

North American **CleanEnergy**

2020 WIND BUYERS GUIDE

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Battling Wildfires

Microgrids offer a new approach to fire suppression Pg. 8

Great Expectations

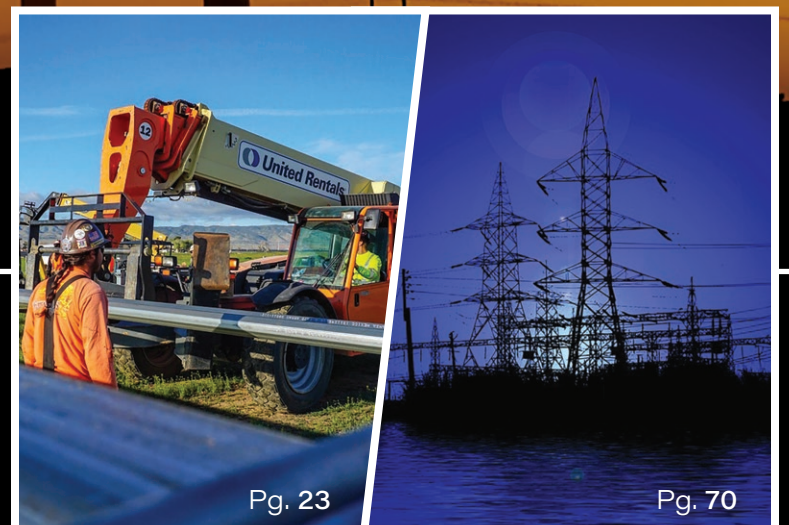
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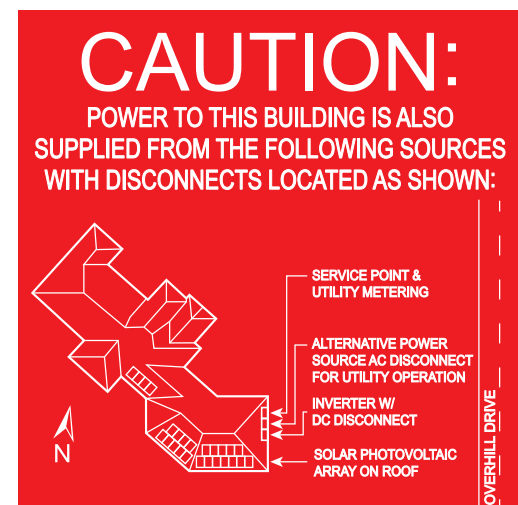
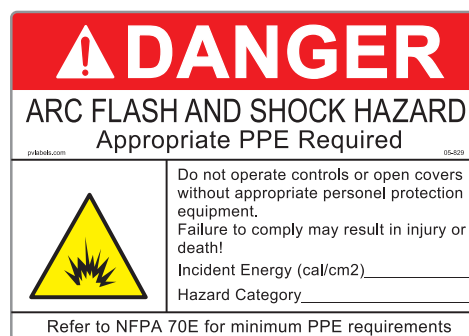
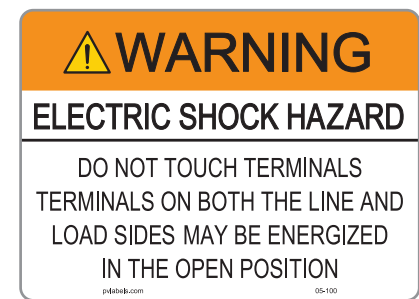
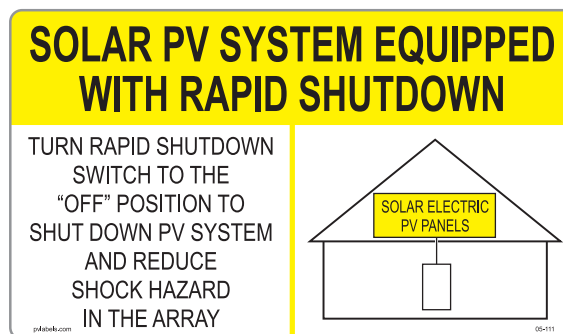
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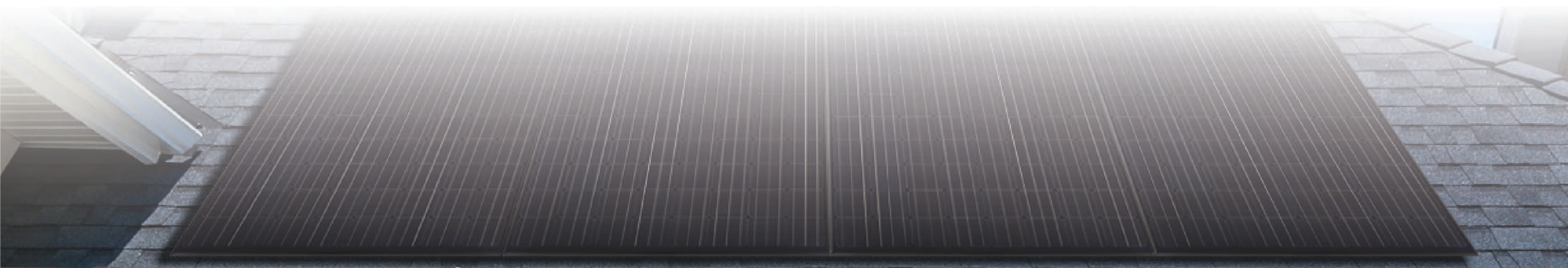
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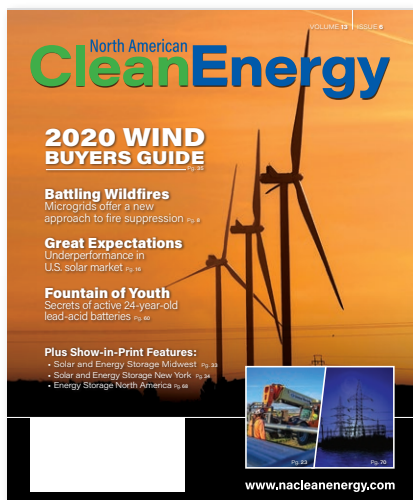
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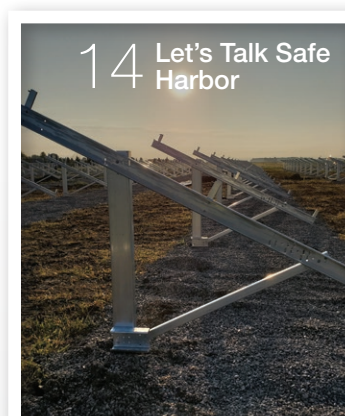


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HAVE YOU EVER BEEN TO SALT LAKE CITY?

It looks a lot like a city. A bunch of restaurants, apartment buildings, highways with traffic, and a scattering of homeless people. I even noticed a faint layer of smog blurring the spectacular sunset mountain views. Barely able to accommodate its burgeoning population, Salt Lake City sits in a topographical bowl surrounded by mountains that perfectly trap the ever-increasing air pollution. Like any other U.S. city, it spends a great deal of time and effort trying to mitigate that problem with the latest technology and energy efficient solutions. If it hadn't taken me so many flights to get to this year's Solar Power International (SPI) show, it would have felt as though I were anywhere in the country (with the exception of Newark, my starting point).

Which is why I found it a little odd to hear so many of my fellow attendees complaining about the location of next year's SPI. We're all due to meet up again next September in Anaheim, California. I like Anaheim. It's certainly more convenient for me travel-wise. And yet, nearly every other person I ran into complained that the decision to hold the show in Anaheim was a cop-out, or not representative enough of the rest of the country, or another sign that the solar industry needs to reach more people outside of California.

Back in the 1990s, while cruising to Juneau, I overheard some passengers saying that they sure hoped Alaska had telephones so they could call home (for those of you under 25, this was pre-cellphone ubiquity). I tried not to laugh while I politely interrupted their conversation to enlighten them about the wondrous conveniences enjoyed by Alaskans - things like cars and department stores and airports and satellite television and, yes, even phones. I was amazed at their conceit in assuming that the typical American lifestyle was confined to the lower 48.

