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2017 WIND Buyers Guide

The Desert Renewable Energy Conservation Plan

Reconciling competing policies in
the California Desert

PERC UP

Next-generation solar modules
promise new opportunities

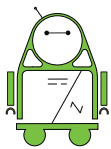
Battery Backup to Off-Grid

Navigating the transition

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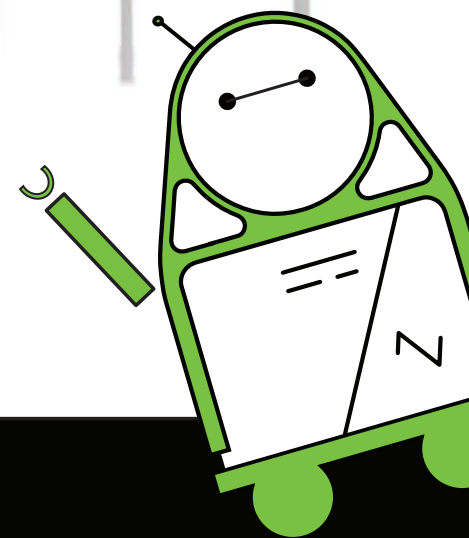
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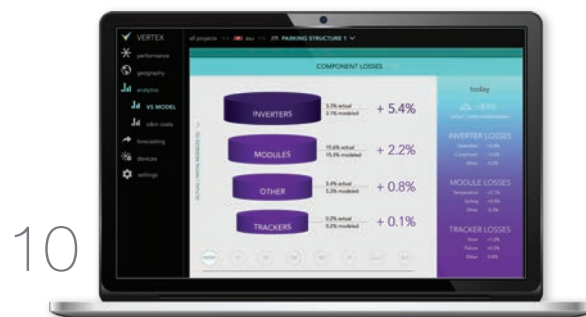
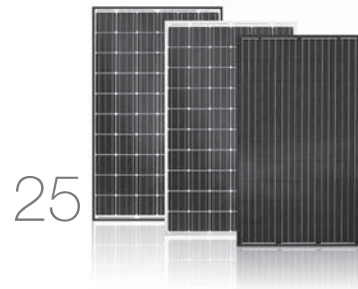
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On our cover...

These Rope Partner technicians are performing blade maintenance and leading edge protection repairs. Rope Partners provides wind turbine maintenance as well as inspection and performance enhancement services for projects requiring specialized access approaches.

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HAPPY 10TH BIRTHDAY TO NORTH AMERICAN CLEAN ENERGY!

Think of how the renewable energy landscape has developed in the last decade.

When President Bush declared “America is addicted to oil” in 2006, he initiated unprecedented growth in the renewable energy industries, not to mention boosting energy efficient technologies. His Advanced Energy Initiative (AEI) increased funding for renewable energies including wind and solar power, and focused on changing the way Americans power their homes and businesses.

Advanced lithium-ion battery technology helped to spur the commercialization of hybrid electric vehicles (HEVs); according to the U.S. Department of Energy’s Alternative Fuels Data Center and www.hybridcars.com, over 250,000 were sold in 2006, and sales spiked in 2013 with nearly 500,000 new HEV acquisitions.

As a part of the AEI, the Department of Energy’s Solar America Initiative (SAI) was created to make solar PV technologies cost-competitive by 2015 and in their Renewables 2016 Global Status Report*, REN21 announced.

“2015 was an extraordinary year for renewable energy. Renewables are now cost competitive with fossil fuels in many markets and are established around the world as mainstream sources of energy. Cities, communities and companies are leading the rapidly expanding “100% renewable” movement. Distributed renewable energy is advancing rapidly to close the energy access gap.”

The U.S. is now adding more renewable electricity capacity each year than natural gas, coal, and oil combined. This is an accelerating trend, spurred on by the decreasing costs of solar and wind power, favorable policy, and greater adoption in the residential and commercial sectors.

In May of this year, a huge milestone was reached in the solar sector with America’s one-millionth solar installation coming online. What took forty years to achieve is estimated to take only 24 months to double.

Construction is complete on America’s first offshore wind farm and commercial operations are about to begin. The 30 megawatt Block Island Wind Farm is the first of potentially many offshore wind operations off the United States’ Atlantic Coast.

Despite the challenges facing President Obama’s Clean Power Plan, many states have independently set aggressive goals committing to source their energy from renewables and the U.S. Energy Information Administration (EIA) estimates one-third of new generation added to the grid in the next three years will come from renewable energy*.

The Department of Energy’s National Renewable Energy Laboratory (NREL) performed the Renewable Electricity Futures Study (RE Futures)* to explore the potential for renewable energy to meet the continental U.S.’s electricity demands through the year 2050 and found, if provided with a more flexible electric system, the current renewable energy technologies are more than adequate to generate 80% of the U.S.’s total electric need in 2050 and still supply enough electricity to meet the hourly demand throughout the country.

A decade ago, renewable energy was something on the horizon, something that perhaps could become a large contributor to our energy mix. Expensive, but necessary to combat the effects of greenhouse gas emissions to improve the outlook of our future.

Here we are, in the future. Renewable energy is here. It is a cost competitive and mainstream choice in many regions. Businesses, communities, and citizens are gearing up for a 100% renewable future and it does look bright indeed. Studies and reports aside, I wonder how close we’ll really be in another ten years. North American Clean Energy looks forward to reporting it to you then!

Have a safe and happy holiday season.

Jill Walters

*Renewables 2016 Global Status Report <http://www.ren21.net/status-of-renewables/global-status-report/>

*U.S. Energy Information Administration (EIA) <http://www.eia.gov/oiaf/aeo/electricity.html>

*NREL RE Futures http://www.nrel.gov/analysis/re_futures/



World’s first clean energy partnership at sea

Virgin Group founder Sir Richard Branson revealed Virgin Voyages as the inspiring new identity for the company’s cruise line. Joined by the company’s President and CEO Tom McAlpin, they announced the name, and shared that Virgin Voyages has officially signed a ship building contract for three vessels with Italian master shipbuilder Fincantieri, and that the company will be the first cruise line to adopt the clean energy system, Climeon Ocean. Virgin Voyages is the first major cruise line to partner with clean energy innovator, Climeon. Virgin will install Climeon Ocean, a system that will transform low-grade energy into clean electricity, on all three of its ships. The resulting environmental impact will be an estimated 5,400 tons of carbon dioxide savings annually per ship — an amount that would take 180,000 trees 30 years to absorb.

Virgin Voyages | www.virginvoyages.com



Urban smart city

For more than two years, partners including Avista, the City of Spokane, Itron, McKinstry, the University District Development Association, and Washington State University (WSU), have been working to create a living laboratory to design cities of the future in the 770-acre University District, adjacent to Spokane’s downtown core. Urbanova’s goal is to harness data to gain insights, empower people, and solve urban challenges in new ways. It will enable healthier citizens, safer neighborhoods, smarter infrastructure, a more sustainable environment, and a stronger economy. The collaborative effort is already yielding results with smart city projects, including a smart and connected streetlight pilot, “Shared Energy Economy” model, and smart city research grants. The smart and connected streetlight pilot is the first of Urbanova’s smart city projects and central to its participation in Envision America’s yearlong technical support program. The pilot aims to intelligently manage and control streetlights to increase energy efficiency, among other goals. The pilot will also feature a human-scale urban air quality R&D component, measuring the quality of the air at different sensor points throughout the district and assessing its role in a healthy city. The Shared Energy Economy model will allow various energy assets -- from solar panels and battery storage to traditional utility assets -- to be shared and used for multiple purposes, including system efficiency and grid resiliency. By doing this, Avista and partners will demonstrate how both the consumer and utility can benefit. Researchers in the WSU Voiland College of Engineering and Architecture are leading a five-year, \$1.5 million initiative to develop a framework to monitor, predict, and control energy and air quality in an urban environment and to record resulting health impacts in Spokane’s University District.

Urbanova | www.urbanova.org



Biomimetic wind turbine

It all began in 2011, when Jérôme Michaud-Larivière hatched the idea of creating an electrical power generating system in the form of a tree, with each leaf an actual mini wind turbine. Capturing low wind speeds and turbulence is at the crux of this novel approach, which can deliver power and autonomy simply through a proliferation of leaves. Thus, the Arbre à Vent was born out of a desire to create the first human-scale biomimetic wind turbine capable of recreating a sympathetic bond between the consumer and his or her means of power generation. Claudio Colucci was entrusted with the design of the Arbre of Vent. Combining elegance and performance, he freed the tree from its central trunk and placed its leaves in a seemingly chaotic manner so as to capture the maximum amount of air movement. Organic and curvilinear in form, the Arbre à Vent turns its back on our very notion of windmills, obscuring cables, blades and generators within the guise of the tree. Its groundbreaking Aeroleaf technology is simultaneously rustic and sophisticated. A microprocessor in each leaf allows it to harvest maximum energy from the wind available at any given moment. It took three and a half years of R&D to latch onto the curve of the wind, without inertia, and attain energy efficiency.

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The Desert Renewable Energy Conservation Plan

Reconciling competing policies in the California desert

by Kate D'Ambrosio and Michael Sherman

AFTER AN EIGHT-YEAR LONG PROCESS, the Bureau of Land Management (“BLM”) recently released the first phase in a plan to encourage renewable energy development in the California desert. In September, the BLM approved the federal portion of the Desert Renewable Energy Conservation Plan (“DRECP”), a landscape-level renewable energy and conservation plan that affects 10.8 million acres of public lands in the California desert, and will potentially impact renewable energy development on private lands as well.

Approval of the DRECP marks a compromise in a long struggle between competing policies affecting the California desert. Many view the region as critical to developing renewable energy projects on a scale large enough to meet California’s ambitious greenhouse gas reduction goals. Environmental groups, however, have questioned the true impact of these projects on sensitive species and their habitat. This tension between renewable energy and conservation goals is nothing new, but the DRECP finally sets the tone for a path forward in the California desert.

The impetus for change

Long viewed as ideal for large-scale renewable energy projects, the California desert has been a focal point for achieving both federal and state greenhouse gas reduction policies.

On the federal front, President Obama’s 2013 Climate Action Plan has prompted federal land management agencies to promote policies that reduce greenhouse gas emissions. Promoting renewable energy development on public lands is a key piece of this plan. As of April 2016, the BLM had issued authorizations to develop 26,795 acres of public land for wind projects and 22,758 acres of public land for solar projects in the California desert since 2003.

California state policies further augment the demand for renewable energy development in the California desert, including California’s goal to cut greenhouse gas emissions to 40 percent below 1990 levels, and to require a 50 percent Renewables Portfolio Standard, all by the year 2030.

Many environmental groups, however, argued that this development in the California desert comes at too high of a cost. Though it is an abundant source for renewable energy, the California desert is also home to many sensitive species and their habitat. These groups view the California desert as one of the last places where these species can be adequately protected from the impact of residential, industrial, renewable energy, and other types of development in Southern California.

DRECP takes shape

In order to resolve this clash between competing policies (ones that protect sensitive species and simultaneously encourage renewable energy development) four federal and state agencies initiated the DRECP in 2008. These agencies include the BLM, California Energy Commission, California Department of Fish and Wildlife (“CDFW”), and U.S. Fish and Wildlife Service. Originally, the DRECP addressed both public and private lands, but after too

much delay in the process, the agencies decided to move forward with a phased approach in March 2015. The first phase of the DRECP focuses on management actions on BLM lands, while Phase II will address state and private lands.

Winners and losers

Although the DRECP has been touted by some as playing an essential role in meeting federal and state climate change and renewable energy goals, Phase I has come under fire from industry advocates claiming it focuses too much on conservation. Notably, Phase I of the DRECP prioritizes renewable energy development on “Development Focus Areas” that include approximately 388,000 acres, or less than four percent of the public lands, affected by the decision. Of the remaining lands, approximately 93 percent (10.1 million acres) have been set aside as BLM Conservation Areas or Recreation Areas. Within these areas, the BLM will prohibit or significantly restrict renewable energy development.

In tandem with Phase I of the DRECP, the BLM is also expected to release a new rule to streamline the approval process for renewable energy projects on public lands, including those projects within the Development Focus Areas under the DRECP. First proposed in 2011, the proposed rule would implement competitive leasing processes and other developer incentives for wind and solar projects located within “designated leasing areas.”

Projects located on designated leasing areas and selected through the competitive leasing process would be eligible for offsets (limited to 20% of the highest bid) if the developer meets certain criteria set forth in the bidding process. Other incentives include reduced application fees, streamlined environmental review, and more favorable lease terms.

Like the DRECP, however, the BLM’s proposed wind and solar leasing rule has received mixed industry response. Some developers have expressed concern that competitive leasing procedures will raise costs of developing projects on public lands, and that processes aimed at streamlining permitting and review, will not offset these costs.

Looking to the future

With much of the public lands in the California desert off-limits to renewable energy, developers will look to private lands for development opportunities. These opportunities will be affected by Phase II of the DRECP. Under Phase II, the State of California and seven California counties (Imperial, Inyo, Kern, Los Angeles, Riverside, San Bernardino, and San Diego) will coordinate with the federal agencies to revise local and state policies for renewable energy development. A significant component of Phase II may include a Natural Community Conservation Plan (“NCCP”) program to allow CDFW to issue take authorizations for species protected by the California Endangered Species Act. Further, Phase II calls for counties to better align their local land use policies with Phase I of the DRECP to promote renewable energy development.

Similar to Phase I of the DRECP, these two components will continue to clash as the State and counties determine how to promote renewable energy development on private land while protecting sensitive species.



Kate D'Ambrosio and Michael Sherman are attorneys at Stoel Rives LLP, where they practice in the area of renewable energy project financing and development.

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Solar O&M

Leveraging technology to maximize ROI

by Michael Maulick



In the solar industry today, return on investment (ROI) is predicated upon the ability to successfully flip ownership of a solar plant several times during its multi-decade lifespan. The initial project developer is likely to sell the asset to a long-term owner, who will frequently bundle the project into a portfolio for sale to a third party, which might sell the assets again down the road. The key to continued ROI in this economic scenario is reliable yields, both financially and energy-wise.

It is incumbent upon the industry to eliminate any governor on growth, and ensure that investment in solar assets becomes increasingly attractive. Unfortunately, due to today's marketplace focus on cost-of-initial-construction, the biggest threat to profitably in buying and selling solar projects is overlooked: the actual costs of long-term operations and maintenance (O&M).

So called "forecasting" of O&M today consists of entering a standard line item as part of a bid or project budget, with no allowance for cost variances connected to the technological complexity of the mounting system, no consideration of component-by-component mean times to failure, and no regard for the differences in environmental loads and conditions. Is it logical that a centralized tracker in Southern California would have the same O&M requirements as a distributed tracker in the Northeast? Of course not. Using tracker technology as an example, a centralized tracker might employ one control unit, where a distributed tracker would require more than 50 control units for the same MWs. O&M estimates will, and should vary. What about the effect of extreme temperatures in some parts of the country on battery life? Or the effect of projects built in high-dust zones vs. those in which the modules do not need washing as frequently? These project-by-project differences are essential to accurately predicting lifetime O&M costs.

In every other industry, O&M costs are calculated based upon the sum of the mean time to failure (MTTF) of every component in a system, times its quantity. RAS (Reliability, Availability, Serviceability) is the total view. Reliability, "R", dissects every part in a system down to its individual components, and develops a mean time to failure analysis for each to determine life span and early life failure projections. Once you have "R", you can calculate a theoretical availability, "A". Serviceability, "S", is the consideration for the cost of servicing a system based upon the two other items. This discipline is measured and prevalent everywhere, except the energy industry. If solar continues to ignore the need for this sort of in-depth analysis and quantification of RAS to inform O&M protocols, it will suffer the consequences.

The potential risk in not embracing a new standard of nuanced, data-driven O&M, is that owners will likely be faced with project cost structures significantly less attractive than anticipated, which reduces the buyer pool.

The good news is that there is better opportunity than ever before to make O&M both predictable and more cost effective. The solution lies in the convergence of energy and technology.

Internet of Things (IoT) and Big Data are transforming businesses in every sector, and solar cannot be left behind. When it comes to energy, the solar industry can easily take advantage of these technologies to intelligently monitor, service, and maintain its solar plants, as well as mitigate and anticipate system failures so that they can be optimally serviced.

Some solar companies are using IoT technology to transform the components on solar installations into physical "networks", by embedding the systems with electronics, software, sensors, and mesh network connectivity, and then leveraging the most advanced analytics technology to translate the real-time data into

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Ballasted solar racking

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

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actionable information. By contrast, most legacy project monitoring is done on a snapshot basis – perhaps at an interval of every 15-seconds – without maintaining an exhaustive historical dataset. Consider, as an example, a Google search. How useful would Google’s search engine be if its algorithms were based on a single day of search activity, rather than all search activity from its inception? The power of the Google platform is tied to the depth of its data. Solar IoT must follow this example. By collecting and maintaining a complete history of real-time data associated with a given system, Solar IoT will enable meaningful analytics to guide long-term asset valuations and investment.

Each subsequent solar project will provide a richer data set upon which to base O&M projections. This data will also make it easier to sell solar assets by producing detailed, historic performance records. Not unlike the increased value of a car that comes with a complete maintenance record, solar projects that include long-term, component-by-component performance data will be more bankable.

Beyond O&M projections, collecting more data and making it actionable also makes O&M more efficient, and reduces costs. The ability to dynamically and remotely troubleshoot without rolling a truck, is important to the financial success of a project. Similarly, targeted alerts that pinpoint the source of a problem, down to the individual component level and location, will dramatically streamline corrective O&M actions.

The insurance industry knows how long a person will live, and the automotive industry knows how long its cars will last, because they are constantly collecting data and updating their models. It is time for solar to do the same. There is no excuse for not leveraging technology to gain a thorough understanding of how every project component will perform over 20 years or more. This knowledge must guide and help revolutionize how we optimally maintain our assets and make investment decisions.



Michael Maulick is CEO of Sunlink Corporation.

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PERC UP

Next-generation solar modules promise new opportunities

by Eric Ma



THE SOLAR INDUSTRY IS BOOMING. THE SOLAR ENERGY INDUSTRIES ASSOCIATION (SEIA) reports that 1,655 MW of new solar systems were installed in Q1 of 2016, up 24% over last year. Solar accounted for 64% of all new electrical capacity in the first quarter. Residential solar sales remain relatively flat, though first time non-residential PV sales showed a 300MW rise in back-to-back quarters. Sales seem to be moving from residential to commercial and utilities, but that doesn't mean residential sales are going to remain flat. Emerging Passive Emitter Rear Contact (PERC) PV technology will change that.

PERC solar modules are the next generation in solar technology. They can increase conventional solar cell efficiency by 1% of the absolute value, delivering 10 more wattage in a smaller PV module footprint, and offer new potential applications. Consider, for example, how much more power a solar array can deliver using the same footprint on a multi-tenant building or office building. More efficient solar panels also can make PV systems more cost-effective in snow belt markets that receive less regular sunshine.

Although PERC technology has been with us for a few years, the challenge to date has been bringing manufacturing costs down to make PERC cost competitive with conventional solar panels. Changes in manufacturing processes and new production techniques currently make PERC panels highly competitive for new solar applications.

The PERC power advantage

PERC technology is able to generate 5% more power by improving solar energy production and volume. It makes better use of available light, providing better electron flow to produce more electricity with more efficiency.

Like conventional solar cells, PERC can be applied to both monocrystalline wafers and multicrystalline-based PV technology, but PERC adds a dielectric passivation layer at the rear of the solar cell. This extra dielectric passivation layer reduces electronic recombination and allows electrons to flow more freely.

In addition, PERC cells reflect less light. Opening the rear passivation stack using chemicals or lasers creates tiny pockets which capture more light. Higher internal light reflectivity increases efficiency.

The largest impediment to PERC adoption has been production costs. The average p-type monocrystalline PERC cell is about 150% the cost of standard p-type multicrystalline cells, yet the power efficiency of PERC cells is 15% higher than standard multi cells, and 7% higher than standard mono cells. In the lab, p-type mono PERC cells claim a 19.89 - 20.4% increase in efficiency, and standard p-type multi cells a 17.2 to 17.8% improved efficiency. However, to date, the cost of production has made standard cells more attractive.

With the advancement of the equipment R&D, the PERC technology can be implemented in a traditional cell processing line at a fraction of the previous investment. Further, by successfully integrating the PERC into the existing cell lines of the manufacturers, the manufacturing cost increase could be kept to a minimum.

More manufacturers are migrating to n-type Cz-Si wafers over p-type mc-Si wafers for high-efficiency panels; n-type delivers >25% efficiency, while p-type delivers >22% efficiency. More importantly, n-type wafers bring three additional characteristics to PV cell manufacturing:

1. Most n-type cells use phosphorous where p-type wafers use boron. Due to the absence of boron there is no light induced degradation in n-type Si wafers.
2. In general, n-type wafers are less sensitive to metallic impurities in silicon feedstock, which means they can use less expensive substrates.
3. n-type Si is less prone to degradation in high-temperature processes.

As a result, combining PERC with n-type cell technology results in lower LCOE.

It's easy to retool for PERC

Market conditions are causing more PV panel manufacturers to rethink their strategy and retool their factories. Industry experts predict that PERC cell production will exceed 15GW in 2017, which means that solar cell production is moving towards PERC. In 2017, p-type PERC solar cells are expected to make up 20% of all solar cell production.

For manufacturers looking to upgrade their cell production lines, PERC offers an easy alternative for rapid production expansion. Converting to manufacture PERC cells from standard cells requires few new processes, such as adding laser tools for contact openings.

In addition, as the market glut for conventional solar cells continues, shifting to PERC production will serve to differentiate solar module products. Furthermore, as prices start to decline, maintaining tight control over production costs and product quality will become as important as manufacturing higher efficiency solar cells.

PERC offers new possibilities

The race for PERC not only helps manufacturers differentiate their products with a solar cell that delivers more power in a smaller form factor, it also gives designers and developers more freedom. With PERC, they can install solar in unorthodox spaces and smaller areas that were previously impractical for solar. And the higher energy density of PERC panels delivers more power per square foot, making them ideal for low light and high temperature applications. When considering total energy production rather than peak wattage, PERC is clearly a winner.

PERC also helps drive down Balance of System (BoS) costs. The ability to produce more energy with less has a trickle-down effect that reduces soft costs, which may be enough to minimize sticker shock on new projects.

As solar cell manufacturing becomes more efficient and more competitive, PERC will become more economical for new installations. More manufacturers will make the minimal investment needed to retool for PERC, and market leaders will go one step further to manufacture n-type PERC modules for even greater efficiency.

Eric Ma is the president of Boviet Solar, USA.

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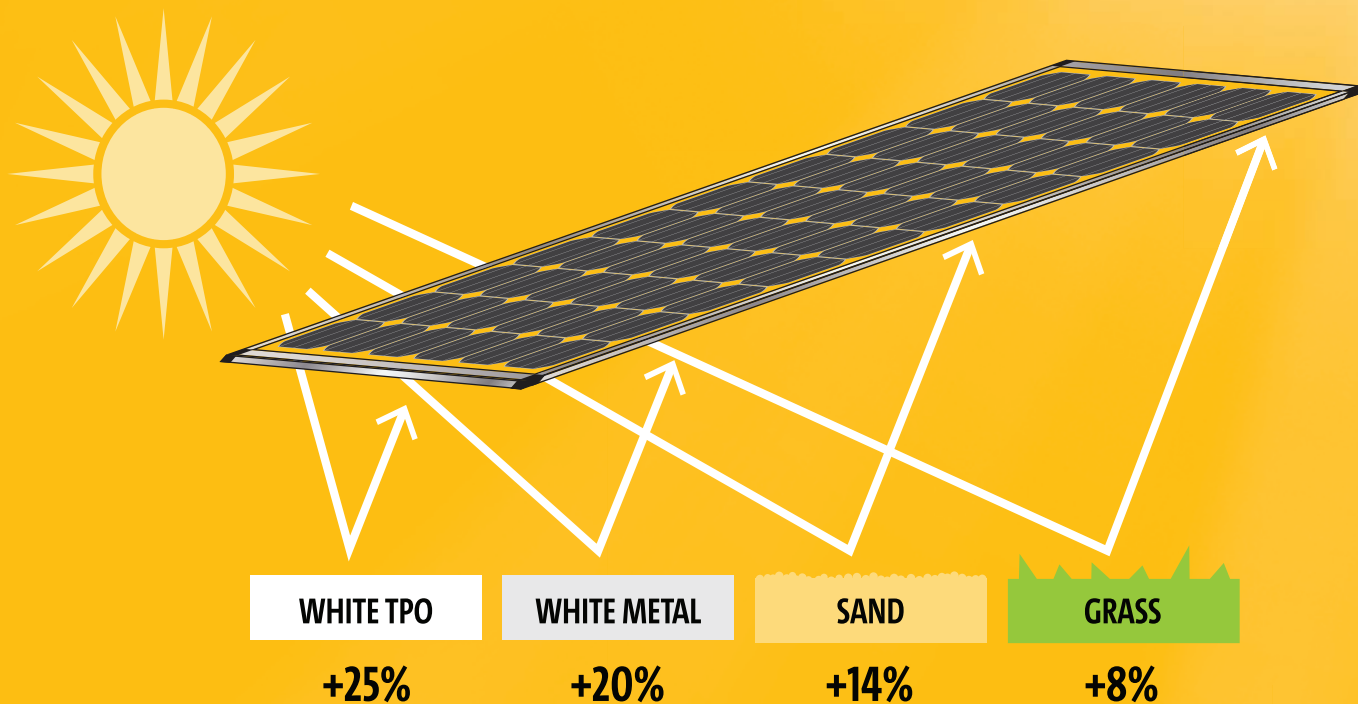
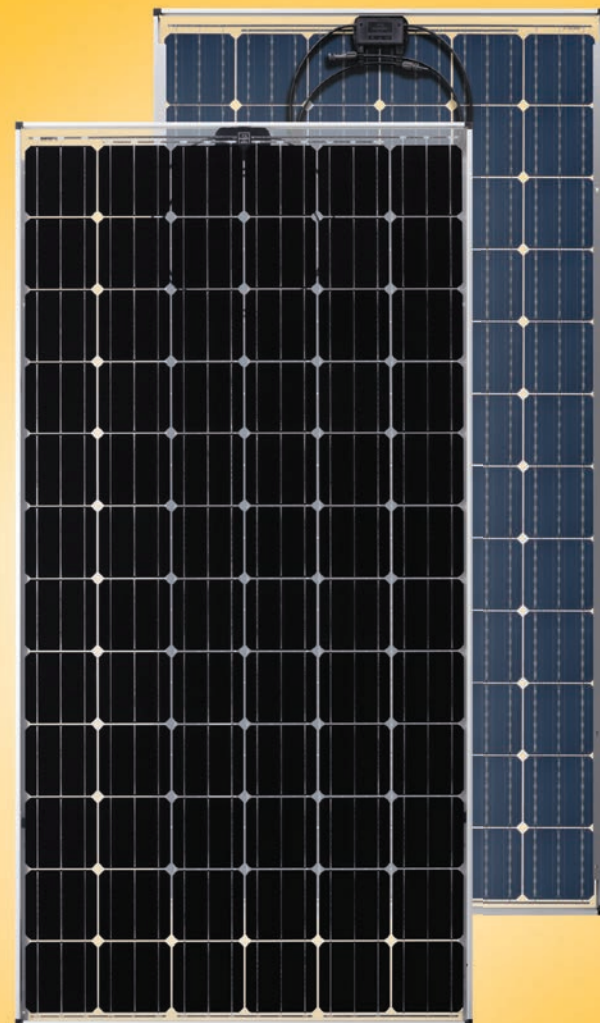
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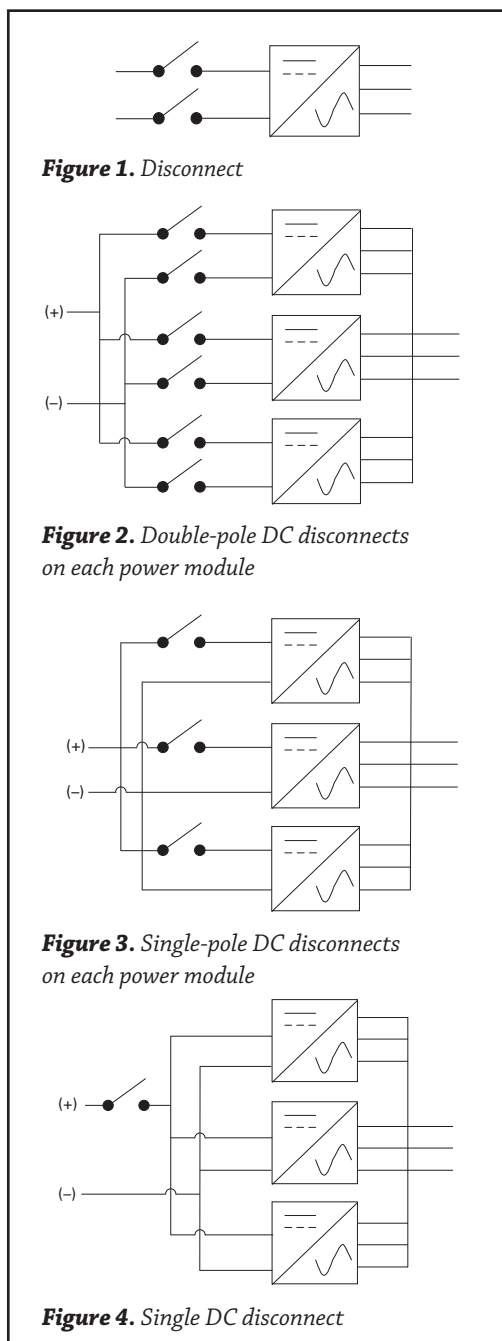
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Selecting Low-Voltage Switchgear for Grid-Tied Inverters

by Chris Thompson

When selecting AC and DC switchgear for grid-tied inverters, system designers have a variety of options. There are key design considerations to avoid downtime and reduce overall project costs.

In many design decisions, there is a “good,” “better,” and “best” scenario directly proportional to cost. As inverter-pricing pressures escalate, many vendors are faced with decisions involving quality and cost tradeoffs. Because many inverter customers are not experts in AC or DC switchgear, it can be tempting to select less than optimal equipment with a lower upfront cost, but may not be well suited for the application long-term.

DC-side design choices

Most inverters have some type of disconnect on the DC side to isolate the inverter from the DC source. (Figure 1)

The DC disconnect has multiple purposes including:

1. A way to isolate and disconnect the inverter for service.
2. Means to isolate the DC source (so work can be performed).
3. Isolation of the power module in the inverter (if the power module fails).

In cases with multiple power modules in the inverter, the DC disconnect becomes even more important. Multiple power modules mean multiple potential points of failure. With proper isolation capabilities on both the AC and DC side, such inverters can become fault tolerant. This is most commonly achieved by isolating a failed module while allowing the other modules to continue operating. This is a critical function, particularly with two or more power modules in the inverter. Without this feature, modular inverters can become substantially less reliable. Figure 2 shows a modular inverter with double-pole DC disconnects on each power module, providing each power module with complete DC isolation.

An alternate approach involves integrating a DC disconnect on each power module, but only in the + line. While this can stop power flow to the inverter for maintenance purposes, it doesn't isolate the DC bus in case of power module failure. This approach may be cheaper and easier, but it compromises fault tolerance of the inverter. (Figure 3)

The final option is putting one large DC disconnect on the + line. (Figure 4) This provides for no containment of a failed power module and no fault tolerance. Although this method can seem attractive when considering initial equipment costs, the long-term operating cost impact of this approach is greater.

AC-side design choices

Given the higher frequency and usage stress of AC switching, the selection of proper equipment is even more important than for the DC side. Extensive research on installed bases of inverters has demonstrated that AC contactors have the highest failure rate of components in the power path of the inverter. In fact, AC contactors have demonstrated failure rates that are twice as high as the next component—IGBTs. Given the usage stress and documented field failure rates of AC contactors, proper selection of AC switchgear on

the inverter is exceptionally important in impacting overall inverter reliability.

