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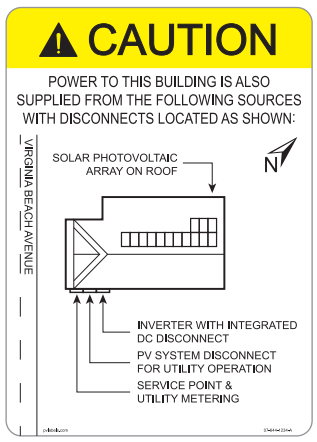

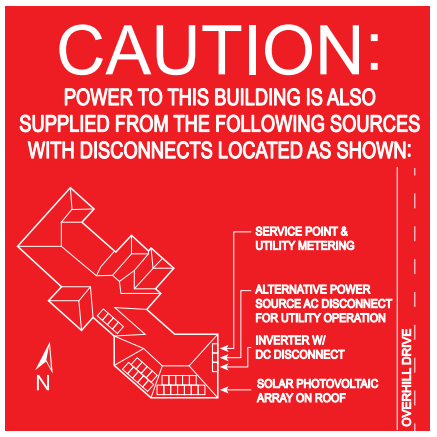

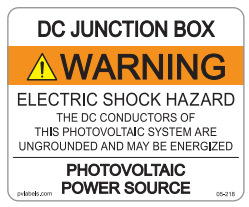

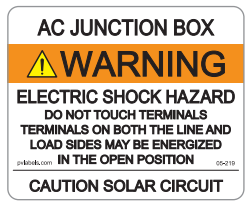

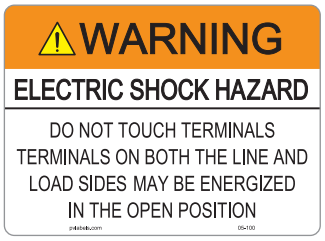

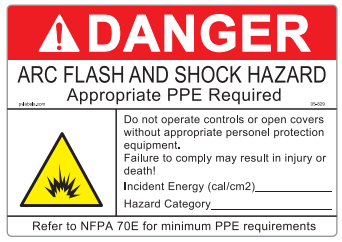

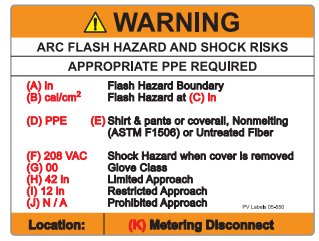

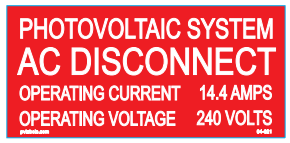

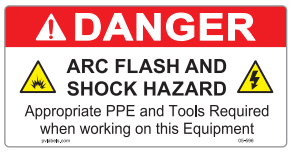

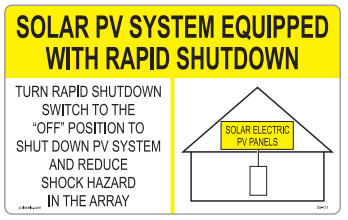

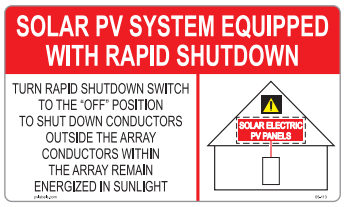

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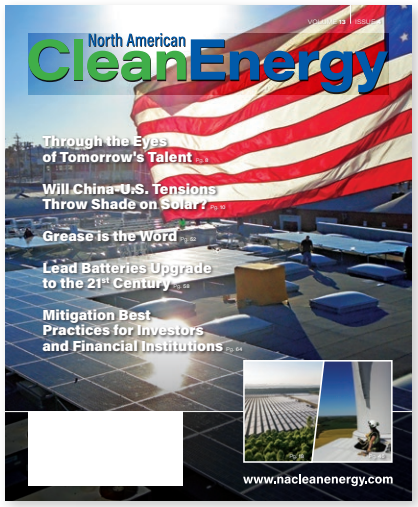

On our cover...

California-based company American Solar Power was founded in 2009. Cover image shows a 150kW install in Los Angeles. American Solar Power, Inc. is NABCEP, OSHA, and CSLB certified.

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What’s parked underneath matters to us!

THE GRADUATION SEASON HAS FINALLY wrapped up. Fancy announcements, Congrats to the Grad balloons, and other cap and gown paraphernalia are gradually fading from the store shelves. Many of us remember college as four years of liberal arts classes, followed by an entry-level job at a company that often had nothing to do with our alleged field of study. The advantage of growing up pre-internet and ubiquitous social media was that we could reinvent ourselves regardless of the path we thought we would take when were undergrads. Usually, what we studied was not nearly as important as where we got our diploma. Religion and political science majors were just as likely as accounting majors to find themselves in incubation programs run by major banks looking to train workers with a relatively blank slate.

It's refreshing to see that, especially in the clean energy industry, the focus is shifting away from where you study, to what you can bring to the workforce right out of the gate. One of the most established and longest-running programs for a career in the solar industry is offered by the San Juan College in New Mexico. You've probably never heard of it, but this unassuming community college has been training future solar industry workers for over 13 years. Now, of course, Going Green is the cool thing to do, touted by every other social media "influencer" and mainstream ad campaign out there. At the same time, renewable-related majors have gained traction on university campuses – prospective students can now get their degree from more easily recognized schools like University of Michigan, University of Texas, and even Stanford.

Higher education in the field of renewable energy is re-embracing traditional technical school values, and producing employable graduates armed with a working knowledge of the industry. This new crop of thinkers and doers will have a slight advantage over the rest of us. Terms we've had to learn from scratch are second nature to newcomers: net-zero, BIPV, SREC, SCADA, Lithium-Ion, Vanadium flow, microgrid, blockchain, and, more recently, conservation banking. In case you didn't know, conservation banking officially began in 1995, as a natural offshoot of wetland mitigation banking established by the U. S. Fish & Wildlife Service (FWS) earlier in the decade. Conservation banks share certain qualities with the more widely known carbon credits, which are intended to offset proposed increases to the carbon footprint of a group or individual. (You can learn more about it on page 42).

Incidentally, the FWS has approved over a hundred such conservation banks since 2011, so you may want to add this terminology to your ever-growing clean energy vocabulary. It's not easy to keep the status of "expert" in our industry; every year brings new developments and surprises. The land lines, road maps, and banks of today are lining up to be the horseless carriages of tomorrow. At least you can look forward to regaling your future grandchildren with stories of how you not only had to drive yourself to work (uphill, both ways) but could expertly parallel park, bumper to bumper, without the aid of a single computer.

"Motivation is the art of getting people to do what you want them to do because they want to do it."
– Dwight D. Eisenhower

Meg

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Blade runners

Engineers at LM Wind Power and its parent, GE Renewable Energy, have been thinking big... to the tune of 351ft (107m). That's the length of one blade on the Haliade-X 12MW, GE's largest and most powerful offshore wind turbine. Just one of these machines will generate enough sustainable energy to power 16,000 European homes. Possibly representing one of the largest single machine components ever built, the Haliade-X blade is longer than a football field and 1.4 times the length of a Boeing 747, and workers have popped one out of its factory mold for the first time. The blades are being built at a plant in Cherbourg, France, by LM Wind Power. In Holland, GE recently laid the foundation of an onshore prototype of the Haliade-X, which will stand 853ft (260m) tall in its full glory, with a rotor diameter sweeping 722ft (220m).

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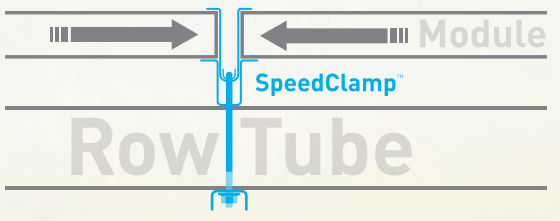

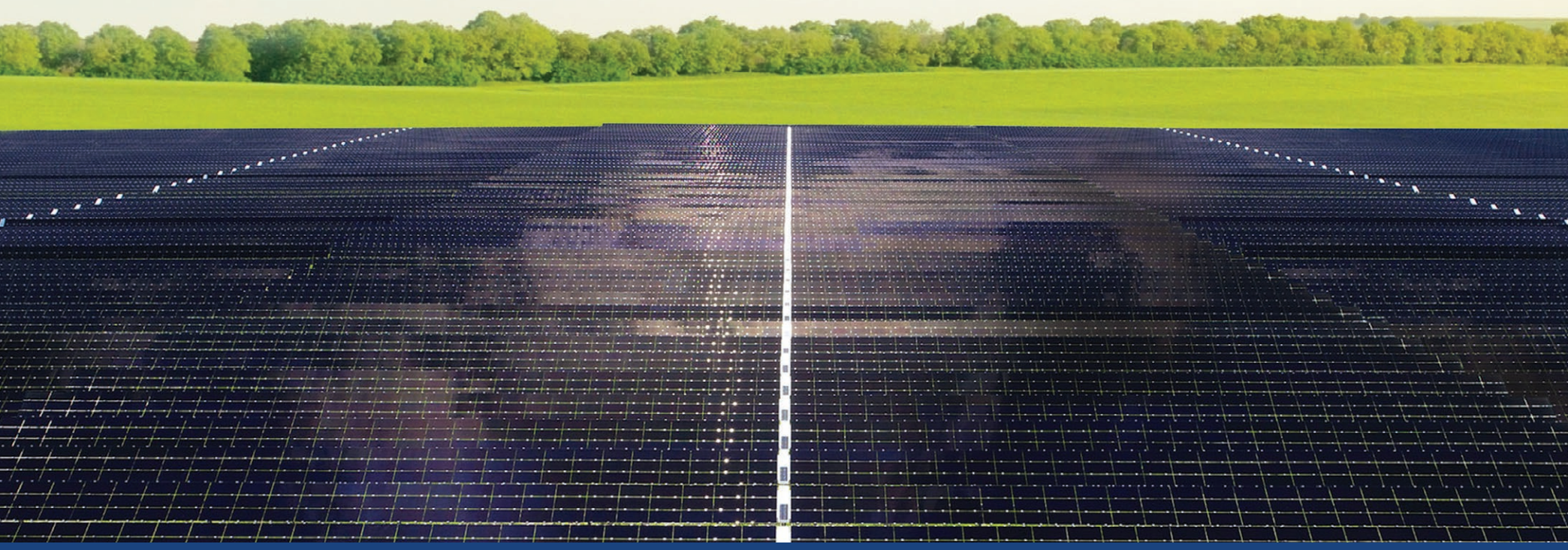

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Through the Eyes of Tomorrow's Talent

by Laura Dwyer

I'VE HAD THE PLEASURE OF WORKING with talented students from all over the country as part of the Department of Energy's (DOE) Solar Decathlon Design Challenge, and surprisingly, I think I've learned more from them than they from me.

More than 80 university teams participated in the competition to design energy efficient homes that are feasible to build, with easy to source, cost-effective materials. These students gathered from all over the world, submitting 82 designs this year, 40 of which were selected to present to jurors. The teams were judged on the robustness of their designs, the design structures, and overall affordability.

By using virtual reality to design high-performance buildings able to offset their annual energy consumption with renewable power, these students – studying architecture, construction, and engineering - showed how much they can teach a seasoned leader how to look beyond the bounds of traditional building and construction to envision a more sustainable future. Here are my four takeaways from these extraordinary students:

1. Go Deep

Whatever the project at hand, make sure you have a deep understanding of the program and its goals. The students in the competition not only had good knowledge of the design space, but also a nuanced understanding of how all the pieces came together. They could speak persuasively to their design choices, discussing, for example, which type of insulation best creates energy efficiencies.

A team from Prairie View A&M University exemplified this "go deep" approach with their modular, community-sourced design. The team avoided getting lost in design details, and kept the context in which the building would exist in mind—in this case, a low-income Houston community at-risk from both environmental and socioeconomic factors. Understanding that affordability and resilience would be key, they used offsite modularized construction to shorten cycle time, increase product efficiencies and construction quality, and lower costs. By going deep, Prairie View A&M could not only design a cool house, but an effective one that considered every conceivable community and construction challenge.

For those of us in the business, the lesson is: Whatever the project at hand, make sure you have a deep understanding of the program, its goals, and perhaps, most importantly, its challenges.

2. Prioritize Resiliency

Without question, resilience is top of mind at the Solar Decathlon Design Challenge. It has been especially interesting to see the growing emphasis on resiliency year over year as student priorities have evolved to create solutions. There should be greater adoption in mainstream construction. One team started its presentation by saying, "we all live in a hurricane-rich zone," before explaining that, as natural disasters grow in frequency and intensity, every part of the U.S. is at-risk from some form of extreme weather, be it hurricanes, tornadoes, wildfires, or flooding. Students particularly focused on this last point, recognizing that increased flooding and rising oceans necessitate raised structures. That's especially true when building in coastal communities.

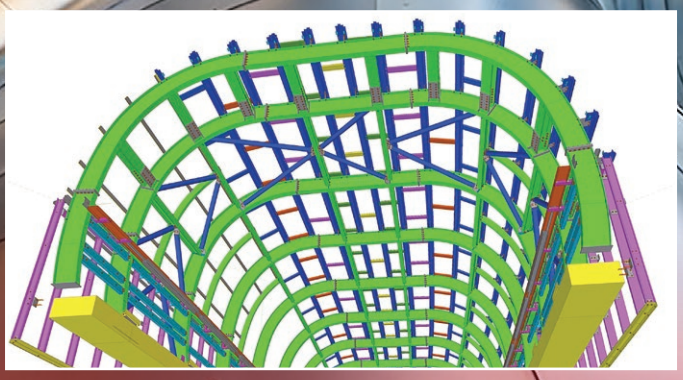
The teams considered ultra-energy efficiency, comfort, health, cost-effectiveness, and constructability, but resiliency was present throughout.

3. Go High-Tech

The construction industry faces a variety of challenges, including the need to decrease costs and carbon emissions, and a shortage of skilled labor, all of which can make the actual building of structures more difficult. The university teams accounted for these factors by using mainstream and soon-to-be mainstream technologies.

For example, to address labor constraints, many teams turned to offsite manufacturing that uses automation. With the labor market continuing to tighten, every design ultimately hinges on the skilled labor needed to complete it. During the design process, students focused on quality and repeatability as critical parts of a great design. To that end, they incorporated both 3D modeling and printing, and automation as important aspects of managing manpower and resource material concerns. Almost all the teams adopted digital software tools like Building Information Modeling (BIM) to help create complex designs.

Furthermore, every project included the most-advanced photovoltaic engineering; quite a few teams included battery storage for solar energy. Integrating photovoltaics in buildings from the beginning, rather than bolting it on at the end, evolved the level of innovation we saw in the competition's designs. The team from Virginia Tech took this integration a step further by using blockchain to manage the solar and battery system's transactions with the electric



grid. That was necessary because solar with battery storage feeds energy into the electric grid, and selling electricity is a complex process that depends on time-of-use rates and varying price structures. Blockchain managed that convoluted interchange.

The tools that students used are familiar to many industry professionals, though it's a good bet that few use them conjointly. That end-to-end design approach is something that really stuck with me.

4. Innovate Now

Because the conference stipulated that everything be either mainstream or close-to-mainstream, it was their entire approach to design that was truly innovative, independent of any exotic or emerging technologies and mediums.

What was so transformative was the way in which students used the most cutting-edge technologies in every part of their design. The long list included: raising and hardening structures to defend against extreme weather; integrating photovoltaics for sustainability; designing with offsite construction in mind for labor concerns; substituting mini-splits for centralized HVAC when advanced insulations make heating and cooling less intensive, and; using smart technology so each part of the housing construction is constantly talking to the others.

Most amazingly, every design is possible today. In fact, many will be built in the coming months.

As I left the challenge, that was my real takeaway – that we have the ability now to design energy efficient, affordable, and resilient homes. The Solar Decathlon Design Challenge students showed the value of an outside perspective, and we should all take a page from their book. I can't wait to welcome them to the workforce.

Laura Dwyer is a global innovation leader for DuPont Performance Building Solutions.

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Will China-U.S. Tensions Throw Shade on Solar?

by Nicki Zvik

On September 30th, 2018, the United States, Canadian, and Mexican governments announced that a new trade agreement, titled the "United States-Mexico-Canada Agreement" (USMCA) was passed, poised to replace the North American Free Trade Agreement (NAFTA) that had been in effect since 1994.

Originally proposed by the Reagan Administration in 1980, during Reagan's Presidential campaign, NAFTA was brought into discussion as an effort to promote fair and free trade, with the intention to benefit all countries involved. Negotiations for NAFTA began in 1986, eight years before Reagan's successor, President George H.W. Bush, officially signed off on the agreement. While there was some controversy surrounding NAFTA, the agreement had been widely praised by many world leaders. However, the current administration discovered a distinct loophole that tarnished NAFTA's original purpose; while NAFTA placed hefty tariffs on Chinese imports, it didn't take long before companies began using other countries as middlemen. This allowed U.S. companies to send manufacturing to China in order to cut costs, but - rather than import goods directly to the United States - China would import products to countries with low tariffs (like Mexico) and then import from those countries to the U.S.

The controversial USMCA is considered a direct reaction by the Trump Administration to further limit China's involvement in the United States marketplace, by closing the loophole and increasing the tariffs to undesirable rates. The agreement places heavy emphasis on many technology sectors of the market, with a clear focus on the solar industry.

The USMCA places a 30 percent tariff on all solar imports, which will eventually taper off to a steady

15 percent within the next few years. The goal of the USMCA, as noted by the Trump Administration, is to boost the American economy, leverage the American job market, and, as the president stated, "deliver for American workers like they have not had delivered to for a long time." Since the 30 percent tariffs were put into effect, the solar industry has been facing integral changes; many companies that previously found it financially advantageous to manufacture solar parts in China have had to rethink their business models, and work on bringing manufacturing to the United States.

Today, the USMCA is in full force, but the trade war shows no sign of slowing down. China recently retaliated against the agreement, announcing a plan to place tariffs on $110 billion worth of American

products, including chemical, coal, and medical equipment. The $110 billion announced by China trails the approximately $250 billion already placed on Chinese products by the United States, but those figures are expected to shift drastically as the war continues.

The Trump administration is threatening an additional $325 billion worth of Chinese products to be targeted, bringing the total to $575 billion ($25 billion more than the total worth of Chinese imports to the U.S. in 2018). Though tensions seemed to subside in December of 2018 between the United States and China, the recent actions of both countries foreshadow a long journey ahead. What does this mean for the solar industry?

Governments around the world are actively pursuing alternative forms of energy as the push to “go green” rises - the most pursued and lucrative form being solar. As a result, the solar industry is growing at exponential rates. In 2007, the solar industry was worth approximately $42 million in the United States alone, and rose to over $200 million by 2017. Given that the global solar industry is expected to generate some $422 billion by 2022, it comes as no surprise that it’s been at the forefront of trade conversations.

As it stands, many leaders in the solar industry believe that the American solar market will continue to flourish. The effects of the tariffs have fundamentally changed the solar marketplace, and the wheels of change have already been set into motion with many of the largest solar panel manufacturers leaving China and opening up shop in the States. Because the solar industry has already endured (and seemingly come to accept) such significant change, those involved in the industry - as well as consumers - can expect solar to remain unaffected by the most recent developments ... for now.

Nicki Zvik is Co-Founder at Green Solar Technologies, a nationwide renewable energy developer.

Green Solar Technologies
/// www.greensolartechnologies.com

Employees are at the Heart of the Solar Industry

by Mark Vogel

AS WITH ANY GROWING INDUSTRY IN THE CONSTRUCTION field, the solar power industry is facing a shortage of skilled labor that needs to be addressed if the industry is going to ride the wave of growth. According to the Solar Jobs Census conducted by the Solar Foundation in September and October of 2018, the solar industry predicts seven percent job growth this year, with 259,400 jobs nationwide.

Across all fields of construction, the industry is seeing a severe labor shortage during a time when it should be flourishing. According to the U.S. Department of Labor statistics, the construction field is one of the few industries with consistent growth in the number of available jobs and contracts. We must spread the word that the solar industry is promising, rewarding, and provides a great alternative to college. From a potential employer's point of view, what's the solar installer job outlook, and what can the industry do to meet the employment demand? Companies across the U.S. strive to recruit, train, and retain employees using a number of strategies. The following tips for success are a good start.

The importance of retention

First and foremost, aim to retain as many capable and skilled employees as possible by providing competitive pay and benefits coupled with a healthy and enjoyable work environment. It's easier to retain employees by making them feel valued and wanted than to find new employees who may or may not meet your human resources criteria, especially within a worker constricted market.

Make employees feel valued and wanted when rewarded for a job well done, either financially or with other means that measure the quality of workmanship, motivation, or leadership skills. A skilled solar installer can earn up to $50 per hour. Additional incentives include a full health plan and other benefits, such as a 401K retirement plan and opportunities for earning overtime pay.

Money isn't always the main motivation; according to a study published in Psychology Today, how valued employees feel in their workplace is often more important than what they earn. Many employees consider management recognition more fulfilling than financial reward.

The solar industry has a reputation for high employee turnover. If companies want their employees to stay long-term, they need to show them that there is an achievable path to more responsibility and success. Knowing that a job offers significant longevity and rewards is a key factor in attracting and retaining workers, especially younger ones. Be direct about how new employees will fit into the mold, and how their roles and responsibilities will contribute to the business. Finding new employees through word of mouth is a high compliment - happy workers are the best ambassadors for recruitment and retention.

The importance of training

Installing modern solar energy systems takes a high level of knowledge and skill. Developing these skills, along with being well versed in workplace safety, requires substantial training. A well-trained employee is a valuable employee who is motivated to do his or her best work every day they are on the job. Often, they become project supervisors and leaders, and are critical factors in improving workplace safety, productivity, and quality control. Comprehensive on-the-job training ensures that all workers - whether new or long-time employees - are fully prepared to safely and successfully handle any tasks that the job requires.

Additionally, the roofing and solar industries are constantly monitored by the federal government through the Occupational Safety and Health Administration (OSHA). OSHA inspectors should be recognized as an integral part of safety.

Looking ahead

California took a major step toward achieving its net-zero energy goal by adopting a policy last year making solar energy systems standard on virtually every new home built in the state, starting in January 2020. This will most likely result in tens of thousands of new homes being equipped with solar systems every year, which will help fuel industry growth over the next three to five years. Other energy progressive states - Arizona, Colorado, Florida, Hawaii, New Mexico, Nevada, Oregon, Texas, Utah, Virginia, and Washington – are expected to follow California's lead, especially as the cost of solar products decrease with better technology and growing demand. Thoughtful legislation to reduce greenhouse gas emissions at the local, state, and national levels is creating thousands of new solar jobs. The need for skilled and savvy employees has never been greater; as an industry, we must be fully prepared to meet the challenges. Given the current labor shortages, when it comes to recruiting, training, and retaining, companies will need strategies like these for success.

Mark Vogel is President and COO at PetersenDean Roofing & Solar-Builder Division, United States. PetersenDean is a full-service, privately-held roofing and solar company in the United States that specializes in new residential and commercial construction. The Fremont, California-based company employs 3,000 workers and operates in 11 states: Arkansas, Arizona, California, Colorado, Florida, Georgia, Hawaii, Louisiana, Nevada, Oklahoma, and Texas.

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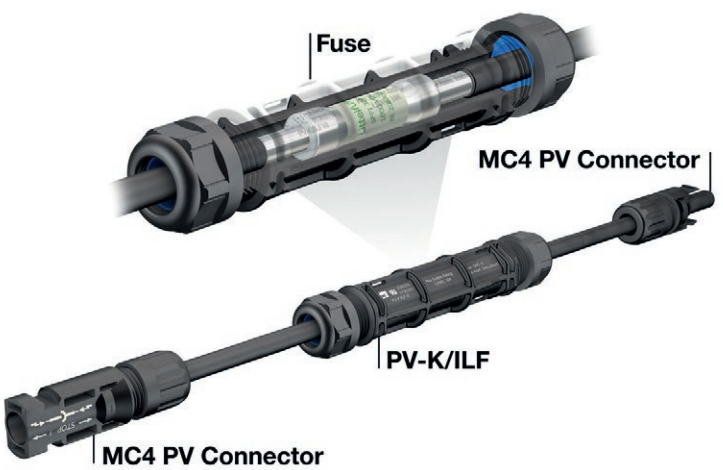

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Multi-Contact

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Keeping the Promise of Community Solar Gardens

by Shaun C. Laughlin

Community solar gardens (CSGs) offer the promise to millions—perhaps someday billions—of people to participate in what has proven to be one of the most efficient and effective ways to slow global warming.

CSGs offer all people, regardless of location, economic, or social class, the ability to be a part of a solution that will affect generations upon generations. One hundred years from now, most energy consumers will get their energy from clean and renewable sources.

According to the Solar Energy Industries Association (SEIA), community solar is where a central solar array is built by a utility, municipality, or third-party owner, on either public or private property. Residential and commercial customers then subscribe to the solar array, pledging to purchase their electricity from the array for a contract-specified period of years.

Currently, 42 states have at least one community solar project in the ground, with 1.2 gigawatts (GW) installed at the time of publication; SEIA suggests that more than 3 GW—enough to power more than half a million homes—will be on board over the next several years. The leaders in this movement are Minnesota, Colorado, New York, and Massachusetts, with states like New Jersey, Illinois, Maryland, Nevada, and California coming on strong.