I wasn't quite as stunned to hear the disappointment by the SPI folks, but it was close. You Californians are proud of your state. I get it. People all over this country are proud of where they live. They're smart, worldly, and knowledgeable. In fact, they're a lot like you. It's a good idea not to discount the "other 49". Try to challenge the belief that, while a more liberal mindset may give California an edge in early adoption of radical clean energy technologies, it's not always the center of progress.

In 2018, California produced the most solar power in the country¹. Do you know who came in second? South Carolina. That's right, California is the 3rd largest state in the country, but South Carolina, the 28th largest state, produced the second largest amount of solar energy. By the way, New Jersey is the 47th largest state and we came in 6th place! Little New Jersey made the top ten. (We beat Utah.)

Even corporate investment reaches beyond the Golden State. True, California's got Apple, which tops the most recent list². But Target and Walmart are close behind, and their headquarters are in Minneapolis, Minnesota, and Bentonville, Arkansas, respectively. You've heard of Proctor and Gamble, right? Not only is it the largest consumer goods company in the world, but you can find its headquarters in a little city called Cincinnati, Ohio. They announced

the purchase of 100% renewable electricity in the United States, Canada, and Western Europe.³

And, in case you missed it, The Princeton Review published their 2019 Guide to Green Colleges⁴. Of the top 15, only two are in California. Nearly every school on their list offers sustainably-focused degrees. Of the top 50, the 43 schools not in California include places like Ohio, Minnesota, Tennessee, Missouri, Michigan, and Iowa.*

Just because we'll be holding our annual meeting in California doesn't mean we'll be able to keep the latest solar advances secret from the rest of the country. Millions of people own the newest iPhones and laptops without ever having attended a tech trade show. Thousands of people who own solar panels have probably never heard of SPI, yet they benefit from our collaboration. We'll fly in from all over the world to talk to each other and share ideas face-to-face because we're human. It's what we do. Who cares where we do it? As long as I can catch a nonstop from Newark, I'm good.



*"It's high time you were shown
That you really don't know
All there is to be known."
On Beyond Zebra! (1955)
by Dr. Seuss*

Meg

¹ <https://www.cnn.com/2018/09/19/the-us-states-leading-the-way-in-solar.html>

² <https://www.forbes.com/sites/arielcohen/2019/07/29/corporate-investment-in-solar-energy-surges/#46d063722464>

³ <https://us.pg.com/blogs/pg-purchases-renewable-electricity>

⁴ <http://www.princetonreview.com/green-guide>

**Challenge yourself to write down all 50 states without looking at a map. You may be surprised at how many you miss.*



Yoga... on a bottle?

Yoga Design Lab is a young Bali based yoga brand that is shaking up the industry with sophisticated technology and uber-colorful yoga mats made from natural tree rubber and recycled plastic bottle microfibres. The goal was to create a beautiful, highly-functional product with the smallest eco footprint possible. Countless yoga mats end up in landfills because they're made from non-recyclable, hazardous materials, so this company has started repurposing what's already out there and keep it from ending up in the oceans.

Yoga Design Lab

/// www.yogadesignlab.com



City waste to city fuel

The City of Oakland, Neste, fuel distributor Western States Oil, and local collectors for used cooking oil joined forces to gather waste cooking oils from restaurants and other businesses in the Oakland metropolitan area and convert it to fuel the city's fleet. By making waste more valuable and supporting jobs that collect and treat it, this concept helps the local economy in the city while the cleaner-burning Neste MY Renewable Diesel improves the lives of its residents by reducing greenhouse gas emissions from the city's fleet. Neste MY Renewable Diesel is a low-carbon fuel produced from 100% renewable and sustainable raw materials, primarily wastes, and residues. It cuts engine-out emissions of nitrogen oxides by 9%, those of carbon monoxide by 24%, and fine particulates by 33%, all while enhancing fleet performance. The concept by the city of Oakland and Neste saves greenhouse gas emissions by 74% compared to fossil diesel. Neste MY Renewable Diesel is a direct replacement fuel that requires no blending and is compatible with all diesel engines.

Neste Corporation

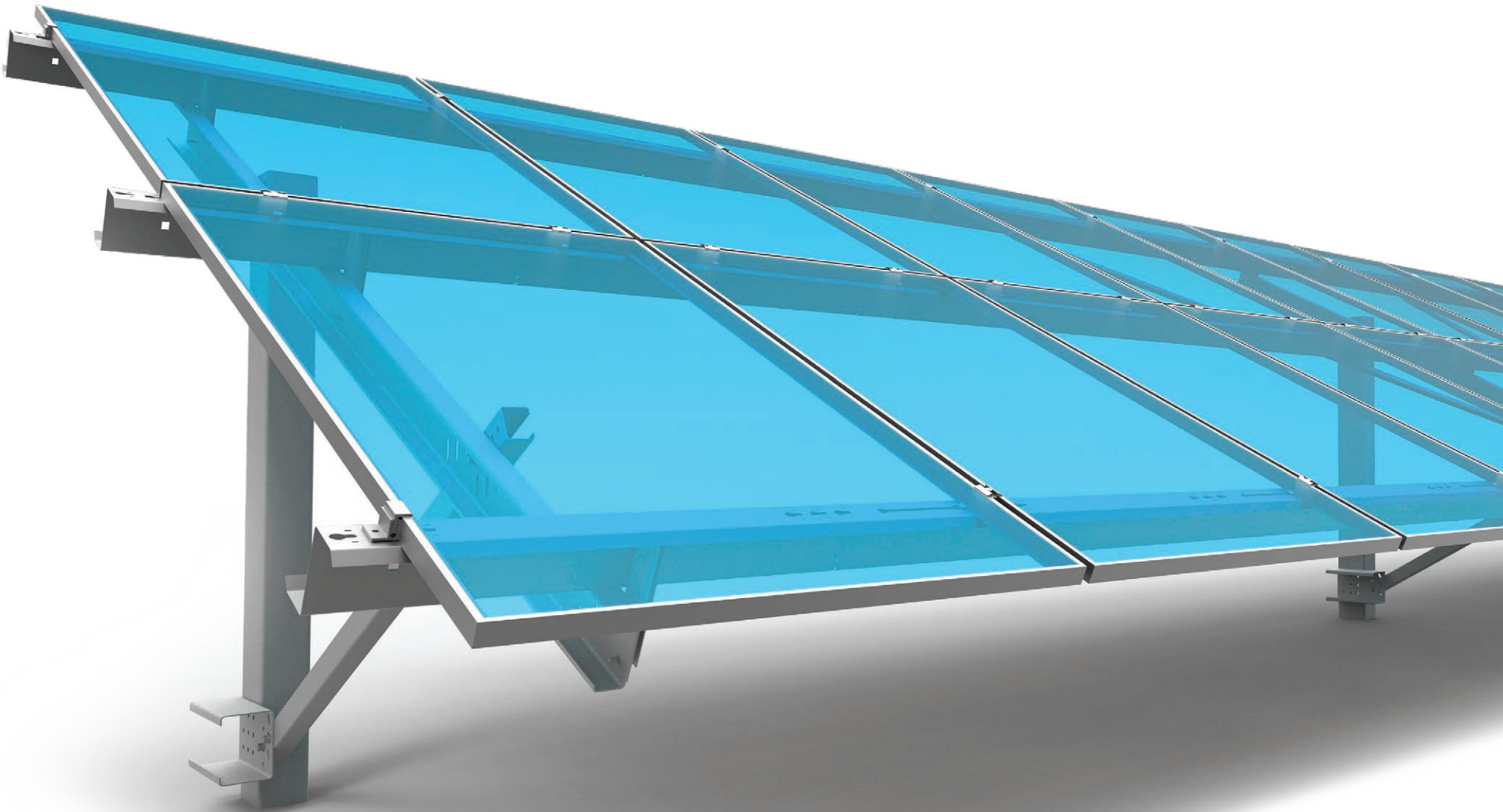
/// www.neste.com



Moving a behemoth

The port of Blyth welcomed a 107m wind blade that will form the rotor of the Haliade-X 12MW, the world's largest and most powerful offshore wind turbine. Possibly one of the largest machine components ever built, the part was shipped from Cherbourg, France. The blade set sail from Saint-Nazaire for a nearly two-day voyage through the English Channel and the North Sea. In Blyth, the blade will undergo a year of advanced testing that will demonstrate its ability to withstand peak wind conditions and simulate its readiness for years of operation in gusty seas. Nothing about the Haliade-X 12MW is small. The machine's nacelle is comparable in size to six double-decker London buses, and houses a generator capable of producing up to 12MW of power, enough to supply 16,000 European households. The Haliade-X 12MW is set to enter serial production in 2021.