Similar to the DC side of the inverter, there are a few design choices for the AC side as well. This includes AC isolation of individual power modules, or isolation of the inverter for an entire unit.

Figure 5 shows a preferred implementation including AC contactor isolation on each power module. Notice there is still a main breaker for inverter isolation and lock-out/tag-out.

The combination of AC contactor with a main breaker is effective in terms of both reliability and system protection. Contactors are specifically designed for a high duty cycle, and are well suited for regular and heavy daily usage. Circuit breakers, on the other hand, are optimized around fault clearing. (Figure 6)

A contactor is not designed for fault protection, log-out/tag-out, or manual isolation. However, the combination of the two addresses all the needs of an inverter, in a safe and reliable fashion.

A less expensive alternative would be to use one main AC contactor, but it doesn't provide fault isolation if a power stack fails. (Figure 7)

A second factor to consider in either of these configurations is the selection of contactor technology. A conventional mechanical contactor will physically move a metal arm from an open to closed position. As the arm approaches the closed position, arcing occurs on the surface of the contacts due to the voltage across those contacts. As this arcing happens, the metallic surfaces can soften, melt, or deform slightly. Though individually these events are relatively minor, over time this surface pitting reduces the contactor's ability to open and close

Table 1. Summary of AC and DC design choices—as good, better and best:

Option	DC side disconnect	AC side primary protection	AC side secondary protection
Best 1	Double-pole, load break rated	Vacuum contactor on each stack	ANSI air power breaker
Better 2	Single-pole, load break rated	Mechanical contactor on each stack	ANSI air power breaker
Good 3	Single-pole, load break rated	Mechanical contactor for entire inverter	Molded-case breaker
Not recommended 4	Single-pole, load break rated	Nothing on each stack	Breaker used as contactor

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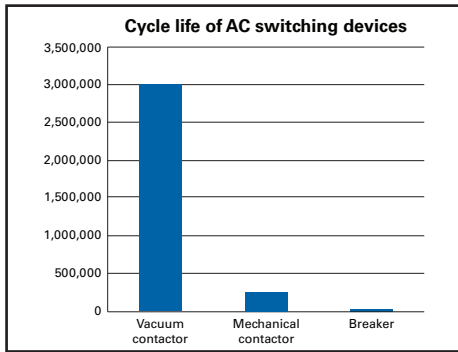


Figure 6. Component cycle ratings

freely, and provides a low resistance current path. Vacuum technology, however, virtually eliminates this phenomenon. With a vacuum type contactor, the contacts actually open and close in a vacuum. This minimizes arcing and greatly enhances contactor life. The chart above shows how vacuum contactors can have a cycle life 10X that of conventional mechanical contactors. (Figure 6)

There are also various alternatives for inverter fault protection and isolation. The highest feature approach is an ANSI air power breaker. These typically have the highest interrupting fault current ratings and can clear such faults repetitively. Molded-case circuit breakers are another alternative, but typically don't have the same interrupting current ratings. Air power breakers also have the best capability to interface with utility protective relays. Finally, a fused mechanical switch provides for good fault interrupting current handling, but "blow" under such conditions, requiring component replacement to bring the device back into service.

An emerging low cost approach removes the AC contactors entirely, but uses a circuit breaker for daily isolation. Because breakers aren't meant to be operated as contactors, and have limited duty cycle in this application, this approach isn't recommended for long-term reliability. In particular, because this component has substantial operating stress and is a leading cause of field failures, it's wise to look for other cost-cutting opportunities. (Figure 8)

There are a variety of protection and control options on both the AC and DC side of the inverter. Summarizing the options demonstrates a classical cost/benefit trade-off. Switchgear options

which provide for maximum reliability and fault tolerance are substantially more costly, while less reliable ones are inexpensive. In this analysis, the most reliable approach uses AC vacuum contactors on each stack, and a main AC air power breaker.

Chris Thompson is the grid power business unit manager for Eaton Corporation.

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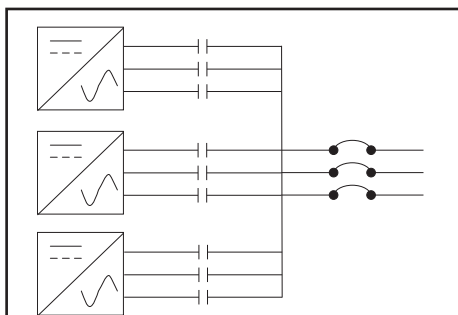


Figure 5. AC contactor on each power module

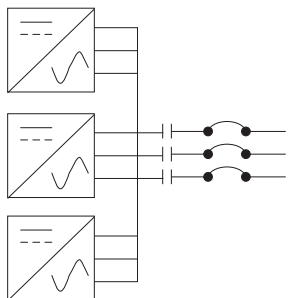


Figure 7. Main AC contactor

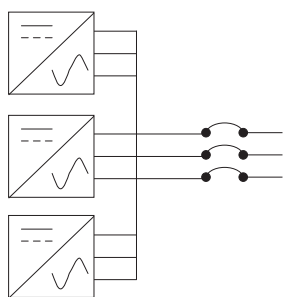
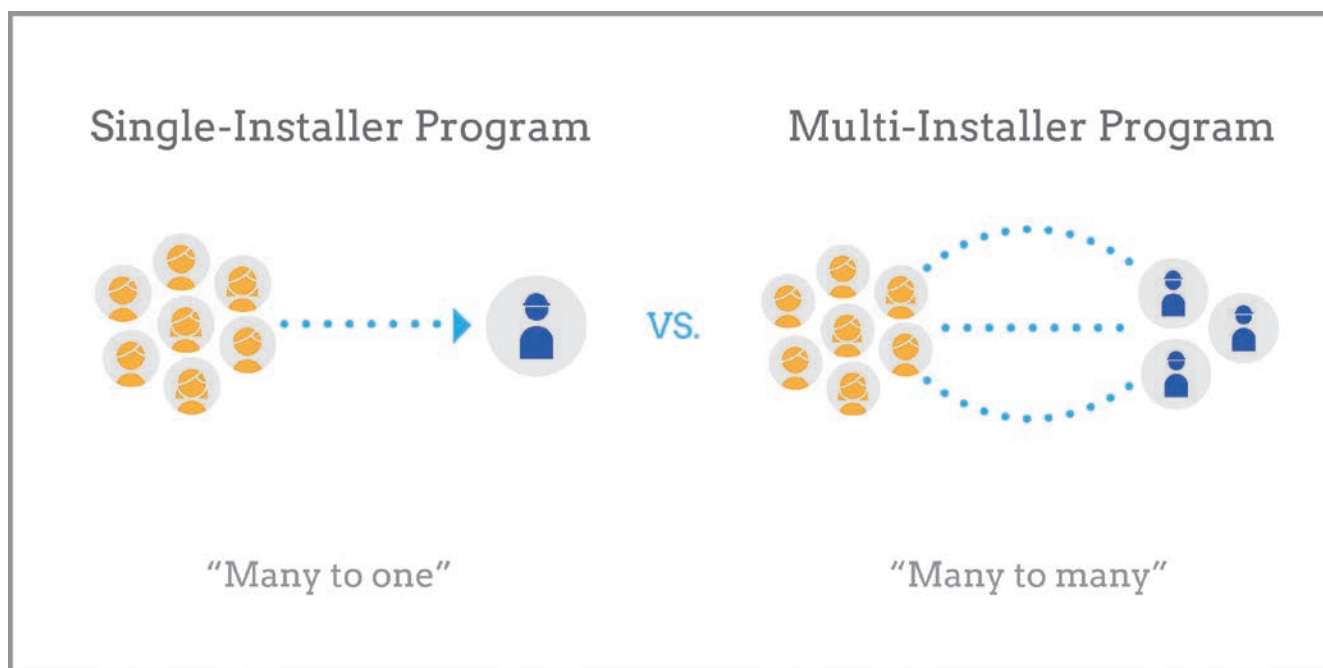


Figure 8. AC protection without contactors and without stack isolation



Designing Solar Programs in a new customer-centric solar landscape

by Vikram Aggarwal

THE U.S. SOLAR INDUSTRY REACHED ONE MILLION ROOFTOP solar installations earlier this year – a major milestone, and a clear indicator of solar energy’s entry into the mainstream. Rising electricity prices and declining equipment and installation costs mean that, for many homeowners, the economic and environmental benefits of residential solar power are still growing.

To encourage greater adoption of solar, organizations across the country are launching programs promoting solar to their customers, members, employees, and residents. Most of these programs follow a standard model connecting program participants with a single installer, selected either as part of a direct marketing partnership, or through a proposal process. Many industry stakeholders consider this single-installer model to be the “gold standard” of solar programs. However, it was developed at a time when the solar industry looked entirely different than it does today.

The single-installer model was popularized in 2009 with the launch of the first Solarize program in Portland, Oregon. At

that time, only 18,900 solar panel systems had been installed, in total, in the United States. By design, these single-installer programs were uniquely suited to solving some of the issues that were limiting solar adoption back then:

They offered a “bulk discount” to participants as an incentive for choosing the program option. In 2008, solar cost \$8.82 per watt, and a standard 5-kilowatt system cost upwards of \$44,000. A bulk discount wasn’t just “nice to have” for program participants – it was a necessary measure which reduced prices and put solar within reach.

They gave solar shoppers a recommendation from a trusted source. Studies have shown that adopters of solar PV are heavily influenced by peer effects. In 2008, the word-of-mouth referral network that’s such a large contributor of growth today simply didn’t exist. When solar was a new technology, single-installer solar programs offered the motivation and endorsement of a trusted source, whether it was a local municipality, utility, or private company.

They encouraged homeowners and businesses to follow through with a solar decision. When solar was still a relatively unfamiliar and expensive technology, early adopters naturally took a long time to make their decision. Just five years ago, the average solar customer took nearly nine months to go from initial idea to final purchase decision. Discounts in single-installer programs are typically framed as “limited time offers” – a natural fit in an industry that, at the time, needed additional incentives to motivate homeowners to make a quicker decision.

Taken together, these three factors resulted in a program design that contributed to exponential growth when the solar industry needed it most. However, the solar industry of 2016 is one that looks fundamentally different from the era of the first single-installer solar programs.

Over the past seven years, growth rates have skyrocketed. While there were only 18,900 total installations in 2009, there were over 318,000 solar energy systems installed in the U.S. in 2015 alone. The country now has over one million rooftop solar installations, and industry experts believe that we will add another million in the next two years. Simultaneously, [costs have dramatically decreased](#). Today, solar shoppers are paying an average of just \$3.57/Watt for their solar energy systems, and making purchase decisions in an average of 54 days.

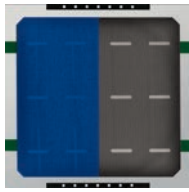
In today’s era of one million rooftop solar energy systems and counting, the most customer-centric solar program is no longer a single-installer program offering bulk discounts and “one size fits all” packages; it’s a marketplace model connecting multiple

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installers, offering various equipment and financing packages, with a diverse range of solar-interested homeowners.

A customer-centric, multi-installer model is the natural evolution of the single-installer programs that helped kick-start the solar industry. Today's customers simply want more choices than a single-installer program can offer. New equipment manufacturers, solar financing providers, and solar installers are entering the market at a rapid pace. By offering access to a wide variety of options, multi-installer programs are better equipped to leverage the growing, dynamic nature of the industry.

Multi-installer marketplace programs also create a competitive pricing environment, ensuring shoppers receive well-priced offers without the need for bulk discounts or time-based incentives. The marketplace model benefits installers, too. Experience shows that multi-installer solar programs actually increase the rate of solar adoption. Solar shoppers who receive multiple quotes are three times more likely to go solar than shoppers who only receive a single quote. Why is this? [Comparing multiple options](#) makes it possible for shoppers to better understand their local market and select an offer tailored for them – resulting in increased consumer confidence and greater solar adoption.

While single-installer solar programs were a necessary innovation that helped kick-start the solar industry early on, the bottom line is that the industry must innovate again. It's time for organizations to embrace the new customer-centric solar landscape. The best way to do this is to roll out more multi-installer solar programs offering choice, transparency, and fairness to the millions of homeowners and small businesses considering solar today.



Vikram Aggarwal is the CEO and founder of EnergySage, an online marketplace for solar. EnergySage allows consumers to easily request and compare competing solar installation quotes online.

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Smart Inverters

by Lior Handelsman

Solar power is becoming an increasingly dominant player in electricity production. The distributed nature of this production requires the need to have greater control of and communication with individual solar generation sites. Because inverters are the brain of solar energy systems, there is a growing demand for inverters to become smarter. This need is being driven by the utility's need to better control and manage voltage fluctuations that can result from this type of distributed topology. This has brought the advent of smart inverters which provide new complex functionalities.

The move towards smart inverters is part of the growing trend for inverters to have increased functionalities. For instance, inverters used to only be responsible for MPPT and DC/AC conversion, whereas advanced inverter solutions are responsible for a variety of roles including communications, remote monitoring and troubleshooting, smart energy management, grid interaction, grid support, safety, and more. With solar energy systems considered an investment, smart inverters are increasingly designed to provide revenue grade data for system owners, utility, and other stakeholders. In addition to embedding these types of capabilities, many inverters tend to offer expanded API functionalities.

Smart inverters take this a step further.

Unlike standard inverters which function in a more isolated environment of the specific PV system they are managing, smart inverters need to interact with the network in a much more dynamic and interconnected manner. These new smart inverters now have flexible, adaptive, and fast bidirectional communications, a digital architecture with more processing power, and robust software infrastructure to manage energy with minimal delays. Some of the functions currently offered include the ability to remotely connect and disconnect from the grid, set the level of reactive power generation or consumption, provide voltage regulation by modulating reactive power output, provide voltage regulation by modulating real power output, etc.

Smart inverters offer value and even new revenue streams to the many solar energy stakeholders. System owners can benefit from increased energy independence and improved RoI. In addition, as the inverter continues to expand its role of energy management into smart homes, it should also be able to provide superior convenience, such as remotely managing appliances. Utilities can benefit from increased grid stabilization, and achieve additional value streams through voltage regulation, frequency control, and power supply/reservoirs. Rather than utilities viewing solar energy as a strain on the system, and needing to limit, ban, or tax feed in (which hurts the profitability of PV systems), smart inverters can help revolutionize the grid to become a decentralized system with mini-power stations.

There are a number of factors moving the industry toward smart inverters, such as customer demand, technological innovation, and new regulations and standards. The two leading considerations, regulations and standards, can be addressed thanks to technological innovations allowing inverters to be designed with more processing power and flexibility, to adapt to different grid codes in various locations. The market expectation is that inverter manufacturers will have products tested over the next twelve months, but there are a few inverters that have already been certified. At the same time, major utilities such as PG&E, APS, National Grid, and HECO, are running pilot programs to determine what parameters to use for features including volt-var, PF, frequency-watt, and power curtailment.

Some of the relevant standards already implemented for smart inverters include IEEE 1547 and UL 1741. The IEEE 1547 standard allows a utility to turn off the inverter when voltage or frequency becomes abnormal. This regulation was later broadened to enable inverters to contribute to voltage and frequency regulation, instead of simply being shut down. The UL 1741 SA specifies the test methods needed for DC devices to stay online and adapt their output to stabilize the grid during abnormal operation, instead of disconnecting.

With the growth of PV, smart inverters are becoming increasingly important to the interconnectivity of PV and the viability of grid-tied systems. What we are seeing now is only the beginning. Smart inverters have the potential to offer many additional benefits such as machine learning, sub-grid/aggregation, and IoT. Before we reach this potential, however, stakeholders need to work together to overcome the hurdles of communication infrastructure, computing power, and cyber security and privacy standards. These could be the key to creating PV-based smart cities.



Lior Handelsman founded SolarEdge in 2006 and currently serves as its vice president, marketing and product strategy where he is responsible for SolarEdge's marketing activities, product management, and business development. Prior to founding SolarEdge, Mr. Handelsman spent 11 years at the Electronics Research Department ("ERD"), one of Israel's national labs, which is tasked with developing innovative and complex systems. At the ERD he held several positions including research and development power electronics engineer, head of the ERD's power electronics group and manager of several large-scale development projects and he was a branch head in his last position at the ERD. Mr. Handelsman holds a B.S. in Electrical Engineering (cum laude) and an MBA from the Technion, Israel's Institute of Technology in Haifa.

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Advanced Storage Battery Technology

Providing a foundation for the new energy paradigm

by Jim Petersen

As the debate over fossil fuels vs. renewables continues unabated, a new energy paradigm is gaining traction; pairing solar power with advanced storage battery technology to supplement the electric grid and protect our environment.

The burgeoning energy storage market is being driven by improved energy efficiency, the declining cost of solar equipment, and higher capacity energy storage made possible by improved battery technology, such as lithium ion. This creates a huge benefit to consumers of electric power, especially with federal incentives covering up to 30 percent of the total system cost.

In the solar energy sector, the rapidly growing residential battery marketplace is making its mark. By combining solar and batteries with smart software, a home energy management system can analyze the occupant's historical energy consumption trends to develop efficiency recommendations, that not only limit energy demand, but also define the exact combination of stored and renewable energy required to power the home.

This makes it possible for homeowners to use stored solar energy during peak times, when utility rates are at their highest, resulting in either lower bills, or financial gain (by selling excess energy back to the grid). In light of all the changes imposed by utilities and regulatory agencies, this transformational storage technology gives consumers more choices and control in their efforts to save money while using renewable energy.

No wonder the industry is growing at a rapid pace. According to IHS Markit, over the next decade, lithium-ion batteries will become the mainstream energy-storage technology, adopted by more than 80 percent of global energy storage installations by 2025. This year alone, the global energy storage market is expected to double, to 2.9GWh from 1.4GWh added in 2015. Half of all energy storage installations will occur behind the meter (in homes and businesses), driven by self-consumption and back-up needs.

Energy independence

For all practical purposes, a solar homeowner can be energy independent, minimizing the effects of ever changing utility company rules, regulations, and billing rates.

Even without a solar power system, a residential battery makes sense for the homeowner by providing the capacity to store less expensive electricity for use during the peak periods, when power demand and cost of a utility's electricity are highest. Additionally, the battery system can protect the homeowner from a "brownout" or "blackout."

Going a step further, the electric utilities themselves understand the value of storage battery technology for creating a smarter grid that, among other benefits, can give utilities better control over managing peak demand, improving system reliability, and reducing the cost of electricity to customers.

Costs vary widely based on battery quality, integrated software included, functionality, and warranty level. The wholesale price for a home battery sometimes excludes the operating software, labor, and other installation costs, as well as the inverter (which converts direct current into alternating current). Homeowners who connect batteries to their solar panels can claim a federal tax credit equal to 30 percent of the total cost of both systems.

In California, the state's Public Utilities Commission approved a target requiring the state's three largest investor-owned utilities, aggregators, and other energy service providers to procure 1.3GW of energy storage by 2020. In response, Southern California Edison announced it will build a 20MW storage project with a power capacity of 80MWh at the utility's Pomona Facility in the east Los Angeles Basin of Southern California. The SCE announcement came a week after San Diego Gas & Electric announced it plans to build 37.5MW of storage projects on utility-owned property in Escondido and El Cajon.

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The new paradigm

This new energy paradigm is a clear win-win for California consumers and its utilities. By investing in solar power along with energy storage and management systems, homeowners can help support the conservation efforts of utilities and reduce the impact of energy disruptions like the massive Aliso Canyon natural gas leak, and the decommissioning of the San Onofre Nuclear Power Plant.

On a national scale, the U.S. energy storage industry includes hundreds of companies and thousands of American workers building commercial energy storage systems. In addition, there is substantial growth on the horizon. Market research indicates the energy storage market is set to expand from 0.34GW installed in 2012 and 2013, to 6GW in 2017, and more than 40GW by 2022.

An IMS Research report expects the market for storing power from solar panels – which was less than \$200 million in 2012 – will catapult to \$19 billion by 2017. New government programs, such as a push by the Obama administration and federal lawmakers to extend renewable energy subsidies, are projected to help fuel the increase.

DOE energy priority

The U.S. Department of Energy's Advanced Research Projects Agency-Energy recently announced \$37 million in funding for 16 innovative projects, as part of a new ARPA-E program for technologies which overcome the limitations of current battery and fuel cell products.

To achieve its goal, the Energy Storage Program works closely with industry partners such as the California Energy Commission, Massachusetts Clean Energy Center (MASS CEC), Oregon DOE, Vermont, Hawaii, Washington, and New York State Energy Research and Development Authority (NYSERDA), to design, procure, install, and commission major pioneering storage installations up to several megawatts in size, such as the SCE and SDGE facilities.

According to the DOE, enhanced energy storage can provide benefits to both the power industry and its customers including:

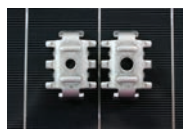
- Improved value of renewable energy generation such as solar;
- Improved power quality and the reliable delivery of electricity to customers;
- Improved stability and reliability of transmission and distribution systems;
- Increased use of existing equipment, thereby deferring or eliminating costly upgrades;
- Improved availability and increased market value of distributed generation sources;
- Cost reductions through capacity and transmission payment deferral.

We are on the cusp of a new generation of energy. Who would ever think a common and ubiquitous product dating back to the 1880s – the storage battery – could become the backbone for the future for our nation's electric power industry? Yet, with advanced digital technology and materials, such as a new generation of lithium ion batteries, the present and future of storage battery technology gets brighter every day.



Jim Petersen is CEO of Fremont, CA based PetersenDean, which he founded in 1984. PetersenDean is a full-service, privately-held roofing and solar company, specializing in new residential and commercial construction. PetersenDean operates in seven states: Arizona, California, Colorado, Florida, Nevada, Oklahoma, and Texas.

PetersenDean | www.petersendean.com



Integrated bonding clamps

BURNDY announces the addition of the new BMCSS integrated bonding clamps to their WILEY line of products. The BMCSS integrated bonding mid-clamps are made of corrosion resistant 304 stainless steel, which makes them a durable, long lasting, and reliable solution for all environments. The down-turned points are designed to pierce the anodized coating of the module frame. The result is excellent conductivity bonding the PV modules together. Essentially, the modules become one singular piece of metal, creating a clear electrical path to the ground.

BURNDY | www.burndy.com

Polyolefin elastomers for use in photovoltaic encapsulant films

The Dow Chemical Company announces the availability of its photovoltaic grades of ENGAGE Polyolefin to the photovoltaic (PV) module encapsulation film industry. Producers of PV modules are demanding modules with longer energy production life and better durability and Dow Elastomers, a business unit within Dow, is meeting this demand by supplying ENGAGE POE as a quality material for use in all types of PV modules, including more demanding N-type cells, glass/glass, high power, and bifacial PV modules. PV modules made with ENGAGE POE-based encapsulant films provide: increased power generation, electrical efficiency, reliability, and extended life of the PV module; improved Potential Induced Degradation (PID) resistance, reducing premature module failure and replacement; lower Lifetime Cost of Energy (LCOE) and better project economics for solar developers; better long-term weathering performance that enables better durability and power output for the life of the module; and lower Water Vapor Transmission Rate (WVTR) moisture resistance eliminating the corrosion problems associated with the use of EVA encapsulants. ENGAGE POEs are used in PV modules that are currently producing clean, renewable energy worldwide.

Dow | www.dow.com

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More developers are reducing pre-construction costs, accelerating timelines and eliminating both risk and sub-surface unknowns with TerraSmart's new TF2 turnkey fixed-tilt racking solution.

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 **TERRAS**SMART. VISIT **TERRAS**MART.COM TO START BUILDING SMART



Dual-task solar light and mobile charging solution

Greenlight Planet's Sun King Charge is an affordable rechargeable lamp and solar panel offering both lighting and mobile charging to off-grid consumers. With the Sun King Charge, consumers can use the lamp and solar panel independently of each other for hours or days at a time. This enables consumers to light their homes or workplace and charge their USB devices simultaneously during the day, offering them more efficiency in their everyday tasks. The Sun King Charge not only features cost-saving mobile charging direct from the solar panel – consumers can also charge the lamp using a mobile charger wherever mains electricity is available. The Sun King Charge's bright 50 lumen white LED lamp yields up to 72 hours of light from a single sunny day, with a long lasting Lithium Ferro-Phosphate battery. It comes complete with Greenlight Planet's two-year warranty. *phone not included

Greenlight Planet | www.greenlightplanet.com



Inrush current limiting NTC thermistors

Ametherm's new series of inrush current limiting NTC thermistors are designed to withstand high input energy from 500 J to 900 J and steady-state currents from 10 A to 50 A. Offering a rugged design, MS35 series devices are optimized for high-power applications, including solar inverters, battery chargers, and DC/DC converters. The MS35 series consists of seven thermistors featuring resistance from 0.5 Ω to 20 Ω , dissipation constants from 78 $\text{mw}/^\circ\text{C}$ to 102.45 $\text{mw}/^\circ\text{C}$, and thermal time constants from 65 s to 240 s. The devices can handle body temperatures up to 235 $^\circ\text{C}$ at 100% of their maximum current rating, and offer maximum capacitance from 1000 μF to 1800 μF at 680 VAC. Featuring diameters of 37mm and 38mm and thickness down to 6.50mm, the thermistors handle the same amount of energy as power resistors in a smaller package, saving valuable circuit board space. In addition, they provide simple one-component alternatives to using power resistors with timers and relays, reducing costs and simplifying designs.

Ametherm | www.ametherm.com



UL listed DC to AC power inverters

AIMS Power has launched a new line of power inverters for applications requiring UL listed DC to AC power inverters. This new line of power inverters has a built in battery charger and transfer switch, allowing users to easily go back and forth between city power and inverter power. The new UL listed inverters also include an improved warranty. AIMS Power offers 1000 watts up to 3600 watts, as well as an economical UL listed line that is a solution for users needing a simple back up power solution without all of the "fancy" options.

AIMS Power | www.aimscorp.net



Solar weather station

Reliable ground measurements are a crucial part of developing and operating utility-scale solar projects. SP-12, the new weather station from Vaisala, was designed specifically for the solar industry as an all-in-one system with everything needed for best practice utility-scale measurement campaigns and resource assessment. The SP-12 arrives ready to install with mast, data logger, instruments, and easy-to-follow instructions. Configuration is flexible depending on the project environment and budget. The standard option includes Vaisala's WXT536, an advanced multi-weather sensor, which monitors solar insolation and other important environmental parameters. This valuable information is all backed up by the rugged and reliable Nomad 3 Data Logger, which is straightforward to use and stands up to even the most extreme weather. In addition, Vaisala provides access to all measurement data through SkyServe, a secure, web-based dashboard.

Vaisala | www.vaisala.com



Low-voltage 1500V inverter for large PV power plants

NIDEC ASI's 1500V inverter is among the company's PV Utility Scale Outdoor Inverter Series, a key pillar of its Power Conversion System (PCS). The new high-performance solar inverter has been developed with the smart inverter technology of Nidec ASI's Answer Drives with Active Front End. These reliable drives have a rapid response time, while the multi-level inverters offer improved efficiency (European efficiency 98.62%, Max efficiency 98.84%) with significantly low harmonics. The three-level architecture provides high performance for the entire life cycle of the plant. The strong reliability and the flexible modular design minimizes system and installation costs. In addition, Nidec ASI's inverter design includes integrated and flexible DC inputs with current measurement. Key advantages of the new high-efficiency 1500V inverter include its high DC input voltage of up to 1500VDC, its outdoor installation capability, maximum power of 5MW (power range 0.5-5MW), advanced air cooling, and effective integration of renewable sources and power unit modularity.

Nidec ASI | www.nidec-asi.com



Central and string inverters

Sungrow's central inverter SG2500-MV is best characterized by its cost effectiveness and highly reliable containerized design. The 20-foot container design reduces the costs of both transportation and installation. With its three-level topology design, the SG2500-MV's maximum efficiency can reach up to 98%. The new SG60KTL string inverter is best characterized by its 99% maximum efficiency, with its maximum DC/AC ratio reaching up to 1.4.

Sungrow | www.sungrowpower.com



Sealing solutions for solar module assembly

SilTRUST SP100 adhesive is Momentive's one-component condensation cure silicone rubber for sealing. This adhesive cures at room temperature to form an elastic, flame retardant rubber and adheres to various types of materials such as metal, plastics, glass and ceramics, without the use of primers. It has excellent storage stability, stable properties after high temperature and humidity (85C/85%RH) and heat age. The low cost silicone grade comes with a complete UL listing including flame retardancy, dielectric properties and certification for indoor and outdoor adhesion to glass, aluminum, mPPE from -35 $^\circ\text{C}$ – >110 $^\circ\text{C}$ to allow PV module manufacturers to quickly adopt this new grade. White, gray and black version SilTrust SP100 adhesive pastes are available.

Momentive Performance Materials, Inc. | www.momentive.com

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www.huawei.com/solar



Huawei Gears Up For Big Year in North American PV



BATES MARSHALL, A SEASONED VETERAN OF THE US SOLAR

energy markets, with over 20 years of executive experience, is now in charge of Huawei's FusionSolar growth strategy in USA. Marshall was previously senior VP at Advanced Energy and before that was VP with SMA Solar. He joined the Huawei in May 2016, as Vice President and General Manager.

At Solar Power International in Las Vegas last month, Marshall outlined the evolution of Huawei's incredible success in solar and the company's vision for the continued rapid growth in the USA.

He pointed out that the key to Huawei's success in PV lies in its history as a telecom and smart phone systems designer and manufacturer.

Marshall stated that the rapid pace of evolution in the network communications industry and the very high demands the industry places on systems uptime, component reliability, smart systems and connectivity are the benchmarks for setting the company's vision of technological development in PV.

Driving the innovation are nine global R&D Centers of Network Energy, employing more than 2000 engineers, 100 PhDs and 800 inverter engineers, including an Inverter Innovation Center in Santa Clara, California. Approximately half of Huawei's 176,000 employees worldwide are involved in R&D.

"Huawei's vision of technological development in PV is based on our experience in developing and deploying wireless network infrastructure and smart phones – high reliability, high availability, rapid innovation, and massive scale. We are both a B2B and B2C consumer-facing company, the number 3 smart phone manufacturer in the world.

"We have taken the key levers of our success in information and communication technology and applied them to PV. That's at the center of our vision for FusionSolar Smart PV solutions."

Marshall pointed out that historically central inverters have offered the lowest capex for large scale PV. But other factors, such as site conditions and complexity of the site design, weigh into the overall equation. These factors can affect

systems availability, and negatively impact overall energy production. The improved energy production and reliability of string inverters significantly improve the IRR of solar projects of all sizes.

"Our string inverters are virtually maintenance free in comparison to central inverters – there are no external fans, no filters, and no fuses.

Huawei's FusionSolar solution combines PV technology with digital information and internet technology to enable automated PV system operations and maintenance through smart data collection, high-speed communications and cloud computing.

Marshall says there is an inflection point in the industry at the moment, and Huawei is well positioned to push it further.

"Huawei now has entered the US inverter market with our FusionSolar solution. The company shipped 10.5 GW of string inverters worldwide in 2015. The biggest EPCs are now going down the road with string inverters – we're at a tipping point now versus the legacy central inverter systems. Next year we will build on our success and enter the residential space in Q2. We will bring the same approach of value generation through digitalization and scale as we have brought to the utility-scale and DG markets."

Huawei United States | <http://www.huawei.com/us>





Sunlight resistant PV cable

Southwire developed an answer to customer needs for enhanced UV protection on photovoltaic (PV) wire slated for solar installations above ground. Southwire's newly-introduced Super Sunlight Resistant - SSR photovoltaic (PV) cable provides a solution for ever-present solar rays, which age jackets on exposed above ground solar cables. Understanding the challenges faced with harsh solar conditions, Southwire sought to help improve the longevity of jacket color on cable used in solar farms. The company's engineers developed a solution to prolong and maximize sunlight resistance. Extensive laboratory testing on the SSR product has proven its longevity for color retention as well as superseding elevated tensile and elongation trials.