But it's not just in those states—there will be an evolution of the energy infrastructure across the entire country that enables resource efficiency not even imaginable right now. Community solar projects will play an integral part, but implementing them won't necessarily be easy.

Putting a solar project together can be challenging. From the land acquisition process to the construction to the different regulations surrounding each particular level of project (federal, state and local), it's a wonder that any solar projects get done at all.

Community solar projects pose particular difficulties. Rather than dealing with one host for a project, it's now opened up to the community. Instead of dealing with one offtaker, there are anywhere from dozens to thousands of subscribers, all with different credit ratings.

CSG subscribers can range from residential, small and large commercial, and industrial, to municipal governments, school systems, and federally classified low- and medium-income facilities. Navigating the logistical and administrative infrastructure to work with all of these varying stakeholders is enough to stop most projects in their tracks. But the challenges don't end there.

CSG subscribers are often presented to developers in prescribed mixes of percentages for the makeup of the subscriber base – handling the accurate submission and management of billing credits, Solar Renewable Energy Credits (SREC) payments, and replacement of those that exit from the base for whatever reason, as well as all of the necessary contracting and legal documentation, becomes a juggling act that can easily turn into a complicated mess. For all of these reasons, CSGs are about as complicated as solar projects can get.

Due to the fact that 50-75 percent of potential solar customers can't put solar panels on their own roof or land, community solar becomes the mechanism that allows them to access the Solar Revolution. Given the influx of money into the segment, the Smart Electric Power Alliance (SEPA) predicts that community solar will make up 30 percent of all distributed-generation solar electricity by 2020, with 42 states having at least one community solar project active. Clearly, the potential for a community solar boom market is there.

For most populations around the globe, solar is easily the most accessible resource on a utility scale and distributed generation basis. There's always room for a "garden" in nearly every "community." This is the promise of CSGs, and it calls to the industry to respond with resources, action, persistence, and drive to fill the need.

As challenging as they are, community solar projects work. They provide access to solar for people who, for myriad reasons, can't afford to put solar on their own roofs. CSG democratizes solar in a way few other opportunities do, and it's the perfect solution for cities that have limited roof space but abundant land.

In other words, community solar is not a passing fad—it's the fastest-growing segment of the solar industry. As more people recognize its potential, the faster it will grow. And because it is complicated, only companies with expertise in this area will succeed in taking advantage of this rapidly growing market.

Shaun C. Laughlin is Head of U.S. Strategic Development for Standard Solar, which handles all aspects of solar power projects, from development to asset management.

Standard Solar
/// www.standardsolar.com

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Bright Spots in the Changing Rooftop Solar Industry

by Chris Fisher

In terms of adoption, rooftop solar in the U.S. still has a way to go. According to the Solar Energy Industries Association (SEIA), there are currently 1.9 million solar installations in the U.S. That's just a small fraction of U.S. housing units (135.4 million according to the most current U.S. Census estimates).

However, America has reached a turning point in its acceptance of rooftop solar as part of the future of energy generation. U.S. consumers have seen the economic and environmental benefits of rooftop solar in places like Sweden, which aims to completely eliminate fossil fuels from its energy generation by 2040; and in China, where in 2017, contributions from the country accounted for 45 percent of global renewables investment, according to the Australian-based Climate Council.

As the technology improves and becomes cheaper to produce, more U.S. homeowners are getting off the fence about solar. According to SEIA, U.S. rooftop solar installations are expected to double to approximately 4 million by 2023, with "signs of diverse and sustained growth of solar" across the country. State and local governments, home builders and roofing manufacturers are starting to notice, and have adapted their products and tactics in ways that signal a bright future for rooftop solar. Here are some of those indicators.

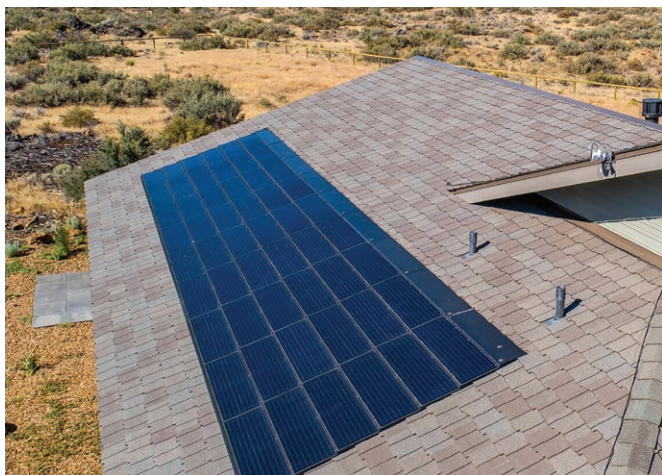
Public and Private Support

Changing attitudes toward solar have encouraged some local governments to mandate or push for rooftop solar on all new housing. Places like California, Hawaii and Colorado have been leading the way with local and state-led programs that encourage adoption and remove financial barriers to solar, but even population centers in the northeast – which receives less sun typically than the west coast – are starting to get in on the action. Solarize Philly – a recent initiative that negotiates with solar manufacturers and installers to secure lower prices for Philadelphia residents – is just one example. According to Barron's, homes with solar panels, on average, sell for 4.1 percent more than similar homes without solar panels.

Home-finding services are also doing more to help homeowners understand the value of rooftop solar. By applying a solar metric to homes in their databases, they provide the extra service of giving homeowners and potential buyers an understanding of their home's rooftop solar and energy-savings potential. Scores are based on the pitch, orientation, and size of the home's roof plane, as well as the average number of sunny days the location experiences. New lenders and loan products have also emerged to help homeowners and contractors finance a variety of home improvements, such as rooftop solar systems, energy storage, and new roofs, all under the same loan.

The Integration of Roofing and Solar

For many years, solar installers and roofing contractors have worked in different silos, but that is starting to change. As solar penetration has increased, the hardware has become less expensive and the software more simplified, allowing more roofing contractors to participate in what will likely be a significant future market. At the same time, more solar installers are adding roofing to their skillset as a way to diversify their product offering. This natural alignment has created the need for cross training and standardized methods among roofing contractors new to rooftop solar installation, and solar installers new to roofing.



Some roofing manufacturers are starting to offer education

and certification courses for solar installers, particularly on products that integrate with existing roofing products. Also, more roofing manufacturers are developing new solar products, such as solar shingles/tiles and low-profile solar systems, which integrate with existing asphalt or concrete tile roof systems to offer an aesthetically pleasing alternative to traditional rack-mounted solar systems.

Pulling together two industries that were once separate simplifies the sales process and creates opportunities for superior warranty protections, more consistent supply chains, and better pricing. As the two industries put their heads together, it also inspires product innovation. Roofing manufacturers have supply chains and distribution channels that are diverse and well-established, while solar developers are steeped in research and development to produce better and more efficient modules. In the end, consumers will likely see more innovative and affordable products that integrate the best of both industries.

Greater demand for energy efficient homes

The cost of energy has always moved in one direction (up) and the cost associated with running air conditioning, electricity, and other utilities is often the most variable aspect of a homeowner's finances. As more people become aware of their energy footprint, more new homebuyers are demanding that energy savings be factored into their purchase from the very start.

Net-zero homes – homes that generate more or as much energy as they consume – are in great demand as they combine the best of solar, insulation, geothermal heating, natural lighting and window/siding thickness to ensure that most of a home's energy comes from natural sources, with little waste. Certain niche home builders focus exclusively on net-zero home building; rooftop solar is a crucial ingredient to achieve net-zero status. This bodes well for solar installers looking to scale up their operations. Emerging companies have taken advantage of these opportunities by working directly with medium and large home builders to facilitate 'solar communities' on a large scale, installing and operating the rooftop solar systems for entire housing developments at minimal cost to the developer and the homeowner.

While the solar industry is learning and growing, the consumer demand for rooftop solar isn't going away any time soon. With manufacturers, roofers, solar installers, and home builders working together and thinking outside the box to bring solar energy to consumers, rooftop solar is on its way to becoming the norm, rather than the exception.

Chris Fisher is Manager of Solar Product Development & Marketing, CertainTeed. He is responsible for research and development, as well as marketing for CertainTeed's solar division. He joined CertainTeed in 2009 as a product development engineer and has been responsible for new product development activities leading to the commercialization of several generations of solar and solar roofing products. Prior to joining CertainTeed, Chris was the manufacturing manager and head of process optimization for a solar module manufacturer. Chris holds a Bachelor of Science degree from the School of Engineering and Applied Science at the University of Pennsylvania and an MBA from Villanova University.

CertainTeed /// www.certainteed.com

Better Financing Options Power Solar Growth

by Jim Spano

BY THE CLOSE OF 2018, THE WORLD'S INSTALLED global capacity of renewable energy had reached 480.3 GW - around one-third of the world's total installed electricity generation, according to IRENA. In the United States, the EIA reports that 2018 solar generation rose to 96 million megawatt-hours, up from 2 million megawatt-hours in 2008. Everywhere we look there is clear, positive renewable energy momentum to celebrate. The boom is breaking through beyond the industry too, with corporations and investors paying attention, and driving new opportunities.

Behind the encouraging data and headlines, we may be overlooking the role that project developers play in supporting this industry; the inefficient and costly financing options that are currently available to developers may inhibit these key players from propelling the market forward to its full potential. With changes to the solar investment tax credit (ITC) looming, there is an opportunity to address some of the long-term financing challenges that have dogged the industry for years. New debt financing vehicles, with terms that match the full operational life of solar projects, will support continued industry growth (even after-tax incentives have changed), giving developers of all sizes the opportunity to build a thriving business.

Growing interest in sustainability outside of core renewable energy industry

Sustainability is top of mind for many, even those outside of the traditional parameters of the renewable energy industry. Corporations and investors are seeking opportunities to integrate sustainable practices into their own business operations. You've likely heard the terms corporate social responsibility (CSR) and environmental, social governance (ESG) thrown around – the former is a set of parameters a company puts in place in order to ensure certain actions and decisions have a positive impact on the environment, consumers, employees and wider communities. Environmental, social governance (ESG) performance indicators ensure investments have a measurable sustainable or ethical impact, such as reducing carbon outputs. Both CSR and ESG prioritize the long-term impact of business decisions and practices under these umbrellas, and are becoming more common.

Even with the increased interest in responsible business decisions and investing, a recent study indicates that only half of U.S. investors feel they have the necessary information to make socially responsible investment decisions. This is where solar investment becomes particularly compelling. Since the carbon reduction and emissions offsets of solar installations are measurable and significant, solar investments present a quantifiable ESG investment opportunity.

Solar financing today

All of this positive momentum has translated into a borrower's market for solar developers, but most of the loans available today have shorter terms that are not aligned with the operational life of projects. According to Wood Mackenzie Power and Renewables' U.S. Solar Project Finance and M&A Landscape, mini-perm debt structures are currently the most common financing vehicle. The number of total lenders and new market entrants is rising, which is increasing competition. This has generally outweighed the negative effects of the ITC step down (a bit more on that later).

With mini-perm debt structures, the lender offers repayment terms of 4-7 years, after which the project sponsor must refinance. This structure is akin to financing your mortgage with a car loan, and results in negative project cash flows from day one. The result is a paradigm in which developers must flip their projects to investors in order to have working capital to develop their next project. In effect, this means that project developers are only as successful as their last project. New models of long-term financing - like the solar mortgage REIT - can help break this cycle, aligning debt repayment terms to the operational life of the project, and ensuring positive cash flow from commercial operation.

This is not a niche problem. 90 percent of solar projects in the U.S. are financed; we cannot overlook the impact that financing has on the success of projects and continued market growth. If we can align financing terms with the operational life of solar projects, smaller developers will be able to grow their businesses more sustainably, with the option to either sell projects to aggregators, or hold the cash flow of their most lucrative projects on their own balance sheets. It is a fundamental shift in how we think about the business of project development.

What is a solar mortgage REIT, and how will it help?

Real estate investment trusts (REITs) are widely deployed and proven in the real estate industry. With similar attributes for the solar market, solar mortgage REITs can lower the cost of capital for projects, increase the net operating income of an asset, and ensure positive cash flows over the lifetime of the PPA. Solar mortgage REITs offer fixed-rate and long-term mortgage loans to solar developers for new installations, or long-term refinancing for existing projects. Ultimately, solar mortgage REITs can provide developers with the option to maintain ownership of a project.

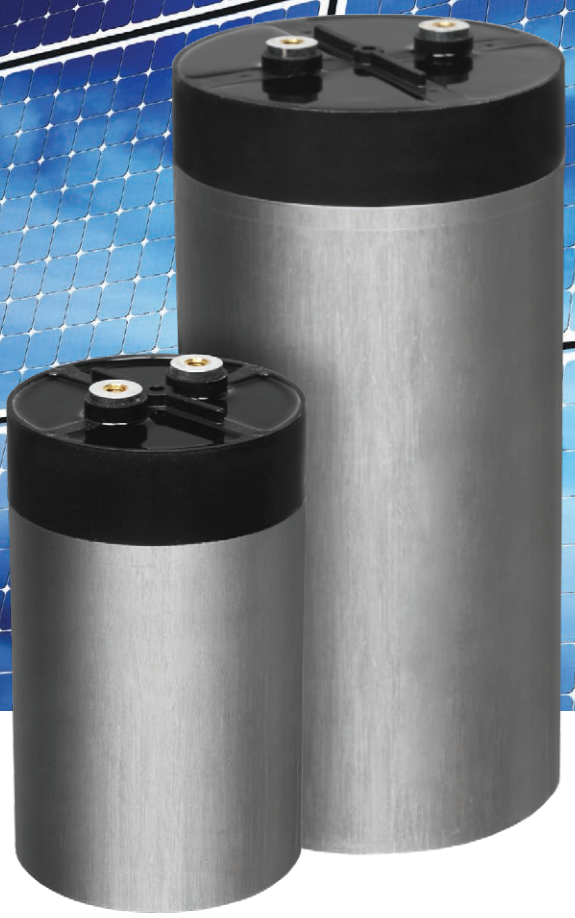
On paper, it may be true that the ITC step down hasn't negatively impacted installed capacity growth, but the changes that come with shifting tax structures are important to recognize. One silver lining to the step down is that expensive tax equity will become a smaller piece of the project finance puzzle, making more room for more cost effective, long-term debt to fill the gap. Again, this ultimately enables developers to maintain ownership of more of their assets.

Project developers are the cornerstone of a successful solar industry, bridging the gap between technology and deployment. But even with the market success of solar as a reliable investment, developers continue to be hindered by suboptimal financing solutions. As we enter the ITC sunset, bringing proven investment vehicles for long-term financing will help to ensure solar's growth is sustainable for many years to come.

Jim Spano is the Co-Founder and Head of Originations at RadiantREIT, and Managing Partner of Spano Partners Holdings, LLC.

RadiantREIT /// radiantreit.com

Type 947D
High Density, DC Link Capacitors



DC link power film capacitors

Next generation inverter designs for renewable energy demand reliable DC link capacitors with higher capacitance values, voltage, and current ratings. Available in new case sizes and ratings, Cornell Dubilier's Type 947D power film capacitors offer the highest bulk energy storage, ripple filtering and life expectancy for wind and solar power inverter designs, as well as electric vehicle applications. Select from hundreds of standard catalog listings, or connect with CDE engineers to develop special designs to your requirements.

For technical information, visit cde.com/solutions/inverters

TYPE 947D POWER FILM CAPACITORS

85, 90, 100 & 116 mm CASE SIZES

CAPACITANCE VALUES TO 3600 µF

APPLIED VOLTAGE TO 1500 Vdc

RIPPLE CURRENT RATINGS >100 A_{rms}

CDE ENERGIZING IDEAS

CORNELL DUBILIER

Analytics mobile application for wind and solar plants

QOS Energy's Quantum Nano mobile application includes a set of comprehensive analytics brought to users' fingertips. In a few swipes, renewable asset owners can get an overview of the performance of their portfolio, including plant functioning status and performance levels. They can also benchmark the performance of their plants against their initial business plan without the need to access the complete Qantum platform.

QOS Energy /// www.qosenergy.com

Complete range of switcher ICs with integrated 900V MOSFETs

Power Integrations' suite of offline switcher ICs incorporating 900V primary MOSFETs include ICs for high-efficiency isolated flyback power supplies and for simple non-isolated buck converters. The new products include 900V versions of the LinkSwitch-TN2 ICs for simple, non-isolated buck converters plus three new members of the flagship InnoSwitch3-EP IC family, which enable high-efficiency isolated flybacks up to 35W. All members of the 900V product families feature internal control engines optimized for high efficiency across load, enabling designs to easily meet energy-related products (ErP) limits, and a variety of line and load protection mechanisms to further enhance system robustness and reliability. The 900V LinkSwitch-TN2 ICs deliver low component count switcher solutions for buck converters. Devices feature selectable current limit and fully integrated auto-restart for short-circuit and open-loop protection. The use of frequency jittering greatly reduces EMI, and devices meet high-voltage creepage and clearance requirements between DRAIN and all other pins both on the PCB and at the package. The 900V InnoSwitch3-EP flyback switcher ICs provide lossless line OVP sensing, which automatically interrupts switching when line voltages exceed a selected threshold, preventing damage to the power supply during severe line overvoltage situations. Devices achieve efficiencies of up to 90% across line and load conditions, reducing power supply losses and resulting in compact power supplies up to 35W without heatsinks. The 900V InnoSwitch3-EP ICs employ Power Integrations' isolated digital communications technology, FluxLink, plus synchronous rectification (SR), QR switching and a precise secondary-side feedback sensing and control circuit. This results in efficient, accurate, reliable power supply circuits without the need for unreliable optocouplers.

Power Integrations, Inc.
/// www.power.com

New roof hook saves material and installation time

The new and improved generation of roof hooks for the Eco and Rapid 2+ series generates significant savings in installation time and costs. The roof hooks are welded in one piece and come in 6mm or 8mm bar thickness. They are made of the high-strength steel grade S700MC in accordance with EN 10149-2: 2013-12 and have already been granted European Technical Approval (ETA). Their strength meets the requirements for mechanical strength, stability, structural integrity, and durability stipulated in EU Regulation 305/2011. PV systems on tiled roofs with wooden substructures can be installed with fewer fixing points per kilowatt of output. This not only saves material costs but also installation time. A new zinc flake coating makes the roof hook particularly corrosion-resistant.

The Schletter Group
/// www.schletter-group.com

Universal datalogger

Only one Tigo Cloud Connect Advanced (CCA) is needed as the general purpose data logger for all components in an entire PV system. All PV modules, inverters, or other 3rd party devices are monitored at the highest sampling rate. The data is uploaded to Tigo's cloud for free and is available via Tigo's SMART Website and SMART App. Tigo's CCA interfaces with inverters, modules, AC meters, weather stations, and more so that a user can have AC production and all other relevant information on their system shown on their Tigo SMART Summary Page. The CCA also allows module-level DC production from the Tigo PV system to be displayed. With advanced charts, graphs, and a sophisticated alerts system, a fleet can be managed from a single platform, from total AC power all the way down to module-level. Tigo's CCA is also an approved reporting device for many rebate programs. By connecting to a revenue-grade AC meter, users can obtain production data that can be saved for these rebate programs like performance-based incentives.

Tigo Energy /// www.tigoenergy.com

Power supply with UPS and PoE

The rack-mountable EdgePower 24V features 24Vdc and 2 RJ45 PoE ports. Users can receive alerts in the event of a power outage, and the EdgePower 24V offers a 12V lead acid battery input for redundancy if the AC input fails over (battery not included). Designed for convenient management, the EdgePower allows users to configure and monitor PSU features in a graphical user interface. They can also use UNMS (Ubiquiti Network Management System) for remote management, and SNMP is available to monitor the EdgePower for issues that warrant attention.

Ubiquiti Networks /// www.ui.com

Six bus bar solar PV cells

RenewSys has launched the production of six Bus Bar (6BB) Solar Photovoltaic (PV) Cells and modules. The 6BB cells, part of RenewSys' RESERV range of solar PV cells, will be manufactured using European PV cell equipment, in a clean room facility. Increasing the number of Bus Bars (BBs) in a photovoltaic cell, along with improved gridline design improves the cell efficiency by lowering the series resistance and thus reducing the resistive loss. The refined design of RenewSys RESERV 6BB cells optimizes the collection of current, reducing losses due to cell shadowing. Lower power degradation due to reduction in the distance travelled by charge carriers under thermal cycling, improvement in reliability, long term stability, and lower susceptibility to power degradation due to micro-cracks are additional benefits of 6BB cells and modules.

RenewSys India Pvt. Ltd. /// www.renewsysworld.com

Tracking system for bifacial modules

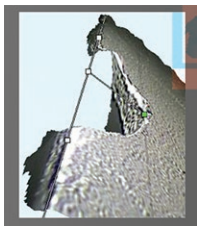
The Schletter Group presents its 2018 tracking system in a new version that is optimized for bifacial modules. For this purpose, the reverse side of the module tables was adjusted so that the modules can be installed without shading. The Schletter Tracker does not require a central torque tube at the pivot point of the table. This allows for greater flexibility when it comes to module arrangement and the use of bifacial modules in particular. The system works with a patented mechanical self-locking system; a mechanical locking element on each post, which locks automatically if the row is not moved. This eliminates all wind-induced vibrations for the entire row. When in the resting position, the system has the characteristics and resilience of a fixed installation, suitable for wind speeds of up to 162 miles per hour (260km/h). The upper assembly group with the drive unit is delivered pre-assembled so the system can be installed almost as quickly as a fixed installation.

The Schletter Group
/// www.schletter-group.com

Rugged UL 810-approved AC filter capacitors

TDK Corporation announced a new series of AC filter capacitors that are UL 810 approved at the component level and carry the CE mark. The capacitors of the B32354S3* series are designed for a rated voltage of 350Vac and are available with capacitance values of 10µF to 40µF. The lead spacing is 52.5mm. Because of the segmented film structure, the new capacitors conform to the safety class of UL 810 at Component Level. Due to their improved protection against moisture, they pass a temperature, humidity, bias (THB) test at 185°F (85°C), 85% relative humidity, and applied rated voltage for 1000 hours. The life expectancy of the new series according to IEC 61071 is 100,000 hours. In addition to AC applications, the rugged capacitors are suitable for output filtering of power supplies and inverters.

TDK Corporation
/// www.tdk.com



Expanding the measuring power of videoscopes

The IPLEX NX industrial videoscope's HD RVI imaging is now supported by an advanced software capability, 3-dimensional modeling. The new 3D modeling feature enhances users' ability to make confident measurements. It enables them to examine the details of the inspection target from multiple angles, making it easier to specify the exact location of the measurement points. More precise placement of these points helps increase the reliability of the measurement results. The IPLEX NX videoscope is the first in the series to offer high-definition imaging (HD RVI), and other notable features include: 4x wider measurement area, powerful laser diode light source providing even brightness and high visibility, 8.4" clear and readable touch screen. With the addition of 3D modeling, the IPLEX NX videoscope provides users the ability to rapidly confirm measurement objects, set reference lines more precisely, and make confident depth measurements. The 3D modeling feature is available as a software upgrade for IPLEX NX videoscopes.

Olympus Scientific Solutions
/// www.olympus-ims.com

Powerful PoE injector

Antaira Technologies' INJ-0200G-60-24-T is an industrial high-power IEEE 802.3bt Type 3 Power over Ethernet (PoE) injector backwards compatible with previous IEEE 802.3af/at standards. By utilizing multiple pairs of pins on the RJ45 cable, this industrial grade PoE injector is capable of providing up to 60W of power to end devices. Each port supports 10/100/1000Tx for both power in and data out. The INJ-0200G-60-24-T is IP30 rated, DIN-rail mountable, and supports an extended temperature of -40°F to 167°F (-40°C to 75°C), making it suitable for outdoor or harsh industrial applications.

Antaira Technologies
/// www.antaira.com

Aesthetic solar street lighting

Vertical solar cylinder street lighting offers cylindrical solar panels which can be mounted to any shape of poles with a diameter up to 6.1" (155mm). LED power can be between 20W to 100W. Couples of cylinders can be connected in series to get higher power up to 200W, 300W, 420W, etc. With a detachable design, the modules are quickly and easily mounted on any suitable pole. 6 slim solar panels are tightly adhered to an aluminum, hexagonal frame, ensuring half of the solar panels will be direct4ed towards the sun at any time of the day for charging. The cylindrical design reduces wind resistance and each model is attached to the pole with 12 screws. The vertical mounting reduces the risk of snow cover and allows the panels to be easily cleaned with long brushes from the ground.

Auroras Lighting /// www.auroraslighting.com

Low priced bifacial tracker

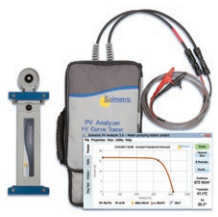
GameChange Solar announced the introduction of the 2-portrait configuration Genius Tracker. The 2P system is designed specifically as a cost-effective solution for bifacial modules which may require long side module mounting and do not allow 1-portrait module configuration in which the module spans across the torque tube. With a comparable install speed to the 1-portrait standard Genius Tracker, the 2P configuration tracker has a lower post count than 1-portrait or 2-landscape.