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Battling Wildfires

Microgrids offer a new approach to fire suppression

by Tim McDuffie P.E.

Recent wildfires throughout California have led to a renewed discussion about ways Investor Owned Utilities (IOU) can adjust their operating procedures to reduce risk of such events happening again. One method that's being utilized by California IOUs is a program called Public Safety Power Shutoffs (PSPSs), where certain electric grid segments in areas at an elevated risk of wildfires will be pre-emptively turned off. These PSPSs can last from hours to days, and stay in place until the elevated wildfire risk has diminished. Intuitively speaking, the idea is simple: less energized high voltage feeds = less potential for sparks or downed lines. But, as with most things, it's not quite that simple.

De-energizing large utility grid segments mitigates one problem, but brings other risks. Critical infrastructure like hospitals, fire stations, and police stations will not be exempt from losing power. This means that facilities and local municipalities will need a plan to continue functioning during PSPSs - that's where microgrids come into play.

The idea surrounding microgrids is straightforward. Utilize Distributed Energy Resources (DER) to serve load instead of transmission network imports. The inherent problem surrounding this approach is less a technical issue and more of an operational one. As a safety measure, most DER is designed specifically to turn off during grid outages to ensure that current is not flowing on wires thought to be de-energized. Asking these devices to stay on and produce power on IOU distribution infrastructure is counter-intuitive to traditional DER operating parameters.

Turning on DER and letting unregulated power flow back onto the grid is not an option. Utility grids are not designed to operate in this manner. Fault detection and mitigation will not detect the minimal amount of current flowing from DER. Even if they did, they might be incapable of clearing the fault. That's why advanced controls, programming, and an automated hierarchy of operating procedures are absolute necessities for any microgrid, as the DER must be operated in tune with existing utility distribution equipment.

Generation and load shedding must work in concert to sustain the most critical areas for as long as possible. In order to achieve this high level of coordination, everything must be managed from a central operating system; like traffic lights, they need to send energy to the right place, or redirect, slow, and stop things if there is a problem or limitation. As the amount of available energy starts to diminish during a PSPS event (i.e. batteries start to drain, sun starts to set, etc.) load must then be systematically shed in order of importance to maintain power as long as possible. In many ways, microgrids would serve a similar capacity to backup generators at a hospital, where loads are segregated in order of importance, and generators work to maintain critical services for as long as possible.

This central management system must serve other functions because, as noted above, protection devices will not work. Close coordination with the utility, and a thorough understanding of their infrastructure is essential in order to maintain power quality and manage faults. One way to manage this concern is to take a scalable approach, whereby very small line segments could operate as a microgrid, and then be expanded to include other areas after completing functional tests.

While the challenges can seem daunting, resources exist that can balance wildfire risks with utilizing DER to its full capability. Recent innovations in grid edge monitoring control mechanisms, like telemetry and Distributed Energy Resource Management Systems (DERMS), play a key role in the equation - they provide key data and control points that, until recently, were unavailable. These data points would feed back into a centralized control platform that





Tim McDuffie P.E is Senior Business Development Engineer at Smarter Grid Solutions (SGS). SGS software has sub-second, autonomous and deterministic control, back-ups and fail-safes required for 'on grid' applications, to interface DER to both markets and networks.

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would use them to calculate the best movements of energy to the right places at the right time.

Future iterations of smart inverter control protocols could be configured for operating in fire suppression mode, where DER is allowed to operate even while the grid is de-energized. This could be managed through a control signal sent from utility DERMS systems to the customer's behind-the-meter DER, to allow operation during very specific grid states (such as a PSPS). While smaller in scale, this approach could work for specific loads, but would limit the effectiveness of microgrids to a specific customer or set of customers. The upside would be a shorter path to implementation at the cost of overall effectiveness to the grid at large.

The pros and cons of using PSPSs are still being debated, but as stakeholders continue to innovate new ways to balance wildfire risks with critical load supply, the conversation will undoubtedly lead to microgrids at some scale. It's a new way to manage an age-old problem, and takes advantage of existing renewable energy resources and new DER control technologies to increase operating resilience and public safety.



Early Money is the Smartest Money in Solar Development

by Scott Wiater

NOT EVERYONE CAN DO MID-MARKET

commercial and industrial (C&I) and community solar development, because not everyone has the ability to handle the early development costs. That's why it's so important to partner with companies that have the ability to fund such early-project costs in-house.

Commercial solar financing has always been the weakest solar segment when it comes to finding adequate financing, especially when you compare it to its sister markets, residential and utility. The reasons for this are myriad.

The utility solar sector has a more than 100-year track record to present to the big banks looking to diversify their energy portfolios. With that history, it was easy to find big bank, institutional lenders to invest. The creditworthiness of utilities was never in doubt (though that may change with the PG&E bankruptcy in California).

On the other hand, once leasing became the predominant way of financing solar systems, financing in the residential solar market really took off - although the pendulum has once again swung back to more traditional loans. But most banks, no matter what their size, understood the concept of leasing. After all, they'd been doing it for cars, apartments, and other capital-intensive projects for years. It's something they understood instinctively.

So, what's held the commercial solar sector back? Well, the fact is that most commercial solar projects are more complex than those at utility-scale. When potential financing partners look at these commercial projects, what they see first is the risk, not the payoff. That's why banks shy away from entering into C&I loans. And that's why finding alternative financing partners is so critical in the segment.

If developers can engage a financing partner to provide money early, before all the extra work starts, the chances of getting a project from concept to completion increase exponentially. In addition, the flow of early money allows those financing partners to share the risks of the development with the developer, meaning the

foundation for a project is stronger than if the developer has to go it alone.

In order to guarantee the success of the partnership, there are four characteristics that developers must find in an early financing partner:

- low cost of capital;
- tax equity solution;
- easy and flexible to work with; and
- a savvy and experienced team that can navigate the complicated and risky world of solar project financing.

By obtaining financing early, the toughest financing portion of any project—development capital—is made easier. Early money partners can support interconnection costs, decommissioning bonds, pre-notice-to-proceed and notice-to-proceed milestones payments, which means the project is far more likely to get off the ground. It also allows the developer to stick to what they do best: managing multiple projects simultaneously.

In-house money for direct financing provides an attractive alternative to traditional banks, which are often unfamiliar with solar projects, and unwilling to invest in something they consider speculative. With real money to invest, companies can take on more risk than other, easily-spooked potential investors.

Companies with experience in the business—especially those that have a history as an engineering, procurement, and construction (EPC) company—are more willing to take the risks that banks or financiers that require tax equity can't. They are also more willing to structure deals that help customers with safe-harbor agreements to weather the investment tax credit (ITC) stepdown.

Companies that can provide early low-cost financing are able to get more repeat business, as their successful track record attracts more customers to seek them out. As more customers come in, the companies gain more experience with different types of projects and can better anticipate the potential obstacles that can come up in a typical C&I or community project. And, although timelines to project completion are getting longer industry-wide, when companies come in with early financing, deals get done more quickly because the process is so much smoother.

To get an effective C&I or community solar deal done, the importance of early financing can't be underestimated. After all, a lack of such financing can kill a project long before it even has the chance to get off the drawing board. But finding a partner that has access to low-cost early financing can often improve the ability of developers to get projects done, with less pain and fewer obstacles than they might otherwise find.



Scott Wiater is President and CEO at Standard Solar, which delivers solar projects around the United States, from financing to final commissioning and beyond.

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How to Develop a Successful Solar Project Permitting Framework

by Rick Haglund

LAND IS YOUR MOST IMPORTANT ASSET IN A RENEWABLE

project. It doesn't matter how much the sun shines - if you don't have land, you don't have a project. Likewise, if you can't secure permitting, your project will fail.