Southwire Company, LLC | www.solar.southwire.com



UL-certified PV module series

Yingli Green Energy Holding Company Ltd.'s TwinMAX 60 Cell is a frameless module composed of two layers of 2.5mm thick semi-tempered glass, which replaced the conventional back sheet and glass structure. As the backside makes use of the reflected light from the surroundings, the modules can yield up to 30% more power, depending on the albedo. Ideal for harsh environmental conditions, TwinMAX modules carry a 30-year linear warranty, which could provide more than 20% power gain for customers. Furthermore, built with P-type monocrystalline cells, UL-Certified YLM Series offer high conversion efficiency and high-transmission glass with a unique anti-reflective coating that directs more light on the solar cells, resulting in a high energy yield. YLM Series are available in both 60-cell and 72-cell series which enhances its versatility for a wide range of applications going from residential and commercial projects to large-scale power plants.

Yingli Solar | www.yinglisolar.com



USA-made medium voltage drive

TMEIC announces their latest medium voltage drive, the TMdrive-MVe2, is now manufactured in the USA and is certified to UL and CSA standards. The new manufacturing facility is located in Houston, Texas, and produces the 4kV version of the TMdrive-MVe2 in four frame sizes. Other versions of the TMdrive-MVe2 drive are built in Japan to IEC standards with 3kV, 6kV, and 11kV output voltage levels. TMdrive-MVe2 has high electrical conversion efficiency and power factor of 1.0, with no need for harmonic filters or power factor improving capacitors. Its active front end enables corrective VAR compensation for the utility and regenerative braking puts energy back into the supply when the load is slowing down. Using identical rack mounted cell inverters, which are easily withdrawn and inserted, allows the repair time (MTTR) to be as short as 30 minutes. The multilevel pulse width modulated control produces an output waveform close to a sine wave, so an output filter is not required, and motors do not require surge protection.

TMdrive-MVe2 family of drives gives the user a wide choice of voltage output and power level. The different drives range from 3 kV to 11 kV at power levels up to 4,100 kW (5,000 kVA). Compared to earlier MV drive designs and other multi-level drives on the market, the unique MVe2 design reduces the module count providing a cost reduction and significant improvement in reliability.

Toshiba Mitsubishi-Electric Industrial Systems Corporation (TMEIC) | www.tmeic.com



Project website improvements

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

Schletter Inc. | www.pvpowersite.com

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Bi-facial module

LG's NeON 2 Bi-Facial module generates power from both the front and rear sides, maximizing power performance and significantly exceeding the output of monofacial modules. The NeON 2 Bi-Facial module generates 310W of power from the front side of the panel, which is supplemented by up to 400W generated on the backside. To help enhance the bifacial performance, the solar module also features LG's Cello technology, which utilizes circular-shaped wires to scatter light for better absorption while reducing electrical loss and increasing power output and reliability by spreading the electrical current through 12 thin wires rather than the traditional three busbars.

LG | www.lg.com



UL1741 central inverter product line

Ingeteam's INGECON SUN PowerMax U B Series inverters are 111" x 35" x 80" inches and are able to supply up to a maximum power of 1,637 kVA in a single unit; making its power density more than 326 kW/m³ (5.34W/in³). The 1500 Vdc INGECON SUN PowerMax B Series inverter family features a Smart Cooling System which makes it possible to optimize and reduce the auxiliary services consumption. Furthermore, the inverter's electronic components are housed in an IP66 (NEMA 4) protected compartment, thereby preventing condensation and lengthening the useful life of the power electronics. This inverter family is ready to be installed indoors (IP50) and outdoors (NEMA3/IP56), and can deliver its rated power up to an ambient temperature of 50°C (122°F). Additionally, the improved inverter design facilitates the installation and wiring tasks (on both DC and AC) in addition to the maintenance and repair work. Reliability of the product has been proved on the Bankability and Reliability report issued by Black & Veatch. Its compact size allows it to be easily integrated into medium voltage solutions or power stations containing all the equipment required for large PV plants. In fact, three (3) inverters can be mounted in the same power station in order to reach up to 4.91 MVA in a single medium voltage unit.

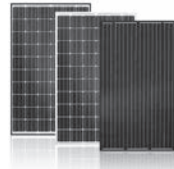
Ingeteam | www.ingeteam.com



Autonomous survey rover

TerraSmart's robotic vehicle, APSR, is powered with a gas/electric hybrid drive system, allowing it to run 24/7 if required. It is designed for all-terrain use with "slope awareness" for undulating sites, and includes a geometric passive articulation suspension system, 24-inch tires with a 10-inch ground clearance, and travels at a maximum speed of 11 mph with a maximum incline of 45°. APSR operates using line-of-sight wireless control, as well as Real Time Kinematics (RTK) GPS that increases its precision, accuracy, and speed. Version two of APSR, coming in the first quarter of 2017, will be able to survey and drill holes with a two-inch diameter and a maximum depth of 20 feet within a half-inch tolerance. The engineering team loads coordinate files onto an Android tablet, making them accessible to the APSR operator to create "missions" for each project site. APSR's operator can prioritize work by site conditions and can save and replay missions at any time. Once the operator provides the commands, APSR will survey each programmed location. A four-level safety system is built into the autonomous vehicle that can stop the rover in its tracks up to a half-mile away. The operator can also hit a kill switch on his belt; there is a power-down command on the companion Android tablet, and APSR shuts itself down if it tips over or if it travels outside of its operating area.

TerraSmart | www.terrasmart.com



High-efficiency SE solar PV module

Itek Energy has announced the release of their new SE Solar Module, which offers up to 300-Watt capacity and is certified PID-free at 500 hours. The new SE modules are composed of high-efficiency monocrystalline M2 cells, which offer a larger cell surface area. The cells utilize a proprietary Passivated Emitter Rear Contact (PERC) process which provides a high cell efficiency. Other efficiency updates to the SE Module include a more reflective back sheet and improved encapsulating materials that increase light absorption. Itek's SE is also certified Potential Induced Degradation (PID)-free. PID-free modules undergo a rigorous testing and certification process which allows consumers to be confident that their modules will remain efficient for a long life span. The SE module is certified Made-in-Washington with quality components, and is available in three styles: Black—a black back sheet and a black frame; Standard—a white back sheet and silver frame; or Tuxedo—a white back sheet and a black frame.

Itek Energy | www.itekenergy.com

High power output PERC and bifacial modules

Mission Solar Energy has added four new module lines to their product offering. The Apollo, Mercury, Gemini and Gemini Elite modules utilize advanced technology to provide efficiency, reliability, power, and aesthetics. The Apollo is a 72-cell module capable of producing 360W of power. The Apollo allows users to reduce system costs through robust design, 1,500V compatibility, and simple installation. The Mercury is Mission Solar Energy's first product designed specifically for the rooftop market. The Mercury is a 60-cell, aesthetically pleasing, black-on-black design module capable of producing 300W of power. The Apollo and Mercury modules utilize PERC technology and 4 busbars to produce module-level efficiency over 18%. The Gemini bifacial module features 72 N-type monocrystalline cells capable of producing 330W of power from the front side and additional power off the backside for up to 400W of total power. Use of N-type cell technology makes this module a solution for use in harsh climates including snow and desert conditions. The N-type cells are not subject to light induced degradation (LID), allowing the modules to harvest maximum energy. The Gemini Elite is a 72-cell, dual-glass bifacial module producing up to 330W of power plus additional power off the back side for a potential 400W of power. This module is durable, features no potential induced degradation (PID), and a Class A fire rating. The Gemini Elite's attractive, frameless design is ideal for carports, breezeways, and built-in locations. Like the Gemini, the Gemini Elite is not subject to LID and operates well in low light and/or harsh conditions.

Mission Solar Energy | www.missionsolar.com



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Modular, cost-effective solar water pumping

Franklin Electric Co., Inc. announces its new Photon SolarPAK System, featuring a Franklin Electric submersible pump and motor, and the Photon solar controller in one package. When used with solar panels to power the pump and motor, the system draws groundwater to the surface for a variety of uses. The catalyst behind this new system, the Photon solar controller, features a compact modular design, providing installation flexibility for the contractor. For added durability, it touts a robust IP66, NEMA 4 enclosure that protects against wildlife, insects, dust, and weather. The controller includes diagnostic features and built-in protection from potential harmful conditions, such as: surge, underload (dry run), overvoltage, locked pump, open and short circuit, overheated controller, and reverse polarity. The Franklin Electric Photon SolarPAK System is cULus and UL approved and available in a variety of flow rates from 2.5 to 90 gpm (9.5 to 270 lpm) and power ratings of 0.75 and 1.5 hp (0.55 or 1.1 kW). Photon can drive a broad range of submersible and surface motor types and can be used in a new solar array or retrofit to an existing array in many cases. The Photon SolarPAK System supports a variety of pumping applications, including: livestock watering, tank/cistern filling, wildlife refuge and game farms, rural water supply for villages and homesteads, irrigation systems, fountains, vineyards, renewable energy projects, effluent pumping, rain harvesting, and more.

Franklin Electric | www.franklinwater.com



1500VDC string combiners

Yaskawa - Solectria Solar's DISCOM 1500 is a 1500VDC string combiner offering utility-scale and large commercial PV designers the design flexibility needed in combiners. The combiners have gone through Highly Accelerated Lifetime Testing (HALT) guaranteeing all components are carefully vetted for highest reliability. The DISCOM 1500's premium features satisfy the needs of PV system designers and reduce overall system cost and increase ROI. These premium features include: gloss white material finish, a high gloss white polyester powder coat painted steel to keep the electronics cooler in higher temperatures and reduce extreme thermal cycling, adding to the product life; heavy gauge bus bars with high quality plating to reduce operating temperature, maximize product life, and eliminate failures. The plating is bright tin which prevents corrosion between components maximizing product life; multi-contact MC4 or Amphenol H4 connectorized wire whips which are a robust option, reducing installation time and costs; compression lug studs designed to fit various output lug sizes for copper or aluminum conductors; and 316 stainless steel Bellville spring washers and nuts on stainless steel output studs to eliminate corrosion possibility.

Yaskawa - Solectria Solar | www.solectria.com

Integrated remote security and surveillance

Sensera Systems' SiteWatch-PRO Series system is a turn-key remote site video surveillance solution featuring dual day/night cameras, long range PIR-based motion detection, and IR or white light illumination, all powered from the integrated solar powered battery system. SiteWatch-PRO Series is compact, portable, simple to install, and can be mounted anywhere. The system's camera supports cellular and WiFi, and is supported by Sensera Systems' MultiSense Cloud Service providing end-to-end remote video surveillance and alerting over cellular or WiFi connections, accessible from any PC or mobile web browser with no additional software. The automated provisioning feature of MultiSense means no IP addresses or camera-side configuration is needed to bring the cameras onto the cloud. The SiteWatch-PRO Series camera features capabilities including: DVR edge recording (64GB), 720p/H.264 video streaming, triggered image and video capture, and email and SMS motion alerts. Motion alerts can be configured to include video or still imagery, providing real-time video alarm verification. Arming of motion detection and alerting can be scheduled from the web interface. The SiteWatch-PRO Series camera also supports the LiveView feature allowing near-real-time continuous site monitoring. The SiteWatch-PRO Series utilizes high performance Optex Redwall V-Series PIR sensors for reliable long-range motion detection with low false alarms, and the Raytec VARIO series LED illuminators for the best images.

Sensera Systems | www.senserasytems.com



DC/DC power converter for photovoltaic applications

Phoenix Contact's new UNO Solar DC-to-DC power converter connects directly to a solar array. The UNO Solar converts high voltages from DC strings to 24Vdc, eliminating the costs and hassle of trenching for combiner, re-combiner, and inverter control for anti-islanding applications. The UNO Solar accepts the 300 to 1000Vdc input generated by the array and converts it to electrically isolated 24Vdc/2.5 A output voltage. For higher current applications, the UNO Solar can be wired in parallel with the use of a decoupling diode.

Phoenix Contact | www.phoenixcontact.com



L-coded power solutions for high power applications

The new HARTING M12 Power offers solutions for high power applications with the small footprint of an M12 connector. This is achieved by a standardization and new encoding, saving users space and interfaces. The IEC 61067-2-111 standard is the basis for future M12 Power connector solutions as well as the universal mating face with L-coding. At 63V/16A, the 5-pin L-coding achieves 0.75kW of power, making it ideal for small servo motors, field distribution boxes, field-bus-controlled I/O boxes, power supply devices, and valve applications. The M12 L-coded is expected to completely replace the application area of the existing M12 A-coded and 7/8" solutions.

The HARTING Technology Group

www.harting.com



Central inverter certified to UL 62109 standard

SMA's newest central inverter is a solution for 1,500 VDC applications and also is UL certified to the new UL 62109 standard. The Sunny Central 2500-EV-US provides 2,500 kVA at 1,500 VDC, allowing developers, owners, and EPCs to benefit from cost reductions due to balance-of-system savings. The Sunny Central 2500-EV-US inverter saves costs by reducing the size of the DC cabling, as well as the quantity of combiner boxes and medium-voltage equipment required. Additionally, fewer system components are needed per inverter pad due to the integrated DC fuse servicing switches and convenience power. The Sunny Central 2500-EV-US represents a new level of safety, functionality, and reliability, as it complies with UL 62109, addressing the latest safety, ground fault, and electric shock testing requirements established to address modern PV inverter designs.

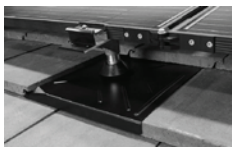
The SMA Group | www.sma-america.com



Affordable commercial and utility scale racking system

The RBI Solar next generation ground mount solution has achieved ETL Classification from Intertek to UL Standard 2703. This new model underwent a rigorous testing regimen for bonding and grounding to pass the UL 2703 Standard. The RBI Solar next generation ground mount solution was specifically designed to make solar installation more affordable for commercial and utility-scale PV projects. New innovations to the solar racking system include a wider selection of component parts, including an economical upright post and top chord engineered to bear the load while using less steel. This new system also reduces costs by incorporating a more streamlined production process. This ground mount solution has multiple foundation designs to be compatible with a variety of site-specific soil and ground conditions. Structural components are also available to match wind and snow loads. All of these innovations are focused on reducing the overall cost of the racking system.

RBI Solar, Inc. | www.rbisolar.com



Rail-free tile replace system

Pegasus Solar designs, manufactures, and sells the LightSpeed Mount, a rail-free residential solar mounting systems for composite and tile roofs. Their latest innovation is the LightSpeed Tile Replace system which significantly reduces installation times by eliminating the need to cut roof tiles, and the replaced roof tiles can be used as spares to replace cracked tiles. The top flashing is shaped to seamlessly replace standard Flat, S, or W tiles, and maintains the waterproof integrity of the roof. The system can also be used for mounting an L foot for rails or for attaching conduit or junction boxes to the roof. Tile Replace Flashings come in Flat, S, and W shapes, and are supplied with a Post and EPDM Boot in packages of 6. The LightSpeed Mounting assemblies also come in kits including Single Mounts (qty 6) or Double Mounts (qty 4). Each system is designed to be waterproof and aesthetically appealing.

Pegasus Solar | www.pegasussolar.com



Cable tray flexible coupler kit

The T&B Cable Tray flexible coupler kit, from Thomas & Betts (T&B), features a bendable plate that allows for electrical continuity, which eliminates the need for a bonding jumper. The flexible coupler kit also provides maximum horizontal installation flexibility and easy installation that eliminates the need for cutting cable tray side rails. Other features include an exterior strap that provides an accurate radius for any cable tray design requirements, formed ribs for greater cable protections, and no sharp edges. It meets electrical continuity requirements of NEMA VE1 and CSA C22.2 No. 126.1.

Thomas & Betts Corporation
www.tnb.com



Touch safe power distribution blocks

ILSCO introduces their next generation of touch safe power distribution blocks. The step shape design of the copper alloy block affords the user the ability to install in confined spaces. The transparent cover provides IP20 touch safe protection as well as aids in visual inspection. The cover design incorporates dovetail tabs for nesting connectors together to create multiple configurations. The connectors can be DIN-rail or panel mounted for application versatility and have a high short circuit current rating of 100kA or 200kA RMS SYM Amps. Suitable for use with copper conductor.

ILSCO | www.ilsco.com



Dynamic tracker design with integrated software

SunLink Corporation's TechTrack Distributed single axis tracker offers dynamic design, site flexibility, and reductions in total project costs. Central to the system is a dynamic design feature called Dynamic Stabilization through which the characteristics of the tracker are changed depending on real-time, sensor-observed environmental conditions. Beyond simply adjusting tilt, SunLink's TechTrack Distributed incorporates control over the damping and stiffness of the array, opening a completely new solution space for increasing energy output, maintaining structural integrity and lowering cost. In addition, TechTrack Distributed solves the challenge associated with monitoring the thousands of electromechanical parts that make up a distributed tracker system via SunLink's VERTEX Project Intelligence Platform. VERTEX enables next-generation real-time data monitoring and secure remote control, which provides greater visibility into energy assets, historical data collection and more efficient O&M – resulting in more valuable energy projects. SunLink also offers PowerCare installation and O&M services for TechTrack projects, making it possible for EPCs and developers to take on more projects successfully.

SunLink Corporation | www.sunlink.com



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Modular, commercial inverter

ABB's TRIO-50.0 inverter combines many of the benefits of a central inverter into the enclosure of a string inverter. This modular, left-to-right, power-flow design offers configurable AC and DC compartments on either end that are separately wired from the inverter module inside the system. This makes the system easier to install and maintain. It's a familiar configuration to those who build commercial projects with traditional central inverters. It offers the flexibility of horizontal as well as vertical mounting and can be installed in direct sunlight. The modular structure also allows for a two-person lift and installation, further reducing the cost of installation. Available in both 12 and 16 string combiner options to accommodate all types of PV modules, including high-voltage modules at full power.

ABB | www.abb.com



Improved industrial insights in the cloud

Schneider Electric delivers solutions for industrial information management. Wonderware Online, built on the Microsoft Azure cloud platform, provides users with a secure, easy-to-use solution offering seamless convergence of operational and information technology (OT/IT) with security, discoverability, and extensibility all being native to the platform. Wonderware Online includes the Wonderware Online InSight Connector, a productivity tool that allows customers to link time-series data stored in Wonderware Online into Microsoft Excel and Microsoft Excel Online. This enables users to run custom formulas, perform ad hoc analysis, and create Excel-based reports and charts. The Wonderware Online InSight Connector is available from the Microsoft Office 365 store.

Schneider Electric
www.schneider-electric.ca



Innovative, aesthetic modules

LG has introduced the company's first Back Contact cell design on the NeON R module. The new cell is beautifully configured with a virtually seamless façade, perfectly blending into nearly all rooftop designs. Instead of visible busbars and wiring on the surface, the Back Contact cell boasts a completely black aesthetic that is both visually pleasing and energy efficient. In addition to a sleek design, LG's NeON R module boasts high efficiency. The cell design positions all the module's electrodes on the rear side of the cell and features LG's N-type cell structure, allowing the panels to produce 365W of energy, up to 7.3kWp, compared to p-type cell's 5.8kWp. This N-type cell structure can also minimize the Light Induced Degradation (LID) – the initial power drop caused by the Boron-Oxygen complex – giving it a longer lifespan and higher output over the lifetime of the module. In addition to higher energy output and beautiful design, the brand new cell design allows the panels to be installed in the shadow of a tree or chimney, which previously posed an issue.

LG | www.lg.com



Solar powered tracking and identification transceiver

SRT Marine Systems plc, announces the availability of their fully certified solar powered AIS Class B small vessel and VMS tracking and identification transceiver. The AIS Class B Identifier has integrated GPS and VHF antennas, a range of security features, dual terrestrial and satellite tracking modes, and can be powered by either its internal rechargeable battery or direct connection to the vessel's power supply. The new Identifier Solar Power Kit is designed and engineered to provide optimal power to the Identifier and enables continuous autonomous operation without the need for connection to the vessel power supply – with the internal battery continuing to provide over 5 days of standby power reserve. The kit includes a full bracket system to make installation with the Identifier vessel mounting bracket simple, secure and robust. The kit comprises of a high efficiency solar panel which has been ruggedized for long term continuous deployment in harsh commercial marine environments, a marine grade stainless steel mounting bracket which is designed to easily clamp to the Identifier Transceiver vessel mounting pole bracket system, or other suitable pole, and the Identifier power control and user interface with a range of configurable user functionality such as SOS and geo-fence alerts.

SRT Marine Systems plc
www.srt-marinesystems.com

Visual solar design solution

PVsketch is a seamless solar design solution for sales people and project developers. Its user-friendly interface requires no special training for use and includes NREL's accurate energy production modeling and makes easy comparisons of design alternatives. An extensive and continuously updated equipment library allows users to see how many panels fit on a roof and models the system's energy output. Project data gets entered once into the PVComplete platform, following the project from start to finish, so there is no need to repeat steps in the design process.

PV Complete | www.pvsketch.com

Now Available from AIMS Power Great for Residential & Commercial Installers



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AIMS Power offers over 90 different models of Power Inverters and Converters
We have the right product for any on-grid, off-grid or mobile power project

775-359-6703
sales@aimscorp.net



Heavy duty flat tile roof mount

SolarRoofHook's new Heavy Duty [HD+] Flat Tile Roof Mount is a durable, 7mm thick, stainless steel mounting solution designed to withstand high wind loads and decrease the amount of hooks needed on the roof. Arrays can be designed with wider spans and fewer roof penetrations. Installers take on risk when drilling through tile and can avoid unnecessary liability by using affordable mounting solutions meeting code requirements throughout the country.

SolarRoofHook | www.solarroofhook.com



Adjustable busbars

WAGO offers a wide variety of shielding products to assist in eliminating unwanted electrical noise. Used with WAGO's new shield clamp that features an exclusive latching spring, 790 Series adjustable busbars provide excellent shield contact and performance. The adjustable carriers are available with heights from 70 to 80 mm and can be cut to the desired length. Adjustable T-connectors also allow the busbar to be positioned horizontally or vertically. Busbars are pre-connected to the DIN rail adapter—cutting installation time. Adjustable busbar carriers are also compatible with other WAGO shield accessories offering a one-stop solution that makes any installation quick and easy.

WAGO | www.wago.us



1500V polycrystalline solar modules

Boviet Solar USA's new high-voltage solar modules are for large commercial and utility scale solar installations and require less balance of system (BoS) components compared to 1000V modules. The new 1500V solar modules are available in a 72-cell configuration with a 12-year workmanship warranty and a 25-year power output warranty. All Boviet Solar USA modules pass a stringent quality control process that includes a three-time Electro Luminescence Examination and Flash Tests.

Boviet Solar USA
www.bovietsolarusa.com



17.9% module efficiency

Japan Solar's LI Series has 260-335W available power and a power tolerance of 0~+3%. Certified to UL 1703, the module efficiency is 17.9%. The LI Series comes with a 10-year product warranty, and a 25-year linear performance warranty. It is available for both poly and mono cells, and for 60cell and 72cell. Coming in the spring of 2017 will be a module with up to 350W with PERC technology.

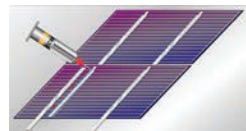
Japan Solar | www.japansolarus.com



Rail-free, reliable solar racking

Mounting Systems' newest racking system, Element, is a rail-free solution designed for pitched-roof systems. Element's rail-free design features die-cast aluminum for superior rigidity and durability, active water diversion, and integrated bonding for a complete connection. With fewer parts and pre-assembled components, installation is fast, shipping costs are low, and logistics are simplified. Element offers both North-South and vertical adjustability for flexibility in either landscape or portrait orientations. Element requires only one tool for the entire system, making installation convenient and efficient. For further design compatibility, Element's mid and end clamps utilize proprietary click technology, so mounting becomes intuitive and expedient for the installer.

Mounting Systems
www.mounting-systems.com



Low-cost snap cure conductive adhesive

Engineered Materials Systems introduces its new EMS 561-676 Low-Cost Snap Cure Conductive Adhesive for stringing or shingling applications in crystalline silicon and thin-film solar modules. EMS 561-676 is designed to electrically interconnect solar cells using ribbons or direct cell-to-cell contact. The adhesive is stress-absorbing to withstand the rigors of thermal cycling and features excellent conductive stability to cell and ribbon metallization during damp heat exposure. Additionally, the conductive adhesive is designed to cure in seconds at 150°C to 180°C to enable fast fixturing of the cells in the stringer. EMS 561-676 offers a more than 50% cost savings compared to standard silver-filled conductive adhesives.

Engineered Material Systems
www.emsadhives.com

AC solar panel

The SolarWorld AC Module integrates the microinverter and eliminates the need to install a centralized string inverter so it allows for quick installations and simplified logistics, reducing installation labor costs and system costs. The design helps increase safety during installation and operation and enables in-field replacement and upgrades. The AC Module offers module-level optimization and enhanced power output and meets NEC 2014 and 2017 690.12 rapid-shutdown requirements.

SolarWorld REAL VALUE | www.solarworld.com



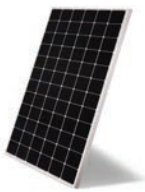
NEW

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- + Internal data logging with Web access
- + Resistant to soiling
- + Most affordable turn-key system
- + On-site calibration station

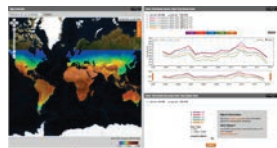
Kipp & Zonen USA Inc. • 125 Wilbur Place • Bohemia NY 11716
T: 631 589 2065 • kipp.usa@kippzonen.com • www.kippzonen.com



72-cell commercial-grade modules

Suited for utility scale installations, LG's NeON 2 72-Cell module represents an efficient and practical solution for commercial installations due to LG's N-Type double-sided cell structure and recently improved 400W output. LG's double-sided cell structure allows the panels to produce more energy with a smaller footprint. The module features a series of 72 high-efficiency cells that make it easier to manage space when installing a large-scale system without sacrificing energy output. The three models available now, LG365N2W-G4, LG370N2W-G4, and LG375N2W-G4, are designed to deliver outputs ranging from 365W to 375W, in a 6.41- by 3.28-foot panel, thereby producing more power in less space. A new model to ship in 2017 offers up to 400 watts of energy output with a similar footprint, making it the most powerful in the collection.

LG | www.lg.com



Solar time series tools

This new subscription service from Vaisala offers convenient access to hundreds of bankable solar time series for resource assessment and project monitoring. Visualize and compare up to five global datasets at any location worldwide for one low annual price. Vaisala's Solar Time Series Tools allow users to quickly and easily evaluate and order data right from their computer screen to improve energy estimates and minimize development risk. The Solar Time Series Tools also provides access to resource information at operational sites for reconciling recent performance against actual weather conditions to uncover and resolve potential equipment and maintenance problems. Data is available in both long-term time series and TMY format and is delivered in less than 24 hours to help meet tight deadlines. All data files are produced by Vaisala 3TIER Services, a provider of solar due diligence services, and the first to develop a high-resolution global solar dataset.

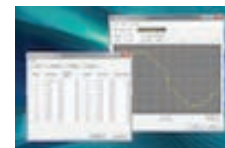
Vaisala | www.vaisala.com



Self-commissioning residential inverter

ABB's self-commissioning residential inverter, the UNO-DM, is a single-phase inverter combining their technology and smart grid capabilities in a compact, lightweight package. The UNO-range, the UNO-DM is a single-phase inverter rated from 3 to 6 kW. The product simplifies installation complexity via a self-commissioning routine that removes the manual configuration process and results in lowered installation time and costs. The integrated web server and user interface enables remote firmware upgrades and parameter settings. Upon setup, the inverter's wireless connectivity begins the self-commissioning process. The connectivity package of the UNO-DM enables for built-in smart grid capabilities such as dynamic feed-in control, which manages the energy fed into the grid, and uses SunSpec-compatible open communication protocols to ensure compliance with future grid codes and maintain off-the-shelf interoperability with other devices in the system.

ABB | www.abb.com



Regenerative grid simulator

NH Research, Inc. (NHR) has released new advanced output control features, improved manual control interface, and comprehensive drivers for the popular Model 9410 Regenerative Grid Simulator. These new control features provide intuitive controls for simulating any abnormal AC-grid condition including: voltage harmonics, sags and swells, sub-cycle, full-cycle, and multi-cycle disturbances. It has never been easier for R&D to validate product designs or for manufacturing teams to ensure functional and regulatory compliance with EN 61000-x, IEEE 1547, UL 1741, CA Rule-21, LVRT, and similar emerging testing standards. Improvements have also been made to permit intuitive access to these new features through the full-featured manual control panels as well as through the fully-documented LabVIEW Compliant and IVI-C / IVI-COM compliant drivers. The Model 9410 Regenerative Grid Simulator is a full featured, 4-quadrant, regenerative, rack-mountable, 12-kW grid simulator in only 15." (9U). Standard models include three (3) fully programmable channels allowing for any combination of DC as well as 1Φ, 2Φ, 3Φ AC outputs making it right-sized for testing Level 1 and Level 2 EV Chargers, EVSE systems, as well as V2G. When higher power is required. The modular design permits expansion in 12-kW increments meeting the needs for grid-tied solar inverters, ESS systems, exporting critical power systems (UPS), and similar AC grid-connected devices.

NH Research, Inc. | www.nhresearch.com



Three-phase string inverter

REFUsol's new generation 24K-UL three-phase string inverters are based on the platform of the REFUsol 08 ... 23K family, which achieves maximum output without maintenance effort. In addition, the devices have undergone further development, and the new software enables them to be modified with ease in the future if, for example, it becomes necessary to connect energy storage or integrate the solar plant in smart grids. The software interface can be easily adapted to evolving grid connection requirements. The 24K-UL is UL-certified and can be connected to the REFUlog monitoring portal via the integrated data logger.

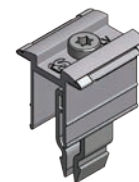
REFUsol | www.refu-sol.com



Integrated AC module

ET Solar has developed AC modules that are fully integrated with high quality micro inverters. With 25mm in thickness, this micro inverter is one of the thinnest products in its class. ET Solar's AC module system offers up to 25% more power yield than conventional PV systems utilizing string or central inverters, minimizing system shading loss due to trees and other obstructions on or near residential and commercial roofs, while reducing up to 50% of the PV system design and installation cost. Moreover, ET Solar launched a web-based ACPV design software for AC Module System. It offers a platform to help customers minimize the risk of PV power plant installation and maximize installation efficiency and satisfaction in an easy way.

ET Solar | www.etsolar.us



Click-in grounding module clamp

Schletter's new Rapid5K grounding module clamp is based on the design of Schletter's Rapid2+, but in a compact design. In addition, the new clamp meets the latest UL 2703 requirements which require higher AMP loading thereby creating a safer system all around. It also provides the quickest option for mounting modules and is completely integrated with a standard grounding feature. The Rapid5K comes pre-assembled as a standard stock item and is available in a variety of sizes.

Schletter | www.schletter.us



Portable solar generator

Smith and Sons LLC is excited to announce the launch of eHub 50 Portable Solar Charger. The eHub portable solar generator provides power for off-grid mobile power requirements and eliminates the need for diesel-powered generators. The portable system comes with an integrated solar panel that charges the energy storage system. The eHub charges eight mobile devices simultaneously plus provides off grid lights.

Smith and Sons LLC | www.smithandsonslc.com



Tile hook flashing

EcoFasten Solar's Tile Hook Flashing was designed specifically for use with 3rd party tile hooks, and because it replaces one complete tile, the need for cutting, grinding, or replacing of tiles is eliminated. The Tile Hook Flashing is currently available in profiles for flat, S and W tile roofs, in either mill finish or sierra tan.

EcoFasten Solar | www.ecofastensolar.com



Electroluminescence inspection for modules

Electroluminescence inspection for modules highlights defective parts and process problems and indicates possible warranty issues with absolute reliability. MOD-Q EL, the electroluminescence inspection tool from ISRA VISION/GP SOLAR, accommodates a wide variety of manufacturing scenarios, be it automated or manual inspection, inline or offline. The reliable system achieves cycle times of less than 30 seconds for optimum throughput. High resolutions allow even the smallest defects to be detected. The automatic defect detection and classification offers outstanding reliability. With the newly developed MOD-Q VISION, optical inspection or a combination of electroluminescence and optical inspection are equally successful. Optical inspection of solar modules is essential for shipping high-quality products. Automated inspection reveals more defects and is much more reliable than inspection by the naked eye, which is impractical for high throughputs, especially when the highest quality standards are needed. Optical inspection with ISRA VISION/GP SOLAR delivers cost-efficient automatic optical inspection at resolutions of up to 25 µm/pixel. The inspection is based on established algorithms and supports any print pattern and the latest cell designs, including multi-wire, IBC and more. Cycle times of less than 30 seconds per module can be achieved. MOD-Q VISION is easy to integrate into new and existing production lines and is also suitable for framed and unframed modules after lamination.