GameChange Solar /// www.gamechangesolar.com

Rapid shutdown fire safety and optimization

Tigo announced its new TS4-A, the advanced retrofit/add-on solution that brings smart PV module technology to standard modules for advanced functionality. This is a new generation of flexible module-level power electronics in the TS4 Platform with improved lightweight hardware for high wattage and low installation costs. The TS4-A is available with multiple functionalities to address a unique range of features and budgets, now including the TS4-A-F (Fire Safety) and TS4-A-O (Optimization). The highlights of the new TS4-A (Advanced Retrofit/Add-on) include: increased wattage compatible with all modules up to 500W, improved heat dissipation, smaller unit dimensions, reduced weight per unit by 25%, reduced shipping costs with 33% more units per pallet, only one side needs to be mounted to panel frame, mounting possibilities fit more racking systems, recessed mounting allows shipments of pre-assembled PV modules, and improved sealing for toughest outdoor conditions.

Tigo Energy
/// www.tigoenergy.com



High throughput I-V curve commissioning

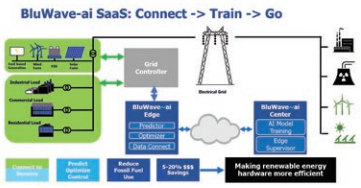
This next gen model ("V2") of the PVA-1500 line of I-V curve tracers for commissioning, auditing, and troubleshooting PV systems adds charging/charged LED indicators, in-the-field firmware upgrade capability so that future firmware features and patches won't require a return to factory, and more. The PVA-1500 V2 also includes all the features of its predecessor, including the ability to measure 1500V at 30A, high accuracy, high measurement throughput, wireless irradiance, and temperature sensor with 300ft range, and easy-to-use interface via WiFi to a tablet or laptop.

Solmetric Corporation
/// www.solmetric.com

Dual radio wireless unit with router capabilities

Antaira Technologies' ARS-7231-AC series is an industrial dual radio wireless with router capabilities which is designed for industrial and enterprise wireless access applications. Embedded with the Qualcomm Atheros QCA9892 chipset, it boasts network robustness, stability, and a wide network coverage with a very low voltage input of 9V. Based on IEEE 802.11 a/b/g/n/ac, the access point supports high-speed data transmission of up to 867Mbps. The ARS-7231-AC series can be used as an access point, WDS Station, transparent bridge, or repeater which makes it suitable for a wide variety of wireless applications. These units also allow the user to position the wireless antennas in a better signal-broadcasting location for improved wireless coverage and signal strength or add external antennas located in an optimized location.

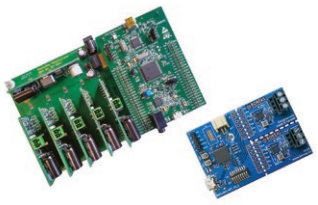
Antaira Technologies /// www.antaira.com



Grid energy optimization platform

BluWave-ai's machine learning platform, release 2.4, builds on the company's grid energy optimization model to simultaneously maximize the use of renewables hardware and power purchase agreements (PPA's), while minimizing energy costs and greenhouse gas (GHG) emissions. Some of the features in this release include enhanced wind and solar prediction models; city, substation, and industrial/enterprise scale load prediction; and an historical and real-time data pipeline for utility and IoT sensors. BluWave-ai's substation and transformer level distributed AI platform supports a smooth migration towards EV-supported utility infrastructure with higher capacity charging and discharging per transformer using distributed intelligence. Furthermore, the distributed AI allows utility customers to leverage EV's as dynamic storage to address fluctuating load periods. BluWave-ai's SaaS-based platform, consisting of BluWave-ai Edge and BluWave-ai Center, resolves the intermittency problem with renewable sources like wind and solar through reliable energy prediction, optimization, and control at both microgrid and utility scale. The company has four provisional US patents, which currently represents 5% of the global 2018 artificial intelligence (AI) patents of Canadian origin.

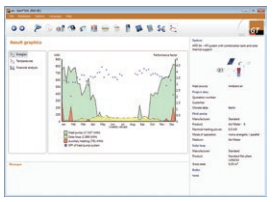
BluWave-ai
/// www.bluwave-ai.com



Haptic feedback evaluation kits

TDK Corporation announced two new evaluation kits that provide an initial impression of the varied possibilities of haptic feedback that can be realized with PowerHap piezo actuators. The BOS1901-Kit development kit is designed for and includes three 60V actuators. The board is based on the CapDrive driver architecture from Boréas Technologies, a developer of ultra-low-power haptic technologies with which TDK Electronics has signed a cooperative agreement. The main features of the BOS1901 piezoelectric driver are its small dimensions, low current consumption and fast response times. The second evaluation kit is suitable for both the 60V PowerHap types, and also the 120V types. It is available in two versions: A driver for one actuator, and driver for up to five actuators. These kits likewise contain three types of PowerHap actuators. Both kits feature a USB interface and offer extensive setting options with regard to voltage amplitude, frequency, pulse repetition rate, signal shape, and sensor functionality.

TDK Corporation /// www.tdk.com



Modern design and simulation software

Valentin Software's new version of the design software PV*SOL premium 2019 makes the design of photovoltaic systems easy and efficient. The inclusion of complex parameters for detailed technical replication of the entire PV system and consumers now includes the detailed input of electric vehicles that can be divided into several groups. For each group, the user can determine the vehicle type, number, and expected kilometers. The timings at the charging station can be set individually for each group, 7 days a week. When inputting the installation of the module array, 3D models can be imported via an interface. Another addition is the calculation of bifacial modules. After the automatic transfer of necessary data from the 3D visualization, the irradiation is calculated for the backs of the mounted modules. The additional yield is shown separately in the energy balance. Other helpful additions for optimizing a system are the output of the U-V characteristics for each time step of the simulation, as well as an energy flow diagram representing the overall system including the battery system and consumers. PV*SOL is a valuable tool for both the right sizing and the determination of profitability. A dimensioning aid for the size of the battery storage performs the calculation of the battery for the user, thus facilitating the design. PV*SOL is available in English, French, German, Italian, Polish, Portuguese and Spanish. The project reports can also be produced in many other languages.

Valentin Software GmbH
/// www.valentin-software.com

Solar power LED light plant and 1.5W generator

Larson Electronics' solar-powered LED light plant generator features automated actuators for raising and lowering the solar panels and provides continuous operation for up to 36.5 hours. Panel assemblies can be positioned towards the sun but do not follow the sun automatically. The SPLT-1.5K-1000A-30-4X16K-LED solar-powered LED light plant and generator features six 265W solar panels, a solar charging system, battery bank, LED light array, dust to dawn sensor, timers, battery charging system, and a pneumatic mast mounted on a trailer. The 1.5W solar generator replenishes up to 363Ah of usable battery capacity per day (assuming 5.5 hours of peak charging sunlight). This unit delivers 24V for lighting, camera use, sensors, and other electronic equipment. Larson Electronics' solar power LED light plant and generator features polycrystalline solar panels that generate a total output of 1590W and are mounted to a rotating axis assembly. Four 2,000lb hand-crank leveling jacks are used for leveling the panels after deployment. This 24Vdc system has panels terminated with a fused combiner box with a single-lever action cut-off switch. The charged controller on this unit is shaded and offers added air flow from the exhaust of a 1400CFM component cooling system. The charge controller charges a 1000A capacity battery bank comprised of eight 12V 250aH 8D deep cycle acid glass mat batteries tied together with panels producing about 11A per hour. All electrical components are enclosed in a NEMA 3R job box bolted to the trailer. The aluminum pneumatic light mast reaches 30ft in height via a low-voltage air compressor. The mast can be rotated 360° and features high-output LED flood lights that produce a total of 64,000 lumens of light covering three acres. The Cree XPH LEDs are paired with high purity optics and are IP67 rated, waterproof, vapor proof and designed for use in harsh environments.

Larson Electronics LLC
/// www.larsonelectronics.com

Solar fuse holder

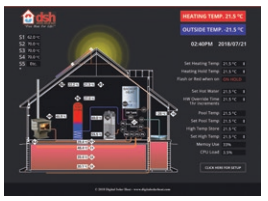
Phoenix Contact's fuse terminal block family now includes a fuse holder designed specifically for solar applications. The UK 10,3-HESI 1500V features a top-loading design for easy access to fuses for testing and replacement. The fuse holder's 50 kA interrupt ensures a long service life. It is rated for 1500V and 32A by UL/CSA and IEC, so it can be used in multiple markets, increasing array design flexibility.

Phoenix Contact /// www.phoenixcontact.com

Smart transducer for pyranometers

For years EKO has been manufacturing and providing pyranometers with built-in transducers, taking the signal from DC voltage to Modbus 485 RTU or DC voltage to 4-20mA current. Recently, EKO developed a new all-in-one sensor Smart signal transducer which allows selecting from 4 types of output in one unit. This new Smart transducer also has additional features such as internal temperature and humidity sensors and a tilt sensor. These additional internal sensors will help the user to monitor the stability of the irradiance sensors as well as to ensure its proper installation and maintenance practices. Pyranometers can be ordered with the basic analog output signal or with this new all-in-one Smart transducer. Following the introduction with pyranometers, EKO will expand the use of this transducer to other sensors and systems as well.

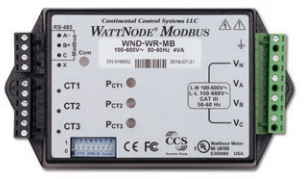
EKO Instruments /// www.eko-usa.com



Free heat for life

Digital Solar Corp., released its sustainable, patented, Digital Solar hydronic Heating (DSH) system for homes, buildings, and process heat. The system is designed to offset 50% to 100% of heating requirements/year, and is now optimized for use in Canada. A low cost heat core storage system, located within the foundation of buildings, is large enough to store summer/excess heat for use later. The system is best suited for new homes and buildings with slab floors, or retrofitted into existing radiant heating. Each heating system is custom engineered for that location and heating demand. DSH, with dozens of systems overseas, recently redesigned it to function in the cold environments of Canada. This includes solar thermal panels that work well down past -22°F (-30°C), and options such as snow melt, a back-boiler fireplace, spa/pool, and high temp heat. The new system is WiFi compatible and 100% on- or off-grid capable.

Digital Solar Heat (DSH)
/// www.digitalsolarheat.com



New SunSpec certification

Continental Control Systems is pleased to announce the recent issue of the SunSpec certified product award for successful testing and certification of the SunSpec Information Models 1, 203 and 213. The SunSpec Alliance has certified the CCS WattNode Modbus Energy Meter, model WND-WR, the newly released Wide Range Modbus Meter, and the WND-M1, the Modbus Meter Module. The new WND-WR-MB provides over fifty electrical measurements over a Modbus RS-485 RTU network. Designed as a universal line-powered meter, it works with any utility service from 100 to 600Vac, single or three-phase, wye or delta. Modular and economical, the WND-M1-MB is also a bidirectional networked energy meter offering energy measurement parameters such as energy (kW) power (kWh), voltage, current, demand, kVAR, kVARh, power factor, frequency etc. The meter module is available as single and three-phase modules and is externally (instrument) powered from 12 to 24Vac or 6 to 24Vdc.

Continental Control Systems
/// www.ctlsys.com

Streamlined, efficient rail-less racking for metal roofs

MetalX Rail-Less Racking reduces attachments, shortens install time, and cuts cost for corrugated, standing seam or R-panel metal roofs. Based on EcoX technology with more than 500MW installed, MetalX has 73% less aluminum to haul and install, no long rails, and speeds installation with fewer attachments and installation steps. Small, simple components streamline shipping and fit 30-50mm modules. Ecolibrium Solar's dedicated support eliminates typical challenges of metal roofs: experienced project managers select the correct roof mount, do project-specific calculations, layout, and bill of materials, and provide needed details for permitting and inspection. Full solution and optional electrical accessories.

Ecolibrium Solar
/// www.ecolibriumsolar.com

Operator interface device

WAGO's new line of Operator Interface devices, the Touch Panel 600 line, brings high-tech screens and high quality visualizations to allow users to accompany their machines with advanced features. The engine has a Cortex A9 multicore processor providing fast operating speeds. On board security include a built in firewall and VPN to help users address cyber attaches. All panels are equipped with the future-ready Linux operating system and support HTML5 technology. The Touch Panel 600 line includes three versions to give users flexibility to use the right technology that fits their application and budget. All of the Touch Panel 600s offer practical features such as an energy-saving standby function, integrated sensors for automatic brightness adjustment, and an easy-to-mount design to make installation and operation simple.

WAGO /// www.wago.us

Innovative thermal management solution

Toshiba Mitsubishi-Electric Industrial Systems Corporation (TMEIC) announces the TMdrive-Guardian, an outdoor enclosure for its TMdrive-MVe2 medium voltage (MV) variable frequency drive (VFD). The self-sufficient enclosure eliminates the need to house the drive in a temperature-controlled industrial control building or E-house, and has the potential to save companies thousands of dollars, while making engineering, procurement, construction, and maintenance simple. TMEIC's outdoor enclosure solves the thermal management challenge. Now, with the custom outdoor enclosure, the drive can be applied outdoors with short lead times and budget friendliness.

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

Measure solar energy wavelength-by-wavelenth

Building on years of successful hardware development, EKO proudly introduces the new Nami software. Nami will provide users with a software platform designed around optimizing the user experience. The new user interface's design focuses on optimizing usability and interactions, resulting in a clean, simplified dashboard that enhances the user experience of the sensors. Nami combines two pieces of software; WSDaq for control and data acquisition and WSDisp for data visualization, while adding functionality. These functionality improvements coincide with the recently introduced EKO RSB-01S rotating shadow band spectroradiometer system(s). Users will be able to measure and visualize all three components of spectral irradiance easily and simultaneously with Nami. Additional visualization capabilities include the ability to toggle between current or historical spectra quickly. While viewing the data, users can create scientific presentation quality images without moving their data to another piece of software. Reference spectra such as ASTM G173 have been loaded into the software for additional comparative tools. EKO is committed to providing a dynamic software platform that keeps pace with a variety of user communities. New features will be incorporated into future releases of Nami intended for a variety of field applications.

EKO Instruments
/// www.eko-usa.com

Meeting rapid shutdown requirements of NEC 690.12 2017

Tigo announced the new Underwriter Laboratories (UL) certification of its Photovoltaic Rapid Shutdown Systems (PVRSS) based on the company's TS4 Platform and PV inverters from Yaskawa Solectria Solar and Huawei. This UL certification is part of Tigo's multivendor initiative providing customers with the advantages of reliable, safe, and cost-effective solutions. The use of Tigo smart modules and high efficiency inverters allows design flexibility for installers to comply with National Electric Code (NEC) 2017 690.12 RSS regulations. Tigo has also been internationally recognized as the only module-level power electronic vendor with UL-certified RSS with multiple PV module manufacturers. The following Yaskawa Solectria Solar inverters are UL listed as PV Rapid Shutdown Systems with Tigo's TS4 units: PVI 23TL, PVI 36TL, PVI 50TL, PVI 60TL with firmware 9.0 or later, and XGI 1000 - 60/60. The following Huawei inverters are UL-listed as a Rapid Shutdown System with Tigo's TS4 units: SUN2000-33KTL-US, SUN2000-36KTL-US, SUN2000-40KTL-US, with SUN2000V200R002C20SPC105 firmware or later, SUN2000-25KTL-US, and SUN2000-30KTL-US.

Tigo Energy /// www.tigoenergy.com

PV plant modelling software handles complex terrain

DNV GL's SolarFarmer software for modelling, design, and analysis of solar photovoltaic (PV) plants can accurately and efficiently handle the demands of layouts in increasingly complex terrain. DNV GL's new SolarFarmer software can be used for conceptual and detailed design and analysis for solar PV plants. It combines thoroughly validated PV simulation algorithms with a user-friendly, modern user interface allowing quick configuration of PV plant designs and simulation of PV layouts. SolarFarmer offers design and analysis of development of solar PV plants, from conceptual model to detailed solar plant design, an efficient and traceable method for modelling in complex terrain including a model for submodule electrical mismatch, an automated layout for fixed tilt and trackers, and thoroughly-validated models for accurate energy production calculations. SolarFarmer engineers are working directly with DNV GL experts to improve modelling of components during the design phase, such as modelling for thin-film modules. SolarFarmer also provides sub-hourly energy assessment calculations.

DNV GL /// www.dnvgl.com

Safety interlock switch

IDEC Corporation's new HS1T interlock switch with solenoid delivers 5,000N of locking force, with many features included to maximize protection in machine and equipment guarding applications. IDEC's HS1T improves performance in a compact size due to a metal head integrating the locking and mounting functions. Also, to maximize installation options, the remaining actuator portion can be independently rotated from the high-strength head using only one screw. With a slim form factor and various mounting options, the HS1T can be installed virtually anywhere, providing flexibility for designers. IDEC has included three independent rotary cams. Two cams control the locking mechanism and one drives the door monitor contact. This provides redundancy, additional strength, and ensures the monitoring function continues to work even if a locking cam is damaged. The HS1T meets the requirements of ISO 14119:203 for Lock Monitoring. For additional integrity, the lock monitoring contact can never indicate closed if the door is not positively closed, thereby preventing the associated machine from being turned on with risks exposed. The HS1T provides multiple available cable entry ports, with fast and reliable wiring connections made possible by spring clamp terminals. These connections offer vibration resistance, prevent wires from loosening, and never need tightening. Spring lock or solenoid lock styles are available, with several options for contact configurations. These flexible installation options are complemented by an IP67 and Type 4X indoor use only rating. An energy-efficient solenoid consumes 200mA while actuated, reducing electricity costs and allowing controls to activate the device directly without a relay.

IDEC Corporation
/// www.us.idec.com/HS1T

SunSpec rapid shutdown certification

Fronius USA and SunSpec Alliance announced the SunSpec Certified Rapid Shutdown certification designation. The Fronius Symo Advanced three-phase inverter comes with an integrated Power Line Communication (PLC) transmitter based on the SunSpec Rapid Shutdown communication standard. In conjunction with SunSpec based components such as the Tigo TS4-F module-level electronics, solar installers get a simple and cost-effective solution for Module Level Shutdown. Featuring ten models ranging from 10kW to 24kW, the Fronius Symo Advanced is a compact three-phase inverter for commercial applications. The lightweight design, the SnapINverter mounting system, and true field-serviceability allow for easy installation and high reliability over the lifetime of a system.

SunSpec Alliance /// www.sunspec.org

Unmanaged ethernet switch

Antaira Technologies' LNP-0800-60-24 series is an industrial 4PPoE unmanaged Ethernet switch featuring 4*10/100Tx 4PPoE Type 3 ports and 4*10/100Tx PoE+. Ports 1-4 support an IEEE 802.3bt Type 3 high power 4PPoE output up to 60W per port, ports 5-8 support an IEEE 802.3at PoE+ output up to 30W per port. The LNP-0800-60-24 series' unmanaged switches are suitable for expanding the network on the outer edge. Four ports of IEEE 802.3bt 60W 4PPoE power provides the flexibility to add intelligent devices the network, while still maintaining 4 ports of IEEE 802.3at PoE+ 30W power needed for traditional PoE edge devices. The series' non-management features allow for quick deployment almost anywhere on the network. Technicians, integrators, and non-administrative personal can install the LNP-0800-60-24 series' switches without provisioning or programming the switches, thus avoiding communication errors related to networking issues. The LNP-0800-60-24 series is IP30 rated and DIN-rail mountable. The series supports the operating temperatures of a standard operating temperature of 14°F to 158°F (-10°C to 70°C) or an extended operating temperature of -40°F to 167°F (-40°C to 75°C) depending on the model, making it suitable for outdoor or harsh industrial applications.

Antaira Technologies
/// www.antaira.com

Rapidly disconnect PV strings

Alencon's Ground Arc and Rapid Disconnect unit, the GARD, is a solution for detecting harmful arc and ground faults in a PV array at the string level. The GARD also offers the ability to rapidly and safely disconnect PV strings with either a mechanical switch or remote command. The GARD can be deployed as a standalone device or in conjunction with Alencon's String Power Optimizer and Transmitter – the SPOT. Additionally, the GARD can be used with or without remote communications. The GARD can be installed in new PV systems or as a retrofit to existing solar plants.

Alencon Systems, LLC /// www.alenconsystems.com

Flexible, lightweight, and powerful solar module

MiaSolé Hi-Tech Corp's FLEX-03W solar module, is now even more powerful, delivering up to 540W in 5.6kg, an improvement of nearly 10%. The flexible solar module can be installed in any location, anywhere the sun shines, on and off the grid, even in places where it previously was not possible to install solar. MiaSolé's FLEX-03W solar modules have production efficiency of up to 17.8% and can be configured in various sizes and modified to fit any application without penetration through exteriors by adhering directly to surfaces with peel-and-stick adhesive. Because they are flexible and only 1.5mm thick, the modules are highly shatterproof and resistant to wind and seismic activity. MiaSolé's flexible solar product can be installed in a wide array of locations and applications, such as curved and unreinforced roofs and other structures; transportation applications; concrete roofs; off-grid products and materials such as awnings, tents, or jackets; infrastructure such as street lamps, reservoirs, and landfills; and off-grid installations in remote locations where grid connections are not available.

MiaSolé Hi-Tech Corp.
/// www.miasole.com

Silicone-based solar product line

DuPont Photovoltaic Solutions (DuPont) have added a new brand to its flagship DuPont Tedlar and Solamet product lines, DuPont Fortasun solar silicones. The new silicone-based product line features sealants, adhesives, potting agents, encapsulants, and electrically conductive adhesives that all deliver the performance and reliability customers expect from DuPont. These products have been used in photovoltaic (PV) applications for over 30 years, and now they are under a new brand name – Fortasun. The durability offered by Fortasun includes delamination and corrosion protection. This helps preserve a level of performance that matches the expectations associated with investments in solar technology. Fortasun has lasting UV stability, high thermal conductivity formulations, strong adhesive bonds that help reduce failures due to moisture and it's electrically insulating. DuPont Fortasun adhesives and sealants endure in the face of extreme climates, ensuring that energy needs are met in all parts of the world. It also helps reduce the risk of performance deterioration due to environmental elements.

DuPont Photovoltaic and Advanced Materials
/// www.photovoltaics.dupont.com

Enhanced cross reference now available

Mersen Electrical Power has announced that a new enhanced cross reference tool is now available on ep.mersen.com. This robust cross reference was created using reference data from Mersen Technical Services and includes over 20,000 Mersen crosses. This easy-to-use tool can be accessed via the Search tool on the ep.mersen.com home page. Simply click on the magnifying glass, enter a part number for a non-Mersen product, click the checkbox to activate a cross-reference search, and click "Find It." Any match includes a direct link to the corresponding Mersen product page. Like the ep.mersen.com website, the cross reference is a dynamic tool that will continue to be updated as more data is available.

Mersen /// ep.mersen.com

Simple, affordable, and maintenance free soiling monitoring

Kipp & Zonen is now delivering the full-feature DustIQ with tilt sensor, module temperature sensor, and daisy-chain capability. They also have available a filler panel the same size as the DustIQ. This is at the request of customers to neatly fill in the gap when a DustIQ is mounted in between PV modules in an array. DustIQ can be easily added to new or existing solar arrays and integrated into plant management systems. The unit is mounted to the frame of a PV panel and does not need sunlight to operate. It continuously measures the transmission loss through glass caused by soiling, so the reduction in light reaching the solar cells can be calculated.

Kipp & Zonen /// www.kippzonen.com

Simulation on the go

COMSOL's Client for Android is now available and allows researchers, engineers, and students to perform simulation tasks from their Android devices simply by connecting to the COMSOL Server software which runs the computations remotely. COMSOL Client for Android expands on the capabilities of the Application Builder and COMSOL Server by enabling users to take their simulation applications on the road, without being limited by their device hardware. Providing field technicians or sales representatives with the power of COMSOL Multiphysics directly on their Android devices allows them to bring the R&D work on site or to the sales pitch. The Application Builder allows simulation specialists to create custom-made applications based on their multiphysics models. With COMSOL Server, organizations have been able to deploy industry-specific analysis tools in a streamlined and quick to implement format that can be scaled for global benefit. COMSOL Client for Android has made the convenience of running simulation applications as easy as ordering a rideshare. Administrators continue to have full control over who can access and run the apps by using COMSOL Server. Android users will have the latest version of a simulation application each time they open the app.

COMSOL /// www.comsol.com

Inverters

An integral part of any energy system, inverters convert the power generated from the sun into functional energy for grid and off-grid use. With technology offering ever-more efficient and reliable power generation, herein we highlight the latest in utility-scale, commercial, industrial, and residential inverters...

SOLAR

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TMEiC
We drive industry

TMEIC Corporation

Product: Solar Ware Ninja Series PV PCS

Application: Utility-scale

Continuous Output Power: 800kW - 920kW

Weighted CEC Efficiency: 98.5% preliminary, under test

Peak Efficiency: 98.9% preliminary, under test

DC Voltage Operating Range: 875V to 1300V

Operating Temperature Range: -4°F to 122°F (-25°C to 50°C)

Dimensions: 43.3" x 43.3" x 74.8" (1100mm x 1100mm x 1900mm)

Certifications/Approvals: UL1741, UL174SA, IEEE1547, NEC2017, IEC62109-1,2, IEC61000-6-2,4, IEC61727, IEC62116, IEC61400, BDEW, IEC61683, IEC60068 *preliminary/under test

Warranty: 5-year warranty, extended warranty options available

Key Features:

- Up to 6 Solar Ware Ninja units on the same skid;
- PV and/or ESS combination available;
- Latest generation of Smart Inverter controls platform;
- Outdoor rated enclosure;
- UL or IEC certified global design.

www.tmeic.com

SEE AD ON PAGE 36

phocos

Phocos Americas, Inc.