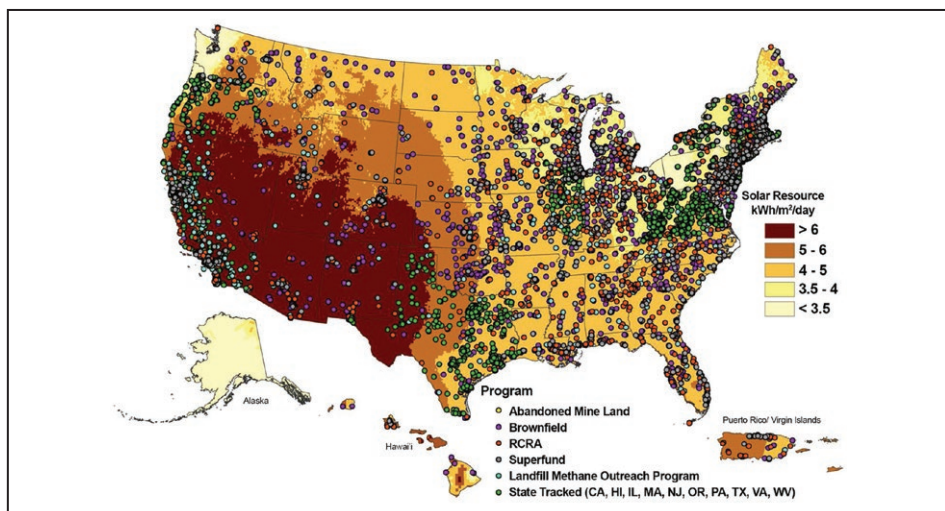
Most solar power plants today are located on privately held land. A recently introduced bipartisan bill, the Public Land Renewable Energy Development Act (PLREDA) of 2019, aims to promote the development of wind, solar, and geothermal energy, on public lands.

Solar energy is a critical component of a comprehensive climate action plan. Solar projects are subject to a vast number of approvals from governmental agencies. Permitting requirements can significantly impact the cost and development time of a project. Understanding the entities that may be involved in the permitting process, and determining the renewable energy commitments made by local governments, will be of tremendous importance in the due diligence phase of any project.

Permits for power plants on federal land fall under the jurisdiction of the U.S. Bureau of Land Management (BLM). The BLM (in collaboration with the U.S. Fish and Wildlife Service, and other state and local agencies) is authorized to issue permits for the development of solar energy projects. Environmental review of a proposed power plant on public land may take three to five years, unless the plant is located on previously distributed land.

Federal, state, and local regulators must follow strict review processes and guidelines. Developers must provide detailed project construction plans, environmental studies, and proposals to ensure that environmental impact is minimized.

Designing a strategic framework can help developers identify how to navigate the process, what may be involved in granting permits, and learn how to address potential obstacles. The following tactics can help ensure successful solar permitting:



1. Identify and cultivate dialogues with stakeholders. Engage thought leaders and champions of renewable energy projects within the public and private sectors. Collaborate with influential stakeholders such as labor unions, who recognize the economic impact of the project.

Interact with potential opponents. Understanding their issues and concerns can be of value in formulating your proposed mitigation strategies. This will also prepare you to answer difficult questions during town hall meetings or press interviews.

2. Assemble an experienced project permitting team. Experienced environmental and engineering consultants are essential. Land use and environmental legal issues such as agricultural land conversion, irrigation district, or public utilities commission approvals, require specialized legal knowledge. An experienced team will ensure that your permitting strategy effectively addresses the concerns of the permitting authority.
3. Prepare an action plan for obtaining permits. Permits from federal, state, and local government agencies may be needed. Each agency may have unique processes, goals, and time frames. Develop a matrix that illustrates the requirements and procedures for each entity. This will ensure that permitting is granted within the critical development phase of the project.

If the project involves federal grants, loan guarantees, or permits, the National Environmental Policy Act (NEPA) may apply. Many states also have their own environmental review requirements. If authorizations are needed for protected species or jurisdictional waters impacts, other agencies may be involved. Identifying and sequencing relevant permitting channels is essential to meeting project deadlines.

The Solar Energy Industries Association (SEIA) www.seia.org is an excellent resource for solar market intelligence.

4. Cultivate relationships with governmental agencies. Developing a positive relationship with governmental agencies is invaluable during the permitting process; this includes submitting excellent biological studies, being responsive to agency concerns, demonstrating an understanding of agency processes, and presenting your plan for compliance.

Take advantage of opportunities to work directly with agencies to assist in preparing underlying studies, or commenting on drafts of environmental documents. These agencies often have limited resources - supporting them not only creates goodwill, but it allows you to address difficult issues proactively.

5. Anticipate mitigation and prepare a realistic mitigation strategy. A large solar project may generate many mitigation conditions to reduce or compensate for its potential impacts. This can impede development and increase costs. Delays and cost overruns can be minimized when a project developer formulates proposed avoidance and minimization measures, along with a compensatory mitigation package. Create financial models that consider costs such as property endowments and monitoring expenses. This plan will likely evolve, so be prepared for modifications as permitting proceeds.
6. Environmental studies must be thorough and accurate. Regulatory agencies and other stakeholders require comprehensive and accurate environmental studies. Proper sequencing of studies is important to ensure timely permitting. Rigorous environmental studies will also help the developer understand and assess the financial impact of this critical phase.
7. Wetlands and endangered species often impact solar project development. If they are dredged or filled during site construction, wetlands - such as swamps and bogs - are subject to government oversight. Federal Clean Water Act

authorization may be required from the U.S. Army Corps of Engineers, which can trigger a series of related federal and state agency approvals.

Endangered species issues often determine where and how major solar projects go forward. The Endangered Species Act has a strong set of public policies protecting these species. It is critical to determine whether such issues exist, to develop a strategy for addressing them.

8. Consider the impact on the construction. Many permitting issues impact construction. If possible, have the contractor review the permit conditions so that unintended consequences can be avoided. Mitigating potential issues that affect construction may be critical to meeting schedules and avoiding cost overruns.
9. Oversee permitting and legal developments. Federal and state renewable energy initiatives have resulted in many new policies. Solar projects raise environmental concerns that can require more complicated permitting. It is advisable to monitor changes that can impact permitting - investigating the permitting successes or challenges of similar projects can help identify potential problems.
10. Be prepared and be flexible. During the permitting process, project design or technology changes will undoubtedly occur. During environmental surveys, for example, anticipate that there could be geographically larger, more intensive, or alternative environmental impact scenarios - your analyses will more likely remain valid when such changes occur.

Solar project permitting is complex, and subject to unexpected challenges. Preparation and foresight go a long way towards avoiding unpleasant and costly surprises. Designing and following a strategic matrix will minimize delays, and help you achieve your financial and scheduling goals.



Rick Haglund is Director of Business Development at TerraPro Solutions. He has provided asset due diligence for over 100 utility solar and

wind projects, and multiple large-scale transmission projects throughout the United States. His expertise includes overseeing the operations of ALTA surveys, civil, environmental, aerial mapping/LIDAR, as well as due diligence surveillance, permitting, and fatal flaw analysis.

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Sunflare's LiteMount is a lightweight module that seamlessly integrates with every existing metal roof attachment system. A lightweight solar system, LiteMount is less than 1lb per square foot installed and withstands winds of 125mph. LiteMount is a shatterproof, glassless mounted panel and mechanically attaches with universal clamps in 3 quick steps, so it's easy to install. Combat shading with bypass diodes at every cell. LiteMount comes with a 25-year warranty for product workmanship and power production and is UL, IEC certified.

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Let's Talk Safe Harbor

by Josh Von Deylen



As every day passes, we get closer to the end of 2019 and (potentially) the reduction of the ITC from 30 to 26 percent. It is the optimal time to start discussions to seriously consider committing capital to one of these attractive tax credit programs. While the deadline is the end of the year 2019, ideally these plans should be finalized in early December.

One of the best options for keeping the 30 percent ITC is to purchase Safe Harbor product in 2019 that can be used in 2020 or 2021. There are many factors to consider when choosing where to invest your capital to secure this credit; racking, module, and inverter selection are all options to achieve the five percent threshold necessary for the ITC. Five percent is the minimum investment necessary to claim the project at qualifying under the current program. Keep in mind, however, that this figure is based on a projected total cost for the project. It is recommended that up to three additional percent is allocated to account for cost overruns in the project.