ISRA VISION | www.isravision.com



Rapid shutdown combiner box with capacitor discharge

Innovative Solar Inc. (ISI), has developed a rapid shutdown combiner box with capacitor discharge. The Combiner comes with optional AFCI and surge protection. Innovative Solar's PV powered combiners accommodate single or multiple MPPTs. Ranging from 4 to 24 strings in grounded or ungrounded applications, this is a product for commercial rooftops and ground mount applications.

Innovative Solar, Inc.

www.innovativesolarinc.com



Robust AC capacitors

TDK Corporation presents two new series of robust EPCOS alternating current (AC) capacitors. Both the cans and the tops of the components are constructed of aluminum, making them particularly robust. All capacitors in the B33331* and B33335* series are CE-compliant, have both VDE approval in accordance with EN/IEC 60252-1 Class A and UL approval. Thanks to their robust design and integrated overpressure disconnecter, the capacitors meet the requirements of safety class S2 as specified by EN/IEC 60252-1. The rated voltage for all the new types is 450 V AC (50/60 Hz) and the permissible operating temperature is between -40°C and +85°C. This results in life expectancy of 30,000 hours.

TDK Corporation | www.epcos.com

safeTrack Horizon

The cost-effective horizontal tracking solution for every challenge



Less leveling work

Flexibly adapts to terrain on slopes with inclines of up to 20° in all directions thanks to a new drive system, making expensive grading unnecessary

Lower O&M costs

Low-maintenance components and a construction which enables easy, automated cleaning, reducing operating costs



High ground cover ratio

The ground cover ratio of the safeTrack Horizon is the highest of all comparable systems, enabling the installation of up to 33% more capacity on the same area

Ready for glass-glass modules

The fully synchronous drive technology prevents tracker twisting, allowing for the use of glass-glass modules



German engineered tracking systems made by

TRACKING & MOUNTING SYSTEMS



www.ideematec.de

Performance Monitoring

Solar performance monitoring systems are necessary to verify the components within a solar system are performing and producing the energy they should. Here, we highlight some of the performance monitoring systems available on the market today.

SEE AD ON PAGE 33



LI-COR Biosciences

Product: LI-200R Pyranometer

Warranty: 1-year parts and labor warranty

Logging Values: W m⁻²

Certifications: Calibrated against an Eppley Precision Spectral Pyranometer (PSP) under natural daylight conditions.

Key Features:

- Detachable sensor simplifies installation and removal, making it a solution for platforms with complex cabling;
- Weather resistant and durable in long-term outdoor deployments;
- Measures global solar radiation under unobstructed natural daylight conditions.

www.licor.com

SEE AD ON PAGE 29



Kipp & Zonen

Product: RaZON+

Voltage: 24V

Current: 500 mA

Power: 13W

Warranty: 2-year warranty (5-year warranty on PH1 and PR1)

Logging Values: Global, Diffuse, Direct, Sunshine Duration, Solar Angles, GPS time, Longitude Latitude, Status

Certifications: CE, FCC

Key Features:

- All-in-one system includes pyrhelimeter, pyranometer, and data logger;
- Accurate DNI measurement;
- Designed for remote locations and resistant to soiling;
- Communication via ethernet, RS485 modbus, or Wi-Fi;
- User-friendly installation, operations, and maintenance.

www.kippzonen.com

ALL HT PV Testers upgraded to 15A!



All HT Installation Testers and PV Curve Tracers now support up to 15 Amps. The 15Amp capability is keeping to our commitment to be the best supplier to the PV Industry.

- IV Curve tracers starting at \$3,495
- Installation Testers at \$1450
- Power Quality Analyzers starting at \$4,995
- ...adding more to the affordability promise



HT Instruments America

sales@ht-instruments.us
<http://www.ht-instruments.com>
 732-952-2111

Premier Distribution Partner



Yaskawa - Solectria Solar

Product: SolrenView Web-Based Monitoring

Voltage: 12-24 Vdc

Current: 1 channel

Power: 120v

Frequency: 60 Hz

Warranty: 10-year warranty

Logging Values: kWh, W, A, V

www.solectria.com



SolarEdge

Product: SolarEdge Cloud-based Monitoring Portal

Voltage: Fixed voltage inverter

Warranty: 12-year warranty, extendable to 20-years (inverters), 25-year warranty (power optimizers), 25-year monitoring portal

Certifications: Inverters: UL1741, UL1699B, UL1998, CSA 22.2, IEEE1547, FCC part15 class B. Power Optimizers: FCC Part15 Class B, UL1741, RoHS, Sunspace Alliance, 1741SA

www.monitoring.solaredge.com

SEE AD ON PAGE 10



EKO

EKO Instruments USA, Inc.

Product: MS-80, Secondary Standard Pyranometer

Voltage: 10 microvolts per W/m²

Current: No current consumption on the analog output, 7mA - 42mA for the 4-20mA output or Modbus output

Power: No power consumed for the analog version, < 0.5W for the 4-20MA output, 0.3W for Modbus

Frequency: <0.5 s

Warranty: 5-year warranty, 5-year recommended recalibration interval

Certifications: ISO 17025

Key Features:

- Immune to thermal offsets;
- Fast analog response;
- High stability;
- No need to replace desiccant resulting in low cost of ownership.

www.eko-usa.com

SEE AD ON PAGE 34



Continental Control Systems, LLC

Product: WattNode Energy and Power Meters

Voltage: 120/208-240V – 347/600V

Current: 5 amps – 6000 amps

Frequency: 50/60 Hz

Warranty: 5-year warranty

Certifications: UL, cUL, CE, ANSI C12, PBI, CE

Key Features:

- Revenue-grade production and consumption energy metering;
- Single-phase, split-phase, three-phase kW / kWh sub metering;
- Modbus, BACnet, LonWorks, and pulse output;
- “Fast-Power” - 200msec power reading output;
- Low-cost, small footprint.

www.ccontrols.com



Solar Data Systems, Inc.

Product: Solar-Log 2000

Voltage: 120V, 240V, 480V, 600V

Current: any voltage/current combination

Power: up to 2MW

Frequency: 50/60 Hz

Warranty: 5-year warranty

Logging Values: V, A, W, Wh, Hz, VAR

www.solar-log-america.com



meteocontrol North America, Inc.

Product: blue'Log

Voltage: 24V

Warranty: 2-year warranty

Logging Values: Central recording and transmission of all system data

Certifications: UL

www.meteocontrol.com



Phoenix Contact

Product: EMpro MA600 series

Voltage: 18-700 VAC (direct); up to 500 kVAC (via external PTs)

Current: 0-10,000 amps

Power: 0-8000 MW

Frequency: 50/60 Hz

Warranty: 1-year warranty

Logging Values: V, A, W, Wh, Hz, VA, VAR, THD

Certifications: UL/cUL/IEC STD 61010-1 Listed Device, IEC 62053-22 Real Energy Class 0.5 S

www.phoenixcontact.com

Need to Monitor PV Efficiency?

Experience the cost effective, low maintenance design of the new LI-200R Pyranometer for yourself.

Contact us for a **FREE Pyranometer***

www.licor.com/try-sensor



*Offer expires December 1, 2016.



Interchangeable heads

Detachable base

Multiple output signals

SEE AD ON PAGE 32



HT Instruments

Product: I-V 400 W

Voltage: 1000V

Current: 15 amps

Frequency: 50/60 Hz

Warranty: 3-year warranty

Certifications: CE

Key Features:

- 15 amp, 1000V coverage;
- Built-in Wi-Fi;
- Software for PC and a new app for tablets.

www.ht-instruments.com



Hukseflux

Product: SR30 digital Pyranometer

Voltage: 5V – 30V

Current: 8.3 - 175 mA @ 12 VDC

Power: 0.1 - 2.1W

Warranty: 5-year warranty

Logging Values: W/m² (GHI, POA, DIFF)

Certifications: ISO 9060 Secondary Standard

www.hukseflux.com



Apogee Instruments

Product: SP-420

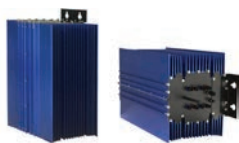
Voltage: USB powered

Power: USB powered

Warranty: 4-year warranty

Logging Values: Can log internally or on PC or Mac with intervals between 1 second and 1 day. Internal values can be stored on unit while unit is plugged into USB power block. Can store up to 10,000 units

www.apogeeinstruments.com



Alencon Systems, LLC

Product: SPOT

Frequency: 60Hz

Voltage: up to 2500V

Warranty: 20-year warranty

Current: 10 amps

Certifications: UL1741

Power: 25kW

www.alenconsystems.com



Steca Elektronik GmbH

Product: Solar charge controller Taron 4545-48

Voltage: 12/24/48V

Current: 45 amps

Power: up to 2700W

Frequency: DC-based product

Warranty: 5-year warranty

Logging Values: 12 years of data logging for: PV yield (last 18 hours, per day, per month, per year, total), load output (last 18 hours, per day, per month, per year, total), battery voltage (min/max), module current (min/max), load current (min/max)

Certifications: CE

www.steca.com



eGauge Systems

Product: eGauge3 Series

Voltage: 3 channels: 85-277Vrms (L1-N); 0-277Vrms (L2-n, L3-N)

Current: 12 channels, up to 4800 amps

Power: Any voltage/current combination

Frequency: 50/60 Hz

Warranty: 2-year, or 5-year warranty

Logging Values: V, A, W, Wh, Hz, VA, VAR, THD, deg

Certifications: UL/IEC STD 61010-1, CAN/CSA STD C22.2, No. 61010.1, Listed Device, Leadfree, RoHS compliant, CISPR 11 Group 1 class B, FCC 47CFR 15 class B, ANSI C12.20 - 0.5%, ANSI C12.1 - 1%

www.egauge.net



Fronius

Product: Fronius Smart Meter

Voltage: 166V – 276V / 384V – 552V

Current: CT's, primary 1-3000 amps

Power: Any voltage/current combination

Frequency: 50/60 Hz

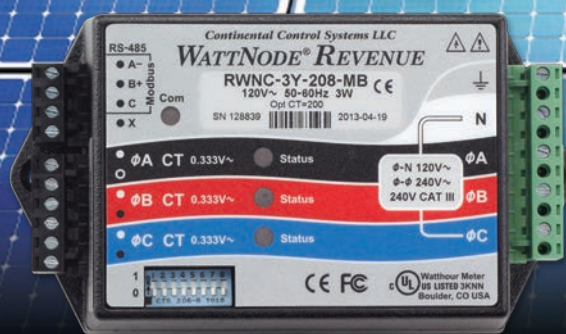
Warranty: 5-year warranty

Logging Values: AC Currents, AC Voltages, AC power and reactive Power, Power factor, Energy, Frequency

Certifications: UL 61010-1, CAN/CSA-C22.2 No. 61010-1-04, IEC 61010-1, EN 61326: 2002, EN61000-4-2, EN61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6, EN 61000-4-11, FCC Part 15 Class B, EN 55022: 1994 Class B

www.fronius.com

PV Production and Utility Consumption Meters



WATTNODE® REVENUE-GRADE
for PV Production

Certified
ANSI C12,
PBI, UL, CE

WATTNODE® MODBUS
for Utility Consumption

Modbus®, BACnet®,
LonWorks®, Pulse Output

Continental Control Systems, LLC

1-888-WattNode (928-8663) • ccontrols.com



Campbell Scientific

Product: CRSI2 Soiling Index Datalogger

Voltage: 50V

Current: 20 amps

Power: 16-32 Vdc

Warranty: 3-year warranty

Logging Values: I_{sc}, Module Temperature, Effective Irradiance, Daily Soiling Index

Certifications: IEC 61000-4-5:2013, IEC 61000-4-2:2008, ASTM D4169-09, IP30

www.campbellsci.com/crsi1



Solar Power PV Conference & Expo

November 9th - 10th, 2016
Hilton Chicago—Chicago, IL

Solar Power PV Conference & Expo has expanded into the growing Midwest solar market. There are a lot of moving parts from a legislative standpoint, making Solar Power PV Conference & Expo – Chicago a must-attend for solar professionals. Hundreds of companies are going to attend the event, prominent organizations are supporting the event, the exhibit hall will be filled, and the education program is full of great speakers, including companies like Sunrun, Commonwealth Edison, Dairyland Cooperative Electric, and more.

events.solar/pvchicago/

show in print

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



Central remote data logger

meteocontrol North America's new generation of data loggers provide tailored feed-in and remote control. Via various interfaces, data are transmitted quickly for evaluation in the meteocontrol Virtual Control Room (VCOM). The data loggers record all data from a PV system centrally and ensure compliance with the national and international requirements of grid operators as well as any country-specific feed-in regulations according to the size of the system. The new generation results from the continued enhanced development of the WEB'log series and offers new functionality and a flexibly extensible system to also meet the requirements of the future energy landscape. The X-Series improves upon safety, installation, maintenance, usability, and networking of web portal and data logger.

meteocontrol North America, Inc.
www.meteocontrol.com



Solar panel mounting kit

The Solar Connection Kit is a UL tested, solar panel mounting system that can attach to virtually any solar panel frame using GroundBonding Technology to create a conductive bond from panel to panel without extra tools or parts. Each solar kit utilizes the cable management disc that allows for cables to be top loaded and secured, making cable management clean and simple. PushLock Technology secures the cable management disc to the standing seam base clamp without extra nuts or bolts. The Solar Connection Kit is compatible with the state-of-the-art Standing Seam Base Clamp that can attach to virtually any standing seam profile and provide unparalleled strength using patent-pending WaveLock Technology with optional 1, 2, or 3 points of attachment. Offering ease of installation, the Silver Bullet set screws include a rounded bullet tip to maximize strength and won't damage the paint or pierce the seam.

Solar Connections
www.solarconnections.com



Smart meter for solar systems

The Fronius Smart Meter offers a solution for dynamic feed-in management, energy consumption monitoring, and energy management. An increasing number of grid operators set feed-in limits for grid-connected solar systems. With the Fronius Smart Meter and the inverter's power reduction feature, Fronius is now offering a simple solution for dynamic feed-in management. The Fronius Smart Meter measures the electricity consumption of a building and communicates in real time with the inverter, which then controls the system's output power to keep the electricity fed into the grid at or below the feed-in limit. In conjunction with Fronius Solar.web, the Fronius Smart Meter offers a detailed overview of the energy consumption within a home or business. Customers get a detailed visualization of their energy consumption and can optimize their energy usage based on their individual load curve.

Fronius | www.fronius.com



Fixed-tilt ground-mount

TF2 is the next generation fixed-tilt ground mount racking solution manufactured by TerraSmart. Based on over six years and 2GW of installed-capacity experience, TF2 not only includes the versatile TerraSmart ground screw foundation, it also incorporates many improvements and features. Leveraging the benefits of their proprietary ground screw foundation to work with any soil condition, TerraSmart focused on the installation process to ensure TF2 offered large efficiencies for in-field teams. TerraSmart's installation machinery not only provides a precisely installed foundation, their state-of-the-art surveying, rock drilling, and installation equipment also removes project risks and increases installation velocity. All of these benefits improve upon TerraSmart's construction efficiency and raises the bar by offering customers an additional 35% reduction of installation man-hours, saving time on every project.

TerraSmart
www.terrasmart.com



Financial services

Rodman CPAs provides tax advisory, accounting, and business strategy services to small and mid-sized emerging and established businesses. They combine the strategic approach associated with large accounting firms with the personal touch of a smaller CPA firm. Rodman CPA's "Green Team" provides renewable energy producers and businesses that pursue energy efficiency initiatives with expertise in renewable energy tax accounting and business strategy. They specialize in renewable energy, offering tax advisory, financial, and accounting services for companies involved in solar, wind, biomass, waste-to-energy, and energy efficiency projects.

Rodman CPAs | www.rodmancpa.com



Pole-mounted tracking system

The new AllEarth L20 Solar Tracker utilizes the pole-mounted tracking system by AllEarth Renewables, enabling higher power 72-cell modules and increasing the tracker advantage, while reducing material costs. The new orientation also improves wind loading and is visually appealing in the landscape orientation, particularly for residential uses. The AllEarth Solar Tracker uses GPS and wireless technology to follow the sun throughout the day, producing up to a claimed 45% more energy than conventional fixed mounted rooftop solar array.

AllEarth Renewables
www.allearthrenewables.com



Rail-less PV mounting system

Roof Tech's compact and versatile rail-less PV mounting system with integrated flashing, RT-[E] Mount attaches to rafters or anywhere else on roof decking. Once panels are fastened, the array is electrically bonded. RT-[E] Mount comes complete with watertight and durable RT Butyl flashing. Power electronics mounting is available for the RT-[E] Mount Air, as are PE stamped certification letters, UL 2703, ICC ESR-3575, and ASTM 2140.

Roof Tech | www.roof-tech.us



Open profile racking and mounting system

SunModo introduces the HR150 open profile rail system to their Helio Rail Family. SunModo's HR150 system makes it easy to route PV electrical wires inside rail channels. Secured in seconds with channel clips and a splice kit, this quick and easy mounting solution removes the cost and hassle of cable ducts and ties. The HR150 open rail system is another industry-shaping innovation from SunModo.

sunmodo | www.sunmodo.com



SOLAR CANADA 2016 Conference & Exhibition

December 5th - 6th, 2016

Metro Toronto Convention Centre—Toronto, ON

The Canadian solar energy market is growing rapidly. Provincial governments and consumers are focusing more on renewable energy in an effort to lower greenhouse gases and utilize more affordable sources of energy. This has created a tremendous opportunity for companies to expand their market presence in Canada. Solar Canada Conference & Exposition provides an excellent platform to connect with industry professionals and enter this growing market. Take advantage of this unique opportunity to network with thousands of attendees and hundreds of exhibitors representing the entire industry: solar integration, development, engineering and EPC, equipment manufacturers, utilities, consultants, federal, provincial and municipal governments, communities, and students.

www.solarcanadainc.com

show in print

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



O&M services

With 30 years of experience and 10.9 GW of energy under contract in North and South America, EDF Renewable Services helps optimize plant performance, maximize availability, and minimize downtime. With services including full O&M, Asset Management, and 24/7/365 Monitoring, they bring an owner-operator sensibility to all projects. Their development group, EDF Renewable Energy, has over 8 GW of renewable energy projects developed in North America.

EDF Renewable Services

www.edf-rs.com



Touchless snow removal

Buffalo Turbine has been manufacturing turbine style blowers since 1945, which are made using high-precision machined components resulting in long-lasting, dependable products. These turbine units are being used worldwide in a variety of applications. The diverse product line provides its customers with the ability to choose a product that best suits their application and various budgets. Touchless snow and dust removal has drastically increased over the past three years in the solar industry and Buffalo Turbine's stacked hydraulic solar blower is an effective solution. The two machines work together for faster removal of snow or dust resulting in less energy lost and more energy gained. Standard and high speed options are available.

Buffalo Turbine | www.buffaloturbine.com



Turnkey containerized universal battery

Canadian Energy announces their CUB 2.0. Developed and produced in Canada, the latest release of the Containerized Universal Battery (CUB) will serve as a means to give power to isolated communities across the country. The CUB 2.0 carries with it all of the beneficial features of the CUB 1.0 unit including components to manage power flow and store energy within a single insulated and serviceable container. The new version is a turnkey system that reduces the overall cost and difficulty of installation with added features and upgrades. The updated CUB 2.0 brings with it an expanded 20 foot container which is easier to transport through conventional shipping lines than the original 10 foot unit. Along with a larger footprint, the CUB 2.0 brings more than double the storage capacity fueled by new lithium ion batteries and more than double the estimated lifespan of the system, expected to last over ten years.

Canadian Energy | www.cdnrg.com



Watertight flashing

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

Kinetic Solar Racking and Mounting

www.kineticsolar.com



A highly secure safety system



Greeneye Smart PV Switch

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

ep.mersen.com

MERSEN
Ferraz Shawmut is Mersen



Panel washing

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

Bitimec | www.bitimec.com



Ayres Associates has provided engineering and geospatial mapping services on a number of wind farm projects.
Ayres Associates | www.ayresassociates.com

2017 WIND BUYERS GUIDE

DIRECTORY

- ADHESIVES, SEALANTS & SURFACE TREATMENTS
- ALUMINUM EXTRUSION & METAL FABRICATION
- ANCHOR BOLTS | FASTENING SYSTEMS
- BLADE | TOWER MANUFACTURER & REPAIR
- CABLE, WIRE & CONDUIT
- COMPONENT SUPPLIER
- CONDITION MONITORING
- CONSTRUCTION PRODUCTS & SERVICES | EPC CONTRACTOR
- CONSULTING SERVICES
- CONTRACTORS
- CRANES | HYDRAULIC EQUIPMENT | AERIAL DEVICES
- EDUCATION | RESEARCH DEVELOPMENT
- ELECTRICAL EQUIPMENT & SERVICES | POWER GENERATION
- ENCLOSURES
- ENERGY STORAGE | GRID CONNECTION
- ENGINEERING
- ENVIRONMENTAL CONSULTANTS & BUSINESS SERVICES
- FINANCIAL SERVICES

- FIRE SUPPRESSION
- GEARBOX MANUFACTURING, SERVICES & REPAIRS
- HYBRID SYSTEMS
- LARGE WIND TURBINE MFG (OVER 100KW)
- LEGAL SERVICES
- LIGHTING
- LIGHTNING & SURGE PROTECTION
- LUBRICANTS
- METAL
- OPERATIONS AND MAINTENANCE
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- SOFTWARE SUPPLIER
- STEEL SUPPLIER
- TESTING | INSPECTION SERVICES

- TOOLS
- TOWER FOUNDATIONS
- TRANSMISSIONS
- TRANSPORTATION | LOGISTICS
- WIND ASSESSMENT | FORECASTING
- YAW, PITCH & BLADE SENSORS
- OTHER
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 - Reactors and Transformers
 - Rescue & Safety Training
 - Revenue Metering & RIGs
 - Satellite Internet Provider
 - Sectionalizing Cabinets, Box Pads for Transformers
 - Spill Containment
 - Track Conversion
 - Utility Poles
 - Wind and Solar Measurement and Consulting Services

Adhesives, Sealants & Surface Treatment



3M Wind Energy

3M designs solutions for wind turbines that enhance reliability, improve performance, and provide protection against weathering and harsh environments. 3M Wind Blade Protection Tape 2.0 helps shield the leading edge of wind turbine blades from damage caused by minor impacts and erosion due to rain, sand, dirt, and other debris. The product is created from a tough, transparent polyurethane elastomer that resists puncture, erosion, and UV rays. The tape also provides a fast and easy application process, extending maintenance and service levels.

www.3M.com/windenergy



GS Manufacturing

GS Manufacturing specializes in custom built dispensing systems for composite fabrication. Their 2 component high output bonding systems are used throughout the world for wind blade manufacturing.

www.gsmfg.com



H.B. Fuller

H.B. Fuller delivers durable, high-performance products, including: structural bonding paste adhesive for blades, bolt lubrication for tower assembly, and sealant materials for turbine nacelle through the TONSAN brand name of products. They perform comprehensive reliability tests such as high/low temperature, moist-heat, QUV ageing, salt-mist, and fatigue torsion in order to make wind turbine operations safer and more reliable.

www.hbfullercleanenergy.com



Sika Corporation

Sika offers a full system of wind product solutions from the base foundation to the tip of the blades, each capable of withstanding the toughest climatic conditions. SikaForce-7800 Blue and Red are 2-C, high-performance, non-sagging polyurethane structural adhesives for windmill blade repair. This product has been developed to offer the same product finish speed at two different temperature ranges: Blue 0°C to 25°C (32°F to 77°F) and Red 25°C to 40°C (77°F to 104°F). SikaForce-7800 is used for finishing and deeper surface repairs on wind blades, with quick-standing time characteristics, at a maximum of 30 minutes time. SikaForce-7800 Red and Blue are packaged specifically for on-location wind blade repair applications.

www.sikausa.com

Aluminum Extrusion & Metal Fabrication



Falcon Steel Company

Falcon Steel Company provides custom metal fabrication products, produced from recycled material for the renewable energy industries. They provide solutions for residential, commercial, or utility-scale projects. Falcon Steel has been designing and fabricating steel structures and custom products for over 52 years, while working for a sustainable world.

www.falconsteel.com



Matenaer Corporation

Matenaer Corporation's Robotic welding capabilities provide the ability to take on high volume production welding jobs with ease. Their multiple Miller robotic weld cells combined with their in-house tool shop and years of welding experience allows them to produce consistent, high quality weldments at a competitive price. With years of experience working in the alternative energy field they are able to ramp up production volumes quickly when a project hits.

www.matenaer.com

sapa:



Sapa Extrusions

Sapa Extrusion, a global manufacturer of aluminum extrusions, is a supplier to the renewable energy industry. Sapa's manufacturing capabilities include standard and custom extrusion, finishing (painting and anodizing), as well as full fabrication and logistic services. Sapa supplies critical components for renewable energy applications that help customers optimize the value of their products.

www.sapagroup.com/na

Anchor Bolts | Fastening Systems



Cooper & Turner

Cooper & Turner is a manufacturer of high quality, high strength, safety critical large diameter (M16 > M100) hex bolts, double ended studs, and thread rod. Employing automation (including in process NDT inspection) and robotics results in high quality and consistent products, having full lot traceability, for supplying the global wind turbine market, OEM's, and major tiers as well.

www.cooperandturner-usa.com

FASTENAL®



Fastenal

Fastenal Manufacturing services customers in the wind energy industry by providing MRO fasteners as well as OEM parts to the original equipment/parts manufacturers, construction sites, and operating wind farms. Fastenal Manufacturing meets wind-specific material specifications of A615 Grade 75 and A722 Grade 150, available in 1-1/4 – 4.0 and 13/8 – 3.0 thread sizes in both stud and nut.

www.fastenal.com



Heico Fasteners Inc.

Heico Fasteners Inc. recently introduced a new range of HEICO-TEC tension nuts for preloading large bolted joints. Instead of rotating the nut, these tension nuts apply a number of small thrust bolts for tightening. Now, bolted joints of any size can be tightened accurately utilizing only a hand-held torque wrench, which would otherwise require powered tools. The bolted joint is preloaded in pure tension without detrimental torsion, so the bolt may used to its maximum capacity. Tension nuts are available in standard and metric sizes in various grades.

www.heico-lock.us



NTC Wind Energy

Grout sleeves are relative newcomers to the wind industry. These sleeves replace foam rings, which are installed on foundation anchor bolts prior to grouting to protect rods from exposure to grout. Grout sleeves take that protection several steps further: They will not float in grout, they prevent grout from entering the flange bolt pattern, they displace no grout, and they prevent grout from entering the bolt sleeve. To install, simply push them down on the rods. Priced competitively with foam, grout sleeves save time and require no cutting or taping.

www.ntcwind.com

Randack Fasteners Americas, Inc. (RFA)

Randack is an authorized distributor of RADOLID protective caps for foundation/anchor bolts, and provide up tower solutions as well. Their caps carry a 15-year manufacturers warranty. Their foundation/anchor bolt caps are certified to -40° C/F for no damage due to icefall, are UV resistant so they will not degrade in high UV areas, and are self-threading and reusable.

www.myesi.net



Threaded Fasteners, Inc.

Threaded Fasteners is a national distributor and manufacturer for the electric utility industry. They stock A325 Structural Bolts, A394 Tower Bolts, Step Bolts, Pal Nuts, Ring Fill Washers, and much more. They manufacture Rebar Cages, Plate Washers, Hex Head Bolts, Square Head Bolts, and Custom Anchor Bolts.

www.threadedfasteners.com

Blade | Tower Manufacturer & Repair



Broadwind Energy, Inc.

Broadwind Energy (NASDAQ: BWEN) is a precision manufacturer of structures, equipment and components for clean tech and commercial applications. We produce utility scale steel wind energy towers for the North American market. Having manufactured more than 2500 wind towers and the first 100 meter wind tower in U.S., they provide high quality, utility-scale wind tower fabrications which are built to meet technically advanced specifications. They offer a design for manufacturability review and service the prime wind belt with facilities in Wisconsin and Texas for multi-modal transportation access by water and rail.

www.bwen.com



Trinity Structural Towers, Inc.

Trinity Structural Towers, Inc. is a producer of structural wind towers servicing the wind energy industry with locations in Newton, IA; Clinton, IL; Tulsa, OK; West Fargo, ND; and Huehuetoca, Mexico. With over 15 years of experience and more than 8,000 units delivered they provide solutions for OEM's in North America.

www.trinitytowers.com

Cable, Wire & Conduit



American Wire Group (AWG)

American Wire Group (AWG) is a single solution for all types of electrical conductors and hardware required to construct and maintain wind and renewable generation projects—for low, medium, and high-voltage applications. Save schedule time and costs with AWG's ability to supply an entire project's cable requirements from stock. AWG inventories 35-kV UL MV-90 Collection System Cables in aluminum conductor in all standard sizes, including 1/0, 4/0, 500, 750, 1000, and 1250 (also available in UL MV-105). All of AWG's Collection System Cables carry a 20-year factory warranty, ensuring protection for the longevity of projects. In addition, AWG inventories the following: fiber optic; copperclad steel grounding; bare copper; transmission cables; OPGW; static wire; low-voltage cables; control cables; and associated hardware.

www.buyawg.com



Cameron Wire & Cable, Inc.

Cameron Wire & Cable, located in Little Rock Arkansas, supplies high performance LV, MV, and HV (Alum & Copper) wind tower, nacelle, and site cables. They can be provided in bulk, cut-to-length, and/or assembled as needed.

www.cameronwire.com

CTC GLOBAL



CTC Global

CTC Global, in association with 20 international manufacturing partners, produces the High-Capacity, Low-Sag ACCC Conductor. The ACCC conductor carries twice the current of other bare, overhead conductors with 25% to 40% less line losses. The use of ACCC can help reduce upfront capital costs for the tie line, and improve the overall economics of the generation project—reduced line losses translate into more power delivered for any wind energy investment.

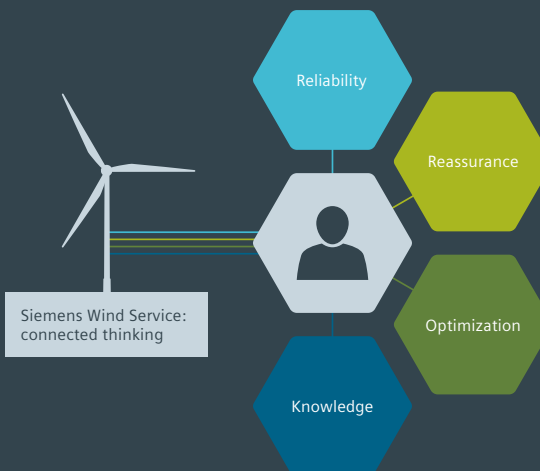
www.ctcglobal.com

SIEMENS

Ingenuity for life

Get just what you need.

Explore choice with our new service portfolio, designed to match your unique needs.



siemens.com/wind-service





General Cable

EmPowr Link CL Advantage is a cable for today's solar and wind farm collection systems. Featuring enhanced, ruggedized installation protection, this cable has a reduced weight and diameter and XLPE jacket technology. Its efficient fault current protection provides reliability and performance. www.generalcable.com



Lapp Group

As fleets age, the demand for replacement parts increases. Lapp Group is a trusted partner in refurbishing and retrofitting for the life of the turbine. They provide their partners with dedicated wind industry experts, as well as engineering and logistics teams. Lapp Group also has relationships with a large network of distribution partners located all around the country, so components are available as needed. www.lappusa.com



OBO Betterman of North America, Inc.