Product: Any-Grid Hybrid Inverter Charger

Application: Commercial, residential, industrial

Continuous Output Power: 5kW

Peak Efficiency: 96%

DC Voltage Operating Range: 40V-64V

Operating Temperature Range: 14°F to 122°F (-10°C to 50°C)

Dimensions: 12.2" x 18.4" x 15.5" (310mm x 467mm x 394mm)

Certifications/Approvals: CE and RoHS Compliant

Warranty: 2-year warranty

Key Features:

- Charge from any source: PV, grid, generator;
- Charge any battery type: lead acid, lithium;
- Power loads from any source: battery, PV, grid, generator;
- Flexible system size: Stack up to 9 units (45kW) single-phase or three-phase, and connect PV arrays up to 450Vdc to the integrated MPPT controller;
- Flexible communications: Detachable LCD unit, PhocosLink App, USB-OTG, RS-485, CAN Bus, and RS-232, 60 day internal datalogger.

www.phocos.com

Morningstar Corporation

Product: SureSine

Application: Residential, industrial

Continuous Output Power: 300W

Peak Efficiency: 92%

DC Voltage Operating Range: 10V - 15.5V

Operating Temperature Range: -40°F to 113°F (-40°C to 45°C)

Dimensions: 8.38" x 5.98" x 4.13" (213mm x 152mm x 105mm)

Certifications/Approvals: CE, RoHS, REACH, ISO9001

Warranty: 2-year warranty

www.morningstarcorp.com

SEE AD ON PAGE 6

CyboEnergy

CyboEnergy

Product: CyboInverter

Application: Commercial, residential, industrial, off-grid

Continuous Output Power: 1.2kW

Peak Efficiency: 96%

DC Voltage Operating Range: 15V to 58V

Operating Temperature Range: -40°F to 149°F (-40°C to 65°C)

Dimensions: 12.5" x 9.5" x 2.3" (32cm x 24cm x 5.8cm)

Certifications/Approvals: UL1741, IEEE1547, CSA107.1, FCC, NEMA-6 (IP67)

Warranty: 3-year warranty with extended warranty options available

Key Features:

- Off-Grid CyboInverter H model for electric water heaters;
- AC Assisted Off-Grid CyboInverter can run AC loads 24/7 with solar power, grid power, or combined power;
- Battery-less off-grid solar systems can take major loads off the grid while meeting PV solar mandate for CA new homes;
- On-Grid and On/Off-Grid CyboInverter for on-grid solar systems with backup power when grid is down;
- Dual-Output Off-Grid CyboInverters for heating, cooling, and air-conditioning.

www.cyboenergy.com

Yaskawa Solectria Solar

Product: SOLECTRIA XGI 1500

Application: Utility-scale

Continuous Output Power: 166kW

Weighted CEC Efficiency: 98.5%

Peak Efficiency: 99%

DC Voltage Operating Range: 860V to 1450V

Operating Temperature Range: -40°F to 140°F (-40°C to 60°C)

Dimensions: 29.5" x 39.4" x 15.1" (750mm x 1000mm x 380mm)

Certifications/Approvals: UL 1741SA, UL 1998, IEEE 1547

Warranty: 5-year standard warranty with 10 year options

www.solectria.com

Growatt New Energy

Product: Growatt 8-10kMTLP-US

Application: Residential

Continuous Output Power: 8kW to 10kW

Weighted CEC Efficiency: 97.5%

Peak Efficiency: 97.8%

DC Voltage Operating Range: 315V to 480V

Operating Temperature Range: -13°F to 140°F (-25°C to 60°C)

Dimensions: 14" x 27.3" x 8.3" (355mm x 694mm x 210mm)

Certifications/Approvals: UL1741, UL1741 SA, CA Rule21, UL1998, IEEE1547, FCC part 15(class B), CSA C22.2 No.107.1, UL1699B(type 1)

Warranty: 5-year warranty

www.growatt-america.com

Enphase Energy

Product: Enphase IQ 7X Microinverter

Application: Residential

Continuous Output Power: 315VA

Weighted CEC Efficiency: 97.5%

Peak Efficiency: 97.8%

DC Voltage Operating Range: 25V to 79.5V

Operating Temperature Range: -40°F to 140°F (-40°C to 60°C)

Dimensions: 8.34" x 6.88" x 1.18" (212mm x 175mm x 30.2mm), without bracket

Certifications/Approvals: CA Rule 21 (UL 1741-SA) UL 62109-1, UL1741/IEEE1547, FCC Part 15 Class B, ICES-0003 Class B, CAN/CSA-C22.2 NO. 107.1-01 This product is UL Listed as PV Rapid Shut Down Equipment and conforms with NEC-2014 and NEC-2017 section 690.12 and C22.1-2015 Rule 64-218 Rapid Shutdown of PV Systems, for AC and DC conductors, when installed according manufacturer's instructions.

Warranty: Up to 25-year warranty

www.enphase.com

Fronius USA

Product: Fronius Primo SnapINverter

Application: Commercial, residential

Continuous Output Power: 3.8kW to 15kW

Weighted CEC Efficiency: 96.5%

Peak Efficiency: 97%

Dimensions: 20.1" x 28.5" x 8.9" (510mm x 724mm x 226mm)

Certifications/Approvals: UL 1741-2010 Second Edition (incl. UL1741 Supplement SA 2016-09 for California Rule 21 and Hawaiian Electric Code Rule 14H), UL1998 (for functions: AFCI, RCMU and isolation monitoring), IEEE 1547-2003, IEEE 1547.1-2003, ANSI/IEEE C62.41, FCC Part 15 A & B, NEC 2017 Article 690, C22. 2 No. 107.1-16, UL1699B Issue 2 -2013, CSA TIL M-07 Issue 1 -2013

Warranty: 10-year warranty

www.fronius-usa.com

SOLAR

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Sol-Ark.com (Portable Solar, LLC)

Product: Sol-Ark 8K

Application: Residential

Continuous Output Power: 8kW/9kW

Weighted CEC Efficiency: 96.5%

Peak Efficiency: 97.5%

DC Voltage Operating Range: 150V-500V

Operating Temperature Range: 50°F to 113°F (-10°C to 45°C), Derates >113°F (45°C)

Dimensions: 25.6" x 18.8" x 7.1" (650mm x 477.5mm x 180mm)

Certifications/Approvals: Electronics certified by SGS labs, UL1741, UL1741SA, IEEE1547, FCC 15 class B, UL1699B, MIL-STD461G, MIL-STD-188-125-1 (Independently tested May 2018), Rule 21, HECO

Warranty: 5-year standard warranty, optional 10-year warranty available

Key Features:

- Grid-tied mode to sell power to the grid;
- Meter zero mode to zero whole home power;
- Programmable loads for high power off-grid items to save battery capacity;
- AC coupling adds up to 7kW backup power to existing grid-tie installs;
- Time of use/peak shaving allows use of batteries to avoid costly power and reduces peak demand charges.

www.sol-ark.com

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CyboEnergy

Product: AC Assisted Off-Grid CyboInverter

Application: Off-grid

Continuous Output Power: 1.2kW

Peak Efficiency: 96%

DC Voltage Operating Range: 15V to 58V

Operating Temperature Range: -40°F to 149°F (-40°C to 65°C)

Dimensions: 12.5" x 9.5" x 2.3" (32cm x 24cm x 5.8cm)

Certifications/Approvals: UL1741, IEEE1547, CSA107.1, FCC, NEMA-6 (IP67)

Warranty: 3-year warranty with extended warranty options available

Key Features:

- Can run AC loads 24/7 with solar power, grid power, or combined power;
- Take major loads off the grid and avoid the challenges of an on-grid solar system;
- Offers low system cost with easy installation, no batteries, and no grid connection fees;
- Has 4 input channels with panel level MPPT to maximize solar production;
- Meets PV solar mandate for California new homes.

www.cyboenergy.com

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AIMS Power

Product: AIMS 8000 Watt Pure Sine Inverter Charger 48Vdc to 120/240Vac

Application: Residential, commercial

Continuous Output Power: 8000W

Weighted CEC Efficiency: 88%

Peak Efficiency: 91%

DC Voltage Operating Range: 42V - 64V

Operating Temperature Range: Ambient temperature recommendation 14°F to 122°F (-10°C to 50°C)

Dimensions: 23.3" x 16.3" x 8" (592mm x 414mm x 203mm)

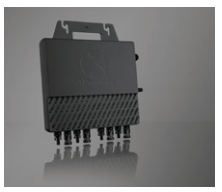
Certifications/Approvals: Listed to UL 1741, CSA 22.2

Warranty: 2-year warranty

Key Features:

- Powerful built in charger for lithium, GEL, AGM, and lead;
- 24,000W surge for 20 seconds;
- Split phase 120/240Vac;
- Automatic transfer switch;
- Hard wire and GFCI outlet.

www.aimscorp.net



APsystems

Product: APsystems QS1 microinverter

Application: Commercial, residential, industrial

Continuous Output Power: 1.2kW (0.3kW per channel)

Weighted CEC Efficiency: 96.5%

Peak Efficiency: 96.5%

DC Voltage Operating Range: 16V to 55V

Operating Temperature Range: -40°F to 149°F (-40°C to 65°C)

Dimensions: 11.1" x 9.1" x 1.6" (282mm x 231mm x 40.6mm)

Certifications/Approvals: UL1741, CSAC22.2No.107.1-01, UL 1741, SA/Rule 21 compliant (240V version only), FCC Part15, ANSIC63.4, ICES-003, IEEE1547, meets NEC 2014/2017 690.12

Warranty: 10-year standard warranty, extendable to 25-years

usa.apsystems.com

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Chilicon Power

Chilicon Power

Product: CP-720

Application: Residential, commercial

Continuous Output Power: 720W

Weighted CEC Efficiency: 96.1%

Peak Efficiency: 96.7%

DC Voltage Operating Range: 47V to 82V

Operating Temperature Range: -40°F to 149°F (-40°C to 65°C)

Dimensions: 12" x 8" x 1.8" (305mm x 203mm x 46mm)

Certifications/Approvals: UL1741, IEEE std 1547, IEEE std C62.41.2, CSA C22.2 NO. 107.1, CISPR 22 Class B, HECO Rule14H (Advanced Inverter), HECO Rule 22 (Self-Supp Rule 21 / UL1741SA, Complies with NEC 690.12 Rapid Shutdown

Warranty: 25-year warranty

Key Features:

- High per module output;
- Compatible with any available panel, including 96 and 128 cell;
- 25-year warranty;
- Contains no electrolytic components;
- Tested at over 300°F.

www.chiliconpower.com

Power Electronics

Product: HEM Central String Inverter FS3430M

Application: Commercial, utility-scale, industrial

Continuous Output Power: 3550kVA @ 40°C, 3430kVA @ 50°C

Weighted CEC Efficiency: 97.5% (including MV transformer)

Peak Efficiency: 98% (including MV transformer)

DC Voltage Operating Range: 913Vdc to 1310Vdc

Operating Temperature Range: -31°F to 140°F (-35°C to 60°C)

Dimensions: 260" x 89.2" x 83.4" (6604mm x 2265mm x 2118mm)

Certifications/Approvals: UL1741SA, IEEE1547, EN62109-1, EN62109-2SA, NEC2014/2017

www.power-electronics.com

SolarEdge

Product: Three Phase Inverter with Synergy Technology

Application: Commercial

Continuous Output Power: 120A per phase

Weighted CEC Efficiency: 98.5%

DC Voltage Operating Range: Fixed string voltage

Operating Temperature Range: -40°F to 140°F (-40°C to 60°C)

Dimensions: 37" x 12.5" x 10.5" (940mm x 315mm x 260mm), Secondary units 21" x 12.5" x 10.5" (540mm x 315mm x 260mm)

Certifications/Approvals: UL1741, UL1741 SA, UL1699B, UL1998, CSA 2.22 IEEE 1547, Rule 21, Rule 14 (HI) FCC part 15 class A

Warranty: 12-year warranty, extendable to 20 years

www.solaredge.com/us

COTEK Electronic Industrial Co. Ltd.

Product: SD3500-xxx

Application: Commercial/industrial

Continuous Output Power: 3.5kW

Weighted CEC Efficiency: 90%

Peak Efficiency: 91%

DC Voltage Operating Range: 20V-32V for 24V model

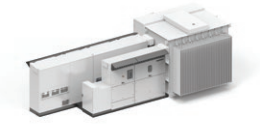
Operating Temperature Range: -4°F to 140°F (-20°C to 60°C)

Dimensions: 11.14" x 5.04" x 19.53" (283mm x 128mm x 496mm)

Certifications/Approvals: UL458 / EN60950-1

Warranty: 2-year warranty

www.cotek.com



Ingeteam

Product: Medium Voltage Inverter Station

Application: Utility-scale

Continuous Output Power: Up to 5.4MVA

Weighted CEC Efficiency: 98.5%

Peak Efficiency: 98.9%

DC Voltage Operating Range: 655V-1300V

Operating Temperature Range: -4°F to 135°F (-20°C to 57°C); -22°F (-30°C) with heating resistor kit

Dimensions: Single inverter 9.25ft x 3.02ft x 7.22ft (2.81m x 0.92m x 2.2m); Dual inverter 18.50ft x 3.02ft x 7.22ft (5.6m x 0.92m x 2.2m)

Certifications/Approvals: UL1741 SA

Warranty: 5-year standard warranty, with extended warranty options up to 25 years

www.ingeteam.com

SMA America

Product: SMA Sunny Tripower CORE1 33, 50, 62

Application: Commercial

Continuous Output Power: Up to 62.5kW

Weighted CEC Efficiency: 97.5%

Peak Efficiency: 98.2%

DC Voltage Operating Range: 150V to 1000V

Operating Temperature Range: -13°F to 140°F (-25°C to 60°C)

Dimensions: 22.4" x 22.4" x 28.8" (569mm x 569mm x 732mm)

Certifications/Approvals: UL 1741 SA, UL 1699B Ed. 1, CSA 22.2 107.1, IEEE 1547 PV Rapid Shutdown System Equipment

Warranty: 10-year, 15-year, 20-year warranty options

www.sma-america.com

ENERGY STORAGE

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AIMS POWER™
www.aimscorp.net

AIMS Power

Product: AIMS 4000 Watt Pure Sine Inverter Charger 24V DC to 120/240V AC

Application: Residential, commercial

Continuous Output Power: 4000W

Weighted CEC Efficiency: 88%

Peak Efficiency: 91%

DC Voltage Operating Range: 21V - 31.5V

Operating Temperature Range: Ambient temperature recommendation 14°F to 122°F (-10°C to 50°C)

Dimensions: 19" x 16.5" x 8" (483mm x 419mm x 203mm)

Certifications/Approvals: Listed to UL 458, CSA 22.2

Warranty: 2-year warranty

Key Features:

- Powerful built in charger for lithium, GEL, AGM, and lead;
- 12,000W surge for 20 seconds;
- Split phase 120/240Vac;
- Automatic transfer switch;
- High/low voltage shutdown, short circuit / over temp protections.

www.aimscorp.net

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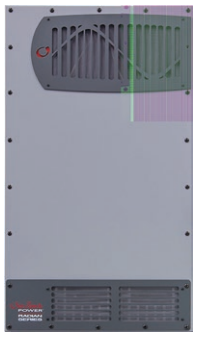

OutBack POWER™
an EnerSys company

OutBack Power

Product: Radian Series Inverter Charger

Application: Commercial, residential

Continuous Output Power: 8kW or 4kW

Weighted CEC Efficiency: 92.5%

Peak Efficiency: 93%

DC Voltage Operating Range: 40V to 64V

Operating Temperature Range: -4°F to 122°F (-20°C to 50°C)

Dimensions: 28" x 16" x 8.7" (71.1cm x 40.6cm x 22.1cm)

Certifications/Approvals: ETL listed to UL 1741 SA, CE, CSA C22.2 No. 107.1, UL 778 Annex F, IEC 62109-1 ETL, RoHS compliant per directive 2011/65/EU, FCC Class B, IEEE 1574.1, EN61000-6-1, EN61000-6-3, EN61000-3-2, EN61000-3-3

Warranty: 5-year standard warranty, 10-year extended warranty available

Key Features:

- Supports frequency shifting, AC coupling, grid-interactive, and stand-alone capability in the same package;
- Unsurpassed surge capacity;
- Dual AC inputs;
- Field serviceable modular design.

www.outbackpower.com

Darfon America

Product: H5001 Hybrid Inverter

Application: Commercial, residential

Continuous Output Power: 5kW

Weighted CEC Efficiency: 95.5%

Peak Efficiency: 96%

DC Voltage Operating Range: 120V to 500V

Operating Temperature Range: 32°F to 131°F (0°C to 55°C)

Dimensions: 39" x 17.6" x 5.9" (990mm x 448mm x 150mm)

Certifications/Approvals: UL1741SA, CSA, IEEE 1547, FCC Class B

Warranty: 5-year warranty

www.darfonsolar.com

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Sinexcel

Sinexcel, Inc.

Product: PWS2-30K-NA

Application: Commercial, industrial

Continuous Output Power: 30kW

Weighted CEC Efficiency: 96.5%

Peak Efficiency: 97.3%

DC Voltage Operating Range: 200V to 750V

Operating Temperature Range: -4°F to 140°F (-20°C to 60°C)

Dimensions: 6.95" x 18.5" x 26" (176mm x 470mm x 660mm)

Certifications/Approvals: ETL listed conforming to UL1741, UL1741SA, CPUC RULE 21, IEEE1547

Warranty: 3-year warranty, 10-year extended warranty available

Key Features:

- 30kVA high power density;
- Bi-directional power conversion system;
- Wall-mounted, making small footprint;
- 120/240 split-phase support by single-phase transformer;
- Can work in two modes: utility-interactive mode (P-Q mode), and stand-alone mode (off-grid mode, or V-F mode).

www.sinexcel.us

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Dynapower

Product: CPS-1500

Application: Utility-scale

Continuous Output Power: 1200kW (@480), 1500kW (@600)

Weighted CEC Efficiency: 98%

Peak Efficiency: 98.5%

DC Voltage Operating Range: 740V to 1500V

Operating Temperature Range: -13°F to 140°F (-25°C to 60°C) Derated above 113°F (45°C)

Dimensions: 81" x 55" x 33" (206cm x 140cm x 84cm) Indoor; 102" x 96" x 118" (259cm x 244cm x 300cm) Outdoor

Certifications/Approvals: IEEE 1547, UL 1741 SA

Warranty: 5-year standard warranty, 10-20-year extended warranty available

Key Features:

- Dynapower's Black Start technology can energize distribution networks even with transformer magnetizing currents that exceed the power rating of the inverters. Multiple CPS units can be restarted at once;
- A Volt Var function provides immediate and automatic voltage support to the grid;
- A Hz-Watt function provides immediate and automatic frequency support to the grid;
- Dynamic Transfer algorithm monitors grid stability and can disconnect from the grid and transition to stand-alone battery backup power mode on the load connection. The transition is seamless to the critical loads and supports 100% phase imbalance in UF mode.

www.dynapower.com

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Rhombus Energy Solutions

Product: Rhombus 30/60 Site Inverter System

Application: Commercial, industrial

Continuous Output Power: 30kW continuous output per stage (two stage option)

Weighted CEC Efficiency: 94%

Peak Efficiency: 97%

DC Voltage Operating Range: 270V to 875V

Operating Temperature Range: -4°F to 122°F (-20°C to 40°C)

Dimensions: 31" x 23" x 70" (787m x 584mm x 1178mm)

Certifications/Approvals: UL1741 SA, UL2202, UL2231 Certified, NEMA 3R and SunSpec compliant

Warranty: 2-year standard warranty with extended option available

Key Features:

- Maximum flexibility with two, 30kW independent, power stages that can be configured in multiple ways;
- Integrated VectorStat site controller that can be configured as a mesh or "hub and spoke" SCADA configuration;
- Multi-mode, multi-port, utility interactive bi-directional inverter for on and off-grid connections;
- Power converter for distributed energy resources in grid or island mode;
- Integrated isolation transformer.

www.rhombusenergy.com

Sensata Technologies

Product: MS-PAE Inverter/Charger

Application: Residential

Continuous Output Power: 4.4kW

Weighted CEC Efficiency: 85%

Peak Efficiency: 94%

DC Voltage Operating Range: 36V to 64V

Operating Temperature Range: -4°F to 140°F (-20°C to 60°C)

Dimensions: 13.75" x 12.65" x 8.0" (34.9cm x 32.1cm x 20.3cm)

Certifications/Approvals: ETL Listed to ANSI / UL1741 and CSA STD C22.2 No.107.1-01

Warranty: 3-year parts and labor warranty, 5-years when installed on MMP or MP system

www.sensatapower.com

ENERGY STORAGE

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Dynapower

Product: MPS-125 EHV

Application: Commercial, industrial

Continuous Output Power: 125kW

Weighted CEC Efficiency: 98%

Peak Efficiency: 98.5%

DC Voltage Operating Range: 740V to 1500V

Operating Temperature Range: -13°F to 122°F (-25°C to 50°C) Derated from 113°F to 122°F (45°C to 50°C)

Dimensions: 36" x 28" x 15.25" (91.4cm x 71cm x 39cm)

Certifications/Approvals: IEEE 1547, UL 1741 SA

Warranty: 5-year standard warranty, 10-20-year extended warranty available

Key Features:

- Dynamic Transfer algorithm monitors grid stability and can disconnect from the grid and transition to stand-alone battery backup power mode on the load connection. The transition is seamless to the critical loads and supports 100% phase imbalance in UF mode;
- Dynapower's Black Start technology can energize distribution networks even with transformer magnetizing currents that exceed the power rating of the inverters. Multiple MPS-125 EHV units can be restarted at once;
- A Volt Var function provides immediate and automatic voltage support to the grid;
- A Hz-Watt function provides immediate and automatic frequency support to the grid.

www.dynapower.com

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Sinexcel, Inc.

Product: Modular bi-directional storage inverter

Application: Commercial, utility-scale, industrial

Continuous Output Power: 62.5kW to 500kW

Peak Efficiency: 98.2%

DC Voltage Operating Range: 600V to 900V

Operating Temperature Range: -4°F to 122°F (-20°C to 50°C)

Dimensions: 43" x 31.5" x 85" (1100mm x 800mm x 2160mm)

Certifications/Approvals: ETL certified conforming to UL1741/CSA22.2/IEEE1547/ CPUC RULE 21 / CE EMC: IEC61000, CE LVD: IEC62477, /G59/ AS4777 (Pending)

Key Features:

- The modular and ETL certified bi-directional inverter, with optional multi-strings-battery tech and same size of PCS cabinet;
- Can work in two modes: utility-interactive mode (P-Q mode), and stand-alone mode (off-grid mode, or V-F mode);
- The external isolation transformer can offer 480Vac or 400Vac 3P4W connection to the distribution system or load for grid-forming operation.

www.sinexcel.us

Go Electric, Inc.

Product: LYNC DR

Application: Commercial, industrial

Continuous Output Power: 75kW, 250kW, 1MW

Weighted CEC Efficiency: 94%

Peak Efficiency: 98%

DC Voltage Operating Range: 540V to 800V

Operating Temperature Range: 32°F to 122°F (0°C to 50°C)

Certifications/Approvals: UL1741

Warranty: 10-year warranty option

www.goelectricinc.com

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Outback Power

Product: SkyBox True Hybrid Energy System

Application: Commercial, residential

Continuous Output Power: 5kW

Weighted CEC Efficiency: >94%

Peak Efficiency: >97%

DC Voltage Operating Range: 42V to 60V

Operating Temperature Range: -4°F to 140°F (-20°C to 60°C)

Dimensions: 47" x 21" x 9.4" (119.4cm x 53.3cm x 23.9cm)

Certifications/Approvals: UL 1741 SA, CSA 22.2 No. 107.1, UL 1778, HECO Rule 14H SRD, CA Rule 21 SRD, IEEE 1547-2003, IEEE 1547.1-2005

Warranty: 5-year standard warranty, 10-year extended warranty available

Key Features:

- Clean balance of systems - single box design;
- Works with wide variety of 48V battery chemistries;
- Backup power and support for time of use optimization;
- Dynamic power management;
- Fast and easy to install with or without batteries.

www.outbackpower.com

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TMEIC Corporation

Product: Solar Ware Ninja Series (ESS PCS)

Application: Utility-scale

Continuous Output Power: 640kW - 840kW

Peak Efficiency: 98.4% preliminary, under test

DC Voltage Operating Range: 710V to 1300V

Operating Temperature Range: -4°F to 122°F (-25°C to 50°C)

Dimensions: 43.3" x 43.3" x 74.8" (1100mm x 1100mm x 1900mm)

Certifications/Approvals: UL1741, UL174SA, IEEE1547, NEC2017, IEC62109-1,2, IEC61000-6-2,4, IEC61727, IEC62116, IEC61400, BDEW, IEC61683, IEC60068 *preliminary/under test

Warranty: 5-year warranty, extended warranty options available

Key Features:

- Customizable block; up to 6 Solar Ware Ninja units on the same skid;
- DC Zone monitoring is standard;
- Latest generation of Smart Inverter controls platform;
- UL or IEC certified global design;
- Outdoor rated enclosure.

www.tmeic.com

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Rhombus Energy Solutions

Product: Rhombus 50kW Inverter - RES-BESS 50kW-480

Application: Commercial, utility-scale, residential, industrial

Continuous Output Power: 50kW

Weighted CEC Efficiency: 94%

Peak Efficiency: 98%

DC Voltage Operating Range: 550V to 840V

Operating Temperature Range: -14°F to 122°F (-10°C to 40°C)

Dimensions: 31.5" x 47.2" x 20" (800m x 1200mm x 500mm)

Certifications/Approvals: Certified for UL1741SA, IEEE 1547, HECO, CEC, Rule 21

Warranty: 2-year warranty and 3-year extended warranty

Key Features:

- Island mode and grid mode capable;
- Power Factor Control Range: +/- .25;
- 60kVA Continuous Output power;
- 75kVA for 10 seconds for Overload.

www.rhombusenergy.com

Alencon Systems, LLC

Product: SPOT V6

Application: C&I, utility-scale, solar + storage, microgrid, repowering

Continuous Output Power: 60kW to 80kW

Weighted CEC Efficiency: 98% to 98.5%

Peak Efficiency: 98.6%

DC Voltage Operating Range: 600V to 1500V

Operating Temperature Range: -22°F to 122°F (-30°C to 50°C)

Certifications/Approvals: UL1741, IEC62109-1, CSA C22.2

Warranty: 5-year standard warranty, up to 20-year extended

www.alenconsystems.com

Banking on Endangered Species

by Paul Sherman and Josiah Maine

When land development projects cause environmental impacts, conservation banks can provide an efficient offset solution.