Solar racking is a great solution for Safe Harbor, considering the rapidly changing capabilities occurring in module and inverter technology. Solar Racking alone accounts for at least the minimum outlay of five percent. Most standard racking systems are not universal, and can greatly limit the customer's ability to source modules in the future. The best solution is to seek out manufacturers that offer a system that works for all modules.

Modules are primary components of a solar project, and can fluctuate in price and availability. Be sure to look for racking systems that offer options to allow for versatility with 72-cell modules. Module manufactures are continuously changing the size and hole patterns with new product release, with a trend towards increasing width as the crystalline wafer sizes continue to grow.

Hardware Only – Customers can choose to purchase only the racking portion of the hardware, and not the foundation. Many sites that are using the Safe Harbor hardware have not completed extensive foundation testing. Look for universal hardware that can be used with a wide range of tilt angles and different front lip heights. All of these items are tied to the foundation, which can be purchased once onsite foundation testing is completed in the upcoming years.

Foundations Only – Customers can choose to only purchase foundations for their 2019 Safe Harbor.

Another consideration is the growing popularity of bifacial modules. Customers should consider the bifacial accommodations of the racking solution they choose.

The number of rails, location of clamping zones, and how the module attaches, all affect backside shading. Standard racking systems are a single post with four supporting rails, and shade around 21 percent of the backside of the panel. Discuss backside shading with your racking manufacturer to ensure you are effectively utilizing your bifacial modules. If a large percentage of your projects will use bifacial modules, it is important to consider this factor.

After you decide on the universal racking solution that best suits your project, you may not be ready to implement your Safe Harbor product. Consider the storage and safeguarding of product prior to development of the site: once your product is produced by the racking manufacturer, look for indoor, climate-controlled warehouse space to prevent exposure to the elements, and potential theft and vandalism.

When choosing the most responsible route to Safe Harbor product for your planned projects, there are many best practices to observe. Choosing a versatile product that will meet the ever-changing needs of the customer will ensure future project success with minimal waste. Once produced, consider a partner who can offer safe, clean, and affordable warehouse

space. Above all else, choose a trusted advisor who has experience in Safe Harbor, and can make your Safe Harbor investment experience seamless and problem free.

Josh Von Deylen is the CEO of APA Solar Racking. In business since 2008 with over 1GW of projects installed, APA offers versatile racking and foundation solutions for every project.

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Great Expectations

Underperformance in U.S. solar market

by Cory Jog, Emily Ling, and Rounak Kharait

FOR YEARS, THE SOLAR INDUSTRY HAS BELIEVED

that utility-scale projects meet expectations. Investors, owners, operators, and developers have been making financial decisions based on the assumption that half of their portfolios will over-perform, to make up for the half that under-performs. Any one project may not be a strong performer, but this is mitigated by divesting across multiple projects. Statistically, with enough projects, an organization should realize the return on investment they expect.

Continued rapid growth is expected in the solar power market. However, the solar energy industry likely can't be sustainable and robust unless power plants consistently achieve their anticipated ROI. In turn, given current competitive market forces, a solar project can't meet its return without an accurate estimate of energy production. This demands that technical, data-driven validations of pre-construction prediction be performed on a regular basis. How can we expect a thriving solar industry if the investment community can't rely on their returns? How can investors rely on their returns without being able to predict how much electricity a project will produce?

A solar power performance study for the U.S. compares initial pre-construction energy estimates to actual project performance for utility-scale solar projects. Publishing these results in an open and transparent manner aims to foster trust between solar project stakeholders across the value chain. The results can offer insight across the clean energy industry, from landowners and project developers, to solar module manufacturers and financial institutions.

Qualification for the validation study

In the United States and Canada, over 10.3 GW of proposed solar power plants have been assessed since 2007. Of the pre-construction projects evaluated, not all were constructed as planned (or even constructed at all.) Ultimately, projects included in the study required a minimum of one year of monthly production data from the U.S. Energy Information Administration (EIA) for comparison purposes, and a bankable pre-construction energy estimate using standard, post-2014 methods.

Current solar project performance database

The validation dataset presently has a total installed capacity of 1.2 GW, with 39 U.S. projects from a wide range of geographies, technologies, and vintages. After thoroughly controlling the data for unrealistic overperformance, data quality issues, and misreported energy resulted in minor additional filtering on a project-year basis, the dataset consists of a total of 67 project-years. While the maximum operating years per project is 4.0 years within the filtered dataset, the average is 1.7 operating years per project.

Projects are representative of utility-scale systems across the country with minimum sizes of 1 MW in operation for at least one year. The regional distribution is shown in Figure 1, where the highest capacities are in California and Georgia, at 50.1% (or 613 MW) and 14.9% (or 182 MW) of capacity in the study, respectively. Maryland (0.1%) and Nevada (0.2%) represent the lowest percent of capacity considered. Projects represent a range of sizes from 1 MW - 5 MW to 20 MW - 50 MW to over 100 MW and a mix of fixed tilt and tracker mounting types.

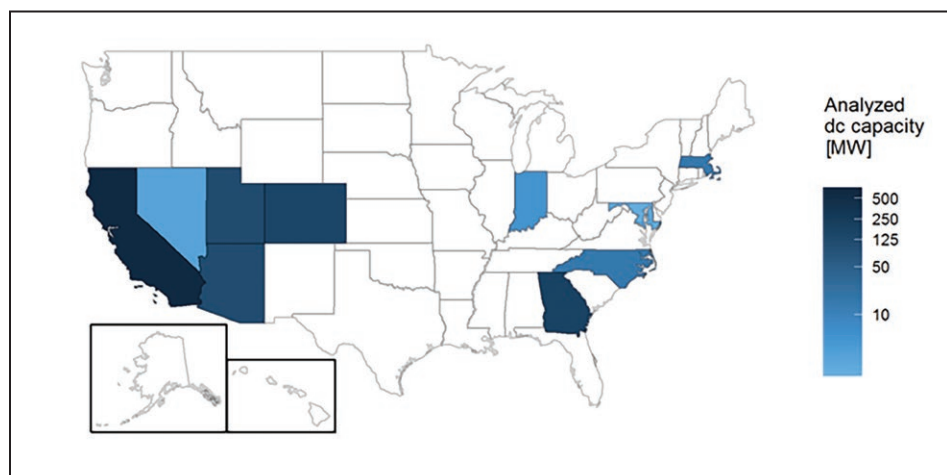


Figure 1. Regional breakdown of solar power projects included in this study

Results of the validation study

This initial solar validation of U.S. operational assets sheds light on the current status of the industry. Across systems within the study, a median performance gap of 3.1 percent was observed on a project basis, while 2.1 percent underperformance was reported on a project-year basis, as seen in Figure 2 and Figure 3, respectively. Interestingly, more data from older projects is included in the project-year results, which could influence these results.

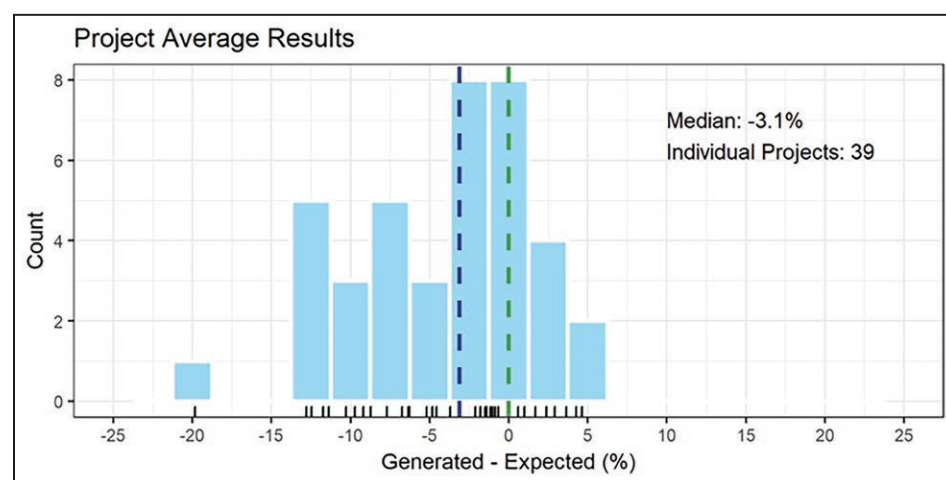


Figure 2. Project-average solar validation results, adjusted for interannual irradiance variability