Cable management is a key component of any renewable installation. Solar arrays, wind turbines, geothermal, bioenergy, and more all have unique needs for routing, protecting, and organizing cables. OBO Bettermann works closely with designers and installers to provide the right solution for each application. They have developed products designed specifically for the solar and wind industries and can provide customized solutions for any application. They have recently acquired Chalfant Manufacturing and now offer aluminum ladder tray and accessories. www.obous.com



Petroflex

Petroflex is an extruder of HDPE (high-density polyethylene) duct and accessories. PNA's CableGuard is a solution for both domestic and international clean energy initiatives and provides cable in conduit for control and power cabling at both wind and solar farms. Long continuous run lengths of fiber optic cable in duct, up to 14000' on 1"IPS, minimize splicing. Cable or fiber installed in conduit at the factory ensures additional protection before, during, and after installation. They stock many 600v combinations and medium voltage cables already installed in conduit for quick delivery to the site. www.petroflexna.com



Southwire Company

Southwire manufactures a complete line of cable for their client's wind installation needs from inside the tower and nacelle all the way to the grid. One example of a cable that Southwire offers is RHH that is torsion tested specifically for the the wind industry to be used in the turbine. www.southwire.com



Superior Essex

Superior Essex is a U.S. manufacturer and supplier of energy wire and cable products serving the commercial, industrial, utility, and renewable energy markets. Low voltage 300V and 600V instrumentation cables for control systems, audio, intercoms, energy management, and alarm controls; low voltage 600V control and power cables for industrial or utility substation circuits; low voltage secondary URD for utility underground power distribution; medium voltage 5kV through 35kV power cables for primary power. Their MV Primary UD 35kV cables are suitable for underground collection systems designed for wind applications. These cables are offered with conductor strand filled, gauge sizes up to 1250kcmil, aluminum, TR-XLPE, or EPR insulation, multiple concentric neutral configurations, and LLDPE jacket, meeting the applicable ASTM, ICEA, and AEIC standards, and are RUS accepted. ce.superioressex.com

Component Supplier

Applied Plastics, Inc.

Applied plastics is a custom extruder of profiles and tubing, providing custom parts for the manufacturing of wind turbine blades. www.appliedplasticsinc.com



Bal Seal Engineering, Inc.

Bal Seal Engineering, Inc. is a designer and manufacturer of custom-engineered sealing, connecting, conducting, and EMI shielding components. Their Bal Spring canted coil spring for electrical contact applications, whether designed into a groove or supplied within a metal housing as a Bal Contact electrical contact, ensures the reliable, consistent flow of current with minimal heat rise. The spring's individual coils compensate for misalignment and surface irregularities that could compromise power transmission. Bal Seal spring-energized seals, which employ their Bal Spring as an energizing component, help wind equipment designers achieve more service life and performance in fluid sealing applications. www.balseal.com



BURNDY

BURNDY offers a comprehensive selection of grounding products including; HYGROUND compression, BURNDYWeld exothermic, and mechanical grounding. The BURNDY HYGROUND irreversible compression system meets the most stringent safety and performance requirements, including those of OSHA and nuclear power plant design. Connectors are just one component of this system; installation tooling is also an integral part. The BURNDYWeld connection process is a simple, efficient method of welding copper to copper, or copper to steel. The BURNDYWeld exothermic process uses high temperature reaction of powdered copper oxide and aluminum. This system is field friendly, since it is light and portable, and requires no outside power system. BURNDY's diversified line of mechanical grounding connectors are widely used throughout the industry, and have been designed for easy installation and outstanding durability. www.burndy.com



BGB Technology, Inc.

BGB Technology designs and produces slip rings and fiber optic rotary joints (FORJ) for use within wind turbines. Applications include generator slip rings, pitch control and yaw slip rings, shaft grounding, and lightning suppression components. www.bgbtechnology.com



Continental Fan Manufacturing, Inc.

Continental Fan is a supplier of fans for nacelle ventilation, GCU (generator control unit) cooling, and tower ventilation. Whether axial fans for high air volumes and low pressures, centrifugal blowers for higher pressure applications or TMK motorized impellers for ventilating electrical cabinets, Continental Fan can provide a rugged and dependable solution. They assist in simplifying their customers' design process by working together on specific design and application needs. www.continentalfan.com

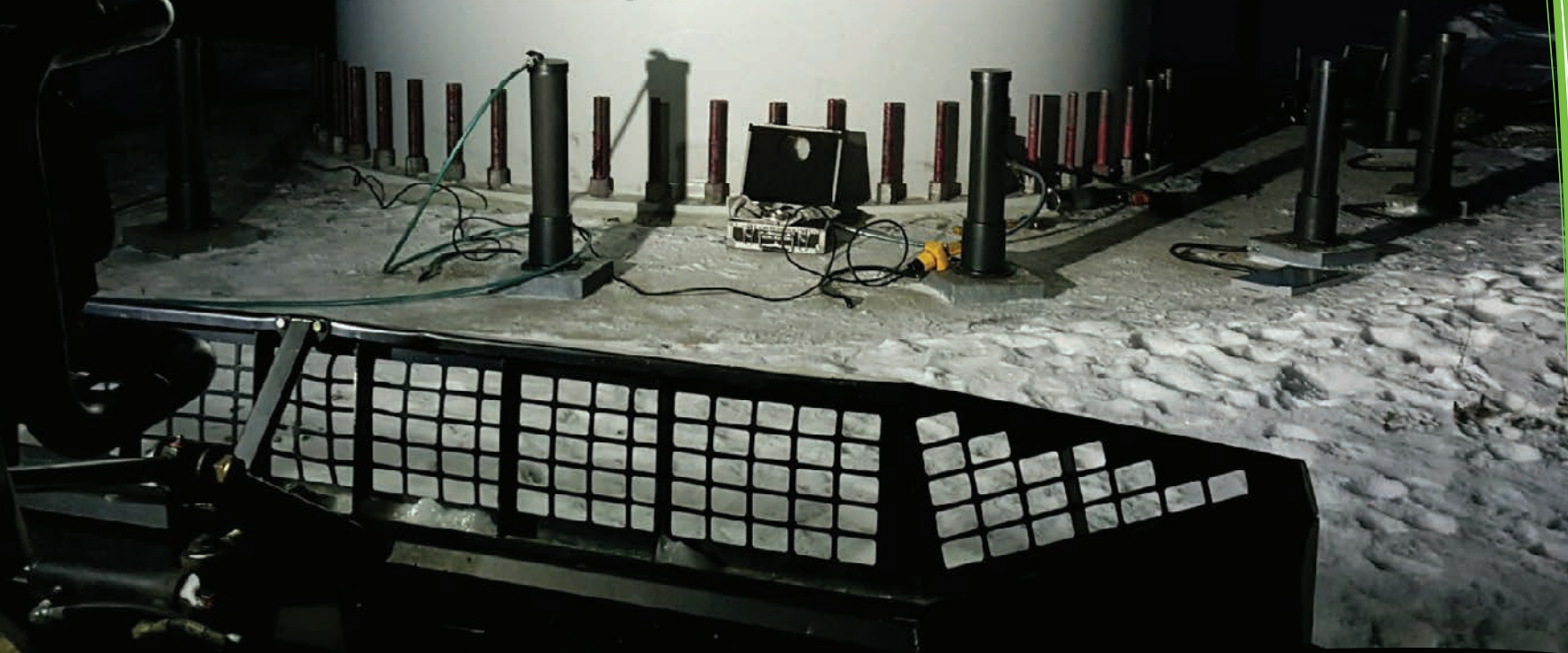


ISO 9001:2008 Registered * ISO/IEC 17025:2005 Accredited

ONSITE BOLTING SERVICES DONE RIGHT.

ANYTIME. ANY WHERE...

even when day looks like night.



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
- ERAD 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

torkworx.com

extreme bolt working solutions

sales
rental
service
consulting
engineering



DBK USA, Inc.

DBK USA, Inc. offers a full line of industrial thermal management products. They manufacture fan heaters, cartridge heaters, finned heaters, convection heaters, thermoelectric coolers, thermostats, and more. Their products have been used in the wind and energy industry for years. They offer engineering services to provide their clients with specific design solutions as well as standard product options to choose from. DBK also specializes in positive temperature coefficient technology.

www.dbk-group.com



Ingeteam, Inc.

Ingeteam provides electrical conversion equipment: power converters, generators (Indar), PLCs, CMS, SCADA management systems and O&M services for wind turbines up to 10 MW. The company's engineering teams can provide tailored electrical solutions, e.g., low- and medium-voltage power converters optimized for DFIG and FC topologies. The DFIG converters are a cost-optimized solution for each country that reaches injection time less than 50ms. The FC converters are specifically designed for each generator technology (PMG, IG, EESG). And, air-cooled, air/water-cooled, and full water-cooled solutions are available for harsh environments.

www.ingeteam.com



Moog Components Group

Moog Components Group has a new pitch control slip ring. The EPA3 slip ring is an advanced slip ring product specifically developed for the wind energy market. It is well suited for both large and small wind turbines. A key advantage of the Moog slip ring is its high reliability, modular design that can be scaled and optimized for most requirements. The slip ring provides advanced contact technology, while extending the life of the product to reduce field maintenance. No maintenance (cleaning) is required.

www.moog.com/wind



Morgan Advanced Materials

Morgan Advanced Materials offers complete brush holder and slip ring rebuild kits for optimum performance in wind turbine generators. Their materials have been improving brush and slip ring life and performance in OEM holders with their Plug & Play brushes, improving life from months to multiple years along with quality replacement springs. Their generator rebuild kits provide an all-in-one solution containing Brush Holder Solutions for improved brush stability, materials and Slip Ring designs which run cooler, improve life, and reduce operating costs.

www.morganelectricalmaterials.com



Motion Industries, Inc.

Motion Industries distributes industrial replacement parts and supplies such as bearings, mechanical and electrical power transmission, industrial automation, hose, hydraulic and pneumatic components, safety/industrial supplies, and material handling products to MRO and OEM customers throughout North America. Services provided to renewable energy facilities include repairs of hydraulic and electrical components, OEM parts conversion, committed inventory to reduce lead times, and field expertise in the areas of fluid power, electrical, hose and rubber, and pumps.

www.motionindustries.com



SIEMENS

Siemens Industry, Inc.

Siemens provides integrated solutions and a broad product portfolio of generators, electric drives, and control systems. They help their clients obtain maximum yield from power generation by providing energy distribution with reliable protection against overload, short circuit, and overvoltage; both in the main circuit, as well as in the auxiliary energy circuits. They offer SCADA turbines with a long-term database and a central service portal for the wind farm management and provide industrial communication for the entire wind farm and technologies for high reliable pitch and yaw systems. Siemens Wind-Equipment provides everything up to cyber-security in order to support the high availability of the operations.

www.siemens.com/wind-equipment



SKF Canada, Ltd.

SKF Group is a global supplier of bearings, seals, mechatronics, lubrication systems, condition monitoring systems, and services which include technical support, maintenance and reliability services, gearbox and gearing components refurbishment, bearing remanufacturing, engineering, consulting, and training. The SKF Life Cycle Management approach applies SKF's expertise in a wide range of technical areas to help customers, both OEMs and the aftermarket, optimize machine productivity and efficiency.

www.skf.ca

Condition Monitoring



Bachmann Electronic Corp.

Bachmann integrates its condition monitoring solution in the automation and links the measured values to other operating parameters. This increases the diagnostic reliability of the condition monitoring; fault patterns can be compared to the current operating situation and interpreted with greater accuracy. A systematic control enables mechanical loads to be reduced. In this way, adjusted operating conditions can extend the lifespan of partly damaged parts up to the next planned maintenance date. System offering includes a worldwide monitoring service, provided by Bachmann Monitoring GmbH. The diagnostics specialists evaluate the measured data and compare it with the reference data.

www.bachmann.info



Helwig Carbon Products, Inc.

Helwig Carbon is a manufacturer of carbon brushes and brush holders used on wind turbine generators. American made ISO certified. Their products are designed to provide long life and low maintenance costs.

www.helwigcarbon.com



ILSCO

ILSCO is a component manufacturer to the renewable energy industry. They provide grounding, bonding, and connectivity solutions, and have the capability of designing custom products for specific installation needs.

www.ilsco.com



IMO USA Corp.

IMO USA provides blade and yaw bearings for wind turbines (100 kW to 7+ MW), and single main bearings.

www.imo.us



KRACHT CORP.

KRACHT CORP. is a subsidiary of KRACHT GmbH in Germany. KRACHT, is a medium-sized, family-run business with 400 employees. KRACHT is a manufacturer of transfer pumps (e.g. noise optimized for air containing oils), hydraulic motors, high pressure gear pumps, valves, pump units, gear type flow meters, and electronics. KRACHT CORP. is located in Maumee, OH.

www.krachtcorp.com



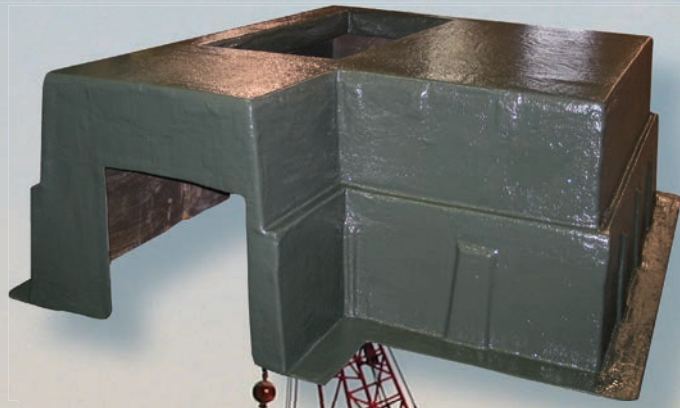
MidNite Solar, Inc.

MidNite Solar is a US-based manufacturer of renewable energy electronics, balance of system components, and small wind turbines. Their Classic Maximum Power Point Tracking (MPPT) wind controller is a solution for both new and existing small wind battery charging systems. It is available in 150, 200, and 250 volt DC input versions, works with 12 to 72 volt battery systems, and allows for programming of custom wind curves. Where a voltage clamp/diversion controller is required, the Clipper works in conjunction with the Classic to provide precise PWM voltage regulation and diversion capability. 1.5kW and 4kW rated Clippers are available for turbines with DC or 3 phase AC output.

www.midnitesolar.com

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Dynamic Ratings

Dynamic Ratings helps utility and industrial customers improve transmission, distribution, and substation systems reliability, leading to increased maintenance savings and reduced outages. They design, manufacture, and integrate innovative sensors, monitors, and controls for data collection, analysis, and diagnostics. With the use of their visualization tools, their customers can realize maximum benefit from on-line monitoring.

www.dynamicratings.com



Romax Technology

Providing end-to-end solutions for owners, operators, and investors, Romax InSight's monitoring capabilities enable wind asset visibility and expert health reporting for a sustainable predictive maintenance strategy. From hardware and software for self-monitoring to their global monitoring service and health assessments, Romax provides solutions for early failure detection and transparency of asset health. ecoCMS provides affordable yet high performance monitoring and can be retrofitted, or installed in new turbines. Romax's monitoring software, Fleet Monitor, uses a single dashboard irrespective of CMS brand and OEM type. Their experienced monitoring engineers use this software internally to deliver clear, detailed reports to assist in implementing data-driven O&M decision making.

www.romaxtech.com



Weschler Instruments

Weschler's Transformer Advantage continuously monitors oil-filled generation, transmission, and distribution transformers. 7 models read oil, winding, LTC and ambient temperature, control cooling, track transformer life, and interface to SCADA systems. They've supplied power and process measurement equipment to industrial users for 75 years. They offer a wide selection of analog panel meters, digital panel meters, bargraph meters, sensors, transducers, signal conditioners, controllers, and electrical test equipment.

www.weschler.com

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Construction Products & Services | EPC Contractor



Blattner Energy, Inc.

Blattner Energy is an EPC contractor in renewable energy construction with more than 30,000 megawatts installed across North America. Blattner provides complete EPC services for utility-scale wind projects, including post-tension concrete tower supply and installation. Blattner also serves utility-scale solar, energy storage, and high voltage transmission and substation projects. Blattner has a history for responding to client needs, delivering on aggressive project schedules, and self-performance on all major work activities to ensure high levels of safety, quality, and overall client satisfaction.

www.blattnerenergy.com



Graham

Graham provides general contracting, design-build, construction management, and public-private partnership (P3) services to the buildings, industrial, and infrastructure sectors. Graham has the resources, capacity, and expertise to undertake wind projects of every scope, scale, and complexity.

www.grahambuilds.com



Signal Energy Constructors

Signal Energy Constructors is a turn-key EPC/BOP renewable energy contractor with more than 9,000MW of utility scale project experience. They provide design and construction services for wind, solar, infrastructure, and other power projects. Signal Energy has the ability to provide in-house support of critical work scope including erection services and electrical system design (collection systems, transmission lines, substations and interconnection facilities). Signal Energy Constructors is the renewable arm of the EMJ Corporation and Barnhart Crane & Rigging.

www.signalenergy.com



The Ryan Company

Established in 1949, The Ryan Company, Inc. (Ryan) is a wholly-owned subsidiary of Quanta Services, Inc. They specialize in providing single service or turn-key EPC construction for PV solar, wind, and renewables, as well as electrical infrastructure, battery energy storage systems, and large scale public sector construction services.

www.ryancompany.net



Worldwide Machinery Pipeline Division

The SPD-150 padding machine is a solution for smaller jobs where space, mobility, and accessibility is restricted. This machine is useful for small pipelines, utilities, and wind and solar energy projects. It is useful in the latter due to the grid-like pattern some of the cabling needs to be laid in. The SPD-150 padder is operated by an easy-to-use remote controller which offers simple handling and provides the operator with views of both the ditch and its surroundings. An optional ROPS is also available if/when the operator needs to sit in the platform for transportation to and from the job site.

www.worldwidemachinery.com

Consulting Services



Civil & Environmental Consultants, Inc.

CEC provides design solutions and integrated expertise at all stages of development or expansion projects, from critical issues analyses, ecological surveys by federally approved surveyors and biologists who maintain an excellent rapport with numerous U.S. Fish & Wildlife Service regions, met tower and property surveys, inspections using small Unmanned Aerial Systems (drones), right-of-way and drain commission permitting, and electrical design coordination, to civil planning and logistics for lay-down, delivery, line drops, crane walks, and intersection improvements. CEC coordinates with land owners, agents, utilities, and regulators, and oversees implementation of the design in the field.

www.cecinc.com



Commonwealth Associates, Inc.

Commonwealth Associates, Inc. specializes in consulting and engineering services for the electrical power industry. Services encompass project management, owner's engineering services, planning, engineering and design, environmental studies, siting, permitting, land acquisition, and construction services for power generation, transmission line, distribution line, and substation projects throughout the United States.

www.cai-engr.com



DNV GL

DNV GL unites the strengths of DNV, KEMA, Garrad Hassan, and GL Renewables Certification. Their 2,500 energy experts support customers around the globe in delivering a safe, reliable, efficient, and sustainable energy supply. They deliver testing, certification, and advisory services to the energy value chain including renewables and energy efficiency. Their expertise spans onshore and offshore wind power, solar, conventional generation, transmission and distribution, smart grids, and sustainable energy use, as well as energy markets and regulations. DNV GL's testing, certification, and advisory services are delivered independent from each other.

www.dnvgl.com/energy



Electrical Consultants, Inc.

Electrical Consultants Inc. (ECI) was incorporated in 1985. Their in-house portfolio of services, including overhead and underground transmission engineering, substation and switchyard design, industrial power systems design, land survey and construction staking, right-of-way services, environmental planning, project management, construction management, and procurement services have provided a key resource for hundreds of utilities. ECI brings extensive experience in power delivery services through 500 kV to their clients.

www.electricalconsultantsinc.com



EPI Group

EPI offers environmental, geophysical, geotechnical, and HSE support service to windfarm developments. Their team provides solutions to geophysical/geotechnical surveys and construction, as well as the full suite of environmental mitigation and monitoring services for marine operations. They support site investigation and hydrographic survey operations from the planning cycle through delivery of final site report. They have worldwide experience working in shallow and deep water rig/site survey, wind farm projects, cable/pipeline route surveys, geotechnical investigations, pipeline/infrastructure inspection, and related survey activities.

www.epigroup.com



Westwood Professional Services

Westwood is a multi-disciplined engineering and surveying firm with experience gained from supporting more than 35 GW of wind projects across the U.S. since 1997. Their services include: site evaluation, permitting, civil engineering, electrical engineering, land surveying, aerial mapping/LiDAR, and construction support. They have offices across the nation and are licensed in engineering and surveying in nearly every state.

www.westwoodps.com

Contractors



Fagen, Inc.

Fagen, Inc. is a full service industrial contractor headquartered in Granite Falls, MN. Utilizing a database of over 25,000 direct-hire employees, Fagen, Inc. has constructed a variety of projects including wind power, biomass to power, conventional power, renewable fuels, and other industrial process facilities. Fagen, Inc. is ranked #202 in ENR's Top 400 contractors, and #76 in ENR's Top 100 Design Build firms.

www.fageninc.com

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Rosendin Electric, Inc.

Rosendin Electric recognizes that renewable energy, including wind power, is an integral part of the future of power generation. Rosendin installs underground and overhead 35-kV collection systems, fiber optic SCADA systems, turbine and tower wiring, as well as substations and overhead transmission lines to connect generating plants to utility grids. Their experience portfolio ranges in size and location, having completed single projects that range from 1 MW (Distributed Generation) to 900 MW (Utility Scale) and over \$100M with a geographic reach not limited to the continental United States.

www.rosendin.com

Cranes | Hydraulic Equipment | Aerial Devices



Bronto Skylift

Bronto Skylift is a Finland based company offering a wide selection of high-reach truck-mounted aerial work platforms for wind turbine and tower inspection, maintenance, repair, and cleaning needs. For over 40 years, they have supplied insulated and non-insulated truck-mounted work platforms around the world. All Bronto units are designed to enhance operational performance and efficiency at challenging heights and environments. The easy maneuverability allows for fast driving and positioning at the jobsite. With advanced controls and one-button automatic leveling of the outriggers, the unit can be set up and elevated up to the overhead area in a matter of minutes.

www.brontoskylift.com

Crane Service, Inc.

Crane Service, Inc. offers crane rental and machinery moving throughout the Southwest.

www.craneserviceinc.com



JPW Companies

JPW Companies owns and operates crawler and hydraulic cranes to 600 ton capacity for new installations and maintenance work on wind components. Riggers and heavy rigging also are available, as well as heavy haul and blade trailers. JPW has a 100,000sq. ft. AISC and ASME certified steel fabrication facility and erections crews located in Syracuse, NY.

www.jpwcompanies.com



The Manitowoc Company

Founded in 1902, The Manitowoc Company, Inc. is a global manufacturer of cranes and lift solutions with manufacturing, distribution, and service facilities in 20 countries. Manitowoc is a provider of crawler cranes, tower cranes, and mobile cranes for the heavy construction industry, which are complemented by a slate of aftermarket product support services.

www.manitowoc.com

Education | Research Development



Appalachian Energy Center

A Small Wind Energy Hands-on Workshop is held every year at Appalachian State's Small Wind Research and Demonstration Site located on Beech Mountain, NC. Participants learn about the typical costs, economics, and maintenance involved with a distributed wind energy project, as well as explore a variety of distributed wind energy technologies and successful case studies. There are both classroom and "hands-on" activities for workshop attendees.

www.energy.appstate.edu



Everglades University

Everglades University is an accredited, private, not-for-profit university offering bachelor's and master's degree programs. Everglades University has partnered with USGBC and Pearson to deliver a structured curriculum to support education in; sustainability, alternative and renewable energy, alternative medicine and promoting wellness, and building green (via the LEEDS certification in Construction Management). They offer undergraduate degrees in Alternative and Renewable Energy Management, Environmental Policy and Management, Construction Management, Land and Energy Management, Surveying Management for Construction and Roadway, International Business, Alternative Medicine, Aviation/Aerospace, Hospitality Management, Business Administration, and Crisis and Disaster Management. In addition, they offer graduate degrees in Public Health Administration, Business Administration, Aviation Science, and Entrepreneurship.

www.evergladesuniversity.edu



Penn State Online Wind Energy Program

Become a clean energy expert with Penn State's Online Masters in Renewable Energy and Sustainability Systems Wind Energy Option. Students will expand their technical expertise and gain valuable project development skills to drive clean energy initiatives. This 100% online program provides specialized courses in wind farm development, wind turbine siting, and technology and offers the flexibility for career advancement without having to relocate or stop working. GREs may be waived with 5+ years of professional work experience. Plus, there is no out-of-state surcharge for online adult learners.

www.worldcampus.psu.edu/windenergy



University College at the University of Denver

Highly flexible, a University of Denver education through University College provides career-focused content that can be immediately applied on the job. Build upon current talent and master new skills with affordable education designed and delivered for busy adults. Pursue a master's concentration or graduate certificate in Energy and Sustainability, Environmental Analytics and Reporting, Environmental Management, Natural Resource Management, Environmental Policy, or Environmental Health and Safety.

www.universitycollege.du.edu

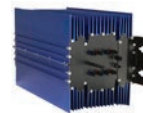
Electrical Equipment & Services | Power Generation



ABB, Inc.

ABB is a large, independent supplier of electrical components and helps connect wind farms to the grid. ABB supports customers along the complete power value chain to plan, generate, connect, transmit, monitor, and control power from wind farms as well as to maintain and optimize their systems.

www.newabb.com/windpower



Alencon Systems

Alencon builds a variety of power conversion products that can be cost effective enablers of PV alongside existing wind installations. Using Alencon's DC-DC optimizers, turbine manufacturers can integrate PV with wind using the resident capability already found in that turbine's converter, eliminating the need for additional BoS equipment such as inverters, which can result in a large cost savings.

www.alenconsystems.com



ComAp

MainsPro is a protection relay for mains-to-parallel applications, including generator sets, cogeneration, micro turbines, or renewable energy sources such as photovoltaic plants and wind turbines. It provides adjustable voltage, frequency, and loss of mains protections to safeguard both the distribution network and the generators.

www.comap-control.com



Marathon Special Products

Marathon Special Products has served the electrical/electronic component industry since 1955. Their facility in Bowling Green, Ohio, contains all manufacturing and warehousing operations including an extensive electrical test lab to design, engineer, and manufacture quality products. They mold, stamp, and assemble all of their parts in house. In addition to their range of fuse holders, they have met or exceeded customer quality requirements and expectations to their terminal block line since receiving their first patent in 1932.

www.marathonsp.com



STEGO, Inc.

Since 1980, STEGO, Inc. has produced products for energy efficient thermal management of electronic components. Convection heaters, fan heaters, and filter fans are just a few of the products STEGO produces which keep enclosed electronics on small and large scales running safely, economically, and reliably, from corporate server racks to wind turbines in extreme environments. With locations in 13 countries and partnerships around the world, STEGO serves a global customer base engaged in a large portfolio of industries.

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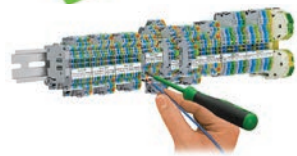
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Wago Corporation

The TOPJOB'S Rail-Mounted Terminal Blocks provide quality and reliable connection technology. WAGO's Push-in CAGE CLAMP technology provides fast and easy installation. The jumper retention spring allows for the same reliable connection when distributing power or signal while accommodating the widest offering of jumpers. WAGO also offers exclusive, cost-effective and time saving marking systems that provide multi-line continuous strips. The TOP JOB'S Rail-Mounted Terminal Blocks are versatile and can be used in virtually any application worldwide, especially wind turbines and other clean energy technology.

www.wago.us

Enclosures



Fibox Enclosures

Fibox Enclosures specializes in corrosion-resistant polycarbonate enclosures for the electrical power generation industry. Their NEMA 4X enclosures protect products from hostile environments and resist impacts and UV damage, making them ideal for wind energy farms. Fibox can also customize their products to meet exact project requirements.

www.fiboxusa.com

Energy Storage | Grid Connection



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 currently leads the industry in 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



Dynapower

The MPSTM-250 has been optimized for behind-the-meter energy storage applications where reliability and footprint matter. This inverter is designed for four quadrant energy storage applications in both grid-tied and microgrid applications. It includes integrated AC breaker with shunt trip, integrated DC disconnect, integrated DC input fuses, Integrated transformer, black start, and an acoustic signature. Multiple units can be paralleled in grid forming mode for microgrid applications.

www.dynapower.com



Energy Storage Systems, Inc.

The 100kW/800kWh Iron Flow Battery (IFB) from ESS, Inc. provides a flexible long-duration energy storage system that safely and effectively addresses the broadest range of energy and power applications at a low Levelized Cost of Storage (LCOS). Utilizing earth-abundant iron, salt, and water for its electrolyte, and simple materials for battery components, the IFB is ideally suited for: time-shifting renewables, managing a facility's demand charges, and smoothing the intermittency of renewables on a constrained grid.

www.essinc.com



Parker Hannifin - Energy Team

For over two decades, Parker's Energy team has been providing wind power solutions touching virtually every critical function in the turbine. From integrated lube oil filtration systems and compact blade actuation systems, to sealing technologies and power conversion systems, Parker has the custom, precision-engineered solutions that help onshore and offshore wind turbines generate energy more efficiently, while improving reliability and uptime. Their high efficiency wind power conversion systems deliver optimum power to the grid, featuring a scalable evaporative cooling system that lowers overall system cost, with up to 40% higher power throughput.

www.parker.com/energy



Saft America, Inc.

Saft's Intensium Max is a ready-to-install containerized solution designed for today's electricity grids and for the smart grids of tomorrow. It provides a complete, fully integrated energy storage system at the megawatt scale comprising Li-ion battery modules, power management and control interfaces, air conditioning, and safety devices.

www.saftbatteries.com



SIBA Fuses

SIBA Fuses introduces a new range of SSK-type fuses in the switch-fuse combination. The SSK-type fuses can replace expensive circuit breakers and be used on transformers rated up to 3,150KVA. SIBA's SSK-type fuse maintains the minimum breaking current at low dissipation, and is specifically designed for wind energy applications. SIBA continues a long-term test series involving heating of the fuses and the SSK production series has been developed in order to meet the demands of the renewable energy industries.

www.siba-fuses.us

Engineering



Ayres Associates

Ayres Associates is a multi-specialty engineering firm providing an array of capabilities that apply directly to the wind industry including: survey, geospatial mapping and imagery services; site-civil engineering; construction management; transportation design; master planning; and environmental services. They perform energy-related projects nationwide, often in remote areas, and have procedures to facilitate rapid staff mobilization with a focus on communication and relationship building.

www.ayresassociates.com

Brugg Cables

Brugg Cables, LLC is the US subsidiary of Brugg Cables AG, a Swiss cable manufacturer since 1896. Their turnkey projects include custom cable design, engineering, manufacturing, and expert installation of their Brugg Designed OPGW, as well as, high voltage cable systems and power accessories up to 500 kV. From their US headquarters in Rome, Georgia, Brugg Cables offers customer focused responsiveness, collaborative support, and quality.

www.bruggcables.com

Freudenberg-NOK Sealing Technologies

Freudenberg-NOK Sealing Technologies offers a portfolio of precision sealing products, serving as a supplier and development partner in a variety of industries. Their product designs, material expertise, and application knowledge ensure maximum performance, even in the harshest operating environments

www.fnst.com



Manitoba HVDC Research Centre (MHRC)

The Manitoba HVDC Research Centre (MHRC) is a software development and engineering company. Their flagship product, PSCAD/EMTDC, provides power system electromagnetic transient simulations. They work closely with customers to provide in-depth training and technical support. MHRC's engineering team provides consulting services in HVDC transmission, wind and renewable technologies, and insulation coordination.

www.hvdc.ca



POWER Engineers, Inc.