Conservation banks are specific areas of land established when a private entity works with a federal agency - such as the U.S. Fish and Wildlife Service (USFWS) - to find a specific area of land that can be enhanced, preserved, and protected as habitats to benefit species that are listed as threatened or endangered under the Endangered Species Act (ESA). Wind developers needing to offset potential ESA impacts can use conservation bank credits (units of trade generated by the enhancements and protections described above) from these banks to compensate for anticipated adverse impacts to threatened, endangered, or special-status species in similar ecosystems.

Conservation credits can only be used when they cover the same species and habitats as those affected. For example, a conservation bank may have been established to benefit a fish in a freshwater stream. However, those same credits may not be used to offset impacts to a forest-dwelling woodpecker.

In addition, when the credits are preserving similar nearby ecosystems, they serve as new habitats for species within the developer's proposed project site. Conservation banks enable developers to reduce their environmental impact immediately, and help control project costs and timelines.

The alternative to using credits is to, essentially, do it yourself. That means acquiring property, reviewing the biology, developing a resource enhancement and long-term management plan, performing the necessary restoration actions, monitoring the site for success and fixing things if or when it doesn't succeed. Additionally, you will manage the site in perpetuity. Not only can these activities be a long-term burden, but they take developers' attention away from their core business.

In areas that are occupied or visited by Indiana bats and northern long-eared bats, this do-it-yourself approach often had been the only option available to developers looking to build a road, install a power line, or otherwise address infrastructure or other construction needs. Now there's an alternative.

First-of-its-Kind Conservation Bank

The Chariton Hills Conservation Bank in Missouri provides 1,300 acres of dedicated natural space for the Indiana and northern long-eared bats, which are listed as threatened or endangered in the U.S. By conserving this landscape, the bank offers credits to developers, who can then use them to offset impacts their work might have on the two species.

The bank is a trailblazing program in terms of both Missouri and national ecological preservation. Along with its status as the first conservation bank in Missouri approved by the USFWS, the bank is also the first in the U.S. to explicitly protect the Indiana and the northern long-eared bat.

Both species have long been federally listed as endangered or threatened, with their numbers continuing to decline across their ranges. To combat this troubling issue, the Charlton Hills properties were carefully selected by a team of bat biologists to serve as a designated preservation site for Indiana and northern long-eared bats for summer maternity, roosting and foraging. Once selected, the team performed environmental enhancements and developed interim and long-term management plans.

Developers of projects with impacts that fall within the Chariton Hills Conservation Bank service area are able to purchase these pre-approved credits to offset their development impacts. The Chariton Hills Conservation Bank primary service area encompasses projects in Kansas City and St. Louis, Missouri, as well as areas in the northern part of the state. Developers in the

southern portion of the state can use these credits on a case-by-case basis.

The site also included a conservation easement on the bank property, and is funding a non-wasting endowment that will be tied to the land to provide funding for long-term management activities. The conservation easement and endowment are held by the Missouri Conservation Heritage Foundation.

Obtaining bank approval

The USFWS will only grant approval to a conservation bank under specific conditions. Before the USFWS green lights a conservation bank, sponsors are required to:

- Enter into a Conservation Banking Agreement with USFWS;
- Grant a conservation easement over the bank property to an eligible third party, precluding future development of the property and restricting certain land uses;
- Develop interim and long-term management plans for the conservation bank; and
- Provide funding for monitoring and management of the conservation bank in perpetuity through establishment of a non-wasting endowment.

By using the resources of a conservation bank, developers can reduce the financial, permitting, and timing uncertainty of smaller, individual conservation projects. In addition, developers are relying on biological professionals who are shaping the ecological restoration. From the helm of a conservation bank, environmental scientists and regulatory agencies can target specific environmental, biological, and stakeholder concerns.

Because conservation banks are beholden to comply with USFWS performance standards, choosing to purchase credits in a bank rather than create an individual mitigation project eliminates the distraction of long-term management and biological performance liability for landowners and developers. This cost-effective solution can expedite permitting efforts, sever specific mitigation obligations, and consolidate smaller mitigation requirements into this large, more ecologically viable site.

Paul Sherman is an environmental professional and project manager with nearly 20 years of experience. He serves as National Mitigation Bank Acquisition + Planning Lead at Burns & McDonnell, a family of companies made up of 7,000 engineers, architects, construction professionals, scientists, consultants, and entrepreneurs worldwide. Paul specializes in land acquisition and planning, and environmental mitigation and restoration. His experience includes conceptualizing, entitling and developing complex projects; and integrating a multidisciplinary team to identify, acquire, develop, and construct economically sound and biologically important restoration and conservation projects.

Josiah Maine is an Environmental Scientist at Burns & McDonnell. He performs a variety of environmental studies, specializing in studies on threatened and endangered bats. In addition, he conducts fisheries and aquatic ecology studies for power generation plants across the Midwest, working work with clients in transportation, transmission, generation, oil and gas, and renewables.

Burns & McDonnell /// www.burnsmcd.com

New Towers and Hub Heights for North America

by Christoph Bosch

Fluctuating steel prices, falling electricity production costs, and technological leaps are creating big challenges for the U.S. wind power market. New solutions are needed. Maximizing hub heights is the next logical step, especially from a commercial viability perspective - each additional meter increases the annual energy yield of the wind turbine by up to 1 percent. For inland locations with weak wind, the lower wind turbulence and subsequent increase wind yield are factors that favor high hub heights. This is achieved with hybrid towers, which are already known in Europe and Asia for their high hub heights.

The U.S. wind power industry has experienced strong growth in recent years, and experts see considerable potential in the future as well. Reasons for this include natural as well as economic conditions, and the energy policy framework. Accordingly, the number of people employed in wind turbine construction, maintenance, and operation reached a new record high of over 100,000 in 2017.

Market research firm Freedonia predicts that wind power generating capacities will grow by more than seven percent annually until 2021, thereby replacing hydroelectric power as the largest renewable energy source in the United States. At the present time, U.S. wind is a lucrative investment because of support programs like the production tax credit (PTC). Analysts expect growth of 10 gigawatts (GW) in wind turbines in 2019, and another 12 GW of new turbine capacity in 2020. Many states offer public subsidies along with depreciation models that are stimulating demand and new wind turbine construction. When the federal tax credit program ends, subsidies in the individual states will play a greater role, from 2020 onward. For U.S. project planners, it is clear that electricity production costs have to come down, and wind

turbines have to be more efficient with higher yields. To this end, there is a much greater focus on technical solutions like modern hybrid towers, which promise greater efficiency in the design and construction of wind turbines through higher hub heights.

High hub heights are efficient

Reduced subsidies aren't the only reason the U.S. wind power market is facing major challenges. The cost efficiency of wind turbine towers made from steel in the U.S. is partially dependent on fluctuating steel prices. Moreover, steel towers in 2017 had an average hub height of only 80 meters, and a turbine output of 1.63 megawatts. These comparatively small dimensions place limits on economic viability – limits that can be overcome with hybrid towers and significantly higher hub heights.

The modular tower concept, made up of steel and concrete elements, allows the economically viable implementation of hub heights up to 190 meters. The lower part of the tower is made of concrete elements, and the steel tube upper sections are placed on top. Each additional meter increases the energy yield of the turbine by up to 1 percent. Especially at inland locations, it is often the case that, the taller the wind turbine, the better the wind shear and hence the yield. At a reference site in Iowa, for example, an average additional yield of 0.8 percent per extra meter was achieved when the average hub height was raised from 80 meters to 140 meters.

The technology in new wind turbines is becoming more powerful, larger, and heavier. Rotor diameters are also growing to generate electricity even more efficiently from the wind, and the forces acting on wind turbine towers are increasing. Hybrid Towers are able to meet these challenges. Using hybrid construction, it becomes possible to find the economic optimum for required tower heights of 130 meters and above. The concrete component is completely maintenance-free and especially durable.

Production with local labor and raw materials

Another factor that speaks for the innovative tower concept is mobile fabrication. National or regional logistical requirements can be met. Just as importantly – especially in the current market climate - punitive import tariffs avoided. On-site production facilities can use local raw materials and labor, and the concrete elements for the tower can be transported with regular trucks, so there's no need for oversize load transportation over long distances. All of these factors benefit the environment and the bottom line.

Christoph Bosch is Head of Distribution at Max Bögl Wind AG, a worldwide company that manufactures hybrid wind turbine towers on site.

Max Bögl /// www.mbrenewables.com

Best Practices in Early-Stage Wind Project Development and Construction

by Richard Ortiz

THE GLOBAL MARKET FOR WIND

energy installations is projected to reach an annual total of $70 billion in the near future. According to the American Wind Energy Association, the U.S. wind industry added 7,588 megawatts (MW) of new wind capacity last year, with an additional 841 MW added in the first quarter of 2019. Across the United States, Puerto Rico, and Guam, more than 56,000 wind turbines produce a combined capacity of nearly 100,000 MW. Wind power in the U.S. has more than tripled in the past 10 years, and is now the largest source of renewable generating capacity in the country.

Reading Wind

A recently announced project, the Reading Wind Facility (located in Osage and Lyon Counties, Kansas) provides an opportunity to review some of the innovations in wind project development and construction. Reading Wind will generate roughly 760,000 megawatt hours (MWh) of clean energy per year once operational, in the second quarter of 2020.

The facility will consist of 62 wind turbines and just under 5 miles of transmission lines. Each turbine is mounted to the top of an 80-meter-tall tower and has a 116-meter, three-blade rotor connected to a generator. The project will generate significant benefits to the local community, including creating approximately 125 full-time jobs during peak construction, and up to eight permanent jobs once operational. During construction and operation, both Osage and Lyons counties will benefit from increased local spending on goods and services.

Key Insights from On the Ground

The development and construction of Reading Wind provides a number of best practices around sourcing, recruitment of trained personnel, and quality control.

When constructing wind projects, a best practice for sourcing is to maximize the purchase of local goods and services to the greatest extent possible. This brings added economic benefits to the local community, and can also contribute to building goodwill. In instances where local sourcing is not feasible, using vendors that have proven to be predictable and reliable partners on past projects is the next best choice.

A second-best practice incorporated into Reading Wind is leveraging the expertise of local individuals as much as possible. Recruiting local workers can sometimes be challenging because of the advanced skill sets required for wind energy construction. To overcome these concerns, Reading Wind personnel organized local job fairs focused on attracting local applicants that align with the labor and operator positions for on-site equipment positions.

Other best practices include micrositing, considering underground cable installation methods, routing access roads and crane movements, and creating a comprehensive development process to improve the impact of wind project complexities.

Connecting with the Local Community

An ideal wind project is one that is sited properly, and effectively engages the local community. Support and buy-in from local communities is absolutely critical. At Reading Wind, a series of job fairs, information sessions, joint route-mapping sessions and more, provided greater transparency and accountability with the local community.

Additionally, local agencies were involved in the establishment of haul routes as well as the permitting and construction execution. And because wind projects can generally take between four and six years before construction ever begins, the project followed best practice by designating senior personnel to serve as focal points to engage with neighbors, local authorities, governments, different counties, and land owners. Developers also hosted dinners with land owners to involve them in the development process, and even engaged local hospitals and EMS agencies in several mock emergency drills to get an idea of what it would take to conduct a rescue from the project site.

In the end, the ultimate goal of a wind energy project is to produce a lower cost of leveled energy to the grid, and, whenever possible, significant benefits to the local community. Deploying the innovations and best practices described above can help both companies and customers realize these benefits with greater efficiency and affordability.

Rick Ortiz is Senior Vice President of Wind with RES. He has been in the construction industry for over 30 years and moved to the renewables sector in 2005. Rick currently oversees all wind construction projects for RES in North America.

RES /// www.res-group.com

The Reading Wind Facility is owned by Southern Power and is being jointly developed by Southern Power and RES.

Southern Power
/// www.southerncompany.com

Cutters and crimpers are backed by a 3-year warranty

Emerson is now offering professionals four new models of Greenlee battery hydraulic crimpers and cutters: the In-Line Quad Point Indenter, the 6-Ton Underground Indenting Crimper, the In-Line ACSR, and Guy Wire Cutter. The new Next Generation Gator tools have a single trigger activation, an enclosed impact-resistant housing to protect the tool from debris and an over-molded grip for easy, comfortable handling and control. They are powered by an 18V Lithium-ion 4.0Ah MakitaÒ battery platform which enables users to accomplish more cuts and crimps per charge, and are equipped with an OLED screen to show instantaneous tool performance when needed.

Emerson /// www.emerson.com

Intuitive, intelligent design with safety in mind

AcraDyne's HT Dual-Lever Nutrunner/Gen IV controller system enhances safe tool operation and provides an intuitive, intelligent solution even in the harshest conditions. AcraDyne's Nutrunners are designed with ultimate operator safety in mind. The dual-lever design helps prevent injuries from accidental tool start with its two-hand operation with no tie-down feature, requiring the operator to use both hands on the trigger simultaneously, eliminating accidental tool start and keeping both hands out of harm's way. Multiple handle styles ensure safe and ergonomic tool usage for each application and significantly reduces the risk of crushed or mutilated fingers from unintended tool start.

AIMCO /// www.aimco-global.com

PA modified flexible conduit

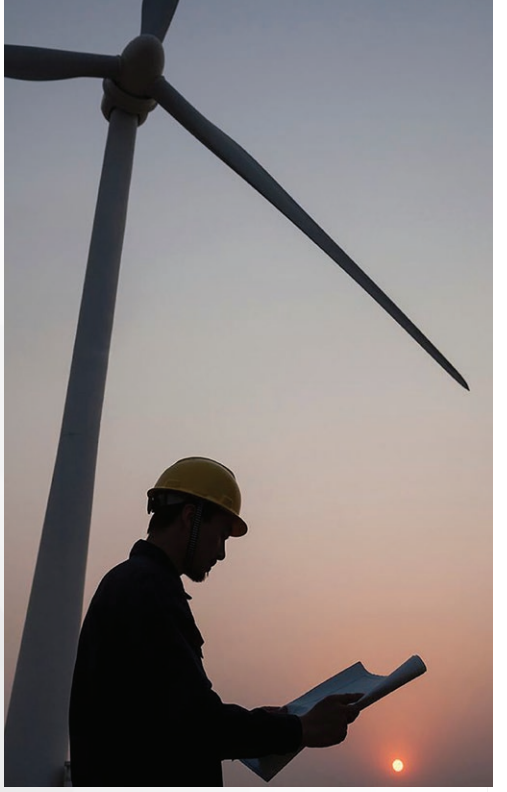
AerosUSA is pleased to announce the launch of their PA 6L flexible PA modified conduit. These flexible, modified conduits are characterized by high resistance to benzene, acid, solvents, and oil resistant up to 248°F (120°C), as well as low-temperature properties down to -13°F (-25°C). They are designed for use in wind towers, for use on lighting assemblies, protecting cables running up the interior tower wall, and for the protection of cabling within the nacelle. Due to their light weight, simplistic clamping methods, and impact resistance, they are suitable for these types of installations. These conduits are also self-extinguishing and flame retardant. The PA 6L conduit is flexible and manufactured from high grade, specially formulated polyamide 6 materials. These conduits are free of silicone, cadmium, halogen. The PA 6L conduits belong to the ROHRflex product range, are available in sizes OD 10mm (5/16") – OD54.5mm (2") and are used with the FLEXAquick fitting system.

AerosUSA /// www.aerosusa.com

Peak shaver hydraulic safety hub

The Riverhawk Hydraulic Safety Hub provides equipment designers and users with a simple and passive method to protect equipment shafting automatically against destructive torque spikes or other sudden short transients. Users will improve their machine robustness without having to specify heavy and expensive oversized components. This device is designed specifically to mount to classical hydraulic shaft ends. Riverhawk designs a Safety Hub to mount directly on an existing shaft end. The Riverhawk Hydraulic Safety Hub can be designed as a drop-in replacement for an existing hub, and it allows the use of standard tooling and procedures.

Riverhawk /// www.riverhawk.com



The Wind Industry Wakes Up to Artificial Intelligence

by Glen Wagner and Jim Kiles

Whether it's improving the accuracy of a medical diagnosis, boosting student outcomes, or advancing autonomous vehicle capabilities, artificial intelligence (AI) has become embedded into many aspects of our lives. Now you can add wind energy to the ever-growing list of industries that are capitalizing on AI and machine learning to drive greater operational efficiencies.

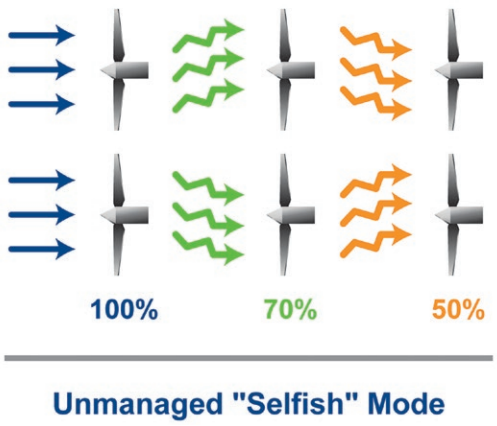
While interest and investment in wind energy has continued to grow (as utilities seek to diversify their energy portfolios to include more clean energy assets) it's hardly a new technology. Wind energy has been used for thousands of years in regions around the world. Although today's wind farms utilize sophisticated technology, the underlying methodologies for wind farms have largely stayed the same. As such, in most cases, wind energy producers are not able to maximize their aggregate power output. By combining AI, machine learning, cloud-based computing, advanced power applications, and networking capabilities, however, it is possible to optimize for a healthy boost in energy production - with commensurate Power Purchase Agreement (PPA) or high-demand-period gains. How healthy a boost? The predicted increase in energy output for optimized wind farms ranges from 2-10 percent.

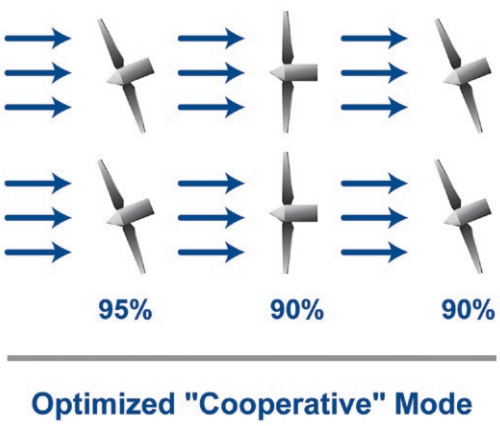
Using Optimization to Boost Megawatt Output

Reducing wind wake, or wake turbulence, is the underlying principle behind integrated wind energy optimization. In traditional wind farms, each turbine is individually optimized. Much like an airplane or boat, each turbine creates its own wake. In this scenario, the wake from the upwind turbines prevents downwind turbines from receiving full energy from the wind stream. This is not an isolated problem: It is estimated that two-thirds of U.S. wind farms experience reduced capacity due to wind wake.

Artificial intelligence enables wake steering, whereby upwind turbines steer the wake away from downwind turbines by adjusting the yaw (or side-to-side) settings of each turbine. In doing so, the turbines can work cooperatively to extract maximum energy from the wind stream.

Wind physics and machine learning algorithms are used to perform complex calculations that determine the optimal yaw settings for all conceivable data combinations, including historical weather and wind patterns, elevation, types of turbines (including thrust and power curves), exact turbine locations and other factors. Specially architected control technology uses a fault-tolerant network to communicate data from each turbine's wind sensor to the optimization platform every 1-2 seconds. This near-real-time data enables a more accurate calculation of the optimal yaw setting for each turbine within a wind farm. Machine learning is then applied to the data generated from all turbines on the network to further improve optimization models over time.

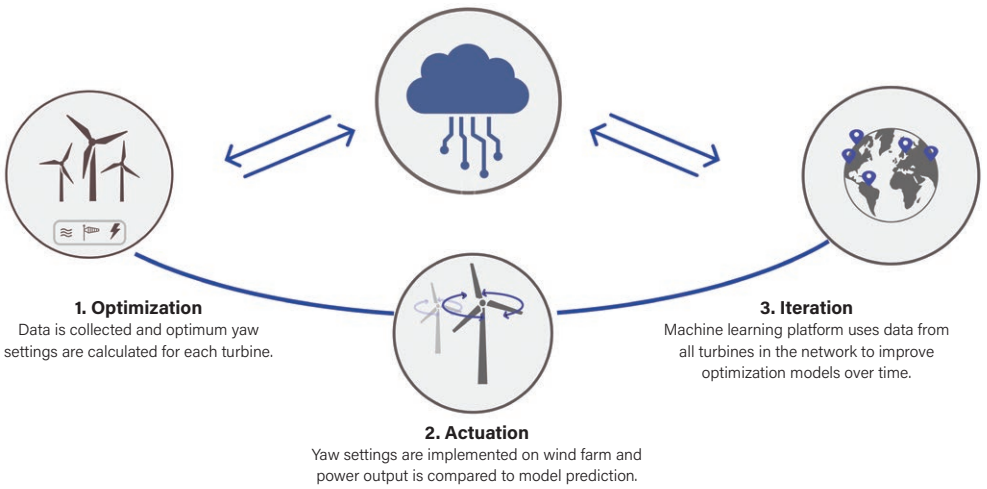




Safety equipment for the summer heat

Pyramex offers a variety of products to help combat the summer heat including the HPSHADE hat shade series, which has an oversized brim with a neck shade, the CNB series, which provides additional cooling, and the CNS1 series which features a padded neck shade. They also offer cooling and moisture wicking towels, cooling towel wraps, breathable skull cap, and cooling hard hat pads. Pyramex's full line of hi-vis short sleeve and long-sleeve shirts and cooling vests are adjustable, durable, and ultra-lightweight. Constructed of a thin polyester material, the breathable and moisture-wicking material won't stick to wearers when they sweat. The material also offers UPF30 sun protection and is ANSI rated.

Pyramex Safety /// www.pyramexsafety.com



Beyond increasing a wind farm's power output, yaw offsets also have the potential to reduce maintenance costs and reliability concerns. It is believed that alleviating stress from wakes may diminish fatigue loading on turbines, thereby improving a turbine's component lifetime.

The industry is well positioned for wind farm optimization. Just look at the numbers; Overall capacity of all wind turbines installed worldwide is 600 gigawatts, according to the World Wind Energy Association. The market is growing at an amazing rate, with nearly 54 gigawatts added last year. Of this additional generation, 7.6 gigawatts originated from the United States, which is now the second-largest wind power market. Most wind farm operators face the challenge of optimizing megawatt output in order to maximize clean energy output. By using AI and other advanced technologies to adjust yaw settings for each individual turbine, all of the turbines are managed so that they work cooperatively. The end result is the diminished impact of turbulence, and increased power generation across the entire wind farm.

Increasing energy output may also have a positive bottom-line impact. Of a mere fraction of the approximately 450 wind farms in the United States, more than $500 million in incremental revenue opportunities have been identified. Traditional full-scale repowering projects can cost millions and disrupt operations. AI-powered optimization technologies offer a cost-effective alternative that does not require replacing existing wind turbines and control systems. By combining smart investment in optimization with machine learning and AI, wind farm operators can aggregate power output, achieve their financial objectives, and deliver clean power to their communities.

Glen Wagner is Vice President, Power Projects for Emerson's Automation Solutions business, which helps process, hybrid, and discrete manufacturers maximize production, protect personnel and the environment while optimizing their energy and operating costs.

Emerson /// www.emerson.com

Jim Kiles is CEO of the VAYU Corporation, a cloud computing service provider for the delivery of optimization and machine learning software services to wind farms and stakeholders.

VAYU /// www.vayuai.com

Expansive bolt size tightening tool

Enerpac's HM-Series HydraMax for bolt tightening is engineered to achieve accurate bolt-load in single or multiple tensioner configurations, delivering reliable bolt tensioning with extreme performance on critical joints. The HM-Series HydraMax tensioners are designed to generate high-bolt loads associated with compact flanges, overcoming dimensional restraints with 15 load cells for bolts from ¾" to 4" and M20 to M100, covering all standard sizes with multiple load cell options. The HM-Series is designed to fit all standard flanges, including ANSI, API, and compact flanges based on Norsok L005, and generates 30% more load capacity than traditional tensioners. With its compact fit and high load generation, alongside the flexibility to work with all standard flanges, the new HydraMax tool can be used in almost every industry and in a vast number of different applications.