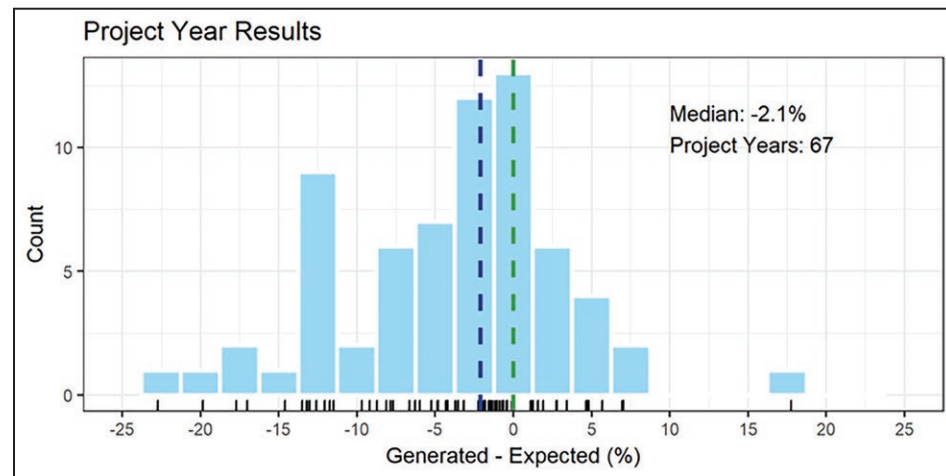


Figure 3. Project-year solar validation results, adjusted for interannual irradiance variability

The study found that, within this limited sample of U.S. projects, assets are performing approximately 3.1 percent below initial predictions from energy assessments performed over the last four years. It is important to consider the uncertainties associated with this validation study, as well as ascertain what could be causing this production gap between pre-construction estimates and post-construction energy production. Could solar resource variability, irradiation data sources, soiling losses, degradation, and availability be contributing to this underperformance?

Resolution and quality of data

Since publicly-available EIA production data was used for operational assets - and is not sufficiently granular - grid availability, plant availability, and curtailment were unknown at the time of this initial study. Force Majeure availability events were not available. Curtailment is not modeled in the pre-construction solar energy assessments, and could not be corrected for in this study due to lack of project-specific curtailment data. Thus, the residual effect of projects with less-severe availability issues or curtailment might not have been detected, and may still be included in the filtered dataset.

EIA production data could not be fully verified for this study. Occasionally, monthly EIA production data was not consistent with values reported in monthly invoices provided directly by the project owners. Annual production, however, was found to be

consistent with that of the project owners, and thus relevant to this study. The median project performance of this study can be affected by the number of months removed at the beginning of the life of each project, due to both this variation in the monthly values and prolonged periods where the project may have been under construction (and actively adding capacity). While only the first month of operation was removed, due to lack of project-specific start-up period information, investigating the effect of removing the entire first year of operation can add value to this discussion.

The commissioning process of an asset is critical. Due to start-up issues, project performance in the first year of operation is typically expected to be lower than the next several years. Slightly more than 50 percent of available data (35 project-years) is in the project's first year of operation in this study. Consequently, eliminating this first year has interesting implications on the validation dataset. On a project basis, the validation dataset without this first operating project-year shows a median performance gap of 1.7 percent (Figure 4), 1.4 percent less than the underperformance associated with the first operating project-year included. The median performance gap result on a project-year basis is 1.9 percent (Figure 5).

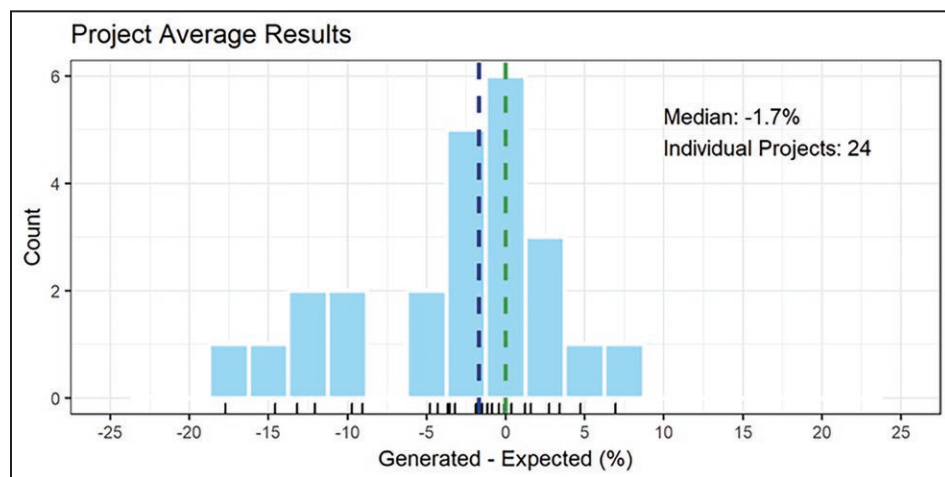


Figure 4. Project-average solar results without Year 1, adjusted for interannual irradiance variability

Need for more performance data

Results may change when additional data become available. With the belief that regularly published validation results may encourage more operators to contribute data to validation, and more independent engineers to publish similar studies, there are plans to update this initial study with additional data on a recurring basis. By collectively evaluating project performance against pre-construction estimates,

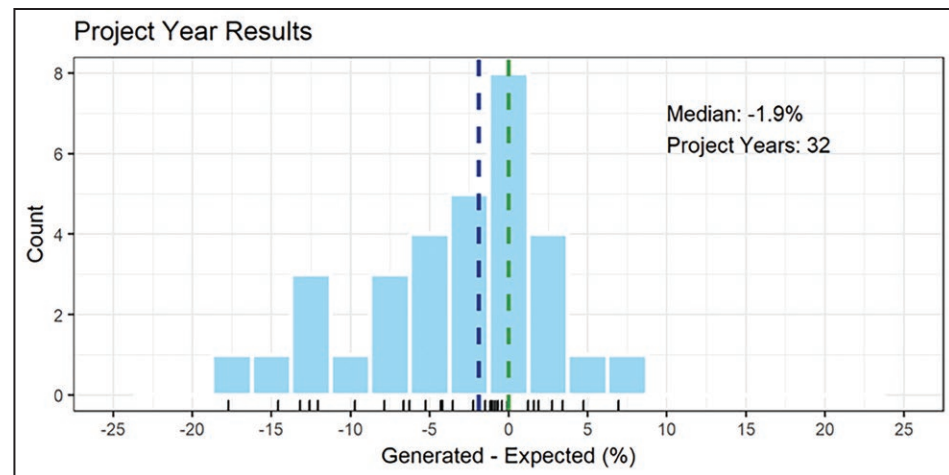


Figure 5. Project-year solar results without Year 1, adjusted for interannual irradiance variability

more accurate energy forecasts and improved uncertainties can reduce the energy production risk for all stakeholders.

Inputs into these models have the potential to be refined. Incorporating a continual stream of higher-resolution data will allow for better interpretation of the performance of these assets in the field. Larger volumes of operational data and measurements facilitate more comparisons of observed project performance relative to their pre-construction energy estimates, allowing for an accurate understanding of the differences between predicted and actual. Particularly given thin margins and aggressive investments in today's US solar market, reducing financial risk is a critical factor in any project, and this introductory study advances a much-needed trend of better transparency in the industry.

Rounak Kharait is solar energy assessment lead in North America for DNV GL, Cory Jog is director of resource assessment for DNV GL, and Emily Ling is an energy analyst for DNV GL. The above-referenced study was released by DNV GL for the overall benefit of the solar industry, and can be found here.

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Solar Thermal Pools

Commercial design and implementation

by Gal Moyal

Watching aerial images of large commercial solar systems often brings to mind the monumental effort and attention to detail involved in getting a project to completion. Over the years, I have come to learn and appreciate the nuances and the fine details that makes a successful project come to life.