POWER Engineers, Inc. provides owner's engineering, environmental, and engineering design services for medium voltage collection systems, site civil, communication networks, SCADA, and associated substations and transmission interconnect lines. They also perform up front interconnection support and complete electrical system studies for developmental projects, as well as construction management, inspection services, and testing and commissioning for wind farm constructors and owner/operators.

www.powereng.com



SNC-Lavalin

SNC-Lavalin provides end-to-end services in wind power. From feasibility studies to full EPC projects, they can also assist with financing support for the development of projects.

www.snclavalin.com



Ulteig Engineers, Inc.

Ulteig is an employee-owned company delivering engineering, planning, surveying, and project management solutions to a wide range of public and private clients.

www.ulteig.com



Westlake Consultants, Inc.

Westlake Consultants collaborates with clients to provide wind farm development services throughout the US. Services include Civil Engineering (access roads, stormwater, pad grading, transportation); Site Due Diligence Pre-Engineering; Permitting Assistance (NPDES/DOT); Land Surveying (pre/post ALTA, aerial control); and Construction Support Services.

www.westlakeconsultants.com

Environmental Consultants & Business Services



Ecology and Environment, Inc. (E & E)

E & E offers all the professional environmental support required to site, permit, and operate wind energy generation and transmission facilities. E & E covers all the bases, from avian and bat impact studies to socio-economic and noise analyses, to wetlands considerations and community outreach. The company operates offices throughout the US, with subsidiaries and affiliates around the world.

www.ene.com/markets/wind



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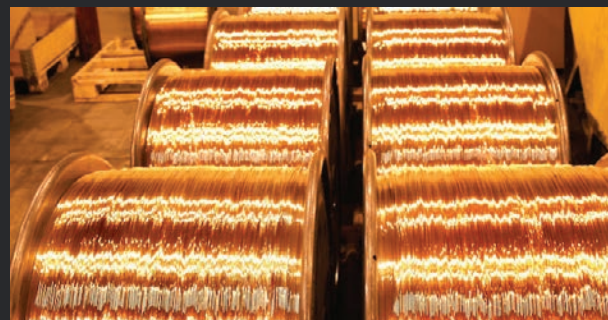
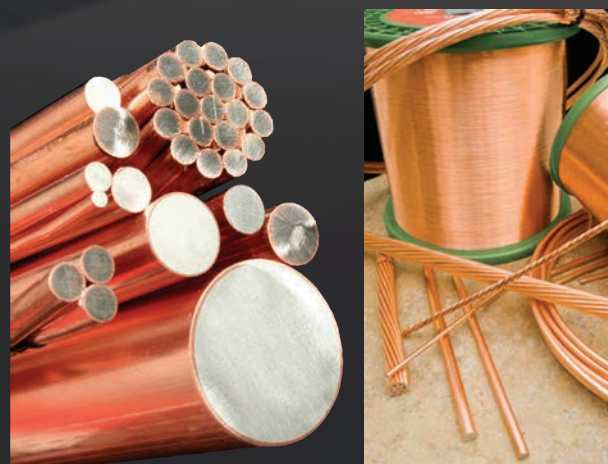
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www.Copperweld.com



S&P Global



SNL Energy

With SNL's Energy offering, it's possible to maintain a steady flow of solar, wind, and combined cycle power plant opportunities with immediate and accurate understanding of all project activities and development progress. Their platform provides project-tracking success, with key metrics like size (MW), online date, PPA / offtake arrangement, construction costs (actual and estimated), stage of development, and project detail transparency.

www.spglobal.com

Financial Services



Rodman CPAs

Rodman CPAs provides tax advisory, accounting, and business strategy services to small and mid-sized emerging and established businesses. They combine the strategic approach associated with large accounting firms with the personal touch of a smaller CPA firm. Rodman CPAs Green Team provides renewable energy producers and businesses that pursue energy efficiency initiatives with expertise in renewable energy tax accounting and business strategy. They specialize in renewable energy, offering tax advisory, financial and accounting services for companies involved in solar, wind, biomass, waste-to-energy, and energy efficiency projects.

www.rodmancpa.com

VENTUS unparalleled

VENTUS ultrasonic cold weather anemometer is proven for precise operation in the cold climate.

Ventus is corrosion tested for seawater and vibration resistance.

It gives the best accuracy with maintenance free operation.



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www.lufft.com

Fire Suppression

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Firetrace International

Firetrace has more than 250,000 automatic fire suppression systems installed on critical equipment. Firetrace systems protect control panels, capacitor cabinets, brake, transformer, and other at risk areas of the turbine without requiring power or excessive space. Firetrace is able to withstand temperature extreme, vibration, and airflow with no concern for system function. The systems can easily be installed in new and existing turbines.

www.firetrace.com

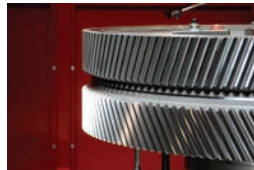
Gearbox Manufacturing, Services & Repairs



Bonfiglioli

Bonfiglioli designs and manufactures complete solutions for the seamless control of energy generation, including planetary gearmotors for continuous nacelle yaw control and blade pitch control, as well as a complete series of compact and versatile inverter drives for wind turbines. Bonfiglioli products cover a wide range of turbine sizes, for both on- and off-shore applications. For nacelle control, Bonfiglioli offers the 7TW Series, a compact, lightweight solution with integrated motor and brake for turbines from 1.5 MW to 3.5 MW; as well as the 700T series of planetary speed reducers, for turbines from 1.0 MW to 8.0 MW. All products are made with the latest materials to provide more lightweight and efficient operation, which results in higher ROI and longer LTV.

www.bonfiglioliusa.com/wind



Brad Foote Gearing

Brad Foote solves tough wind gearing challenges by manufacturing a wide variety of wind gearbox OEM gearing and replacements. With their 350,000 sq.ft. manufacturing footprint, they have a large climate-controlled grinding room, housing 13 form tooth grinders. They adhere to strict quality assurance protocols and are capable of grinding to AGMA 15 and AGMA grade 3 heat treatment. Brad Foote's failure mode Root Cause Analysis (RCA) process offers advanced performance DriveMAX gear sets.

www.bradfoote.com



Comer Industries, Inc.

Comer's broad range of solutions for wind generator yaw and pitch drives can be applied to wind turbines up to 10 MW. These products are characterized by reliability and safety.

www.comerindustries.com

Hybrid Systems



Max Bögl Wind AG

The modified System 160+ allows Max Bögl to improve upon dimension and efficiency. The hybrid tower system was also designed to meet the challenges presented by the demand for great hub heights, also on an international level. The newly developed system allows concrete sections to be produced directly on the project site, thus incorporating an increase in local content while maintaining the high quality standards of the tower system. The mobile factory's modular structure guarantees optimum versatility to ensure different project locations can be served worldwide within a short period of time.

www.max-boegl.com

Large Wind Turbine Manufacturer (Over 100 kW)



Airgenesis

Airgenesis' turbine is capable of generating 11MW and will produce power at wind speeds outside current recognized thresholds. Using two rotors of equal diameters at a 30° offset, the Airgenesis design and power curve have been tested and validated and is able to achieve capacity factors much greater than all conventional designs. Characteristics of Airgenesis' turbines include improved performance at both low and high wind speeds. This results in low production cost per MW (\$750,000 per MW), making wind power economically viable in lower wind resource regions and without government subsidies. Most of the heavy equipment is mounted at the base of the turbine which significantly reduces maintenance costs.

www.airgenesiswind.com



Emergya Wind Technologies Americas, Inc.

EWT offers an efficient product range based on direct drive technology with a high yield and low cost of energy. The combination of direct drive technology and advanced control features makes EWT's DIRECTWIND 250kW up to 900kW a solution offering energy yield and reliability. With over 600 turbines spinning, EWT has a certified and high performing product range targeted on the decentralized wind sector, including energy solutions integrating with other sources of generation.

www.ewtdirectwind.com



Gamesa

Introducing Gamesa's debut model from its new generation of multi-megawatt turbines: the G132-3.465 MW, a solution for Class II sites. The turbine features 64.5m fiberglass blades and tower options ranging from 84m to 134m. An evolution of Gamesa's 2.0 MW and 2.5 MW turbines, the G132-3.465 MW combines an improved nominal capacity with a 34% increase in swept area to deliver optimum CoE in the 3.0-3.6 MW segment. www.gamesacorp.com/en



Goldwind

Goldwind's GW121 2.5 MW Permanent Magnet Direct Drive (PMDD) wind turbine's rotor design maximizes annual energy production within Class III low wind sites. The 121-meter rotor provides diverse application opportunities while maintaining upwards of 98% fleet-wide availability. The GW121's high load tolerance capabilities and full power conversion respectively provide site suitability and effective grid interconnection. Utilization of PMDD technology with the patented belt-drive pitch system eliminates failure inherent to gearbox systems. Fewer moving parts reduce costly breakdowns and time delays, allowing fluid annual energy production. www.goldwindamericas.com



Siemens Wind Power
Siemens drew on over 30 years of experience in the onshore wind industry in adapting their SWT-2.3-120. Designed with the demands of the U.S. market in mind, the SWT-2.3-120 was developed with an eye toward increasing energy production as well as increasing availability for the medium to low wind sites available for development in the U.S. The SWT-2.3-120, belonging to the G2 platform, represents one turbine type of Siemens' four wind turbine product platforms utilizing geared or direct drive technology. Whether inventing a new technology, redesigning an existing product, or simply finding a smarter way of working, Siemens strives to maximize return while delivering a lower cost of energy. usa.siemens.com/wind



Vestas

Vestas has designed, manufactured, and installed more than 76GW of wind turbines in 75 countries across the globe. Through their smart data capabilities and 63 GW of wind turbines under service, they use data to interpret, forecast, and exploit wind resources to deliver wind power solutions. www.vestas.com

Legal Services



Troutman Sanders

Troutman Sanders represents investors, lenders, utilities, independent power producers, and developers in wind projects throughout the U.S., including offshore. They counsel clients through every stage of development, including project acquisition and structuring; environmental permitting and federal, state, local regulatory compliance; real estate acquisition and leasing; turbine procurement and balance of plant construction; interconnection and transmission; power and REC sales and hedging; optimization of tax credits and other benefits; debt and equity financing (including tax equity); and operation and maintenance. www.troutmansanders.com/renewable_energy

Lighting



Moltec Windpower Products

Moltec International is a designer and manufacturer of tower and nacelle lighting and electrical distribution systems. Quik-Fit II, introduced in 2006, became the first "true" plug and play lighting system which is pre-engineered, pre-fabricated, and pre-tested in the Moltec factory to assure 100% quality and performance from quick installation through its entire service life. The included LYS Lighting offers high quality and performance, with UL/CSA/CE/ETL approvals, and is available with emergency back-up and cold climate heating elements. Moltec's engineering and manufacturing teams offer a "no cost" evaluation of their customer's systems. www.moltecinternational.com

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Phoenix Contact

Phoenix Contact's new LED tower lighting system for wind turbines makes lighting installation nearly maintenance-free. The complete solution ensures optimal lighting of work surfaces and escape routes. The LEDs have a long life, eliminating frequent bulb replacements. Due to the lower temperature operation, they also eliminate fixture heaters. The system features Phoenix Contact's QPD connection system for quick and easy installation. A central, uninterrupted power supply ensures lighting in case of power failures and eliminates the need for batteries in fixtures. Service technicians can conveniently read the UPS's charge level and the battery's expected service life.

www.phoenixcontact.com/us



**TIME TO
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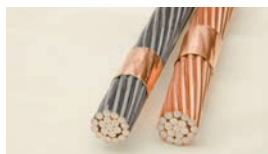
MANOSKOP® 730 N MANOSKOP® 730 N – at home in all weathers, such as in wind turbine maintenance. Accurate up to 1000 N·m. Quick & easy one-handed setting – proven to be reliable and robust – keeps downtimes to a minimum. Promised.

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Lightning & Surge Protection



Copperweld Bimetals, LLC

Since 1915, Copperweld Bimetals has manufactured bimetallic wire and provided Copper-Clad Steel (CCS) for grounding applications. Benefits of Copperweld CCS include: theft deterrent, no scrap value, stronger than copper, corrosion resistant, made in the USA, and ASTM B910, B227, B228 Certified.

www.copperweld.com



Dexmet Corporation

MicroGrid's single unit structure won't unravel or have loose strands that become problematic during processing into a pre-preg material or when conducting a dry lay-up. The homogenous design also ensures uncompromised conductivity between strands when forming the material to a variety of shapes and contours and provides a smooth surface on the end product. Desmet has the ability to tightly control the manufacturing process to meet a specific weight, open area, and conductivity requirement. This allows engineers the options of varying materials according to specific strike zones on the turbine blades and generator nacelles, minimizing the overall weight. Dexmet's common materials have the ability to withstand a Zone 1A strike of 200,000 amps.

www.dexmet.com



Pentair

ERICO offers a family of lightning blade receptors as part of a complete range of lightning protection products for the wind energy industry. The receptors are available as a stand-alone component or part of a complete preconfigured blade protection assembly. Blade receptor assemblies offer replaceable disks and provide insulation of internal components to inhibit undesired leader initiation. The features of the receptor assembly provide a smoothing of electric fields which eliminates the potential streamer initiation point.

www.erico.com

Lubricants



American Chemical Technologies

EcoGear 270XP is a wind turbine lubricant made from polyether polyol and has been engineered specifically to eliminate disadvantages of other full synthetic oils. American Chemical Technologies, Inc.'s (ACT) polyether polyol based PAGs essentially clean systems with their natural detergency and the incapability of varnish formation while in operation. EcoGear 270XP has valuable filtration properties, better cold temperature start-ups, condensation and water forgiveness, extended service life, and offers low volatility in high temperature applications. The extreme pressure properties in EcoGear 270XP have been formulated with an additive package created by advances in lubrication used in aerospace technology. Once activated by high specific loads and corresponding temperatures, the additive package helps to equalize surface roughness without creating abrasion. EcoGear 270XP is a solution within wind turbine gearboxes where other lubricants experience short change intervals and insufficient load carrying capacity.

www.americanchemtech.com



AMSOIL, Inc.

In 1972, AMSOIL, Inc. developed the first synthetic motor oil to meet American Petroleum Institute service requirements. Today, AMSOIL continues to formulate synthetic lubricants for the Industrial gearing needs of modern wind farms. With more than 7 years running the wind industry on the same formula, and reaching over 10,000 MW Class turbines in North America, AMSOIL Synthetic Power Transmission EP Gear Lube products and their line of hydraulic fluids are cost-effective choices for prolonging equipment life, reducing maintenance, and increasing gearbox performance and reliability. Anti-foam qualities preserve oil film thickness and optimize bearing life by controlling micro pitting and scuffing wear, increasing run times and reducing maintenance costs. AMSOIL's resistance to moisture extends filter life and eliminates additive depletion.

www.amsoilwind.com



BEKALube Products, Inc.

BEKAwind offers 3 customizable lubrication systems for wind generators: The Single Line system is easy to install, operate, and maintain and can be applied to main bearings, blade bearings, and yaw bearings. The Progressive system offers a flexible lubrication system for oil and grease up to NLGI Class 2 and can be applied to main bearings, blade bearings, and yaw bearings. The Progressive system can be matched with a lubrication pinion for the pitch and yaw drives. BEKAwind Flow, a spray lubrication system is selected for use with special lubricants with high solids content. This efficient noncontact technology offers a clean alternative for pitch and yaw drives.

www.beka-lube.com



Castrol

Optigear Synthetic CT 320 is formulated for use in wind turbine gear box applications, but it can be used for all types of enclosed gears – including heavy and shock-loaded gears and bearings where EP properties are required. It is suitable for use in gear boxes where high micro-pitting resistance and ultra-low water absorption is required. It is also capable in a wide range of applications in extreme environments. Optigear Synthetic CT 320 is fully compatible with nitrile, silicone, and fluoropolymer seal materials.

www.castrol.com/windenergy



Petro-Canada

HARNEX 320 Wind Turbine Gear Oil is a synthetic lubricant formulated for lubricating wind turbine gearboxes for reduced downtime and less maintenance. HARNEX 320 is designed to provide anti-wear/extreme pressure (AW/EP) protection and corrosion control under tough conditions. HARNEX 320 is part of a select group of gear oils that have GE service fill approval for 1.x and 2.x platforms with Winergy gearboxes. In addition, HARNEX 320 meets the technical requirements of Shanghai Electric, and is approved for use in any gearbox on a Shanghai Electric wind turbine.

lubricants.petro-canada.com



Royal Purple

Royal Purple's line of high-performance lubricants is specifically engineered to handle the toughest industrial applications, including for wind energy. The company's industry experts have strengthened their premium base oils with proprietary additive technologies to create a range of very specific industrial lubrication products, which have outperformed many other synthetic and mineral-based oils. Synerlec, Royal Purple's cornerstone additive technology, creates an ionic bond that adheres to metal parts, providing continuous protection. It helps strengthen the oil, offering unmatched performance and protection.

Royal Purple industrial lubricants deliver a higher level of energy savings and improved productivity across a wider range of equipment.

www.royalpurpleindustrial.com

Metal | Metal Cutting Machines



Fives Giddings & Lewis

Fives Giddings & Lewis builds high-precision metal cutting machines including boring mills, horizontal machining centers, and vertical turning centers used in the production of turbine gear boxes, planetaries, bearings, generators, shafts, and hubs.

www.fivesgroup.com



Samuel, Son & Co., Limited

Samuel, Son & Co., Limited is a metal service center and metal manufacturing company. Since 1855, Samuel has been in the metal business throughout North America in multiple market segments. With a diverse product line, they are able to supply all market segments, especially the energy markets.

www.samuel.com



Klüber Lubrication NA LP

Special gear oil is required to prolong the life of critical components and improve the performance of large drive trains. Klübersynth GEM 4-320 N reaches high levels of wear resistance while providing a platform for achieving ISO Cleanliness Codes. Foam resistance, compatibility, and stable viscosity are key features of this product from Klüber Lubrication.

www.klueber.com

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Operations & Maintenance (O&M)



Ar-Tech Coating Ltd.

Ar-Tech provides services in the application of internal and external coatings and paint. Corrosion costs industry billions of dollars a year, whether it be infrastructure, plant or equipment. Their products help assets achieve their designed life and eliminate any chance of premature coating failure.

www.artechcoating.com



Duromar, Inc.

Duromar is a manufacturer of high performance polymeric coatings for wind energy. Their product line includes a durable, easy to apply leading edge protection system, an innovative "Icephobic" coating to prevent accumulation of ice on turbine blades as well as a full line of blade repair products. Their tower and blade coatings provide more than 20 years of protection even for the most challenging offshore and coastal turbines.

www.duromar.com



EDF Renewable Services

With 30 years of experience and 10.9 GW of energy under contract in North and South America, EDF Renewable Services helps optimize plant performance, maximize availability, and minimize downtime. With services including full O&M, Asset Management, and 24/7/365 Monitoring, they bring an owner-operator sensibility to all projects. Their development group, EDF Renewable Energy, has over 8 GW of wind, solar, bioenergy, and storage developed in North America.

www.edf-rs.com

Composite Tooling for Windmill Blades

LARGE SCALE | HIGH QUALITY | PRICE COMPETITIVE | ON-TIME DELIVERY



- ▶ Patterns, Molds, Plugs
- ▶ Precision 5-axis machining
- ▶ Composite Fabrication
- ▶ Engineering Services

www.janicki.com
360.856.5143



Eilon Engineering/Ron Crane Scales

Eilon Engineering/Ron Crane Scales specializes in the development and manufacture of advanced load and force measurement systems for industrial applications, such as load cells, crane scales, dynamometers, and overload detectors for cranes and hoists. The systems are used as important safety devices, complementary to lifting equipment for industrial weighing. As such, they also serve to improve efficiency and reduce manufacturing costs. The systems are also used for horizontal force measurement, such as dragging force measurement, controlled tensioning of electricity cables as well as all manners of heavy rigging tasks, including the installation and maintenance of wind farms.

www.eilon-engineering.com



HYTORC

From the foundation bolts to the blades, HYTORC has developed solutions for nearly every bolting application in the wind turbine industry. For custom projects, their experienced engineering team is available to custom design the most efficient solution, with simple operation and economical pricing in mind. HYTORC's mission is to ensure customers' jobs as safe and efficient as possible. All of their products are covered by a worldwide, one-year, no-questions-asked warranty, which includes free parts and labor. With authorized repair facilities located globally, fast and professional service is always available.

www.hytorc.com



Integrated Power Services (IPS)

Integrated Power Services (IPS) offers wind turbine and generator repairs across North America, providing turbine owners and operators single-source, up-tower services, in-shop repairs, and product sales. IPS regional service centers offer 24/7 dependability, with trained professionals who have years of experience in the wind power industry. They're backed by technical resources and capabilities, plus a network for North American coverage.

www.ips.us | www.ips.ca



Power Climber Wind

Power Climber Wind helps wind turbine OEMs, owners, and service providers around the globe manage their operation and maintenance costs by providing reliable access equipment and expertise to improve employee safety, productivity, and retention. With 70 years of experience performing productively at elevation, they offer a range of solutions including IBEX climb assists, turbine service lifts, tower access platforms, blade access solutions, safety equipment, and training.

www.powerclimberwind.com



PSI Repair Services, Inc.

PSI Repair Services, Inc. is an independent service provider (ISP) to the wind energy industry. They offer component repair and engineering services for GE, Vestas, Gamesa, Siemens, RePower, and Clipper wind turbines. PSI covers the critical electronic, hydraulic, and precision mechanical components that drive the turbines' pitch and yaw systems and down-tower electronics. Commonly repaired components include printed circuit boards, pitch drive systems, inverters, IGBTs, PLCs, VRCC units, AEBIs, proportional valves, hydraulic pumps, pitch and yaw motors, encoders, slip rings, transducers, and much more. PSI uses the latest diagnostic tools to detect failures down to the microchip level.

www.psi-repair.com



Rope Partner

Rope Partner provides at height services specializing in blade repair, tower coating repair, cleaning, and retrofitting among others. They offer proactive blade maintenance programs, and have a highly trained blade repair workforce.

www.ropepartner.com



Sentient Science

Sentient Science works with wind operators and suppliers to provide life extension to wind assets and ultimately reduce the operator's cost of energy by a goal of \$10/MWh. Sentient's DigitalClone Live technology uses a material science-based approach to calculate the earliest point in time cracks initiate within the subsurface of each individual component. Sentient provides a watchlist over time with life extension actions that prevent unplanned and major maintenance events from occurring. Sentient works with suppliers to design longer-lasting products and help them digitalize their product offerings.

www.sentientscience.com



Spider

With 70 years of powered access experience, Spider puts workers on wind turbine blade or tower surfaces for the full scope of work performed at height. From single point tower access inspection systems to 360° blade access platform solutions to specialized custom designs, Spider has the modular platform components, ease of supply and transportability, engineering expertise, and installation know-how to get wind turbine repair work done safely and productively. Their solutions are available for rent, sale, and aftermarket support from 25 locations in the Americas, and they also offer Wind Access Safety and Training courses.

www.spiderstaging.com

Project Developer | Operator



BayWa r.e. Wind, LLC

BayWa r.e. Wind, LLC is a turn-key developer and operator of renewable energy projects in North America. Headquartered in San Diego, CA, the company has been active in the U.S. since 2001. The company's business model is to develop, construct, own, and operate renewable energy projects. It seeks to complete the life-cycle by either divesting of or partnering on the operating assets. The company is actively seeking new renewable energy projects.

www.baywa-re.us

Recruiting | Staffing Services



System One

System One offers renewable energy staffing and solutions. They provide engineering, technical, field, and managerial professionals for all stages of wind project development, from site selection, construction, cabling, and commissioning all the way through to operations and maintenance. They also offer personnel knowledgeable in blade remediation as well as major component replacement.

www.systemone.com

Remote Monitoring



Campbell Scientific, Inc.

Campbell Scientific delivers accurate, rugged, flexible data-acquisition systems built around Campbell dataloggers to wind-energy professionals throughout the world. Campbell Scientific offers the ZephIR 300 wind lidar as a complement or replacement to traditional meteorological masts. The ZephIR 300 provides wind measurements across ten user-defined heights from 10 to 200 m. It can be used throughout the wind project: site prospecting, wind-flow model verification, power-curve assessment, permanent wind-farm anemometry, and operational wind-farm analysis. Data from traditional meteorological instruments and the ZephIR 300 can now be shared seamlessly on Campbell Scientific dataloggers.

www.campbellsci.com/wind-energy



Electro Static Technology

AEGIS' WTG-MR Rings combine wind turbine bearing protection with continuous monitoring of shaft voltage levels from a remote location in real time. Combining an AEGIS Shaft Grounding Ring and a shaft monitoring ring in one, it ensures maximum uptime and reliability of wind turbines and is designed for OEM installation or easy up-tower retrofit. High-frequency currents induced on the shafts of wind turbine generators can reach levels of 60 amps and 1200 volts or greater, and can cause severe electrical damage, bearing failure, and catastrophic turbine failure. The WTG-MR safely diverts up to 120 amps of continuous shaft current at frequencies as high as 13.5 MHz and discharge up to 3000 volts (peak).

www.est-aegis.com



Systems With Intelligence

Systems With Intelligence provides utility grade video monitoring systems for remote industrial sites. These systems provide low bandwidth monitoring for safety, security, and asset monitoring with visual and thermal technology. Analytics automate the monitoring process that detect events or abnormal thermal conditions at the remote site and trigger alerts by email or directly to the SCADA monitoring system.

www.systemswithintelligence.com

Safety Equipment | Fall Protection



3M Personal Safety Division

3M's Personal Safety Division offers well-designed personal protective equipment (PPE) that provides employers a range of options for effective protection. From the most basic to the most specialized needs, 3M offers the health and safety protection workers need most, so everyone can perform at their best. 3M's specialists help companies build integrated PPE plans and programs supported by the latest technical innovations, training support, and resources to help employers make sure every worker stays safe.

www.3m.com/workersafety



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With 30 years of experience and 10.9 GW of energy under contract in North and South America, EDF Renewable Services is the trusted leader to **optimize plant performance, maximize availability, and minimize downtime.**

With services including full O&M, Asset Management, and 24/7/365 Monitoring, we bring an owner-operator sensibility to all projects.

Our development group, EDF Renewable Energy, is a green energy leader, with over 8 GW of renewable projects developed in North America.

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DEVELOPED
8 GW

PUT INTO
SERVICE
6 GW

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Gravitec Systems

Gravitec Systems provides a full range of fall protection and rescue services worldwide, including training, engineering, testing, and technical equipment sales. They offer year-round, comprehensive fall protection programs and can customize courses to fit site-specific needs. They represent over 30 manufacturers for fall protection and rescue products, and their engineers provide a combination of services, from full-service system designs, fabrication and install, or off-the-shelf system install. Gravitec Systems has a fully equipped ISO 17025 accredited testing lab that allows for a range of testing services to ensure product integrity and conformity to CSA and ANSI standards.

www.gravitec.com



Power Climber Wind

Power Climber Wind helps wind turbine OEMs, owners, and service providers around the globe manage their operation and maintenance costs by providing reliable access equipment and expertise to improve employee safety, productivity, and retention. With 70 years of experience performing productively at elevation, they offer a range of solutions including IBEX climb assists, turbine service lifts, tower access platforms, blade access solutions, safety equipment, and training.

www.powerclimberwind.com



YOU WORK HARD TO DEVELOP CUTTING EDGE TECHNOLOGY, LET US PROTECT IT WITH INNOVATIVE THERMAL MANAGEMENT OPTIONS.

The CS / CSL / CSF 028 fan heaters prevent the formation of condensation and provide evenly distributed interior air temperature in enclosures. The heaters are connected using internal terminal connectors. The surface temperatures of the housing are minimized as a result of the heater design. The small sizes of the CS / CSL / CSF 028 make them ideal for use in enclosures where space is at a premium.



The Touch-Safe PTC Fan Heater
CS / CSL / CSF 028
(Shown: CSF028)



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Spider

With 70 years of powered access experience, Spider puts workers on wind turbine blade or tower surfaces for the full scope of work performed at height. From single point tower access inspection systems to 360° blade access platform solutions to specialized custom designs, Spider has the modular platform components, ease of supply and transportability, engineering expertise, and installation know-how to get wind turbine repair work done safely and productively. Their solutions are available for rent, sale, and aftermarket support from 25 locations in the Americas, and they also offer Wind Access Safety and Training courses.

www.spiderstaging.com



Sterling Rope Company, Inc.

The PDQ is Sterling's lightweight evacuation system for use in wind turbine and tower environments. The PDQ descent-control device and the 6 mm XTEC heat resistant Technora rope form the core of this system whose total weight is under 10 lbs. Rated for a user-load of 310 lbs, the fully-assembled kit comes ready for deployment and its slim profile means it can be stored compactly and carried by each technician until needed. Certified to ANSI Z359. The addition of the optional Raise and Rescue kit converts the PDQ to a mechanical advantage system that can be used for simple and efficient victim raising and multi-directional transfers.

www.sterlingrope.com

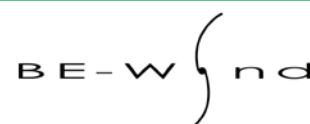


Tech Products, Inc.

Since 1948, Tech Products has been a source of identification products used to mark everything from URD Distribution cable to O/H Phasing. Their Everlast product line is a solution for pole marking, substation signage, and transmission tower identification. It is being used on the cold substations of AEP OHIO and on the hot, sunny, and humid AEP Texas distribution poles. Fasttag miniature cable markers identify smaller indoor cable that will be exposed to chemicals, salt, and water.

www.techproducts.com

Small Wind Turbine Manufacturer (under 100kW)



BE-WIND Systems

BE-WIND manufactures Urban / Micro-grid wind solutions. Their dual axis vertical wind turbine is designed for extreme low wind capture and high wind structural strength. It has self-regulating over-speed control and uses a diversion shield to divert any resistant wind loads on the trailing side of the blades, which allows for very low wind speed startup or kick in. 2mph / 1 m/s wind speed. Blade gapping technology controls the blades' maximum rpm to prevent over-speed and out of control rpm in high wind speed conditions (excess of 100 mph 45 m/s). The dual-axis vertical wind turbine is offered in 3d solids and cnc manufactured from solid aluminum 6061 T6 billet.

www.be-wind.com

Software Supplier



First Base Solutions

VuMAP is a feature-packed online mapping application with easy to use, built in tools to measure, draw, compare high resolution aerial imagery year over year, build custom aerial maps, and research and report on land information. Providing unlimited access to Ontario property boundary mapping with PINs, elevations, soil descriptions, and more an annual subscription can streamline the site selection process.

www.firstbasesolutions.com



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

Steel Supplier



Leeco Steel

Leeco Steel, headquartered in Lisle, Illinois, with 11 locations, maintains a large inventory of carbon, HSLA, and alloy plate steel originating from worldwide mills. Leeco Steel's quality service and collective buying power provides flexibility in securing product, agility in reacting to changes, and the ability to keep their customer's operations competitive in today's ever-changing marketplace.

www.leecosteel.com

Testing | Inspection Services



BladeEdge

EdgeData's BladeEdge, is an automated analytical software tool which transforms raw data from aerial inspection into actionable intelligence for the wind industry. For wind farm owners, leveraging unmanned aerial inspections, which are up to ten times faster than human teams, helps improve wind farm planning, safety, and efficiency, ultimately extending blade infrastructure lifespan and reducing costs. BladeEdge's proprietary software stitches the photographs together and transforms the data, enabling wind farm owners the ability to schedule maintenance, extend blade life, enhance turbine performance, and prevent condition-related revenue loss.

www.bladeedge.net



EdgeData

EdgeData equips businesses with the software to systematically capture, compute, and consume big data intelligence. The company's BladeEdge is an automated software tool, customized for the wind industry. BladeEdge's software transforms raw data from aerial inspection into actionable intelligence.

www.edgedata.net



Intertek

Intertek supports wind power industry manufacturers, owners, developers, and operators with critical services including product and system certification, structural analysis and inspection, field inspection and labeling, independent verification, and monitoring. Their responsiveness and turnaround time brings improved reliability and safety to their clients, with reduced failure-related downtimes. Their expertise across a global footprint ensures testing programs run quickly and efficiently. They offer support in: Small Wind; Mid-Size/Community Wind; Large Wind Offshore Wind; and System Components and Installed Systems for Wind.

www.intertek.com



UL, LLC

UL is a global, independent safety science company, continually expanding to meet the needs of customers and to deliver on UL's public safety mission. UL provides safety, performance, and function testing services for the assessment of wind turbines and turbine components that must comply with international, national and regional regulations and standards—as well as meet the needs of insurers, developers, and investors. UL is further advancing in the field of renewable energy, in particular for on- and off-shore wind turbines and wind farms. This combined technical expertise provides customers with global, one-stop wind energy services.

www.dewi.de



WINDGUARD NORTH AMERICA

WindGuard North America, Inc.