Enerpac /// www.enerpac.com

Easily send alerts to smart devices

The Lufft I-Box and Opus20 combination makes it easy to set up E-mail alerts from a Datalogger to smart phones and other devices. The Lufft I-BOX is a gateway for almost every measurement task, thanks to flexible app-technology. Users select an app for data input, data handling, and data output. For example, a particular Data Entry App will query 10 OPUS20 devices, the Data Processing App can generate an alarm, and the Data Output App will send the data to a database. The I-Box "plug-and-play" solution gives a uniform query to live data from different instruments such as the OPUS 20 Datalogger. In addition, an app for controlling alarms is included with the I-Box. Other apps are available at the I-Box App Store to suit individual needs.

Abbeon Cal, Inc.
/// www.abbeon.com

Modular wind turbine base

RUTE Foundation Systems' new concrete-saving, CO2-reducing foundation system for wind turbine towers has been awarded the 2019 Merit Award from the Post-Tensioning Institute (PTI), based on the first installation of the foundation technology. The modular wind turbine tower base, developed by with early support from climate impact accelerator VertueLab, cuts the amount of concrete needed by 75% over the life cycle of a wind farm. Because concrete contains cement, a material that generates large amounts of CO2 during production, the RUTE system also reduces CO2 emissions. The precast, modular components in the RUTE system are made in beam manufacturing plants and use post-tensioning technology.

RUTE Foundations
/// www.rutefoundations.com

Do more with less

2-in-1 impact sockets by Klein Tools allow hands-free adjustment to switch between two sizes within the same socket. These deep 1/2" drive sockets work great for pole hardware installation and removal. The high-torque 6-point design KL66004 reduces round-off and is available individually. The high-torque 12-point design KL66001 works on square fasteners and is also available in a 6-piece 2-in-1Impact Set KL66010.

Hi-Line Utility Supply Co.
/// www.hilineco.com

Converter Component Failures

What you don't know can hurt your bottom line

by Tommy Duckworth and Colleen Voisin

MAKE NO MISTAKE, THE WIND ENERGY industry has experienced a serious boom. In 2018, wind energy generated 6.5 percent of the nation's electricity. To put that into perspective, it's enough energy to power 26 million homes. Over the last decade, the US wind industry has invested over $142 billion in new wind projects - it is the largest source of renewable generating capacity in the country.

Despite growth of this industry, new wind turbines are expensive: up to $4 million per unit installed, which can last up to 20 years. Many things factor into the overall reliability and performance of each unit, including wear-out related failures, temperatures, humidity, precipitation, as well as the age of turbine components. Older wind turbines will feed more into your operation and maintenance costs. Understanding and finding ways to improve the reliability and performance of these turbines is paramount. The cost of new equipment (from the OEM) isn't cheap, nor is upgrading obsolete technology. Ordering replacement parts from your OEM often keeps a unit down for weeks because the parts are coming from overseas.

IRSP Partner

The key to improving wind turbine reliability is bridging the gap between the wind farm and the OEM. How do you do this? Partner with an Independent Repair Service Provider (IRSP). Wind farm managers should establish preventative maintenance strategies and preventative repair actions after the OEM's warranty has expired. The IRSP can help reduce operation and maintenance costs by identifying high failure components which, in turn, will help extend overall turbine life. If your IRSP isn't experienced in servicing electronic components such as IGBTs, Pitch Controls, Printed Circuit Boards, PLCs, and can't fully load-test your AC drives/Converters, you should look elsewhere.

Another advantage of a great IRSP is the service warranty that they can provide to your equipment on the back end - anywhere from 3 months to 2 years. Equipment warranties vary from provider to provider, so dig in and really get to know what's covered and what isn't.

The Power Converter Blues

One failure unit that comes to an IRSP from a wind farm is inarguably the Converter. The best way to identify high failure components is to open the unit and inspect the electronics. Not all Converters are created the same - high failure components will vary with each OEM. Take this failure example:

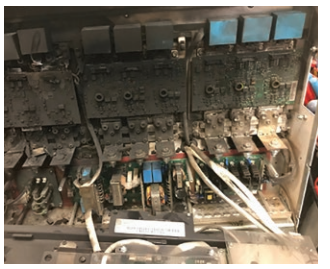
- IGBTs
- Flat ribbon cable that connect IGBTs to the control board
- Clamp Capacitors
- Gate driver boards that mount to the IGBTs

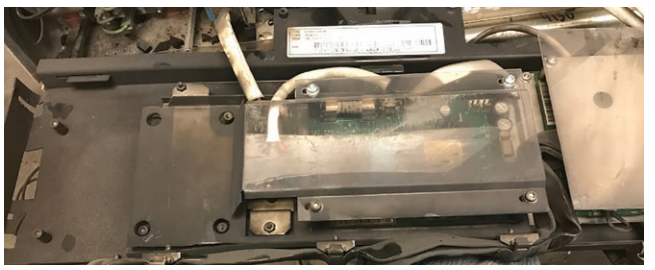
If there is an IGBT failure, the reasons could be excessive voltages, excessive current or excessive thermal stress, or even insufficient cooling. Excessive currents can happen because of wrong limits set forth for currents, or even an external short circuit (i.e.: motor, cable). Other failure factors could be temperatures, vibrations, humidity, and even age of components. All of these factors should be considered in order to accurately diagnose any performance issues and repair actions.

Troubleshooting Converters

Here is an effective, 5-step process for troubleshooting and repairing Converters by an IRSP technician:

1. Remove the cover on the unit and perform a VOI (visual overall inspection); inspecting for any burnt, blown, loose connections, and bus caps that have swelled.
2. Perform a static check with a digital multi-meter (DMM). The DMM checks the inputs and outputs of the rectifier section and the inverter section.
3. Power up the control board and power supply board to verify all voltages are correct.
4. Test the DC link for leakage, also known as Internal Resistance (IR).
5. Test the blower.

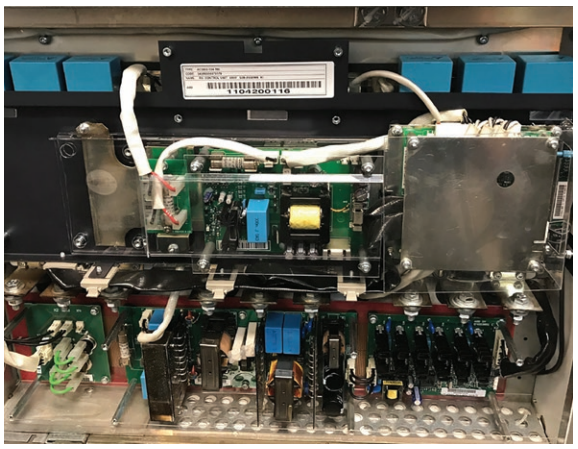


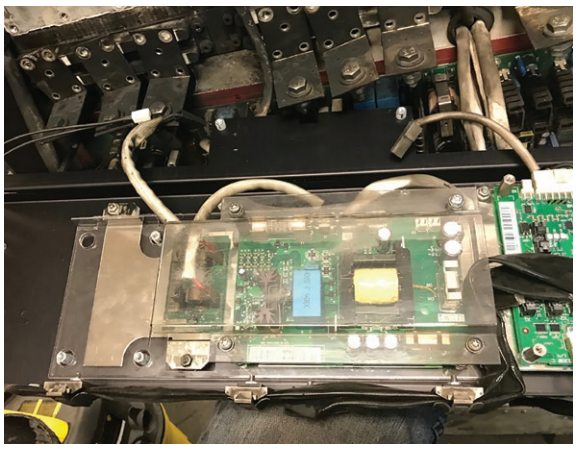


The Repair Process

After initial inspection, the IRSP technician begins to remove, repair, clean, and rebuild any stressed parts and obsolete components.

1. Remove the IGBTs, heater plates with control board, power supply, and blower.
2. With all components removed, clean bus bars and heat sinks inside and out of unit.
3. Verify which IGBTs are the correct ones for the unit; this is dependent upon the type of DC filter inside the unit.
4. Install of IGBTs with the correct torque specifications.
5. Build heater plates and install control and power supply boards, and make sure all connectors are securely fastened.





VFD Testing Phase

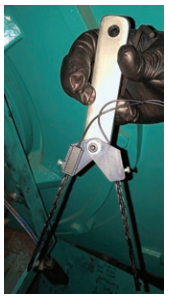
This is by far the most crucial step in the overall process, because the IRSP technician must make sure that all components are in working order before they are returned to the wind farm. The repaired unit moves into a load testing center and fiber optics connect to the control board. Proper voltage is applied to the DC link and control power is applied to an external controller. The unit should power on with no faults. After power up, initiate a run command and ramp the unit up to 50 Hz. The final step is scoping the outputs to verify that each phase is properly turning on and off.

If the unit passes all the above, the VFD connects to the load center and runs at a 200amp load for one hour to allow burn-in of the IGBTs. It's important to use an IRSP that can fully load-test drives up to 400 horsepower. The testing process allow technicians to identify weak and faulty components, as well as any hotspots, while measuring and monitoring the voltage and currents coming out of the drive. It's important to send all test reports to the client. It will give them peace of mind that their equipment will work as soon as it's shipped back.

Properly maintaining converter components is a big deal, particularly after hoisting a 100lb unit up a 300-foot wind turbine. Partnering with the right IRSP who can fix and test your equipment is critical, and can help you avoid a big (and costly) headache down the road.

Tommy Duckworth is Electronics Shop Manager and Colleen Voisin is Marketing Director for Industrial Repair Service. Industrial Repair Service technicians use state-of-the-art technology to test and repair wind power equipment, especially older and obsolete components.

Industrial Repair Service /// www.industrialrepair.net



Carbon fiber contact for shaft grounding

Schunk has developed a product that is proven to safely transfer parasitic current through a rotating shaft via way of carbon fiber grounding. Without a low impedance path parasitic current will transfer through ball bearings causing pitting and leading to high temperature bearing faults. Using a proprietary coating, Schunk can utilize the high surface area of a carbon fiber strand as a conductive path for high frequency current. This creates hundreds of individual connection points with the ground shaft and utilizes the skin effect principal to reduce electrical impedance.

Schunk Carbon Technology, LLC
/// www.schunk-carbontechnology.com

Naming convention for wind turbines

SCADA International makes available its Global Wind Data Tag-List, providing uniformity to roughly 1400 tag-names and data points that cover diverse turbine types, models, and brands. The tag-list is a naming convention which attempts to promote data exchange within the industry, rooted in and compliant with the IEC 61400-25 standard.

SCADA International
/// www.scada-international.com

Battery powered in-line cutting tool

ILSCO announces an addition to their battery powered in-line cutting tool offering. The TB-CUT26ACSR-IS features a 350° rotatable scissor head design with heavy duty blades that cuts up to 3/8" EHS Guy Wire and 556 ACSR. Blade inserts make for easy field replacement. A DataTrack / USB interface captures output performance and data. The tool is backed by a 5-year TaskMaster Pro warranty.

ILSCO /// www.ilsco.com

Mobile-enabled wireless security device

Supra's TRAC-Guard padlock provides authorized, secure access to virtually any remote site. This Bluetooth-enabled padlock adds convenience and security in place of traditional mechanical or combination locks. The versatile TRAC-Guard padlock comes ready for use and fits seamlessly into Supra's TRACcess Manager system to enable mobile access, real-time communications, and 24/7 cloud-based management. The padlock enhances security via authorized and tracked access. TRAC-Guard padlock operations are protected with layers of security such as individually authorized keys that routinely expire, required individual PIN codes, user permission for each locking point, and encrypted system communications. Cloud-based, 24/7 TRACcess Manager administration provides a view to access activity from the portal, or email alerts or routine reports, to monitor job status, confirm vendor maintenance visits, and check the electronic logbook. Setting up mobile keys is quick and easy with permissions delivered in real time to the TRACcess eKEY app. This eliminates the need for staff travel solely for opening gates or doors or providing access to assets such as heavy machinery. Bluetooth communications between the mobile key and the lock enable operations even in areas lacking cellular coverage.

Supra /// www.suprasystems.com

Grease is the Word

by David Swanson

MOST LUBRICATION BASICS are fairly well-understood in this day and age, and there are plenty of resources of documentation regarding lubricating systems and analysis. But there's still one lubricant that remains a mystery to many – grease. Grease itself is a poor lubricant. The oil and additives held in place by the grease soap fibers are the elements that actually perform the lubrication in a system.

Areas such as manufacturing environments, OEM formulations, correct sampling methods, and compatibilities give us a better understanding of the functionality and necessity of grease analysis in lubricated equipment.

Grease Manufacturing Causing Complications

The manufacturing process for grease requires high temperatures and pressures, and accurate applications, which cause complications during manufacturing. The tests designed to qualify grease from the manufacturing environment were designed decades ago, mainly to ensure quality. However, they were not specifically designed to encompass qualifying grease for use in the field.

Not All Greases Are Compatible

To make the scenario more complicated, most OEM's specify three parameters: National Lubricating Grease Institute (NLGI) grade, soap type, and (sometimes) a base oil viscosity requirement. Grease manufacturers have identified formulations. While these three parameters may be identical, the actual formulations could be significantly different. Not all greases are compatible – even greases of the same soap composition may be incompatible with each other. In extreme cases, this can result in a complete loss of lubrication in the component, and, ultimately, equipment failure.

Grease Sampling vs. Oil Sampling

Collecting an accurate, representative sample of your grease – to send in for analysis that provides a valuable maintenance recommendation – can be challenging; it's not as simple as oil sampling. Poor sampling techniques and processes can give you limited information, or a false sense of security when there could, in fact, be a catastrophic problem.

The sampling processes of grease lubrication and oil lubrication are different. Grease is designed to release the lubricating oil charge with the soap holding it into the area where the lubrication is required. As a result, the grease in the compartment will most likely be extremely non-homogeneous. Collecting a grease sample from the incorrect location (for example, the outer surface of your component) may not be representative of the grease next to the area being lubricated. Sending in an incorrect, non-representative sample can mean receiving incorrect analysis results and maintenance recommendations.

To help collect a representative grease sample, some fluid analysis laboratories provide customers with cost-effective, easy-to-use sampling devices and other materials used to extract grease from the system. These sampler devices are included in each type of sample kit. They come with shipping tubes and labels for easy sampling and submitting to the laboratory.

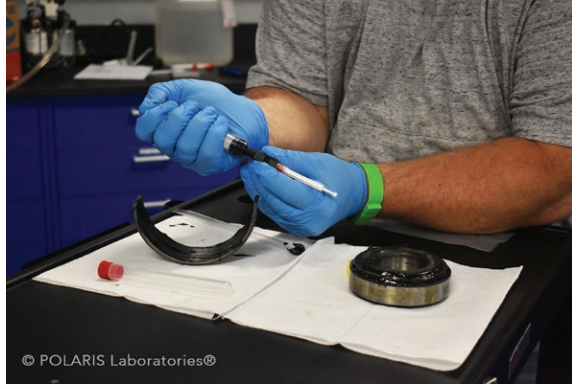
Why Test?

It all comes down to cost. Grease is significantly more expensive than an equivalent lubricant. Accurate grease analysis is a major value add when it comes to maintenance, given that grease-lubricated systems are designed to last extensively longer than oil-lubricated systems. This means there's a financial gain from gathering effective and actionable maintenance recommendations from the results of your grease analysis.

Grease Testing and Analysis

Grease testing and analysis provides valuable insight into grease performance and integrity, including reliability-centered areas like wear, consistency, contamination, and oxidation.

Performing the maintenance actions recommended after grease is analyzed will result in: Minimized unplanned repairs; Decreased downtime; Extended machine life.



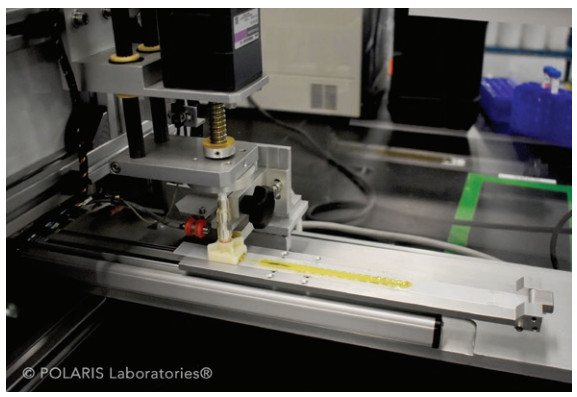
The following laboratory tests analyze properties within grease to target potential problems that could cause equipment failure.

- **Die extrusion** | Measures the grease's consistency by applying different loads on the sample and extruding the grease through a die and measuring the resistance
- **FTIR** | Identifies contaminants and oxidations levels by looking at the absorbance of different functional groups in the spectra
- **Colorimetry testing** | Finds changes in appearance that are caused by overheating, aging and contamination
- **ICP-OES** | Evaluates grease for wear metals, additive elements, and contaminants
- **Linear sweep voltammetry** | Measures antioxidant content and estimates life expectancy of the antioxidant package in the grease
- **FdM+** | Identifies ferromagnetic materials in the grease to determine wear concentration by passing the sample through a magnetic field, and measuring the disturbances of that field from the entrained magnetic particles

Unfortunately, grease as a lubricating agent will continue to be a mystery for the foreseeable future. Accurate grease sampling, coupled with laboratory analysis can help alleviate the confusion, provide insights into what is going on in the system and help protect your grease investment. The results from testing your grease can give you an inside look into your system, the grease-lubrication properties to stop problems from occurring, and extend the health of your system.

David Swanson is Director of Technical Services for POLARIS Laboratories, an independent fluid analysis laboratory specializing in oil, grease coolant, and diesel fuel analysis. David has more than 25 years of analytical laboratory, industrial processes and management experience, including quality control, laboratory analysis and leadership roles for petrochemical and industrial chemical companies. He leads the science, quality and maintenance teams at POLARIS, and also oversees the laboratory processes, ensuring our science operations are compliant and functioning under the highest quality standards. He is the ISO 17025 Quality Manager for the company.

POLARIS Laboratories
/// polarislabs.com



Lubricants and Greases

An important part of the planned maintenance of a wind turbine, proper lubrication will help keep the machinery working well for years. Keeping a wind turbine's gearbox properly lubricated is essential to extending the life of the turbine. Herein we highlight some of the solutions available on the market today...

OILS

American Chemical Technologies, Inc.

Product: EcoGear 270XP

Application: Wind turbine gearboxes

cSt @ 40°C: 270 cSt

cSt @ 100°C: 39.5 cSt

Viscosity Index: 215

Pour Point: 13.9°F (-25.5°C)

Flash Point: 426°F (219°C)

www.americanchemtech.com

Shell Lubricants

Product: Shell Omala S5 Wind

Application: Shell Omala S5 Wind is designed to help extend maintenance intervals. It will defend against deposit formation and prolong gearbox life.

cSt @ 40°C: 320 cSt

cSt @ 100°C: 39 cSt

Pour Point: -54°F (-48°C)

FVA micro-pitting fail load stage: >10

www.shell.com

Hydrotex

Product: SYN-Nth Gear Oil

Application: SYN-Nth Gear Oil maximizes gearbox reliability. Its protection against gear scuffing and micropitting has been documented with FZG testing and field-proven in wind turbines. Its high oxidation stability extends drain intervals. Guaranteed ISO 4406 cleanliness: 16/14/11.

cSt @ 40°C: 390 cSt

cSt @ 100°C: 43.6 cSt

Viscosity Index: 167

www.hydrotexlube.com

GREASES

Fuchs Lubricants

Product: Gleitmo 585K

Application: Gleitmo 585K is used in Pitch and Yaw Bearing in Wind turbines. It provides the much needed protection from wear and micropitting that is evident in the modern pitch bearing systems.

cSt @ 40°C: 50 cSt

Temperature Range: -49°F to 284°F (-45°C to 140°C)

Dropping Point: >356°F (>180°C)

Oil Type: Synthetic

Thickener Type: Lithium

NLGI Grade: NLGI #2

Oil Separation (40°C for 40 days): <5%

www.fuchsus.com

AMSOIL, Inc.

Product: Synthetic Main Bearing Grease

Application: AMSOIL GMB grease is engineered specifically for use in wind turbine main bearings. Its combination of synthetic PAO base oils, lithium complex thickeners, and carefully chosen additives specifically solve common main bearing issues such as wear, rust, and grease deterioration or hardening. AMSOIL GMB grease works well in large slow-speed bearings with high loads and in the moisture-laden environments that wind turbine bearings are subjected to. AMSOIL GMB allows bearings to run freely with an ultra-low starting and running torque, yet provides wear protection and prevents drag. AMSOIL GMB grease can be used in other applications and is a solution for pitch and yaw bearings.

cSt @ 40°C: 460 cSt

Viscosity Index: 181

www.amsoilwind.com

Drones

Ensuring the continual performance of renewable energy assets requires a systematic approach to maintenance, repair, and monitoring. In order to prepare a comprehensive maintenance plan, inspections must be performed to determine faults and failures, whether through sensing technology, photographic evidence, or human interface. Advances in technology are rapidly changing the way the industry conducts this business. The evolution of drones and artificial intelligence technology have developed into increasingly accurate methods of inspecting equipment, analyzing, and reporting generated data to produce actionable planning for scheduled maintenance, effective budgeting, and reducing urgent repairs.

Nearthlab

Product: Autonomous drone for smart defect detection and analytics using AI

Description: Drone flies up and gathers photos of a wind turbine. Images are uploaded to Nearthlab's web service to create full reports within one week.

Industries: Wind

Services: Inspection, Drone-as-a-Service

Autonomous: Intelligent pathing, blade aware

Inspection time: 15 minutes

Flight features: Hover capability, autonomous detection

Safety features: GPS redundancy, collision-tolerant, emergency landing

Software: LiDAR, interactive, deep learning, 46 mega pixel

Data analysis: Consultants, analysts, AI (predictive analytics)

www.nearthlab.com

Alerion

Product: Autonomous wind turbine inspections and real-time analytics

Description: Alerion provides fully automated wind turbine inspections in less than 15 minutes, including a damage assessment report on the field.

Industries: Wind, solar, commercial

Services: Inspection, surveying, Drone-as-a-Service, infrared, thermal imaging, beyond line of sight (BVOL)

Pilot: FAA Part 107 exam

Autonomous: Intelligent pathing, blade aware

Length of operation: 15 minutes

Flight features: Fixed wing, hover capability

Safety features: Geofencing, GPS redundancy, collision-tolerant, emergency landing

Software: 3D mapping, modelling, LiDAR

Data analysis: Consultants, analysts, AI (predictive analytics)

www.aleriontec.com

Measure

Product: Drone Services & Software

Description: Measure's flight operations, specialized data engineering, and comprehensive software help corporations deploy drones at scale, saving thousands of hazardous man-hours and providing millions of dollars in operational benefits.

Industries: Wind, solar, commercial, T&D

Services: Inspection, surveying, Drone-as-a-Service, confined spaces, infrared, thermal imaging, beyond line of sight (BVOL)

Pilot: FAA Part 107 exam

Autonomous: Intelligent pathing, blade aware

Image capture: Up to 47 mega pixels

Length of operation: 40 minutes (wind), 10 minutes/MW (solar)

Flight features: Fixed wing, hover capability

Software: 3D mapping, modelling, LiDAR, interactive

Data analysis: Consultants, analysts, AI (predictive analytics)

www.measure.com

Clobotics Corporation

Product: Clobotics Windspector - Autonomous Drone Inspection Solution

Description: Clobotics' Windspector is an end-to-end solution combining autonomous drones, artificial intelligence, cloud-based data analytics, and asset management for automated inspections of both onshore and offshore wind turbines.

Industries: Wind

Services: Inspection, Drone-as-a-Service

Pilot: FAA Part 107 exam

Autonomous: Intelligent pathing, blade aware, no predefined path

Inspection time: Under 25 minutes

Flight features: Hover capability

Safety features: Geofencing, GPS redundancy, emergency landing

Software: Modelling, LiDAR, interactive, AI algorithms

Data analysis: Analysts, AI (predictive analytics)

www.clobotics.com

Scanifly

Product: 3D Modelling Software for Solar Surveying and Design

Description: Scanifly has built a solar-focused reality capture 3D modelling software. Using the platform, solar developers create projects up to 90% faster, for less cost and greater safety. The software produces array layouts, bankable shade reports, and CAD files.

Industries: Solar, commercial, residential

Services: Surveying, design, marketing, Drone-as-a-Service

Pilot: FAA Part 107 exam

Software: 3D mapping, modelling

Data analysis: Consultants, customer-led

www.scanifly.com

Wind Products Shipped to the US West Coast Require More On-Dock Space

The Port of Stockton is the best option for wind energy OEMs on the West Coast of the United States. Components are getting larger, timing and availability of cargo are becoming more critical, and the Port of Stockton offers the flexibility of 24/7 gates and ease of access to major freeways. Additionally, the they are served by both the BNSF and UP railroads. All of this gives cargo owners better control of their shipments.

OFFSHORE WIND FARMS ARE PROJECTED TO EXPERIENCE EXPLOSIVE GROWTH IN THE UNITED STATES

The expected growth of offshore wind farms off the coast of California will require ample laydown area for the assembly and staging of tower components for subsequent movement to the erection site. The ability to assemble onshore and near-dock provides efficiencies, and the Port of Stockton has more than enough laydown area and rail capacity for virtually any project.

SPEED

OEMs increase efficiencies by getting their components to the erection site on time and within budget. With immediate access to uncongested highways like I-5, CA-99 and CA-4 as well as on- and near-dock rail the Port of Stockton gets product where it needs to go as quickly and efficiently as possible in the easiest possible way.

