grid Singularity, developing an open-source blockchain platform specifically for the energy sector in concert with a network of affiliate partners. He is also the founder of Inflection Point Agency, and an alumnus of Rocky Mountain Institute and Panasonic.*

**Energy Web Foundation** | [www.energyweb.org](http://www.energyweb.org)

speak? Reconsider Tesla's South Australia virtual power plant, expected to ultimately include some 50,000 households. That sounds like a large number... until you consider where the grid is going. Analyst Gartner estimates there were ~8.4 billion IoT devices in use in 2017, and McKinsey forecasts that number to grow to 30 billion by 2020. Look at smart thermostats in particular. As of September 2017, U.S. utility "bring your own thermostat" programs alone had more than 2 million smart thermostat installations, expected to triple to 6 million by 2024. Analyst Navigant forecasts the global smart thermostat market will reach \$4.4 billion by 2025 (up from \$1.1 billion in 2016).

As renewable energy continues to displace conventional generation, and as we connect millions—and eventually, billions—of grid-interactive customer devices and technologies with flexible electricity loads to the grid, how will utilities and grid operators manage and balance all those resources and assets? That's where the power of blockchain really shines.

### Blockchain for the Energy Sector

From streamlining utility billing programs; to increasing the transparency and lowering the transaction costs of certificates of origin markets (e.g., renewable energy certificates); to enabling open and fair market access for all people, organizations, and devices, regardless of resource size; to unlocking opportunities for peer-to-peer (P2P) and machine-to-machine (M2M) energy transactions, blockchain's attributes are transformational and make it especially well-suited to a wide range of use cases.

But in a blockchain-powered energy future, the right platform design will be critical: able to handle high transaction volumes per second while keeping

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Anaheim Convention Center – Anaheim, CA; www.expowest.com
- 07-08 **SEIA's Inaugural Codes & Standards Symposium**  
Santa Barbara, CA; www.seia.org/codes
- 14 **ACORE National Renewable Energy Policy Forum**  
Washington Marriott at Metro Center – Washington, DC; www.acorepolicyforum.org
- 14-16 **GLOBE Forum 2018**  
Vancouver Convention Centre – Vancouver, BC; www.globeseries.com
- 19-22 **NABCEP 2018 CE Conference**  
Conference & Event Center Niagara Falls – Niagara Falls, NY; www.nabcep.org
- 20-21 **AWEA Wind Project Siting & Environmental Compliance Conference 2018**  
Memphis, TN; www.awea.org

**APRIL**

- 04 **Inter solar & ees Summit USA East**  
New York, NY; www.intersolarglobal.com
- 18-20 **28th Annual Energy Storage Association Conference & Expo**  
Boston, MA; www.energystorage.org
- 23-25 **SEPA Utility Conference**  
Rancho Mirage, CA; www.sepapower.org
- 23-26 **CxEnergy 2018 Conference & Expo**  
Rio All Suites Hotel and Casino – Las Vegas, NV; www.cxenergy.com
- 24-26 **Financial Structuring for Renewable Energy**  
Miami, FL; https://info.greenpowerglobal.com/financemiami/
- 30-02 **Midwest Solar Expo & Smart Energy Symposium**  
DoubleTree by Hilton Minneapolis, Park Place – Minneapolis, MN; www.midwestsolarexpo.com

**MAY**

- 07-10 **AWEA WINDPOWER 2018 Conference & Exhibition**  
Chicago, IL; www.windpowerexpo.org
- 11-12 **Solar Power Southeast**  
Loews Atlanta Hotel – Atlanta, GA; www.events.solar/southeast/
- 19 **26th Annual Solar Boat Regatta**  
Eden Prairie, MN; www.mnrenewables.org/solar-boat-regatta/
- 20-23 **Federation of New York Solid Waste Associations Strive For Sustainability Solid Waste & Recycling Conference with Trade Show**  
The Sagamore, Bolton Landing – Bolton Landing, NY; www.nyfederation.org

**JUNE**

- 13-14 **Solar Power Texas**  
Sheraton Austin Hotel at the Capitol – Austin, TX; www.events.solar/texas/
- 20-21 **36th West Coast Energy Management Congress (EMC)**  
Washington State Convention Center – Seattle, WA; www.energysummit.com
- 26-27 **Regional Wind Energy Conference - Northeast**  
Portland, ME; www.awea.org

**JULY**

- 10-12 **Intersolar North America**  
Moscone Center – San Francisco, CA; www.intersolar.us
- 10-12 **ees North America**  
Moscone Center – San Francisco, CA; www.ees-northamerica.com
- 17-19 **2018 Plugvolt Battery Seminar**  
Plymouth, MI; www.plugvolt.com

**SEPTEMBER**

- 05-06 **Wind Power on Capitol Hill**  
Washington, DC; www.awea.org
- 11-12 **Wind Resource & Project Assessment Conference**  
Sheraton Austin Hotel at the Capitol – Austin, TX; www.awea.org
- 24-27 **Solar Power International 2018**  
Anaheim Convention Center – Anaheim, CA; www.solarpowerinternational.com

**OCTOBER**

- 01-02 **Wind Energy Finance & Investment - East**  
New York, NY; www.awea.org
- 05 **Wind Energy Finance & Investment - West**  
San Francisco, CA; www.awea.org
- 16-17 **Offshore WINDPOWER Conference**  
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