The Team

To bring a large commercial solar project from inception to reality, a team of professionals needs to cooperate and work in concert to get the job done. A mechanical engineer will provide the system design to include system drawings, equipment specification, and schedules; this becomes the plan the contractor needs to follow. The engineer is the responsible party, and the PE stamp certifies that the plan adheres to local building codes. A structural engineer provides wind loads calculations and roof attachment methods, to make sure the roof

can carry the extra load (and panels stay on the roof when wind speeds get to 90-120 MPH). That stamped permit plan turns into a bid that contractors use to vie for the job; surprisingly, the lowest bidder is not always the contract winner. The contractor is responsible only for providing the equipment, materials, and labor needed to complete the project as designed.

Design considerations

The golden rule, "Reduce Before Produce", is to optimize the existing system for minimal energy waste, and only supplement with renewable energy. This helps reduce the solar system cost and increase energy efficiency, resulting in better system control and a much shorter ROI (which is more likely to get approved by the customer). A smart designer starts with a complete account of the existing system, and how can it be optimized for minimal energy waste. Then, based on the updated energy demand, the solar system size is set.

Equipment selection

Choosing a high-efficiency TEFC premium Motor pump that can be controlled by a VFD can reduce energy consumption by 40 percent. VFDs size and type are selected based on ease of programming and communication protocols, which allow pool energy management to take control over the pump (which varies for seasonal pools and pools that operate annually). Solenoid valves eliminate "ghost" flow

through the array, and stop radiating heat to the cosmos at night.

Location Considerations

Arrays don't necessarily have to be on the roof, but that's where 90 percent of them end up. In some cases, ground-mounted systems might be a better choice due to additional benefits they can offer, such as shading, better access, and avoiding potential roof reinforcement and leaks.

Piping

The most efficient and cost-effective solar pool system is a drainback system that operates in relative lower temperatures (ranging from 80-140°F, with peaks of 160-180°F). CPVC schedule 80 piping is recommended because of its thicker wall and ability to sustain up to 200°F for short periods of time. In most cases, the solar array is located far from the pool mechanical room, connecting with long pipes (either underground or exposed). Array piping should allow for even flow across the array, and automatic drainback as soon as the pump stops pumping water. In large commercial systems, active drainback is recommended, where a designated drainback pump actively pumps water assisting in draining the array.

Mechanical room equipment

A typical commercial pool deploys a 30HP - 60HP pool pump, 4 MMBTU - 8 MMBTU



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boilers, filtration, and chemical systems. Each system operates independently, and has certain energy usage and flow requirements. Eliminating energy waste takes precedence over energy production. Therefore, the first step should be to consider a Pool Energy Management System that can manage both pool energy usage and a solar thermal solar system. The system has to maintain a delicate balance of flow and energy savings without derailing the overall system into emergency shutdowns. Considering that 80 percent of ownership cost is the electricity it takes to run a pump, it makes sense to employ a pool pump VFD that can reduce energy usage by up to 50 percent. Add that to a solar system that works harder than the boilers, and the cost of pool operation drops by 40 percent.

Control and monitoring considerations

A successful control strategy includes measuring the pool, boiler and solar flows, pool chemistry (ORP and PH), and associated temperature of all three loops. In addition, it is important to install solar and drain solenoid valves, pumps, and boiler control switches on top of a solar pump variable frequency drive (VFD) and required plumbing. The array flows must be balanced, and the array able to drain when the time is right. The conventional strategy of solar control - turning the solar pump "full speed" ON or completely OFF based on the temperature differential (dT) between the array and the pool - ignores the rest of the subsystems, and will eventually send the boiler or chemistry controller into emergency shut down. A sophisticated designer will choose a control unit that modulates pool and solar flows as needed, keeps pool temperature in acceptable range, and can submeter the solar BTU production and boiler BTU consumption. The subject of solar pool control strategy was covered extensively in our North American Clean Energy article "An innovative approach to solar pool control strategy"

Commissioning and post installation

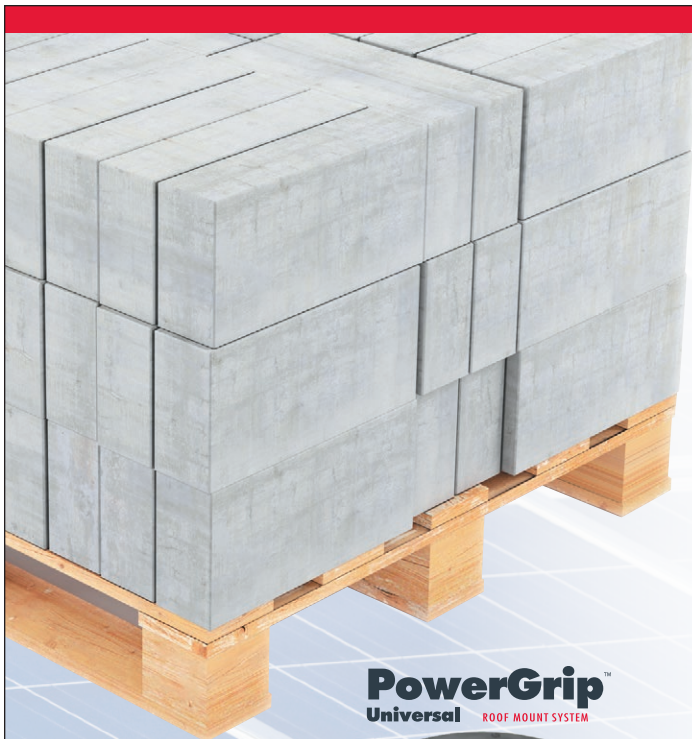
Once the solar system is up, operational, and tested, it must be integrated into the existing mechanical room. Keep in mind that a commercial solar system pulls a substantial flow out of the existing pool



flow, which can disrupt normal operation for some of the subsystems. Seamlessly integrating a large commercial solar system sometime feels like balancing act - it requires expert knowledge of pools and solar systems. Unfortunately, it is not uncommon to find large systems that were delivered to the customers with much fanfare, only to fall short of operating expectations. Close, post installation monitoring of pool and solar systems is vital. It allows for system fine-tuning for additional energy saving, and prevents a system shutdown. Making smart decisions on equipment, installation, and monitoring will help ensure that the customer gets the performance and energy saving they paid for.

Gal Moyal is the Founder and CEO at Maktinta Energy, a provider of comprehensive cloud-based control and monitoring solutions, energy efficiency design and implementation of renewable energy solutions. Maktinta manages on/off grid energy efficiency of large complex mechanical systems covering hydraulic, electrical, agricultural and renewable disciplines with emphasis on solar thermal and PV solutions.

Maktinta Energy /// www.maktinta.com



Get Out of the Stone Age!

Most rooftop solar racks are designed around ballast blocks or cement pavers. But ballasted rack systems can move around on the roof, grind broken pieces of ballast into the roofing membrane, and leave the building vulnerable to leaks and other roof problems. More important, many buildings cannot accommodate the dead load weight that ballasted systems require.

Move beyond the Stone Age with PowerGrip!

The OMG PowerGrip family of products was designed to reduce ballast from commercial solar racking systems by providing a secure connection directly to the roof deck or structural members. Once secured in place, properly installed PowerGrips minimize rack movement and remain watertight.

Let us show you how a PowerGrip from OMG Roofing Products can help bring your next solar project out of the Stone Age.

Evaluation samples of the new PowerGrip VRM will be available soon. Contact Kevin Kervick at kkervick@omginc.com today to claim yours!

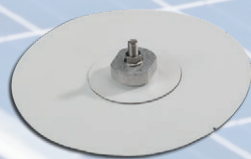
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The Power of Time

by Erik Anderson



POWER vs ENERGY. KW vs KWH.

Inverter capacity vs battery capacity. Do you know the difference? A sustainable future featuring solar power plus energy storage should be getting more transparent and less confusing. But, as you can tell, that's not always the case.

If we are to truly witness a paradigm shift in how we create and consume energy using solar and storage technology, we must first understand a few basics. This will help minimize confusion and friction that would otherwise slow widespread and rapid deployment of new technologies critical to transforming our future in eco-friendly renewables.

think of watts as the size of a bathtub faucet, or its power potential. At any single point in time, you can measure how much water is flowing through it. When that flow accumulates in the tub, you end up with a volume of water you can measure differently, just like with energy.