COMMITMENT TO A CLEANER ENVIRONMENT

The Sacramento-San Joaquin Delta, in which the Port of Stockton operates, is an important and delicate environment. Not only does it provide drinking water for two-thirds of the state, it acts as a habitat for countless fish, birds and wildlife. The Port is deeply committed to maintaining and protecting this area. The Port's Delta Environmental Enhancement Program (D.E.E.P.) aims to enhance air quality, water quality and wildlife habitats in the Delta and surrounding communities.

The Port of Stockton continues to expand its commitment to a cleaner environment by being a participant in the Green Marine Project. Green Marine is a leading North American environmental certification program for the maritime transportation industry.

The Green Marine certification process is rigorous and transparent. Results are independently verified every two years and each company's individual results are published annually.

The Port is also in the process of replacing its fleet of diesel forklifts with electric zero-emission lifts.

FLEXIBLE AND SECURE

With 15 Berths the Port can quickly adapt to changing vessel schedules. With 24/7 Security they keep your cargo safe.

PLANNING OPPORTUNITIES FOR FUTURE GROWTH

Due to the increased shipments of wind components to the US West Coast, OEMs need more and more space to meet the demands of their customers. The Port of Stockton offers 500 near-dock acres for development for importers to store and handle large scale projects.

No other Port offers the advantage of having ample laydown area the space for the on-shore assembly of product, the ability to handle increasing volumes and hundreds of acres to give customers opportunities to grow.

Port of Stockton
CALIFORNIA

Coupling technology

Timken imagined a way to transmit torque between the gearbox and generator while protecting attached components from overload and stray currents. Next-generation Lovejoy couplings, bolted to an AeroTorque WindTC torque control, are now available for 2MW+ turbines. These couplings integrate directly with the generator hub, include an anti-flail feature, and use a composite fiberglass spacer for weight and cost efficiencies. An AeroTorque-enabled coupling provides advantages such as reducing peak torque by up to 40% and reducing torque oscillations up to 70% to extend gearbox life. Together, Lovejoy and AeroTorque are part of a strong, technical solution for making reliable gearbox-to-generator connections.

The Timken Corporation
/// www.timken.com

Redefining the use of lidar

Vaisala introduced Leosphere's lidar (Light Detection and Ranging) technology into its portfolio of offerings in North American markets, providing end-to-end sales and support services for the Windcube portfolio of lidar systems to customers in the U.S. and the rest of the world. Leosphere lidars offer a wide range of solutions to track wind speed and direction required for new wind farm planning and construction. The Leosphere Windcube suite of systems is discreet, mobile, and capable of remotely reaching greater heights to aggregate superior data for wind prospecting. The Windcube systems empower owners to increase efficiency in long-term wind energy production by enabling the potential for full rotor sweep measurement. Vaisala offers four distinct Leosphere Windcube lidar systems: Windcube Vertical Profiler, Windcube Scanning Wind Doppler Lidar, Wind Iris, and Wind Iris TC (Turbine Control).

Vaisala /// www.vaisala.com

Wireless multimeter with bluetooth technology

Extech has launched the MM750W, a CAT-IV True RMS digital multimeter (DMM) that can be used to view real-time readings and datalog remotely using the ExView W-Series app on smartphones and tablets. The datalogging sample rate can be adjusted according to a job's requirements and up to 15,000 datalogged readings can be stored. The new meter includes a Bluetooth module for wireless connectivity to iOS and Android devices, allowing safe testing at a distance of 33ft/10m. The MM750W transmits real-time data for monitoring, trending, reporting, and analysis and allows for remote tasks such as powering up circuits, motors, pumps, or other plant equipment from a distant control panel. The ruggedized Extech is a 14-function True RMS DMM that reads AC/DC voltage and current (both A and µA), resistance, capacitance, frequency, duty cycle (dwell), continuity, diode testing (3.0V), and temperature (using its Type K thermocouple bead probe). The new meter ensures precise readings with 0.6% accuracy and it is rated to Category IV overvoltage (CAT IV-600V, CAT III-1000V). Several statistical data functions include minimum/maximum, difference (MAX-MIN), relative mode to zero the meter, and data hold to freeze the display reading. Auto-power-off protects battery life but can be disabled when extended testing is needed, such as datalogging. The Extech MM750W includes test leads, Bluetooth wireless datalogging module, Type-K temperature probe, 9V battery, and carrying case.

Extech Instruments
/// www.extech.com

iOS and Android apps for PLC access

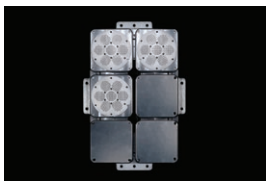
IDEC Corporation's WindEDIT Lite app for iOS and Android devices provides two-way access to its family of MicroSmart FC6A PLCs. With the WindEDIT Lite app, users can monitor any PLC parameter, and change set points and other values. Data register, input, output, timer, and counter values can be monitored and controlled using the standard Dialog Interface. The WindEDIT Lite app has a custom Dialog Interface which the user can configure to allow only certain PLC parameters to be monitored and controlled. Trending is supported within the app, with users able to plot multiple register points for graphical views. The WindEDIT Lite app runs on any iOS or Android mobile device, typically a smartphone or tablet. Once the app is downloaded to the device, it interfaces to the MicroSmart FC6A PLC via wireless Bluetooth or Wi-Fi Ethernet for two-way local or remote access. The WindEDIT Lite app provides access to an SD memory card installed in the PLC, so logged information stored in the SD memory card can be easily accessed. The logged data can be viewed, and then attached to a text message or an email, either of which can be sent to recipients. Logged data can also be pushed to a local or cloud-based database, or to a data storage platform such as Dropbox, Google Drive, Apple iCloud, etc. In addition to logged data, other data such as user programs, firmware, recipes, etc., can be sent and retrieved from databases and storage platforms.

IDEC /// www.idec.com/usa

Alternative lifting solution

LiftWerx, in close co-operation with the Kenz Figee Group, has developed a cost effective, versatile, and environmentally-friendly up-tower crane for the wind energy O&M industry. LiftWerx's GenHook cranes are designed to perform major corrective repairs in wind turbine nacelles. The cranes are equipped with fully-electric winches which can lift and exchange gearboxes, blades, and generators with extreme accuracy, while working in wind speeds up to 18m per second.

LiftWerx Solutions, Inc.
/// www.liftwerx.com



Bat deterrent system

NRG Systems' Bat Deterrent System was developed to help the wind industry mitigate its impact on bat populations. The nacelle-mounted system creates an ultrasonic acoustic field around the rotor-swept area of a turbine which "jams" bat's echolocation capabilities. The animals then leave the treated area in favor of easier to navigate airspace, effectively moving them out of harm's way. Successful trials of the technology have been held in Texas and Illinois, proving it is an effective tool for reducing mortality of certain species of bats caused by wind turbines. NRG's Bat Deterrent System is commercially available in North America.

NRG Systems, Inc.
/// www.nrgsystems.com

Robust, affordable cable cutters

Working even smarter is utilizing Greenlee Ratchet Cable Cutters which convert automatically to ratchet mode during heavy duty cutting, making those tough cuts a breeze. Greenlee cutters also feature a unique anti-slip mechanism for positive ratchet action. There are four styles of cable cutters to choose from; the 28" Ratchet Aluminum and Copper Cable Cutter, the 29" Ratcheting ACSR and Soft Steel Rod Cable Cutter have extra thick blades, ground flat to reduce the potential for breakage and a rubber boot to protect the ratchet mechanism, the 32" Heavy-Duty Cable Cutter with pivot bolt for blade adjustment, and the 26" Standard-Duty each with strong, lightweight fiberglass handles and replaceable, forged, heat treated, and precision ground blades.

Hi-Line Utility Supply Co. /// www.hilineco.com

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THE TECHNICAL SYMPOSIUM

Lead Batteries Upgrade to the 21st Century

by Paul Bundschuh

THE LEAD BATTERY WAS INVENTED IN THE 19TH CENTURY. Today, in the 21st century, it remains the most commonly used rechargeable battery, in spite of the emergence of newer technologies such as lithium-ion. When it comes to key performance indicators – safety, reliability, sustainability, and initial cost ($/kWh) – the lead battery has few competitors, whether for powering our cars, providing standby power, or storing energy to optimize new renewable inputs.

The lead battery hasn't just survived. The industry is accelerating the pace of innovation and improving performance factors such as cycle life, water loss, self discharge, internal resistance, and charge acceptance – all of which directly impact safety, reliability, sustainability, and costs in a market expected to reach $84.46 billion by 2025.

Safety

Lead batteries have an unmatched record for safety. Lithium-ion batteries, on the other hand, continue to have significant safety issues in both electric vehicles and grid storage applications. Even if the lithium industry continues to improve on safety issues—like self-combustion—it is unlikely to site commercial- and grid- scale lithium batteries in dense urban settings (such as the basements of Manhattan high-rises) due to the inherent flammability of lithium material.

Reliability

Lead batteries have been relied upon extensively for 160 years. They're used in a wide range of temperatures and operating conditions; due to their higher reliability, even fully-electric vehicles (with lithium-ion batteries) use 12V lead batteries to power their most critical computer and electronic controls.

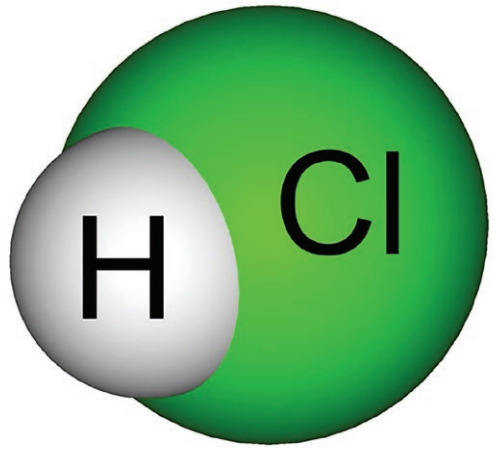
Sustainability

According to Battery Council International, more than 99 percent of the lead batteries in the U.S. are recycled - all of the materials can be reused. In fact, more than 60 percent of the lead used by lead battery manufacturers in the U.S. comes from recycled batteries instead of virgin lead material.

Because they can be economically recycled, lead batteries have high residual value, which further reduces their economic cost. Compare this to lithium batteries, which only have about a 5 percent recycle rate. Improving the recycle rate for lithium-ion batteries will likely require a significant subsidy, but this is not cost competitive with virgin sources, and will only add to the battery's costs. Usually, the recycling of lead batteries is included in their price; for Li-ion batteries, this is not the case.

Additionally, lead batteries are greener than lithium-ion; they have less embedded energy and carbon dioxide in their manufacture, are sourced and recycled in North America, and are not dependent on foreign, and possibly unstable sources for raw materials.

Cost



Though certain storage battery systems can be comparable in cost, the initial cost per kWh of lead batteries is generally about 1/3 that of lithium-ion batteries. But if lead is more cost effective, why isn't it used more widely in grid storage? In fact, it is becoming more widely used – the Consortium for Battery Innovation website (www.batteryinnovation.org) highlights lead battery applications for grid storage with a searchable map of installations. Lead batteries continue to be the standard for grid backup power in applications such as data centers, hospitals, and telecom. Lithium has gained more recognition recently for newer applications such as frequency regulation and time shifting of renewable energy supply—specifically solar and wind—but lead batteries are proving effective and cost-competitive in these applications as well.

Major Innovations in Lead Battery Technology

As the North American lead battery industry continues to accelerate innovation with increased battery lifecycle and other performance improvements, the gains in safety, reliability, and sustainability will not only make lead more competitive with lithium, but—just as importantly—it will help manufacturers and other high energy consumers reduce costs and grow their bottom line.

Argonne National Lab – the premier Department of Energy National Lab focused on battery technology – has established an industry collaboration with 14 U.S. lead battery manufacturers and suppliers to continue this drive for innovation. With this public-private partnership leading the way, the market can soon expect to see critical advancements in areas such as battery design, carbon technologies, lead oxide technologies, and new electrolytes.

Battery Design

Bipolar lead battery test results demonstrate improved AGM battery lifecycle in the range of 3-4x, while also improving energy density by 40 percent. Several top global lead battery manufacturers are taking advantage of this newer technology.

Lead-Carbon Technologies

Advanced carbon technologies are substantially improving charge acceptance and cycle life in many applications. There are several carbon suppliers that are improving battery performance without sacrificing on other factors such as safety, reliability, sustainability, or costs. Specialized carbon materials improve durability and performance of batteries for hybrid and electric vehicles, and for grid-level electricity storage.

Lead Oxide Technologies

Lead battery manufacturers are the biggest consumers of lead, with different types of oxide to meet specific product characteristics such as acid absorption, water absorption, and tamped density values related to the reactivity of the oxide.

Electrolytes

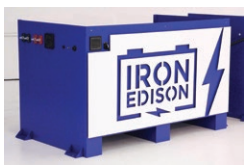
Since the invention of lead batteries, sulfuric acid has been the electrolyte used as the third active material, but this is one area where innovation can transform the lead battery for the 21st century. Electrochemical cyclometric tests have shown that replacing the sulfuric acid in lead batteries reduces parasitic reactions on both positive and negative electrodes, and may offer significant performance improvements on several critical lead battery performance parameters including water loss, charge/discharge resistance, and self discharge.

The lead battery technology innovations in bipolar battery design and materials - including carbons, lead oxides, and electrolytes - has the potential to improve lead battery performance in deep cycle stationary storage applications by 5 to 10x in the next few years as these technologies are realized in volume commercial products.

Lead batteries have proven their effectiveness for 160 years because they get the job done simply and efficiently. Furthermore, this established and mature market is on the verge of real transformation. The future of the lead battery industry is as promising – and electrifying – as any of the newer technologies on the market.

Paul Bundschuh is CEO of Tydrolyte, which innovated an electrolyte solution for automotive and stationary storage lead battery manufacturers. Tydrolyte's chemistry replaces toxic sulfuric acid in lead batteries for safe and sustainable energy storage.

Tydrolyte /// www.tydrolyte.com



Plug and play lithium ion battery

Iron Edison introduces its newest lithium battery for solar, the 4LiFe Lithium Ion Battery, which can be used as a direct replacement for lead acid batteries. The 4LiFe Battery is designed to simplify battery installation with its plug-and-play design. The 4LiFe battery can add battery to an existing solar installation, and can be used for a new off-grid or grid-tied solar system coupled with energy storage. There is a variety of sizes available, starting at 100Ah at 48V (4.8kWh), and is also available in 200Ah 48V (9.6kWh), and 300Ah 48V (14.4kWh). The 4LiFe battery can operate in parallel from two to twenty units to achieve up to 6,000Ah at 48V equalling 288kWh of energy storage. The 4LiFe batteries come with an integrated battery management system, that allows the battery to charge and discharge at a super fast rate. Iron Edison's 4LiFe lithium battery utilizes safe Lithium Iron Phosphate (LiFePO4) chemistry. The Iron Edison 4LiFe batteries can be used in commercial solar applications, residential solar with battery, boats, and RV's. The 4LiFe lithium batteries from Iron Edison are compatible with all inverters and charge controllers such as Schneider Electric, Outback Power, Magnum Energy, MidNite Solar, and SMA. This helps solar installers to save time hunting for compatible parts, giving them a faster and more convenient installation experience. From a practical perspective, the 4LiFe batteries are lightweight and can be easily moved around. This Iron Edison 4LiFe battery has an expected cycle life of 7500+ cycles at 80% DoD. The 4LiFe lithium battery also comes with a 10-year warranty, and lifetime technical support.

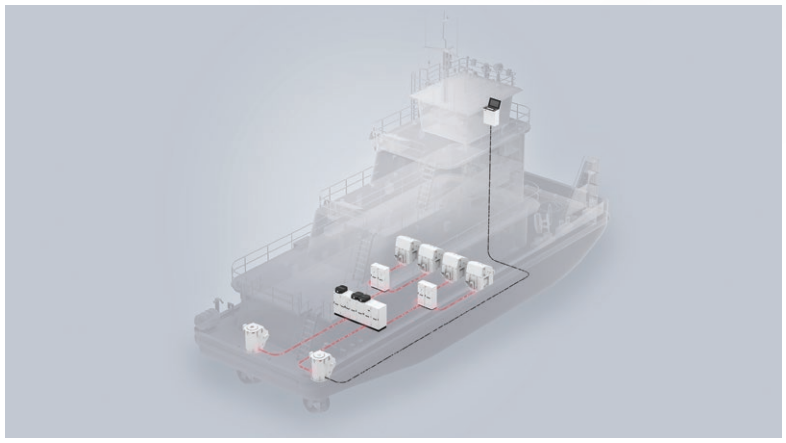
Iron Edison Battery Company
/// www.ironedison.com

Charging the Marine Industry for Tomorrow's Demand

by Ed Schwarz

THE DEMAND FOR SUSTAINABLE SOLUTIONS is a relatively new concept in the maritime and shipping industry.

Historically, the marine and shipping market segment has fallen under the radar on policy discussions regarding carbon footprint reduction, but there has been a recent internal and external push on the industry to find ways to rectify their environmental impact. Maritime activity accounts for approximately 3 percent of global greenhouse gas emissions annually. The International Maritime Organization, a United Nations agency responsible for regulating shipping, has set a global target to cut annual emissions by at least 50 percent by 2050, from 2008 levels. Vessel electrification is widely considered to have a strong potential to significantly reduce this figure.



Environmental and cost benefits of emission-free, electric vessels compel many marine vessel owners to seek electrification solutions for both new ship builds and existing diesel vessels. However, this recent influx in electric ships entering the market highlights a series of unique challenges for marine chargers at port.

Compared to other transportation market segments, maritime has an exceptionally broad operational profile – from long-distance large container ships, to small passenger vessels that ferry short distances. There is no one-size-fits-all solution when it comes to marine chargers. These demands vary throughout the entire industry, and can even differ within segments of the industry.

For instance, the degree of electrification can vary from ship to ship based on the level of equipment conversion the owner opted for (from retrofitted systems to full teardown and replacements). The conversion market has become one of the largest growing sectors in the industry as a large majority of owners are looking for quick, easy ways to electrify vessels operating today.

Building a new vessel is another option available to owners. In North America, vessels typically have a 35- to 40-year lifespan; it's worth noting that if you're considering a new-build project, it might take a couple years from concept to delivery of the vessel. This is why it's important for owners to make sure the vessel not only meets the regulatory and operational demands for today, but also for tomorrow. Many owners prefer to update their existing equipment, which may require custom chargers to meet their vessel's specific electrical demands.

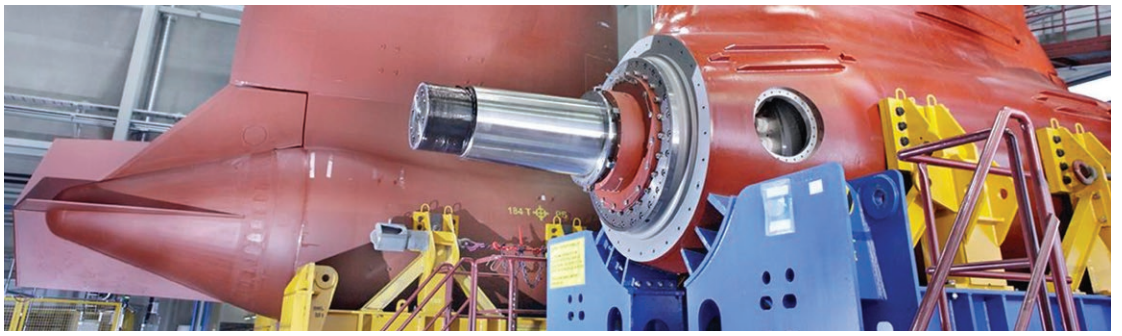
One of the biggest challenges for these chargers stems from the short connection issue within the design. While docked, ships remain mobile on the water, continuously moving in three different directions, which makes it difficult to establish a secure shore-to-ship power connection. This tedious connection process can be detrimental for cargo and passenger ships, both of which have imposed strict time limitations at each port. Vessel owners often spend more time with electrification companies discussing how their vessel will achieve that shore-to-ship power connection, than any other part of the design.

Some standards have already been established for these marine chargers, and the connection itself could eventually become standardized. In the United States, many marine chargers use industry-approved IEC standards. However, most ships require customized connection solutions due to reasons such as the vessel mission, conditions of operations, environmental impact, and more. Additionally, the US Coast Guard subjects

chargers to additional approvals, on top of local municipality requirements that can fluctuate from city to city. There are a lot of differing opinions on the current state of marine charging standards. Some may think they're a little loose, but this provides opportunities to develop custom designs to fit the owner's unique vessel needs.

In the past, most of the demands in the maritime industry involved bringing down the costs of transportation of goods and, more recently, improving safety. Now, we're starting to see a push for sustainable solutions to curb carbon dioxide emissions and reduce the potential for other forms of environmental contamination.

In addition to environmental concerns, conventional vessels have associated maintenance and operational costs that can be mitigated through electrification. Converting to electric could result in significant cost savings for large cargo fleets. Electrification also liberates much of vessel's storage of petroleum products, reducing the weight of the vessel for further cost savings.



Electrification is the necessary next step toward digitalization, and the ushering in of the Fourth Industrial Revolution for the maritime industry. Throughout history, the industry has made significant developments during each global period of major technological advancement. Dating back to prehistoric civilization (when the first vessels were all wind-powered) all the way to the Industrial Revolution of the 18th and 19th centuries that introduced the steam engine. Sailors no longer needed to worry about wind conditions, and were able to travel quicker to certain distances. We then progressed from dangerous steam engines to more reliable diesel engines, which brought down the cost and size of vessels.

While environmental and cost benefits may be the biggest attraction for vessel owners today, what electrification will really do is open a door to connectivity throughout the maritime industry, signaling the next big jump in technological advancement – fully autonomous vessels. These vessels will use sensors that communicate with other ships and crews on shore to safely control, navigate, and drive the vessel.

We're in the very early stages of evaluating how to reduce accidents, improve the life of seafarers, become more accurate with our tracking of vessels, and so much more. This is where the industry is headed, with electrification laying the groundwork. But first, we must overcome today's challenges with marine chargers and electric standardization.

Visitors to the iconic Niagara Falls will soon be able to experience one of the US's top landmarks emission-free. Two new passenger vessels will be powered entirely by high-capacity battery packs, becoming the first all-electric vessels ever built in the US. The new vessels will benefit from zero-emission technology when they start operating later this year, allowing guests to experience Niagara Falls undisturbed by engine noise, vibration or exhaust fumes from a conventional diesel engine.

Ed Schwarz is Vice President of ABB Marine & Ports, which researches and develops power solutions for marine applications - including power storage - for shipbuilders, owners and operators, and the entire renewable energy industry. Ed Schwarz graduated from the United States Merchant Marine Academy (Kings Point) in 2000, with a Bachelor of Science in Marine Engineering and Shipyard Management. After sailing for MEBA on varies US flagged merchant vessels for 7 years, and upgrading his license to an unlimited First Assistant Engineer he joined the shore-side of the maritime industry. His first job after sailing was being responsible for aftermarket business for North & South America for Voith Turbo in York, PA. In 2011 he was promoted to be responsible for all Voith Marine aftermarket business and moved to Germany to work directly with the factory. In 2014 Ed joined ZF Marine where he was the commercial vessel business development manager and later commercial thruster products manager. Continuing his career in ship prolusion Ed joined ABB Marine and Ports in 2017 as the Vice President of Sales responsible for developing and leading the new build sales team for North America.

ABB Marine & Ports /// www.abb.com/marine

Next generation lithium battery storage

Fortress Power's new Fortress Power eVault Series offers more power than ever before, a brand new LCD display with easy readability for state of charge, and maintains 6,000 cycles. The system has a powerful 15kWh. The eVault Series can work with most chargers and inverters available and utilizes the same safe Lithium Ferro Phosphate battery chemistry that is in the original generation.

Fortress Power /// www.fortresspower.com

Compact energy storage system

The compact VARTA pulse energy storage system has been updated. VARTA's own linux-based VS-XMS operating system makes additional functions possible. Now, VARTA pulse neo can charge on a forecast basis, and is easy to integrate into Smart Home applications. Thanks to the high-power operating system, individual functions can be continuously added via a software update, without impairing the basic functions. New software updates can be installed faster and more easily, and the storage system is equipped for the future demands on the "Internet of Things". VARTA pulse and VARTA pulse neo are available in two performance classes (3.3kWh and 6.5kWh) and are easily mounted to the wall. The energy storage system can be installed in just 30 minutes, thanks to a plug-and-play facility, and can be combined with all sources of green energy. VARTA pulse neo has a standby consumption of 1.4W, and is quick to regulate. The storage system is suitable for anyone who wants to bundle a high energy density in a small space in a single or dual family home.

VARTA AG /// www.varta-ag.com

An interface between inverters and a monitoring solution

Trimark Associates, Inc. has launched the Trimark SMA Gateway product. Designed around the Trimark Data Gateway (TDG), the SMA Gateway is a drop-in replacement for the discontinued SMA Sunny WebBox. The TDG is an industrial gateway loaded with a derivative of Trimark's SCADA software. This platform provides a robust and resilient solution that will provide many years of reliable non-stop service in the demanding environments of photovoltaic power plants. The Trimark SMA Gateway ships with easy-to-understand instructions on how to remove the old unit and install the new one. Once the unit is energized and connected to the inverter and a laptop computer, the technician will use a web browser to trigger the Trimark SMA Gateway to scan each serial port to find all connected SMA inverters and map the data into the Trimark SMA Gateway.