WindGuard's testing laboratory offers power performance measurements according to all established technical standards (for example IEC 61400-12-1). In addition, WindGuard has developed other methods to verify the power performance of wind turbines, implementing both ground-based and nacelle LiDAR technology. With the experience from hundreds of tests on turbine types from 30 kW to 7.6 MW, they are a reliable partner for verifying warranted power curves as well as prototype testing. WindGuard is committed to providing extensive scientific, technical, and operational services, which are unbiased and manufacturer-independent for onshore and offshore wind projects.

www.windguard.com

Tools



Aimco-Global

The HT Series from AcraDyne combines high torque and performance in an electric high torque bolting tool with accuracy, speed, and safety. When combined with AcraDyne's Controller, customers have a high torque critical bolting system that handles tough and important bolting jobs. The HT Series is available in over 300 models with an ergonomic, robust design which implements five handle configurations. Including a built in integral transducer for optimal monitoring and control and data retrieval, the HT Series is a traceable system at the square drive for high torque bolting.

www.aimco-global.com

AS Tech Americas, Inc. (ATA)

ATA offers bolt tensioning equipment including electro-hydraulic and pneumatic pumps, tension cylinders - thread on and thru hole versions, hoses, couplings, and hydraulic nuts. They provide offer sales, service, rentals, and consultation for all bolt tensioning applications.

www.astech-hydraulik.com

Serving the Wind Energy Sector since 1999

Capps

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Dakota Riggers

Dakota Riggers is a stocking distributor for Tuff Bucket products. These high-quality lifting buckets feature the innovative roll-down closure system. This closure system allows for the bucket to fully load, rated both right side up and upside down. Tuff Buckets are available in a variety of different sizes, in either heavy-duty canvas or vinyl-coated polyester material.

www.dakotariggers.com



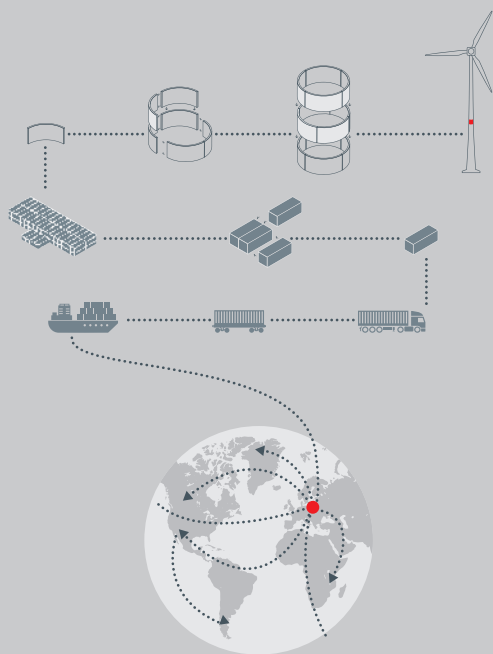
McCann Equipment, Ltd.

McCann Equipment Ltd. is a multi-branch Canadian industrial tool distributor, specializing in the sale, service, and rental of torque and tensioning products. Their services include the repair, calibration, and certification of torque tools (manual, electric, pneumatic, hydraulic), transducers, and testers. Additionally, they certify air pressure gauges and hydraulic gauges as well as tension calibration testers (Skidmore). Each of the company's branch offices is ISO 17025 accredited. The scope and accreditation for each is available on their website.

www.torquetools.com

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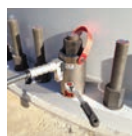
Max Bögl Wind AG
P.O. Box 11 20 · 92301 Neumarkt i. d. OPf., Germany
Phone +49 9181 909-11624
wind@max-boegl.com · www.max-boegl.com



Hi-Line Utility Supply

With over 10,000 products in stock, Hi-Line Utility Supply is a “one-stop-shop” for tools, safety equipment, rubber goods, and services for wind farms, electrical utilities, and contractors since 1960. Hi-Line also custom grounds and jumpers, tool repair, fiberglass refinishing, and rubber goods testing at two NAIL accredited test labs (Gilberts, IL and Millbury, MA). Both warehouses house a large in-stock selection of rubber goods. Hi-Line also provides the required certification documentation to meet the unique needs of wind farms.

www.hilineco.com



ITH Engineering

ITH provides bolting technology to the wind power industry. Their complete scope of supply includes: tools, engineering, fasteners, and service. Products include: hydraulic tension tools, hydraulic torque tools, torque multipliers, hydraulic pumps, and fasteners. In the wind industry, ITH supplies tooling for all OEM wind turbines and designs this tooling directly with most major OEMs. ITH has a worldwide sales network, international patents, and qualified application engineers to assist with specific bolting needs.

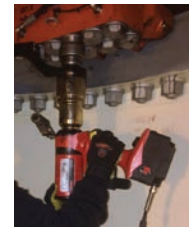
www.ith.com



Janicki Industries

Janicki Industries is a privately owned, full-service engineering and manufacturing company. Janicki manufactures tooling for wind energy blades made of composite materials and metals. Janicki fabricates auxiliary equipment: hinges, scaffolding, fixtures. Janicki is capable of tackling large projects, utilizing precision five-axis mills, large facilities with overhead cranes, curing ovens, and large autoclave. Janicki has experience using many composite systems and metal forming, employing a 1,100 ton press. Janicki is proficient in transporting large products to a project location. They provide 100% in-house capability for the total tooling and equipment solution for wind energy customers.

www.janicki.com



Norbar Torque Tools, Inc.

Norbar introduces their electric torque multiplier, EvoTorque2. EvoTorque2 delivers true 3% accuracy, durability, and enhanced capabilities. EvoTorque2 can store 3000 readings, measures in torque and torque + angle, and features an audit mode, designed to accurately check pre-tightened bolts. Norbar and Evotorque2 can help save time and money by reducing downtime and maintenance costs, while delivering performance. EvoLog software is designed to be fast and efficient to use, and allows for quick set-up, easy data storage and manipulation, and provides detailed reports.

www.norbar.com



Norwolf Tool Works, Inc.

The Norwolf X-Driver is a thin, flat, fast, and versatile hydraulic torque wrench. Simply engineered, one Powerhead locks into 3 separate drives without pins or screws to be completely convertible. The X-Driver locks into 1) A-Drive for direct fit on nuts, 2) M-Drive for hyper-low clearance applications, and 3) V-Drive which is the square drive tool. The A Drive fits well onto wind applications, the ease of fit makes it safe with less chances of operator error.

www.norwolf.com



Rad Torque Systems

The E-RAD Blu series for the wind industry, including E-RAD Precision torque wrench tools, are designed to provide a high degree of accuracy (+/-2.8%) and repeatability (+/-2%). Using 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.eradtorque.com



Snap-on Industrial

Snap-on Industrial is a supplier of tools and protective equipment for professional technicians. Their Tools at Height tethered tool program includes more than 1,000 tools designed for work being performed at height or anywhere dropped or lost tools are a concern. All tools are designed with a tethered system to maintain or enhance the tool's functionality when used at height or near critical assemblies. Engineered, tested, and certified to improve safety and productivity for technicians working at elevated levels, Snap-on's Tools at Height use a retention system that is designed in conjunction with the tool so it doesn't inhibit the technician's ability to complete the job.

www.snapon.com/industrial



Stahlwille Tools, LLC

SmartCheck is a newly launched, small sized, versatile, and easy-to-use torque tester that will find a home in any workshop and service vehicle. Due to its compact dimensions, the ability to mount it horizontally or vertically, and the rotatable display, it can be used virtually anywhere. Display and keypad are splash-proof and it can be operated through power supply or battery. SmartCheck quickly provides information on whether or not a torque wrench is still within the prescribed tolerances or whether it requires adjustment. The integrated visual and audible overload protection mechanism, and impact resistant plastic housing ensure the durability customers expect of STAHLWILLE.

www.stahlwille-america.com



Torkworx, LP

Torkworx provides controlled bolting systems for the wind industry. The ERAD-BLU provides the ability to control multiple tools through one single control case. The calibration is stored inside the E-RAD Handle which allows for multiple handles to be used with any E-RAD BLU controller. Torque and angle operation is standard in all systems and WTG electronic digitally controlled presets make the torque process error free. Torkworx also provides expertly trained bolting technicians to assist with torque and tension checks.

www.torkworx.com

Torque Tools California

Torque Tools California provides sales, rentals, and service of hydraulic torque wrenches, pneumatic, electric, battery powered torque guns, manual torque wrenches, impact guns, flange alignment tools, hydraulic pumps, cylinders, tools, and impact sockets.

www.torquetoolsca.com

Tower Foundations



Con-Tech Systems, Ltd.

Con-Tech Systems supplies foundation solutions to suit all ground conditions. Their HRTB Solid Bar and Strand Systems are well suited for foundations on rock. Post-tensioning of these anchor piles to their design load eliminates anchor and foundation movements, and provides a higher safety factor. Their single-step CTS/TITAN Hollow Bar IBO Micro Pile System is a solution for foundations on soils, particularly when collapsing soils such as sand and gravel are encountered. Ground conditions and "grout to ground" bond values are greatly improved during drilling and flushing of the bore hole through their grout injection process, resulting in shorter piles.

www.contechsystems.com

Transmissions



Fabrimet, Inc.

Fabrimet is a fabricator of lattice wind towers and transmission towers. Fabrimet has set up a process allowing the production of quality galvanized steel lattice foundations and supplies the steel for foundation of stubs, anchors, anchoring bars, and steel grillage. Fabrimet assists their customers with the design of various types of steel galvanized foundations in order to comply with specific ground characteristics.

www.fabrimet.com

Transportation | Logistics



Capps Van & Truck Rental

Capps provides box truck, heavy duty pickup truck, and crew van rentals. Capps serves large and small businesses in the energy, construction, cartage, logistical, and service sectors throughout the continental United States. Their heavy duty pickup trucks are equipped for towing and hauling (receiver hitch and gooseneck). All pickup trucks are all 4 wheel drive vehicles equipped with diesel engines and Allison automatic transmissions. A selection of ¾ ton, 1 ton, and 1 ½ ton crew cab vehicles with regular bed and flat beds are available. All rentals are covered with 24/7 road side assistance. Medium duty trucks are available with van bodies including 24 foot box trucks, 16 foot box trucks, 24 foot stake beds, and 15 foot cutaway vans. The 24 foot and 16 foot trucks are equipped with large platform lift gates.

www.cappsvanrental.com



C.H. Robinson Project Logistics

As a global freight forwarder, C.H. Robinson Project Logistics has experience in developing and executing cost-effective, successful logistics plans for the transportation and management of heavy-lift and over-dimensional wind turbine equipment; from pick-up to final site. After a proactive analysis of all project requirements, C.H. Robinson Project Logistics helps customers develop solutions and contingency plans to help ensure shipping schedules are consistently met. C.H. Robinson Project Logistics offers several services including: detailed route planning; part/full charters; aircraft chartering and emergency rush air freight; accurate information documentation; timely status reports; and consulting services for complex letters of credit and bid documents. Their experienced team of professionals is available onsite at locations globally to manage the successful completion of technically demanding projects.

www.chrprojectlogistics.com

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Diamond State Port Corp.

Port of Wilmington, Delaware provides 24/7 marine terminal operations with wind project handling experience. They offer two independent stevedores, prompt and efficient State permitting and police escort services, logistics coordination, Class 1 rail, local towing co., and ship agencies. They have onsite CBP & USDA, FTZ Min/Max Loads/Tonnage, and 6 open, project friendly berths. Their heavy lift capacity is up to 100 MTs, and they have 59 acres of outside storage with immediate access to the interstate highway. They service the central mid-Atlantic region and are the first deep water terminal on the Delaware River. Having been established in 1923, they've been handling wind turbine components since 2001, and are certified in C-TPAT as well as a member of AWEA.

www.portofwilmington.com



Goldhofer Aktiengesellschaft

Goldhofer designs and produces transport equipment for wind power plants.

www.goldhofer.de



Logisticus Group

Logisticus Group is a global supply chain partner with a full suite of services to help support successful project execution. Their team has the ability to transport over-dimensional cargo in a safe and effective manner by providing planning, government relations, execution, risk/crisis management, and advanced technology solutions.

www.logisticusgroup.com



Port of Brownsville

The Port of Brownsville is a deep water seaport on the U.S./Mexico border. At the southernmost tip of Texas and connected to the Gulf of Mexico by a 17-mile long ship channel, the Port of Brownsville is also a large land-owning public port authority with approximately 40,000 acres. As a bulk and breakbulk commodity port, the Port of Brownsville has developed a versatile marine terminal operation for both liquid and dry bulk cargoes. The port's infrastructure includes 13 cargo docks, 5 liquid cargo docks, 635,000 square feet of covered storage facilities, and more than 3 million square feet of open storage.

www.portofbrownsville.com



Port of Longview

The Port of Longview has more than 10 years experience handling wind cargo. In 2016, Port of Longview discharged blades direct-to-rail, decreasing handling costs and reducing the risk of damaged cargo. The Port is served by BNSF and UP, offers double tracked on-dock rail, and a 70 acre paved laydown yard. Their equipment consists of 2 heavy lift Liebherr mobile harbor cranes, reach stackers, and other equipment for their customers' handling needs. Located on the deep-draft Columbia River in Washington State, just 66 miles from the Pacific Ocean with direct access to Interstate 5 and BNSF mainline, the Port of Longview offers a full service transportation destination.

www.portoflongview.com



Port of Vancouver USA

The Port of Vancouver USA provides a gateway for importing wind energy components and large modularized cargos via the Columbia Snake River System into North America. In addition to their cargo space, they are also a truck and rail gateway to the U.S. Midcontinent and Canada. The port's two Liebherr mobile harbor cranes operate at any breakbulk berth and have a lifting capacity of 140 metric tons each. In tandem, they can easily lift heavy loads up to 210 metric tons. Terminal 2 is equipped with a multi-purpose crane capable of lifting 51-metric-tons and has a 115-foot outreach.

www.portvanusa.com



Ports America

Ports America is a large terminal operator and stevedore, operating in more than 42 ports and 80 locations. With experience and expertise to handle breakbulk and project cargo, Ports America provides modern equipment which can handle all specialized cargo, regardless of size or shape. Ports America has a presence on all three coasts, with wind energy capabilities in Davisville, RI; New Orleans, LA; Galveston, TX; Houston, TX; and Vancouver, WA with plans to expand further as the wind energy market remains consistently strong over the next 10 to 15 years

www.portsamerica.com

Wind Assessment | Forecasting



EAPC Wind Energy

EAPC Wind Energy is a wind consulting firm offering bankable wind resource and energy assessment, wind farm design, turbine site suitability analysis, project due diligence, noise and shadow flicker assessment, visual simulations, and met tower sales and installation. EAPC Wind Energy is the exclusive North and South American (excluding Mexico and Brazil) sales and support agent for WindPRO.

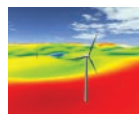
www.eapc.net



Lufft USA

The VENTUS ultrasonic wind sensor by Lufft provides precise and maintenance free measurement of wind speed, wind direction, and air pressure as well as calculation of acoustic virtual temperature accurate to within 2°K. The ultrasonic wind sensor is designed without mechanical parts known traditionally as "cups and vane". For wind turbines requiring wind sensor replacement, Lufft has provided a drop-in solution for anemometer replacement. The WindBridge signal converter is configured and programmed to aid in data transfer from an analog sensor to the controller, allowing for easy integration into existing hardware platforms of wind turbines of any age. The Ventus communication is translated into the existing format and received at the controller.

www.lufftusainc.com



Meteodyn

Meteodyn develops wind energy software and custom IT engineering solutions. Available wind software solutions for wind projects and running farms include, meteodyn WT software and meteodyn Forecast. meteodyn WT software includes tools such as wind resource assessment, annual production assessment, wind farm design in complex terrain, turbines layout, IEC compliance, site suitability, and analysis. meteodyn Forecast is a wind power forecast system to predict wind production at short and very short term, wind farm optimization, and wind farm monitoring.

www.meteodyn.com



Remtech, Inc.

Remtech manufactures and maintains the Remtech DOPPLER SODAR(s) for acoustic wind profiling. Their systems remotely measure a vertical profile of wind speed, direction, thermal stratification, and turbulence parameters up to 400, 700, and 3000 meters average altitude range depending on Sodar model. Their SODAR(s) are used in over 55 countries worldwide for various applications such as wind energy, airports, nuclear power plants, meteorological, and military applications.

www.remtechinc.com

Yaw, Pitch & Blade Sensors



fos4X GmbH

fos4X is an industry 4.0 company with wind energy as their core market. fos4X develops solutions for monitoring (predictive maintenance, blade ice detection) and control (individual pitch control) of wind turbines based on proprietary fiber optic sensing technology. Advantages of fiber optic sensors include immunity against electromagnetic interferences, long distances between sensor and controller, as well as intrinsic isolation against high voltages or lightning strikes.

www.fos4x.de

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Phoenix Press, Inc.

Phoenix Press powers their presses and related equipment with their on-site 100KW NorthWind turbine. They use FSC-certified papers and vegetable-based Biolocity Inks. Their pre-press department provides a variety of digitally generated proofs to fit their customer's needs, and process their files with digital computer to plate (CPT) systems. Phoenix Press accommodates sheet-fed jobs of all sizes: One- to six-color plus coatings; perfecting (printing on both sides of the paper simultaneously); print-on-demand and in-line finishing (POD), with or without variable data for any short run quick-turn around needs in color and black and white; and small format four color process printing. Phoenix Press maintains its own Bindery, Mailing, Fulfillment, and Logistics Departments providing: in-house binding and finishing including automated collating, stitching, wire-o; spiral, scoring/perforating, drilling, shrink-wrap, and wafer sealing; Addressing, Inserting, and Mailing; Variable data and UV Inkjetting; Kitting; Fulfillment and Warehousing; Material management programs; Free inventory and Storage; and Worldwide Shipping.

www.phoenixpressinc.com

Radar Remote Sensing



DeTect, Inc.

DeTect, Inc. specializes in radar remote sensing technologies and systems for aviation safety, security surveillance, environmental management, and wind energy supporting projects worldwide with over 140 radar systems installed and operating. In response to the Dark Sky initiative to reduce light pollution and customer demand, DeTect developed the HARRIER Aircraft Detection Lighting Systems (ADLS) for automatic obstruction lighting activation for aviation obstructions such as wind farm turbines, high voltage transmission lines, and communication towers.

www.detect-inc.com

Reactors and Transformers



Trasfor

Trasfor produces dry-type transformers and reactors for the wind application, among others. Air natural, air forced, or water cooling are some available options depending on the requirements of the installation.

www.trasfor.ch

Rescue and Safety Training

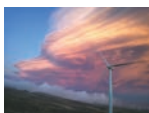


TEAM-1 Academy, Inc.

TEAM-1 Academy, Inc. specializes in training for Working at Heights/Fall Protection, Confined Space, HazMat/Spill Response, many forms of Rescue, and much more. They provide Professional Safety and Rescue Training, Equipment Sales + Service + Inspections, and Consulting Services for the renewable energy sector, utilities, energy sector, Fortune 500 companies, industry, construction, health care, fire services, police, EMS, military, MOE, government, and numerous others.

www.team1academy.com

Revenue Metering and RIGS



Trimark Associates, Inc.

Trimark helps wind resource owners meet requirements for revenue metering and secure data telemetry. This includes: QF Conversions which meet CAISO's requirements for QF resource conversion; Meter Maintenance and Calibration to ensure revenue meters are maintained and accurate; and Data Management to support data validation required by incentive and other renewable energy programs.

www.trimarkassoc.com

Satellite Internet Provider



Skycasters

Broadband satellite internet service, Skycasters, provides reliable data communications. Their business-grade, high-speed satellite internet solutions offer a low-latency connection with guaranteed speeds supporting all communications and data operations needed by the energy sector; SCADA, VoIP, email, fax, streaming data, and more. A direct and redundant connection to the U.S. internet backbone provides Skycasters' customers with reliable communications whenever and wherever they go. Fixed and mobile satellite internet solutions all utilize business-grade equipment built to last and perform in rugged environments. Flexible and customized service plans are available.

www.skycasters.com

Sectionalizing Cabinets, Transformer Box Pads

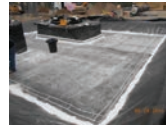


Nordic Fiberglass, Inc.

Nordic Fiberglass designs and manufactures chuted box pads for pad-mounted transformers installed in a slurry mix solution next to the tower pedestal. These chuted box pads provide a reliable and simple solution to protect underground cables from the tower to the transformer. Nordic also offers stilt support systems. These leveling legs for the box pad can be adjusted to obtain desired level height next to the tower pedestal. Nordic's three phase 35kV 600Amp sectionalizing cabinets house up to three, 3 or 4 pt. 35kV 600Amp junctions with U-straps if requested by the customer. 18" or 36" high extensions are available for large cables radius.

www.nordicfiberglass.com/wind

Spill Containment



Albarrie GeoComposites, Ltd.

Albarrie engineers, supplies, and installs secondary oil containment using patented oil reactive self-sealing smart fabric technology. Their oil containments are maintenance free and offer cost savings on both installation and operation. Albarrie works with engineers, consultants, EPCs, contractors, and OEMs to design maintenance free oil containment that meets specific needs and complies with regulations.

www.albarrie.com

Track Conversion



Mattracks, Inc.

Mattracks, manufacturer of rubber track conversion systems, has expanded their line-up of tracks for commercial, large equipment with axle loads up to 10 and 20 tons. Mattracks offers over 100 track conversion models for everything from ATVs, UTVs, and trailers to pickups, tractors, 4x4's and more for customers globally. Ideal for the tough terrain at many wind farm sites, Mattracks track conversions provide mobility and traction in mud, sand, snow, swamp, and muskeg. They provide users access to roads that can no longer be traveled by tires, with decreased impact to the vehicles and the environment.

www.mattracks.com

Utility Poles

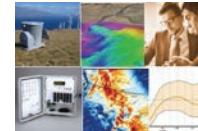


Bell Lumber & Pole Co.

Bell Lumber is a 110 year old family-owned wood pole manufacturer, supplying wood utility poles to contractors, developers, and utility customers across North America.

www.blpole.com

Wind and Solar Measurement and Consulting Services



Vaisala

As the fuel for wind and solar projects, understanding weather is critical for the renewable energy industry. Vaisala provides weather measurement and consulting services with an 80-year reputation for reliability and decades of experience assisting clients throughout the entire project life cycle, from greenfield prospecting and due diligence to operational forecasting and plant optimization. Its customers include utility-scale energy players who require weather expertise to develop and operate efficient, reliable, and profitable projects around the globe using a wide range of measurement, assessment, forecasting, and asset management products and services.

www.vaisala.com/energy

PA-XS sodar wind profiler latest design

Lidar / Sodar Intercomparison

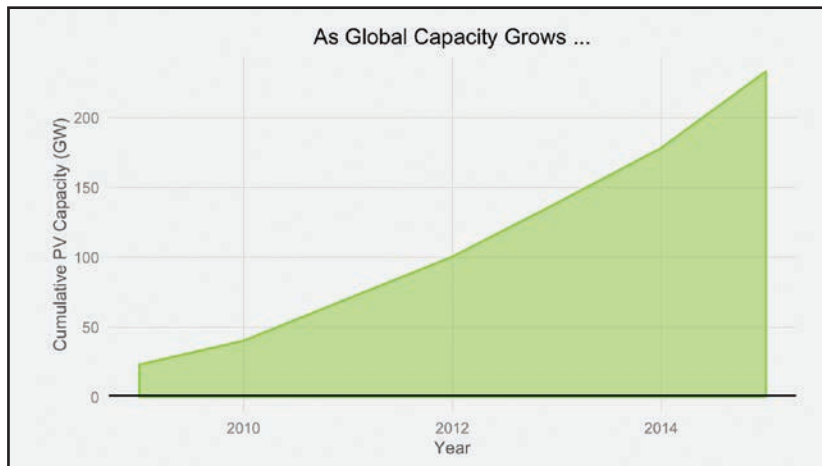
$R^2=0.982$
— WindCube
— PA-XS

[e-mail: sales@remtechinc.com](mailto:sales@remtechinc.com)

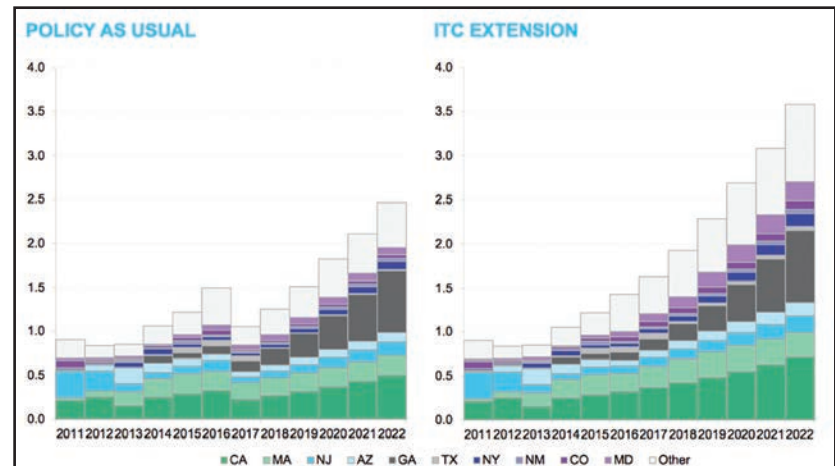
<http://www.remtechinc.com>

The Evolution of Solar Finance

by Jon Powers



Sources: *Global Market Outlook 2015-2019, Solar Power Europe; Global Market Outlook for Photovoltaics 2014-2018, European Photovoltaic Industry Association*



The early days of solar investing

It was not that long ago solar energy developers needed to convince a capital partner there was enough sunshine in New Jersey to power homes. The uncertainty of the market, questions about the reliability of the photovoltaic panels themselves, and unfamiliarity with power purchase agreements caused significant challenges to get new projects financed. Over time, as the right policies began to align, projects were built and the cost of solar panels declined. The risks began to mitigate allowing more capital to enter the market and reduce transaction costs. Cheaper deals meant better prices for the power, better prices meant more deals, and the solar marketplace grew exponentially. Today, solar is competing for a share in the \$5 trillion renewable energy market projected for 2030. This changing business landscape leads us to the next phase of solar finance.

Policy innovations drive down costs

President George W. Bush signed the Energy Policy Act of 2005 which had tremendous bipartisan support and ushered in solar, along with other renewables. It established the Section 48 Investment Tax Credit (ITC), providing a lucrative 30% tax credit for solar projects. Leaders at the time saw this as a transformational tool to allow this nascent technology that had been hanging around for 30 years to compete against traditional energy sources. Over the course of the next few years, other policies aligned at the state level, and then a combination of the ITC and appropriate technology advancements bolstered the solar industry, with the number of solar installations truly accelerating around 2010 and beyond.

Early clean energy investors took on an incredible amount of risk while earning high returns. Today, most of the risk around technology has been mitigated. Better engineering and data analytics can predict power generation capacity and thus the expected returns from a project. Access to clear information makes solar assets even more lucrative for investors.

Solar investing in a post ITC world

It is also important to note, if developers or owners of these assets utilize the Section 48 Investment Tax Credit, they are restricted by the IRS from transferring ownership for five years. This brings us to today. We are now seeing the first generation of early solar projects being bought and sold in the marketplace post their ITC hold. In recent years, the Yieldcos recognized if they come in on year six of a 20-year Power Purchase Agreement with a strong customer, these projects can be tremendous cash flow yielding assets.

The opportunity of high yielding assets

These yields can look tremendously attractive to more conservative investors who are interested in holding long, optimizing assets, and receiving predictable cash flows from the Power Purchase Agreements. While YieldCos have hit a few bumps in the road, they still demonstrate the basics of economics around the long term yields solar projects provide.

Since YieldCos raise money from public markets, even if they make appropriate economic investments in high yields, a panicked market can hurt their stock prices. So there are other ways to address these markets such as the booming financial tech (FinTech) industry which allows accredited investors to purchase direct equity in existing projects or portfolios. This eliminates the public market risk, but still provides access to these yields.

Why solar is such a great investment today

The yields are real. This is the unique opportunity operating, cash-flowing solar projects provide, and they can be a great investment for new investors beyond the traditional, large banks, private equity firms, and tax equity investors. Data models now provide significant clarity on the revenue coming in over the life of these deals. Institutional investors, family offices, or even individuals, who may not like the risk exposure of new build projects, can now get into solar through operating assets. This is the evolution of solar finance.

Clean energy for all: going solar through investment

The US solar market is projected to grow by 25-50% this year, and 30% globally. Figure 1 is a great snapshot of this growth, and makes clear the expanding investment opportunity this market presents.

Continued growth means a continued need for new capital to enter into the market. Operating projects provide the gateway to get investors familiar with the asset class and also helps developers exit their current portfolios. These developers, who have a higher risk tolerance, are looking for exit opportunities to access capital and address their future pipeline. More capital coming into the market as a whole will accelerate the continued growth of the industry.

The first million solar panels took over 62 years to be installed, but the next million solar panels will come online in the next 2 years. This market expansion means more assets will mature and become available for investment. Clean energy investments, and solar in particular, have proven to be very reliable. The next generation of clean energy financing will see a reduction in the barriers to marketing these lucrative deals, and an expansion in the pool of potential investors. Millions will have the opportunity to go solar, not only through direct installations at the residential, commercial, and industrial scale, but also through their investment portfolios.

Jon Powers is the co-founder of CleanCapital and former White House federal chief sustainability officer.

Clean Capital | www.cleancapital.com

"Solar project investing offers the opportunity to invest in clean and renewable sources of energy with predictable cash flows each year."

**- Scott Kushner, Director,
Power & Infrastructure at
John Hancock**

AWEA Wind Project O&M and Safety Conference 2017



Partnering for Success

Success means driving operational excellence by partnering in four main sectors, health & safety, O&M, workforce training & development, and quality assurance.

The AWEA Operations & Maintenance and Safety Conference is where the industry comes together to recognize unique challenges and identify solutions in these areas. And as the wind energy industry continues to expand, so does the need for an evolving approach to operating the nation's growing number of wind projects.

Fortunately, there is no shortage of experience to draw from in this arena. Individuals from across industry sectors and across functional disciplines will join in San Diego in February to set a vision and plan for continued and expanded operational excellence in the wind industry.