Trimark Associates, Inc.
/// www.trimarkassoc.com

Large 48V lithium batteries

In addition to their newest 4LiFe series of LiFePO4 batteries, Iron Edison proudly assembles their high capacity 48 Volt Lithium Iron batteries for solar, battery backup, off-grid, and energy security. With capacities from 72kWh to nearly 300kWh, these batteries require zero maintenance, no watering, venting, equalizing or specific gravity readings and are suitable for new or existing 48V systems. They provide over 95% charge efficiency, 15-20 years of life with a daily 80% DoD, and can charge from solar, generator, or the grid. This solution incorporates Active BMS technology and up to 1,000 amps of peak charge / discharge current. Installation is simple.

Iron Edison Battery Company
/// www.ironedison.com

Scalable building block inverter for energy storage

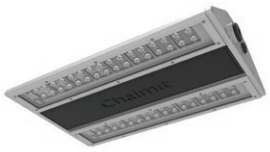
The PowerBRiC inverter offers the ability to parallel the inverter on both AC and DC sides, making it easily configured into any size inverter in increments of 125kW. The PowerBRiC can operate from 200VDC up to 1500VDC, making it compatible with most current and future energy storage technologies. Air cooled, the PowerBRiC can operate in environments up to 131°F (55°C) (w derating), making it suitable for most applications.

LS Energy Solutions
/// www.ls-es.com

Flexible storage solution for homes, businesses, and smaller industries

ADS-TEC's StoraXe scalable system series covers the need for flexible, medium-sized storage solutions for larger households, apartment buildings and businesses, industry, and public institutions. The new portfolio includes storage systems with an installed capacity of 30kWh to 66kWh. Systems with power of 20kW to 60kW are available for this purpose. The complete systems combine both the storage as well as the associated power electronics in one compact housing. Minimal installation work is required in existing buildings, where often limited space is available and if there is not enough space in the building, the storage systems can also be supplied in an compact, air-conditioned outdoor enclosure. The integrated emergency power function and the comprehensive energy management system (EMS) make these products suitable for a wide range of applications. In addition to "day-night shift", the energy management solution also includes an automated load peak shaving function. The integrated emergency power function also turns the system into a backup power system, providing a stable power supply in the event of a potential power failure. With off-grid and black start functions, the new series is suitable for off-grid applications. ADS-TEC offers a solution for these applications, providing intelligent hybrid control of generators and consumers with high-performance hybrid storage systems.

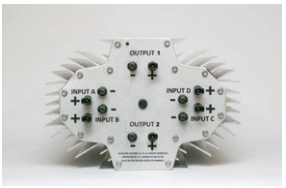
ADS-TEC Energy GmbH /// www.ads-tec.de



LED lighting for the energy storage industry

The Protecta X LED, from Chalmit, has a user-definable light distribution, a maintenance-free lifespan of over 120,000 hours at 77°F (25°C), is easy to maintain, and with its optional battery stick, can be installed quickly. The Protecta X has specialized optics which deliver the output of a 4ft linear in a lightweight and slimline luminaire package. The optics control the light, generating a highly targeted, bright, white output over the desired area, and limiting the amount of wasted spill light. The optics are available in a variety of distinct distributions, designed for key site applications, such as mounted from handrails for walkway illumination and localized lighting in low/medium bay applications. This high, focused output means fewer luminaires are required, reducing installation and inspection times and overall project costs within an energy storage and power plant. Furthermore, the Protecta X is 50% more energy efficient than a fluorescent luminaire, reducing energy costs too. The Protecta X's LEDs and driver are housed in separate enclosures, extending the life of both components. Air gaps between the luminaire and central body prevent the collection of dust and particulates, which helps avoid overheating. Made of recyclable marine grade aluminium, heat is conducted away from the new luminaire's central body.

Chalmit /// www.xseriesled.com



DC coupled solar + energy storage solution

Alencon Systems LLC's SPOT (String Power Optimizer and Transmitter) is a string level DC-DC optimizer which optimizes the power from PV string inputs with voltages ranging from 600V to 1500V. The SPOT-ES family of products has been specifically designed for the needs of DC-coupled Solar + Storage deployments. The SPOT-ES V5 includes a true 1500V input based on 1700V rated Silicon Carbide (SiC) rated mosfets, an ability to map a wide battery charge/discharge voltage range, reliability enhancements developed in concert with Solar + Storage technology providers and integrators, as well as flexible communications options for better integration with Solar + Storage and Microgrid control systems. The SPOT-ES's galvanic isolation concept isolates the PV input from the output by attaching isolation transformers to each PV input. This technique provides a unique benefit in the DC-coupling of Solar + Storage because the integral magnetics to the SPOT can be easily configured from one deployment to another to easily support a broad battery charge/discharge DC-bus voltage, where the voltage range could vary by as much 20% from complete discharge to full charge. The SPOT-ES V5 includes an ultra-fast circuit to protect it from sudden system power output overloads. The SPOT-ES V5 features enhanced communications features to allow it to be interfaced with third party system controllers via either Modbus TCP, for communicating to the SPOTs wirelessly, or Modbus RTU, which allows for hardware communication to each SPOT directly. The enhanced communication functionality offered in the SPOT-ES V5 allows for granular control over the PV, including the ability to curtail production at the string level.

Alencon Systems, LLC
/// www.alenconsystems.com

Flexible commercial storage system

"Large, yet flexible" is becoming an increasingly important feature when it comes to energy storage systems. The AC-coupled VARTA flex storage energy storage system is suitable for plants with a nominal system capacity of between 36kW and 600kW, and a useful capacity of between 52kWh and 750kWh. As a result, VARTA large-scale storage systems can be used in a variety of different ways: to increase own consumption, for peak shaving and tenant power solutions, as well as emergency power supplies.

VARTA AG /// www.varta-ag.com

Low cost, high performing, utility-scale inverters

With over 500MWs of energy storage deployed worldwide, Dynapower is pleased to introduce its next generation of utility-scale energy storage inverters. The air-cooled CPS-1500 and CPS-3000 are available in both indoor and outdoor configurations, and work with all battery chemistries. Each feature a high-efficiency, three-level topology designed for both grid-tied and microgrid applications. The Gen 4 CPS inverters also feature Dynapower's proprietary Dynamic Transfer technology, which allows for the seamless transfer from grid-tied to microgrid mode, and Black Start capabilities. Multiple CPS units can be paralleled together to meet the sizing and power needs of any energy storage installation.

Dynapower Company, LLC
/// www.dynapower.com

Energy management solution

Rhombus Energy Solutions' VectorStat Energy Management System (EMS) software is a distributed EMS software package providing reliability, security, and resiliency over a variety of network configurations. VectorStat's open architecture is easy to customize and extend, allowing companies to quickly and economically adapt VectorStat to new hardware and network configurations. VectorStat's open, distributed architecture allows new features and open source software to be easily integrated, speeding time-to-market for new solutions, and speeding the time to deploy these new solutions. VectorStat ensures that even with lost or intermittent connections, data is protected and available later when the connection is restored. VectorStat's distributed database architecture also significantly enhances energy system resilience and reliability by ensuring the functionality of each node even when network connectivity is interrupted. When network connections are re-established, data is replicated across the network across encrypted communications links.

Rhombus Energy Solutions
/// www.rhombusenergy.com

Intelligent lithium ion batteries

Trojan Battery Co., LLC announces the Trillium line of Trojan Intelligent Lithium batteries. With life expectancy over 5,000 cycles, Trillium maximizes total energy throughput and lowers lifetime operating costs. Trillium is suitable for meeting demanding deep-cycling requirements across a wide range of stationary and motive power applications. Trillium is designed and engineered in the USA and is initially available in 3 popular sizes that can be used in a variety of applications. Trillium offers a range of advanced safety, environmental, and electronic features including an intelligent built-in diagnostic as well a superior cell and battery design. Trillium is designed to be a replacement for existing lead acid batteries. The built-in battery protection system guards the battery from the extreme demands of various motive and stationary applications. Aftermarket customers without Lithium battery experience are now able to switch to this advanced energy technology without the need for sophisticated expertise in Lithium Ion technology or system integration. In addition, OEM customers can quickly add the Trillium range of products into equipment without significant investments in custom pack design and development. Trillium features automotive-grade safety components, CAN-bus communication, and an integrated state-of-charge indicator. The electronic controls allow for voltage compatibility for all 12V, 24V, 36V, and 48V applications including the ability to use most existing lead-acid chargers.

Trojan Battery Company
/// www.trojanbattery.com

Software for energy storage valuation

The latest version of QuESt, Sandia's open source software for energy storage valuation, has been released. QuESt v1.2 features the debut of QuESt BTM, an application aimed at providing analysis tools for behind-the-meter energy storage. The first of these tools estimates the cost savings provided by energy storage for time-of-use and net energy metering customers. By strategically using energy storage, the customer can reduce his or her time-of-use energy charges or reduce demand charges by peak shaving. Energy storage can also be used with on-site solar power to reduce the customer's monthly bill by time-shifting. QuESt BTM uses simulated load profiles of different commercial and residential buildings located around the United States. It leverages a database of U.S. utility rate structures to allow users to select the rate structure most pertinent to his or her project. Additionally, QuESt BTM can utilize simulated solar power profiles for projects with energy storage co-located with, for example, rooftop solar. By simulating different energy storage system configurations, QuESt BTM can help users size the appropriate energy storage system for reducing his or her building's monthly electricity bills.

Sandia National Laboratories
/// www.sandia.gov

Expanded energy storage solution for solar

As a turnkey supplier of battery energy storage systems and stand-alone power conversion systems, ABB has expanded its EssPro Energy Storage portfolio to include more compact and modular battery energy storage systems as well as a new power conversion system platform. Pairing ABB's Esspro Grid Battery Energy Storage system with solar can optimize the performance of the solar plant by providing instant power and ramping support during cloud coverage and load shifting services as the evening approaches.

ABB /// www.abb.com

Turnkey medium voltage inverter station

Ingeteam's turnkey medium voltage solution for North America now features a new design. It integrates from one to three UL 1741 SA-compliant PV inverters up to 5.4MVA. This solution also integrates the padmounted transformer, the auxiliary services panel, and the auxiliary services transformer. All these elements are supplied already installed over a skid or metallic platform, facilitating the transport, installation, and commissioning works. In the energy storage sector, Ingeteam's battery inverters are UL 9540 compliant and can be close-coupled connected to a padmounted MV transformer in a turnkey solution up to 5MVA, also supplied with everything integrated in a single skid.

Ingeteam /// www.ingeteam.com

Next generation ultracapcitors

Maxwell Technologies, Inc. has launched a new full-featured 3.0-volt (3.0V) product platform. With the introduction of these next generation ultracapacitors, users have the ability to increase energy and power in the same form factor as the 2.7V product line and can significantly cost-optimize their system designs by using fewer ultracapacitor cells or modules. Alternatively, users can upgrade to a 3.0V solution to extend the expected life of their products. The 3.0V platform is designed for single-cell applications as well as multi-cell complex module systems. Designed from the ground up, Maxwell's new 3.0V platform addresses energy storage requirements driven by trends in renewable energy, industrial electrification, and smart grid. Whether used alone, integrated into a module assembly, or in a hybrid configuration with fuel cells, Maxwell's 3.0V platform of products can help reduce the overall cost and weight of the system while improving return on investment for customers.

Maxwell Technologies
/// www.maxwell.com

Mitigation Best Practices for Investors and Financial Institutions

by Kimberlee Centera

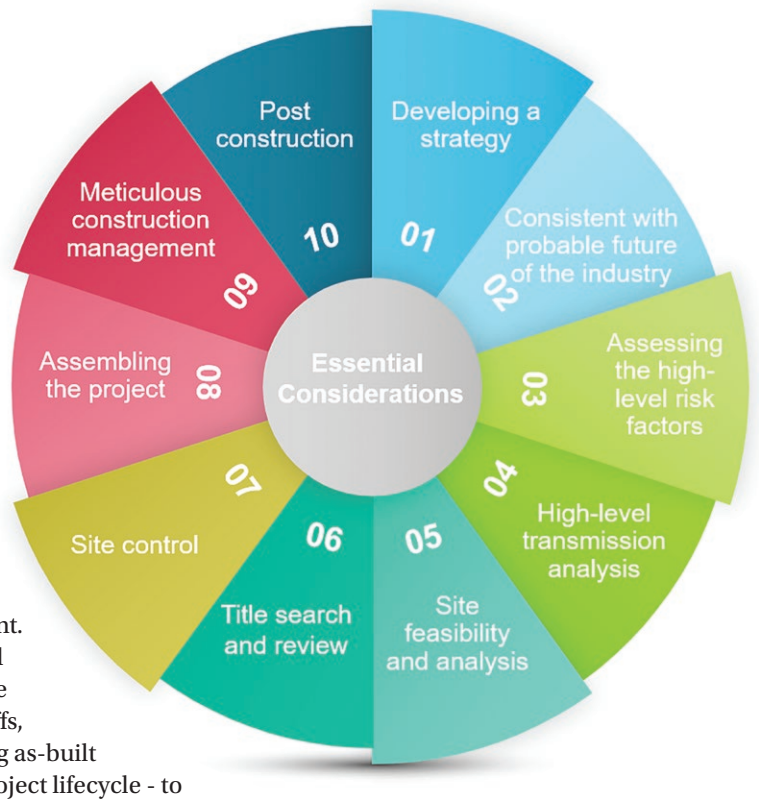
Renewable energy policy is vital to the development and deployment of renewable energy. According to the Sierra Club, ninety U.S. cities, ten counties, and two states have already adopted ambitious 100 percent clean energy goals. How are these projects financed?

Bloomberg's Clean Energy Investment Trends report for 2018 states that more than half of all new investment in clean energy is largely achieved through asset financing. That means collateralizing investments with hard assets such as property, or soft assets such as cash flow, accounts receivable, or bonding bills. Unlike venture capital funds, which anticipate that some investments will result in tax deductible losses, prudent asset financing requires a high probability of success.

Risk mitigation is critical when assets are used to finance development, as is often the case with municipal energy projects. Investor confidence is established with the creation of a strategic thinking framework. This includes an in-depth analysis of potential risks, and how they can be managed or alleviated at every stage.

At the outset, a check list of essential considerations includes the following:

1. Developing a strategy, establishing a brand, and leveraging the power of relationships. How will you articulate precisely who you are to the myriad people who shape the outcome of your project, and those it affects?
2. Ensuring your project is consistent with the most probable future of the industry. Developers need to understand the short- and medium- term trends that affect their business arena: sunset dates for tax credits, changing RPSs, the growing number of environmentally progressive cities and corporations, cost curves that make power cheaper to generate than to buy, the changing regulations of our power utilities, and, ultimately, the integration of energy storage.
3. Assessing the high-level risk factors associated with the project.
4. High-level transmission analysis including load, transmission capacity, and a solid off-taker.
5. Site feasibility and analysis and high-level permitting review.
6. Title search and review.
7. Site control with executed lease or option and easements in place.
8. Assembling the project, identifying various phases of development, and setting the timetable.
9. Meticulous construction management.
10. Post construction (for a smooth and transparent transition to operate the project) includes conditional signoffs, transfer of all documents - including as-built engineering drawings and entire project lifecycle - to the owner/operator. This is referred to as Commercial Operations Date and Compliance (COD).



Due Diligence Best Practices to Mitigate Risk

Due diligence includes a comprehensive review of legal and financial considerations. This means discovering any potential risks and evaluating their impact to determine whether the project is a viable investment.

Technical due diligence identifies total energy yield, social, and environmental implications. Non-financial goals, such as goodwill that is gained when demonstrating environmentally responsible corporate citizenship, may also be an important factor.

A Best Practices framework includes:

- **Site feasibility** and analysis with a high-level review of permitting and jurisdictional issues. This includes a review of the public agencies that may be involved (such as the FAA).
- **Compliance review** to ensure that the project adheres to pertinent regulations.
- **Title Insurance** with a comprehensive analysis of the title environment.
- **Mechanics lien** coverage and ALTA 35 endorsements, which provide insurance coverage for damage sustained by the insured for the removal or alteration of an improvement.
- **High-level transmission analysis** along with transmission capacity assessment.
- **Off-taker negotiations** such as PPAs with utilities or private entities.
- **Off-taker review** and evaluation of the time required for the off-taker to build the transmission line to ensure that it meets project completion deadlines.
- **Future phases** - feasibility analysis and project negotiation must consider making reasonable provisions for future phases. Pre-approvals that facilitate future project phases are much easier to obtain at the initial planning stage than further down the line.
- **Quantifying energy yield** for lenders to obtain a bankable energy yield assessment. Annual variations in generation must also be factored in.
- **Ensuring that power can be exported** into the electricity grid without constraint. Understanding the risks associated with the eventual operational regime is critical to the success or failure of a project.
- **Identification, mitigation, and management** of the environmental implications of the project is crucial to the long-term success of a project and the corporate reputation.
- **Commercial market for the energy and policy environment** must be understood in order to negotiate power purchase agreements.

In addition to comprehensive due diligence, a careful business case assessment includes understanding the goals of the investors to ensure that the financial realities of the project are clearly addressed. This considers both technical viability and environmental impact, as well as long-term financial soundness and the ability to withstand the competitive pressures of the market. The more detailed a due diligence process is, the less likely that potential risks will be overlooked. Thorough due diligence is imperative to the success and resilience of every renewable energy project.

Kimberlee Centera is CEO of TerraPro Solutions, a consultancy made up of renewable development experts with project experience across the United States in solar, wind, and energy storage. Kimberlee is a risk management expert for the development and financing of large-scale generator energy projects. Under her leadership, TerraPro Solutions has generated over 5,500 MWs in renewables, with a total financed value of over $6 billion.

TerraPro Solutions /// terraprosolutions.com

eventscalendar

JULY

16-18 **July 2019 Battery Seminar**
The Inn at St. John's – Plymouth, MI; www.batteryseminars.com

17-18 **5th National Grid-Scale Energy Storage Conference**
Albany, NY; www.wplgroup.com/aci

17-19 **Mid-Atlantic Renewable Energy Summit**
The Bellevue Hotel – Philadelphia, PA; www.infocastinc.com

18-19 **Community Solar Power Summit**
Sheraton Philadelphia Society Hill Hotel – Philadelphia, PA; www.events.solar/community-solar

29-01 **SEPA Grid Evolution Summit**
Washington, DC; www.sepapower.org

AUGUST

20-22 **DOE's 5th Annual Energy Exchange**
Colorado Convention Center – Denver, CO; www.energy-exchange.com

SEPTEMBER

10-11 **Wind Resource & Project Energy Assessment Conference**
Hyatt Regency Lake Washington – Renton, WA; www.awea.org

15-18 **GRC Annual Meeting & Expo**
Palm Springs, CA; www.geothermal.org/meet-new.html

18-20 **Horizon 19**
Boston Convention and Exhibition Center – Boston, MA; www.horizon19.org

23-26 **Solar Power International 2019**
Salt Palace Convention Center – Salt Lake City, UT; www.solarpowerinternational.com

23-26 **Energy Storage International**
Salt Palace Convention Center – Salt Lake City, UT; www.solarpowerinternational.com

OCTOBER

01-02 **AWEA Wind Energy Finance & Investment Conference**
www.awea.org

05-06 **2019 National Solar Tour**
USA; www.nationalsolartour.org

08-10 **CANWEA Annual Conference & Exhibition**
BMO Centre – Calgary, AB; www.windenergyevent.ca

22-23 **AWEA Offshore WINDPOWER Conference and Exhibition**
Boston Park Plaza – Boston, MA; www.awea.org

NOVEMBER

05-07 **Energy Storage North America**
San Diego, CA; www.esnaexpo.com

14-15 **Solar Power Midwest**
Palmer House Hilton – Chicago, IL; www.events.solar/midwest

19-21 **AWEA Clean Energy Executive Summit**
Omni La Costa Resort & Spa – Carlsbad, CA; www.awea.org

DECEMBER

12-13 **Solar Power New York**
Hilton Albany – Albany, NY; www.events.solar/newyork

FEBRUARY 2020

04-06 **Intersolar North America**
San Diego Convention Center – San Diego, CA; www.intersolar.us

12-13 **The Energy Expo**
Miami Airport Convention Center (MACC) – Miami, FL; www.theenergyexpo.com

JUNE 2020

01-04 **AWEA WINDPOWER 2020 Conference & Exhibition**
Colorado Convention Center – Denver, CO; www.awea.org

SEPTEMBER 2020

14-17 **Solar Power International 2020**
Anaheim Convention Center – Anaheim, CA; www.solarpowerinternational.com

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59	Rhombus Energy Solutions	www.rhombusenergy.com
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OBC	Shoals	www.shoals.com
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THE PORT OF STOCKTON
YOUR PERFECT PIVOT POINT

We stay in constant motion so that your wind energy components reach the market on time and ready to spin. We give you 24/7 access to your cargo, on-dock rail facilities, and we are adjacent to less congested highways. This makes our turn-around time second to none. Need space to prepare your cargo for the next leg of the journey? We have ample lay-down area to stage your over-size and heavy lift cargo.

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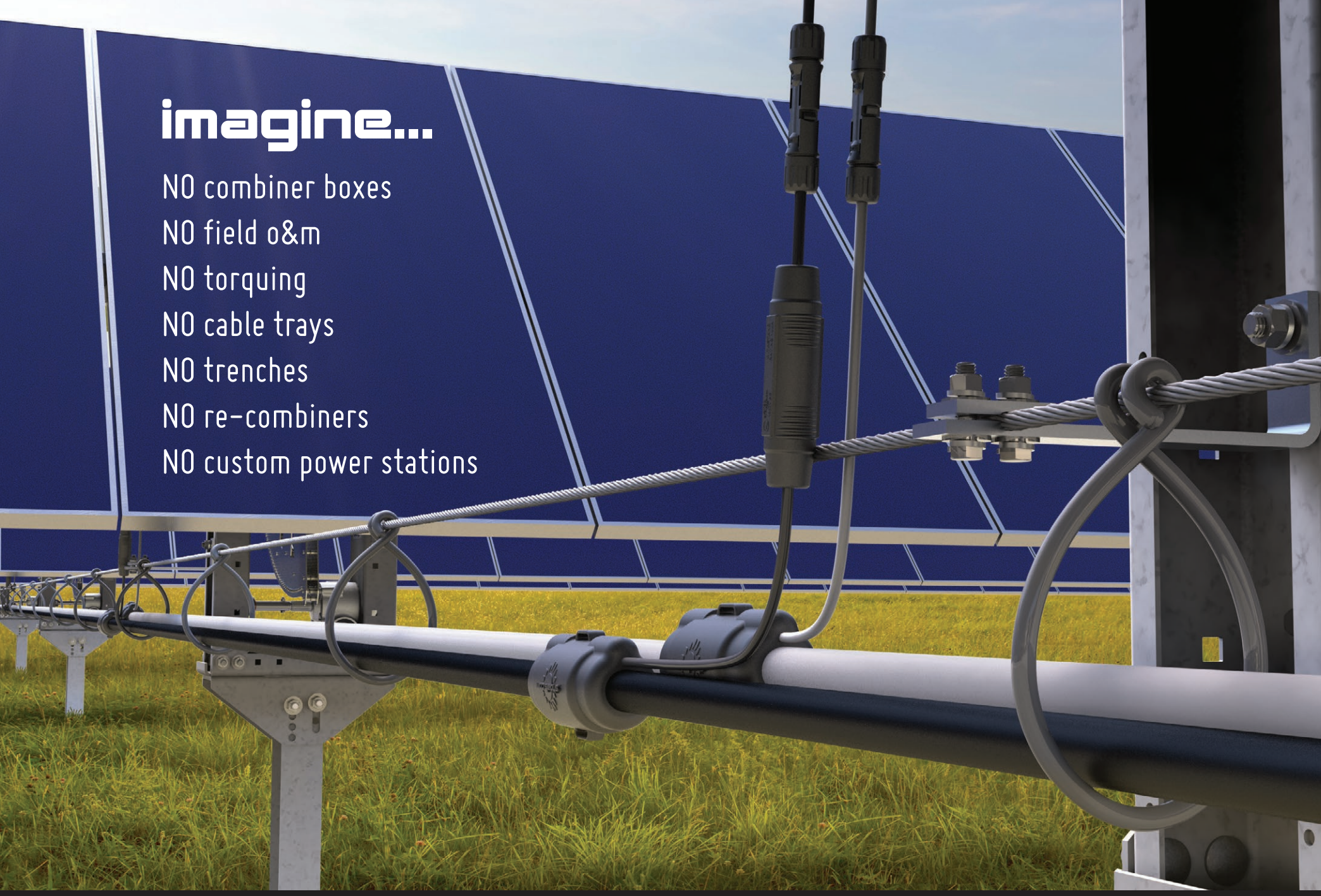

bla
big lead assembly™

The BLA (Big Lead Assembly ®) takes all the guesswork out of wiring your solar field. Using Shoals' latest in-line fuse and wire manufacturing technology, we offer you a site free of DC string combiners. The entire load is combined into a single pair of aluminum conductors running from the string combiner to the inverter. There's no need to trench for DC feeders or hang string combiner boxes. And when terminated with the BAC connector, the whole array is plug-&-play. Plug in the panel strings, plug into the inverter, and just walk away!

Combining the function of:

- ☑ cable assembly
- ☑ combiner box
- ☑ external fuses
- ☑ re-combiner

shoals® technologies group

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