Make sure you are a part of the largest North American gathering of wind energy operational professionals and technicians, as we combine the essential elements of O&M, health & safety, workforce development, and quality assurance to develop a successful partnership for today and beyond.

| February 28 - March 1, 2017

| Paradise Point Resort & Spa, San Diego, CA

Early Registration ends
January 13, 2017

Register now at www.awea.org/oms



Learning from Uber

How batteries are revolutionizing the energy industry

by Dr. Xiaoxi He

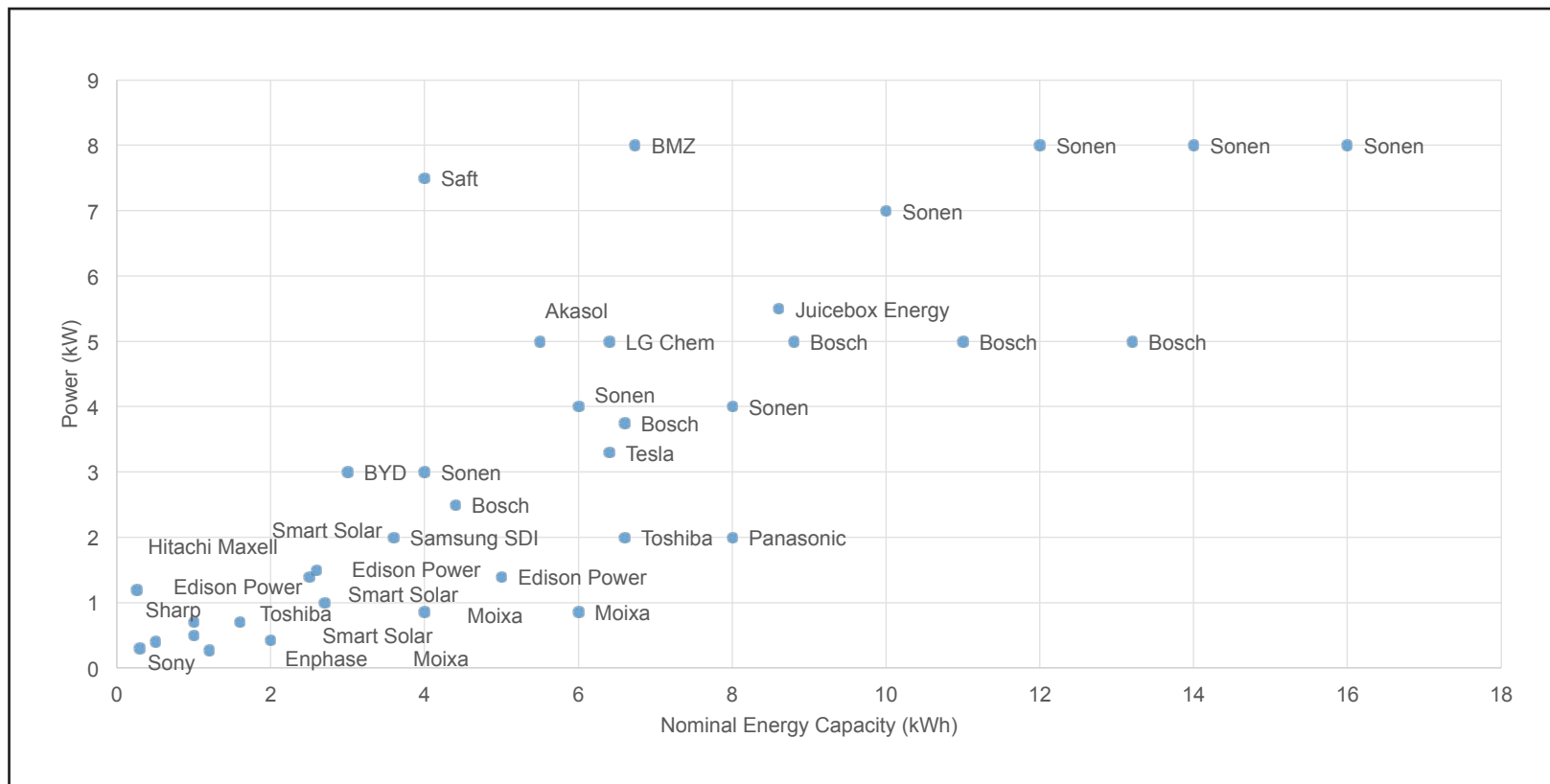


Figure 1: Comparison of current and future residential battery products in the market

The phenomenon of the shared economy has already changed many industries, such as hospitality and transportation, to wit Airbnb and Uber. Energy storage, thus far immune from such models, may soon be dramatically affected.

Batteries commonly found in consumer electronics are moving beyond this traditional sector and gravitating towards electric vehicles and energy storage systems (ESS). The emerging business models applying the “sharing” idea will force utilities to overcome the inertia of an unchanged structure and exert pressure for regulatory changes, which will help this industry achieve a \$6 billion market value by 2026.

Moving beyond automotive and consumer electronics into ESS

Multiple consumer electronics players have recognized that consumers no longer want to change their mobile phones every two years. This means the growth rate of consumer electronic batteries is plateauing.

In order to find new growth points, battery makers and electronics manufacturers are exploring new business areas. Automakers, already active in the residential, commercial, industrial, and grid ESS businesses are also entering the vehicle to home areas.

In essence, a cross-industry business is taking shape, as evidenced by the large number of recent acquisitions, joint ventures, and investment deals. The market is fragmented with all manner of companies jumping in: solar cell integrators, automotive players, cell makers, battery manufacturers, chemical suppliers, trading companies, power utilities, etc.

With Tesla’s Powerwall and Gigafactory bringing global attention to the market, residential or home batteries for behind-the-meter applications are gradually becoming accepted as backup power and as assets to store electricity for PV systems. This allows consumers the flexibility to buy and store electricity when rates are low, and consume it as needed.

Beyond residential systems, batteries are being used on a larger scale for a variety of commercial and industrial applications. Their use is also being explored by utility companies, even at the grid and utility levels. The National Grid Electricity Transmission’s enhanced frequency response (frequency response at 1 second or less of registering a frequency deviation) tender is also a potential game changer.

Besides frequency services, battery storage can offer other benefits such as energy capacity, investment deferral, transmission congestion relief, voltage control, load following, arbitrage, etc.

Reality behind the hype

However, this is not yet a market-oriented industry. Government support plays an important role in both residential and grid applications. Two examples of this are Germany and California. For instance, Italian residential battery players are pursuing the German market instead of the local market. In the commercial and industrial (C&I) sector, incentives and electricity pricing structure are important considerations. Many California C&I entities use battery storage systems for demand charge reduction, which helps them save a significant amount in electricity charges.

For front-of-the-meter applications, the driver for supporting energy storage is often linked directly with renewable energy, particularly in areas of the grid with high penetrations of renewable generation. Pilot and demonstration projects take the majority.

For behind-the-meter applications, when the end-users already have a PV system, the differences between wholesale electricity rates and earning for selling electricity is vital. For end-users without an existing PV system, wholesale electricity rates are important.

Lessons from PV growth

Similarities are found between the history of the rapid uptake of solar PV and what is happening in the battery storage market, especially in the behind-the-meter sector. The opportunities and risks of the battery storage boom are more complex than those of PV, because of the multitude of applications and value streams involved, more safety concerns, and their cumulative impact on the continued growth of rooftop solar. Based on historical data, the PV industry has experienced boom-bust cycles due to excess capacity caused by over-investment in this area. Battery storage may experience similar conditions if investments exceed demand. Regional policies and regulations may impact the industry as well.

Technology is not the major driver

The interests in current and future choices for battery solutions are largely stimulated by further battery cost reduction, especially lithium-ion batteries. At the same time, cost is one of the major barriers for further large deployment. Therefore, how to use the same asset efficiently is an important consideration based on current prices.

Sharing economy, revolutionizing the energy industry

It is widely accepted that a battery system used for a single application is not economic, based on current prices. However, it can be used for numerous applications to generate multiple value streams. Like Uber and Airbnb, these same assets can be utilized for owners and others; battery systems can be simultaneously shared by residential owners and utilities. Of course, barriers and difficulties such as regulatory structures, lack of common codes and standards, and safety concerns are temporary hurdles that may hamper growth. But we have already seen companies applying the "sharing" idea emerging in the energy industry. Those who can follow this rising trend will seize the opportunity and win.

Dr. Xiaoxi He is a technology analyst for IDTechEx Research specialized in energy storage. She obtained her PhD from University of Cambridge and holds a Master's degree from Universität Ulm. Established in 1999, IDTechEx provides independent market research, business intelligence, and events on emerging technology to clients in over 80 countries. IDTechEx is headquartered in Cambridge UK; additional offices are in Berlin, Boston and Tokyo.

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Plug-and-play energy storage system

Developed in partnership with solar and energy storage installers to optimize equipment and streamline cost calculations, SimpliPhi Power has released a complete plug-and-play energy storage system, AccESS, that easily integrates power storage into new and existing solar installations both on and off grid. SimpliPhi's fully integrated solution includes the company's battery technology combined with a Schneider Electric inverter charge controller and associated power electronics and system management in one box. Pre-programmed software settings and system performance monitoring round out the solution. By eliminating any ventilation or active cooling requirements, SimpliPhi's new all-in-one AccESS can be safely installed both outside and inside. SimpliPhi assembles all the equipment into the AccESS box and ships it out as a plug-and-play solution. The AccESS offers three software modalities meeting the requirements of different applications, such as new and retrofit systems, including solutions that utilities can access for asset monitoring and deployment off-site for grid stabilization.

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Battery Backup to Off-Grid

Navigating the transition

by John Connell

AS NET METERING AND OTHER GRID-TIED SUBSIDIES DRY UP, more people are transitioning from battery backup to off-grid systems.

This article examines how to go off-grid, with an emphasis on reducing energy demands and selecting and sizing the right battery bank for a system.

Reduce energy demands

Battery backup systems only need to provide a few hours of electricity during power outages. Off-grid systems, however, must store enough energy to run an entire household every day, as well as hold ample reserves for cloudy or windless days.

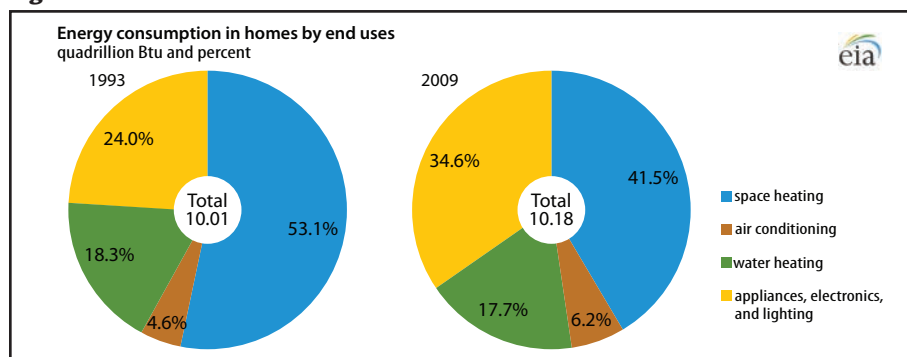
Since every kWh requires additional solar or wind power, battery storage, and backup generation, it pays to start with improving efficiency and lowering electrical demand.

Simple steps include replacing inefficient appliances with Energy Star models, raising or lowering thermostat settings seasonally, and putting vampire loads on switchable power strips.

Because almost half of household energy consumption goes to space heating and air conditioning, upgrading attic and wall insulation can slash heating and cooling demands.

In addition, mechanical systems like compressor-less Variable Refrigerant Flow HVAC technology can cut HVAC energy usage by ~90%, without sacrificing comfort. Other options are inexpensive whole-house fans and simple ventilation systems that draw in cool night time air and expel heat. (See "Living the Dream of Net-Zero Energy & Storage - March/April 2015.

Figure 1



Source: Energy Information Administration <http://www.eia.gov/todayinenergy/detail.cfm?id=10271> U.S.

Calculate electrical load

After reducing electricity demands, review the past year's utility bills to identify a baseline of power needs.

Inexpensive devices can reveal vampire loads and provide accurate power monitoring for individual appliances. This data can then be applied to the basic calculation for power needs: Watts = amps x volts.

For instance, if you need 1,000 Watt hours (1 kWh) a day, and have a 12-volt battery bank, you'll need 84 amp-hours of storage.

Add additional storage capacity for worst-case scenarios

Off-grid systems aren't connected to the power grid. Batteries require additional capacity to store solar or wind energy for extended periods, without over-discharging batteries.

Undersized solar panels and battery banks make it difficult to use large appliances and slash battery life through over-discharge. If storage reserves dwindle, off-grid homeowners could be left in the dark.

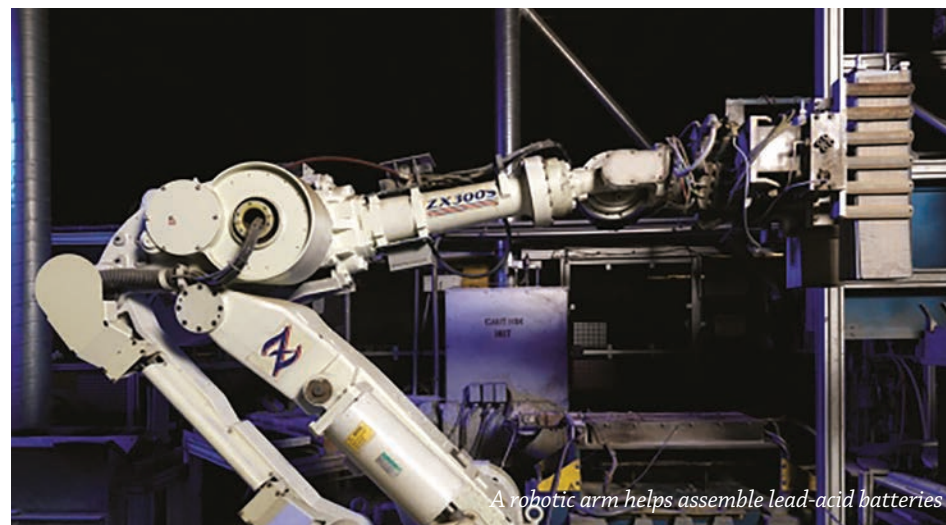
Important considerations for additional capacity include: number of days of autonomy (no sun); seasonal variations in wind generation; hot streaks that increase A/C use; decreased sun-hours during winter; and foggy and cloudy days that reduce solar output.

Maintain a safe depth of discharge (DoD)

Every off-grid household needs reserve power for heavy loads and cloudy days with limited solar charging.

Some battery technologies tout 80% or 100% DoD. They even compare their affordability using unrealistic and unsafe assumptions, such as needing half as much capacity as other technologies. However, when any battery is discharged 80% or more, it has almost no reserve capacity left to run high-energy appliances. It certainly won't deliver enough electricity to power common household appliances during low-solar days.

Plan on a maximum of 50% DoD. A good rule of thumb is to double the calculated ampere-hours needed.



A robotic arm helps assemble lead-acid batteries

Select the right batteries

Lead-acid and lithium-ion (Li-ion) are the most common battery types, but there is no one-size-fits-all battery technology. It's important to consider technology type, preferred voltage, ambient temperature, maintenance requirements, recyclability, and cost.

Li-ion batteries offer higher energy density and reduced weight, and, like some lead-acid batteries, don't require regular maintenance. However, Li-ion batteries have a shorter lifespan and can cost up to 10X as much for the same capacity as their lead-acid counterparts. They also require battery management systems (BMS) to protect against cell damage and overheating (which can start fires). Recyclability varies from 0% to 60%, with fewer than 20% of Li-ion batteries partially down cycled.

Lead-acid batteries are the most-used because they've been proven for over 100 years. They're also economical, at 50% to 90% cheaper than other technologies. According to the US Environmental Protection Agency (EPA), lead-acid batteries are 99% recyclable and 99% recycled – the highest recovery percentage of any product in the USA.

The most common battery options are flooded lead-acid, which require periodic water service and other preventative maintenance throughout battery life, and sealed valve-regulated lead-acid (VRLA), which are maintenance free but more expensive than flooded batteries.

Look for key features for longer battery life

- Heavy, gravity-cast plates with more active lead allow for more chemical reactions and longer life;
- Previously recycled, 100% recyclable lead improves sustainability;
- Computerized lead oxide mixing, plate curing, and formation charging maximize performance and consistency;
- Robotic cast-on strap (COS) welding allows for over 4,000 adjustments versus 40 for manual welding, improving lifespan and reliability;
- Automated vision systems eliminate common human errors and ensure quality.

Extend lifespan with proper storage

Batteries last longest in moderate temperatures (ideally, 77°F). Each 18°F temperature increase reduces the number of cycles available by half. Lower temperatures increase lifespan but reduce available capacity.

Avoid putting batteries in insulated coolers and old refrigerators, which trap heat and spike battery temperatures.

House batteries in well-ventilated locations or standalone utility structures.

Make maintenance easy

Maintenance is crucial for lifespan and performance. Typical maintenance includes adding distilled water, checking and cleaning connections, and effective battery charge control setup and operation. Follow manufacturer recommendations and schedule periodic maintenance on the calendar.

By following the approach in this article, navigating the transition from battery backup to off-grid can be fast and easy – and electrical bills will be a thing of the past.

John Connell is the vice president of Crown Battery's SLI Products Group. Crown Battery manufactures all its advanced technology, lead-acid batteries at its ISO-9001:2008-certified plant in Fremont, Ohio.

Crown Battery | <http://www.crownbattery.com>

For more information, see:

July/August 2015 - How to select the right AGM battery

<http://www.nacleanenergy.com/articles/20652/how-to-select-the-right-agm-battery>

May/June 2016 - Will It Recycle?

<http://www.nacleanenergy.com/articles/23242/will-it-recycle->

Early Days: Lessons the Storage Industry Can Learn from the Solar Sector

by Philip C. Farese, PhD

Few nascent markets have benefitted as much from the buzz of high-profile aspirational marketing as energy storage. The Tesla Powerwall announcement triggered exuberance that far exceeded the realities of today's marketplace. Most of today's storage products promise a great future but don't yet offer the full suite of customer benefits needed to make them truly viable. As storage solutions emerge that can meet those customer expectations, we expect significant value creation and market growth that will justify even more exuberance.

In a way that only Elon Musk could have, the topic of "behind-the-meter storage" has moved from a utility/grid management conversation taking place in industry journals to a trendy retail-side conversation playing out in New York Times headlines. However, the excitement has grown much faster than the megawatt-hours of behind-the-meter storage actually installed. Residential behind-the-meter energy storage systems deployed since 2013 still only amass to less than 13MWh: that's fewer than one thousand installations in little more than three years, according to GTM Research/ESA. For all its multi-billion-dollar value creation and resulting potential, the battery storage market—especially the residential variety—remains in its early days and has a lot of issues to work out before realizing that potential.

One of the major issues is the fit between the product benefits and the market requirements. Many assumed Tesla brought to market a disruptive break-through product representing a \$3,000 solution that backs up an entire home indefinitely and with perfect reliability, runs off green solar power, and pays for itself by trading energy on the grid with a buy-low, sell-high strategy. Although we may see such platforms in the not-too-distant future, this kind of complete residential storage solution is not available today. In reality, storage systems currently available are about double that price, offer limited backup with unknown reliability, and require on-site expert system integration. Solutions will need to come down in price, improve in reliability, and become much simpler to install, configure, and use to truly reach their mass adoption potential.

Many have written about the cost of battery cells and their expected trajectory. While we have nothing to add to that rich dialogue, we do find much less discussion on the other requirements for a successful solution: most notably, simplicity.

On this topic, the emerging residential storage industry could learn some lessons from the past. The residential solar sector has seen a major transformation from the original model of semi-reliable string inverters converting DC energy from the PV panels into grid-usable AC power. In the early days of the solar boom, installers were piecing together modules, inverters, and (on occasion) monitoring software to create a rudimentary home solar solution. This took a lot of time and expertise which kept installation labor and system costs high, and slowed deployment. With the success of module-level power electronics (MLPE), technologies such as microinverters and optimizers, rooftop solar arrays have become smarter, more efficient, more reliable, and easier-to-install systems. The built-in intelligence of module-level monitoring and management has become the residential solar standard.

In short: the solar industry learned that component compatibility is not the same as true system integration. When we look at the emerging storage industry, we see that many first-to-market storage offerings are assemblies of product components, not integrated solutions. Most battery offerings look to third parties to provide the power conversion unit (inverter) and the operating software. These early-to-market products require complex, cross-manufacturer interplay among the inverter, battery, and software vendors. The resultant system is labeled "integrated," when, in fact, the components are compatible, not truly integrated.

To be fully integrated, one must consider all parts of the system: battery hardware, battery inverter, solar modules, solar

inverter, balance of system components, operating software, user interface, and the ability to work with other home energy management devices. With most hybrid DC-coupled solar-plus-storage platforms, compatibility does not translate to integration: there is a tradeoff between flexibility and functionality, instead of an approach that maximizes both.

Some manufacturers have taken another route, offering integrated AC-coupled solutions comprising all these elements and have demonstrated considerably faster installation, easier commissioning, and a more satisfying user experience. In the long run, this system-level integration model will likely emerge as the leading solution in this fast-growing market.

The economic case for residential storage is just beginning to emerge in Australia, Germany, Hawaii, and other regions. Market drivers such as innovative time-of-use utility tariffs, restrictive solar power export regulations, and reduced or eliminated feed-in tariffs have begun to move the needle on consumer interest and adoption. GTM Research forecasts the U.S. residential storage sector will soar to 632 MW (1580 MWh) of annual deployments by 2021 and become a billion-dollar market.

However, realizing this potential requires meeting or exceeding the minimal customer requirements outlined above for a truly integrated solution. Once such solutions are in place and these growth forecasts become reality, there will be even more exuberance that will drive a virtuous cycle of growth and product innovation in residential energy storage.



Philip C. Farese, PhD is the vice president, strategy for Enphase Energy.

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*[Data source: GTM Research/ESA U.S. Energy Storage Monitor Q2 2016]

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Flooded Lead Acid Battery Charging & Seasonal Maintenance

by Jeff Myles

Sizing a battery bank

Each renewable energy system is unique, and the requirements vary due to the homeowner's energy usage. Although a system may be adequately designed and sized for one home, it may not be suitable for another home of a similar size. Many home owners and inexperienced installers will improperly size systems, often selecting components in the wrong order, and overlooking several key considerations and requirements which determine efficiency and overall success. (Figure 1) In these circumstances, the battery bank is generally the first to show issues or signs of failure. Don't make the mistake of purchasing PV panels and an inverter/charger before first completing an energy audit to calculate the estimated storage capacity requirement. This will determine how much power must be generated to adequately recharge the batteries, and ultimately the required PV array, equipment and configuration needed to do so. Undersized charge sources will deficit cycle the battery bank. An undersized battery bank will be heavily discharged. Both scenarios will reduce battery capacity and shorten cycle life.

When properly sized, the battery bank will store adequate power to run the system between charge cycles at a desired depth of discharge based on pre-determined load calculations. Deep cycle batteries should not be sized to discharge more than 50%, as this will significantly impact cycle life. Most systems are sized to discharge to 60-75% state of charge, providing a balance of cycle life, capacity and cost. The charge source should be sized and selected to produce the adequate voltage and charge output (Amps) to fully recharge the battery bank effectively during a limited timeframe (peak daylight hours).

Charging

Caution: It is important to follow the proper charge voltage settings outlined by the battery manufacturer; these are specific to the build of the product and are generally a condition of the manufacturer warranty. Do not use the default Bulk, Absorption, and Float voltage settings programmed in the charging equipment unless specified by the battery manufacturer, as these are often lower than recommended.

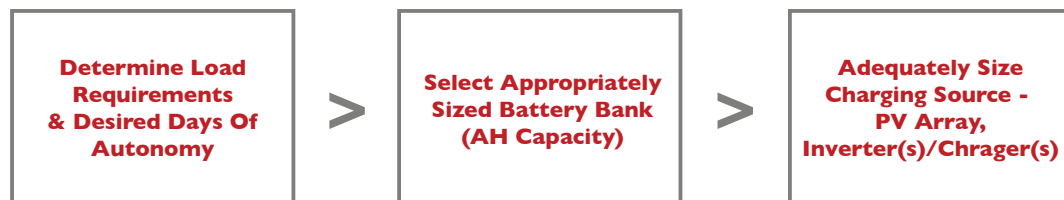
Many inverters/chargers are designed to operate with a temperature sensor mounted to one of the cells, which is used to adjust the charge voltage accordingly. At higher cell temperatures, the charge voltage is lowered from the programmed voltage. At cooler temperatures, the charge voltage is increased slightly (adjustments: 5mv/°C/cell). Systems are commonly set up at default using an inadequate charge voltage of 2.4 VPC, based on ambient temperature at the time of install. This often causes the system to adjust the charge voltage lower than recommended by the battery manufacturer. The result is accelerated sulfation and capacity loss, which may not be immediately identified. To prevent sulfation build-up and prolong the life of the battery bank, systems using temperature compensation should be initial programmed to charge at 2.45 VPC.

Temperature sensor readings are only accurate and reliable when sensors are properly installed. Sensors should always be mounted directly to the side of a battery cell, below the liquid level, to ensure an accurate reading. Do not mount a sensor to the top of the battery case, to a terminal, or to the outer case in dual-container models, as this will not provide a reliable measure of cell temperature.

Specific gravity readings should be taken with a measured hydrometer or refractometer at the end of the charge cycle when the battery bank is resting in Float charge. Note that increased cell temperatures will raise specific gravity readings. These will lower when the batteries cool following heavy charging.

It is important to understand using charging equipment with temperature compensation does not make the system fully self-sufficient. Adjustments to charging parameters may still be necessary based on a variety of factors including varying ambient and operating temperatures, cycling frequency, depth of discharge, and the accumulation of sulfation. Voltage and specific gravity readings should be taken on a regular basis to identify when adjustments to these parameters may be necessary, as well as any spotting issues early on (such as charge imbalance) to prevent cell damage or failure. Performing routine maintenance such as testing, watering, cleaning, and corrective equalizations when needed, is key to protecting an investment in battery-based storage.

Figure 1



Clean battery terminals and acid spills, and top up cells with distilled water when necessary. Run corrective equalizations when charge imbalance or sulfation/capacity loss is identified.



Flooded lead acid batteries which froze due to heavy discharge in freezing temperatures.

Figure 2

Freezing Temperature	
Specify Gravity	Temperature
1.280	-69°C (-92°F)
1.265	-57.4°C (-72.3°F)
1.250	-52.2°C (-62°F)
1.200	-26.7°C (-16°F)
1.150	-15°C (5°F)
1.100	-7°C (19°F)



TBU encapsulated valve

Battery Watering Technologies' new VB-TBU valve is an encapsulated valve offered for commercial applications. The new valve design was originally intended for the Trojan PLUS Series batteries to prevent the valve from being damaged by the vent opening obstruction during installation. The shut-off level for the VB-TBU is the same as the VB-TBB valve. Due to the performance and robustness of the new VB-TBU, they will replace the VB-TBB valve with the VB-TBU valve effective October 11th, 2016. Kit part numbers will not change. If a replacement valve is needed for the VB-TBB, a VB-TBU will be shipped.

Battery Watering Technologies | www.batterywatering.com

Seasonal properties

In addition to primary off-grid homes, these systems have grown in popularity for use in seasonal properties like summer cottages and remote cabins. Whether visits are infrequent, limited to weekends, or simply in locations with limited accessibility throughout the year, these off-grid systems will require ongoing maintenance. At the beginning and end of the usage season, it is recommended owners perform a corrective equalization on the battery bank to balance the state of charge and clean any build-up of sulfation. Refer to the battery manufacturer for step-by-step instructions and additional considerations.

Taking the time to perform these steps will prolong the life of a battery bank considerably. Prior to winter storage, cells should be topped up with distilled water to prevent plate exposure. If the system will be left on, holding the battery bank at Float charge, be aware that PV panels covered in ice or snow will not generate power. System components will still draw power from the battery bank, which can result in heavy discharge if left unattended for extended periods of time. Lowered specific gravity in cold temperatures increases the likelihood of permanent damage due to frozen cells. As the electrolyte drops in specific gravity, the water begins to freeze and expand, causing case bulging or cracking. (Figure 2) Lead is soluble in water, which degrades plate construction and lead oxide paste, reducing capacity and/or shorts the battery. When disconnecting a battery bank for extended periods of time, it is important to fully charge the bank to avoid excessive self-discharge in storage.

Jeff Myles is the marketing manager at Rolls Battery Engineering.

Rolls Battery Engineering
www.rollsbattery.com



ESS solutions

Sungrow-Samsung SDI has released new energy storage system solutions which integrates, energy storage inverters and Li-ion batteries and is designed to address system integration problems, especially in the North America market and is based on Sungrow-Samsung SDI's technologies. This integrated system solution is applicable to commercial energy storage, energy storage power systems, and the micro grid. Sungrow-Samsung SDI's 250kW/500kWh energy storage system is especially designed for commercial energy storage. It combines Li-ion batteries and energy storage inverters, effectively solving a number of problems including communication, battery pack design, battery protection, and equipment layout thanks to its high system efficiency and compact design. The SC250KU inverter employed in this energy storage system, is best characterized by its high power density, high efficiency, and wide voltage range, as well as the virtual synchronous generator. Furthermore, the Li-ion batteries deployed in the 250kW/500kWh system can charge and discharge up to 6,000 times with multiple protection functions and high power density. The Li-ion batteries also have international certifications such as UN38, VDE, CE, UL and JET, and are capable of being used in various applications.

Sungrow-Samsung SDI Energy Storage Power Supply Co., Ltd.
www.sungrowpower.com



Reliable 8-volt deep cycle battery

U.S. Battery has redesigned its US 8VGCE XC2 8-volt deep-cycle battery with more amp-hour performance and improved longevity, to provide greater power and reliability for a variety of applications. U.S. Battery's US 8VGCE XC2 was built for economy, and now offers 110 minutes of runtime at a 56 amp draw, (155 amp-hours at a 20-hour rate) and weighs a 60-lbs. (27kg). The US 8VGCE XC2 comes in a durable black polypropylene heat-sealed case with a black top, and features standard bayonet vent caps. It is also available with the company's SpeedCap as an added option, and can be ordered with a variety of high-quality terminals to match a wide range of wiring options. Built with U.S. Battery's XC2 Formula and Diamond Plate Technology, this redesigned 8-volt battery can also reach high initial rated capacity, and fast cycle up time to full-rated capacity.

U.S. Battery | www.usbattery.com



Hydrogen energy storage

The AESHG technology is a reliable, cost effective, advanced energy storage hydrogen power solution. The technology overcomes the biggest obstacles for mainstream marketing and mass deployment of fuel cell power; manufacturing cost, end user price, and deployment. The technology is now available for manufacturing, Territory Rights, and development solutions. The Advanced Hydrogen Technology generator is composed of an intricate synthesis of 16 physical and chemical processes that are combined and tuned to work in unison to produce clean, affordable energy. The output of the Advanced Hydrogen Technology generator has been tested by EPA certified prominent engineering and gas measurement companies. The test certificates are available for validation and were conducted in accordance with EPA standards. The Advanced Hydrogen technology produces power by utilizing controlled electrical discharging with renewable and or recyclable resources. The Advanced Hydrogen Technology generator converts diverse fuels directly into electricity without combustion, and is the key to a broad portfolio for building a competitive, secure, safe, and practical sustainable clean energy economy.

eMpasys | www.empasys.org



Low voltage/high current battery charge/discharge test system

NH Research, Inc. (NHR) has released its new 9220 Series Low Voltage/High Current Battery Charge/Discharge Test System (Dual Bay). This 9220 Series Dual Bay Test System is designed for testing all battery chemistries including lead-acid, lead-cadmium, and other low voltage, high current, large format batteries (LFB) typically used in energy storage systems (ESS). The system is bi-directional requiring no additional equipment to charge or discharge the unit-under-test (UUT). Additionally, the built-in measurement system eliminates external measurement devices by providing time-stamped digital readings for voltage, current, power as well as Ah and kWh. Unlike typical high-current systems which convert battery discharge power into waste heat, the 9220 Series Dual Bay Test System converts up to 87% of the battery discharge power into usable electrical power that precisely matches the facility's AC line. This process, called regeneration, results in lower operating costs, reduces air-conditioning usage, eliminates expensive water cooling systems, and often provides enough savings to payback the entire system within a few years.

NH Research, Inc.
www.nhresearch.com

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15.	Average No. of Copies Each Issue During Preceding 12 Months	No. Copies Single Issue Published Nearest Filing Date
a. Total Number of Copies (Net press run):	32,956	33,737
c. Total Paid and/or Requested Circulation:	18,253	17,678
d. Non-requested Distribution :	14,171	15,049
e. Total Non-requested Distribution:	14,171	15,049
f. Total Distribution:	32,424	32,727
g. Copies not Distributed:	532	1,010
h. Total:	32,956	33,737
i. Percent Paid and/or Requested Circulation:	52.29%	54.01%
16 a. Requested and Paid Electronic Copies	20,765	22,049
16 b. Total Requested and Paid Print Copies + Electronic Copies	39,018	39,727
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16 d. Percent Paid and/or Requested Circulation (Both Print and Electronic Copies)	73.26%	72.53%

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