To further clarify, a watt is a static instantaneous measure of moving electrons - also known as "electricity". With each passing second, minute, and hour, those individual measurements add up to a cumulative measure of energy. A watt is a two-dimensional measure of power; time adds the third dimension of power's cumulative effect, describing energy as a function of power over time.

Power vs. energy explained

To understand the difference between power and energy is to understand the effect of time on the units of measurement, which we rely on to measure the flow of electricity. These two terms are related, but unique. Utility companies use both to plan and operate our grids, as well as bill us for our monthly power usage.

If a 100-watt light bulb is used for 10 hours, it will have consumed a total of 1,000 watt hours (WH) of energy (10 x 100 = 1,000), or 1 kilowatt hour (kWh). We can

Variable power consumption in the home

This concept is further complicated when power usage is variable. A home does not

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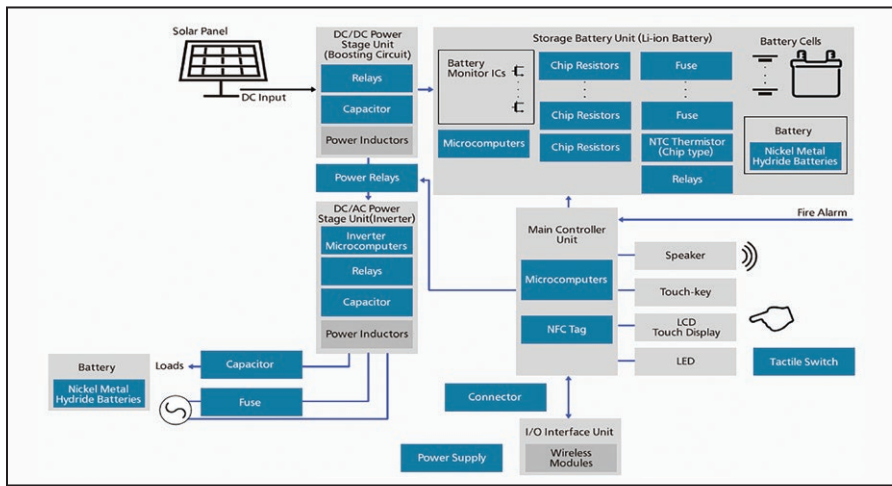
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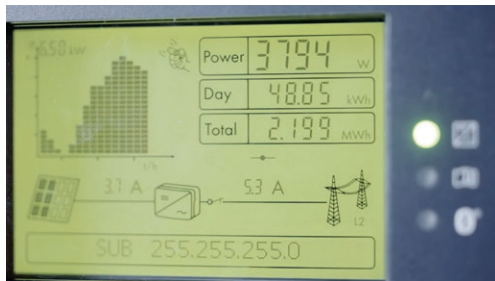






have a steady continuous usage of power. It varies and spikes from one moment to the next, and tells us an important story of how electricity is being used in the home at any given point in time. But, it is ultimately variable.

When we adjust for the cumulative effect of time on power usage throughout each day, and add up the power being consumed every second in a home for a day, week, month, and year, we discover that home's energy requirements. (By the way, both are equally important in sizing an energy storage system.)



Battery storage & net energy metering

Cue the batteries. Lithium-ion (Li-ion) batteries, that is (as opposed to the NEM-facilitated grid 'battery').

Li-ion batteries are finite in their capacity to hold energy. Contrary to popular belief, they are not 100 percent efficient.

However, they do facilitate onsite storage of energy, which is perhaps our most potent antidote to avoid higher electricity costs from disappearing net energy metering (NEM) policies, and the implementation of time-of-use rates.

Given that Li-ion batteries have a finite capacity to store energy, the importance of energy and power becomes even more significant. In a world where energy storage is growing increasingly popular and affordable, understanding this point is essential for solar professionals.

When we talk about solar plus storage systems, it is important to understand that the power rating of the system is dictated by the kilowatt (kW) size, or rating of the inverter. An inverter's ability to deliver a specific amount of power at any point in time enables us to deliver on a home's specific power needs. It is the energy in those batteries that will enable us to power those needs over time.

In order to make smarter decisions for our companies and our customers, all of us in the solar industry need to be on the same page. Take the time to really understand the power behind our technology. Remember, when talking energy storage systems, the power is in the inverter, and the energy is in the batteries.

Erik Anderson is a Regional Sales Manager with Panasonic Life Solutions and has been a strong advocate and promoter of renewable energy and home solar power for over a decade.

Panasonic Life Solutions

/// www.panasonic.net



Simplifying material handling and streamlining installation

Sunfolding has launched upgrades to the Sunfolding T29 Single-Axis Tracker which make it easy to transport material to the project site and through the field, further reducing project costs, thus improving project profitability. The upgraded Sunfolding T29 uses the same durable materials and advanced manufacturing processes that enable Sunfolding, with just three components, to achieve fast installation times and low operational costs. The upgraded Sunfolding T29 features a strong and light actuator that relies on half the actuator bolts, weighs 20% less, and requires 15% fewer posts per MW compared to its predecessor. Sunfolding trackers, with their low part count and streamlined design, don't require installation teams to spend time on extensive training or handle expensive custom tools. The upgraded design brings the same sensibilities to improving project site logistics, benefiting installers with reduced costs and timelines from project start to finish.

Sunfolding

/// www.sunfolding.com



Utility inverter solution

Ginlong Technologies expands its Solis portfolio with a new utility-scale solution for the U.S. solar market. The Solis 125kW 1500V three-phase string inverter features built-in string monitoring, which measures all string parameters for quick fault isolation and system commissioning. An integrated smart I/V curve scanning feature helps detect such string faults as panel mismatch and shading, decreasing O&M time and increasing system energy yield. DC fuses on both positive and negative inputs protect the inverter and DC cables, while built-in replicable DC and AC Type II surge protection devices (SPD) safeguard during power surges, further ensuring system availability. Lastly, Type I SPD optional protection is also available to shield against damage from frequent surges and lightning strikes.

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Building Trades Lead California's Clean Energy Future

by Donald Zampa

Last year, U.N. Secretary-General Antonio Guterres warned that the world is facing “a direct existential threat” and must rapidly shift from dependence on fossil fuels by 2020¹ to prevent “runaway climate change.” Many nations in the world are falling behind on their commitments to combat climate change. In the U.S., the EPA announced plans to roll back limits on methane emissions². Under the Trump administration, 85 percent of environmental rules are being rolled back.

While the country is taking a step back in combating climate change, California - the fifth largest economy in the world - stands out in climate change action. California state governor Jerry Brown recently signed into law the Senate Bill 100³ (introduced by state Senator Kevin de León, D-Los Angeles), mandating that all of the state's energy come from clean power sources by 2045. In 2015, Hawaii signed a similar bill into law⁴.

The California mandate does not lay out a particular roadmap for reaching the goal. Energy sources considered clean power under the law include solar, wind, geothermal, biomass, small hydropower, renewable gas projects, wave, ocean current, and waste conversion. Nuclear power and large hydropower projects are not considered clean energy.

The legislation requires California to meet 50 percent of its energy needs with clean power by 2025, and 60 percent by 2030, before reaching the 2045 goal of 100 percent. California is already on track to reach its clean power goal with an estimated 32 percent of clean retail energy⁵. Although meeting 100 percent of energy needs with clean sources by 2045 will be a challenge, supporters believe that setting an ambitious target will set off new rounds of investment and research. California will have to figure out how to move beyond natural gas, which is currently the largest source of electricity in the state.

Solar is the most widely deployed renewable energy source in the state. Both solar and wind energy are weather-dependent renewable power sources, only generating energy when the sun shines or the wind blows. Geothermal can play a key role in getting fossil fuels off the grid. However, most energy experts believe that the most cost effective and feasible way to reach California's clean energy targets, is by combining an expanded and better-connected transmission power grid system (that makes it easier to share electricity across states) with large-scale, high-capacity energy storage systems.

California Energy Storage Alliance⁶, estimates that the state will need to procure an additional 9,604 megawatts of storage capacity to meet its needs.

A UC Berkeley Center for Labor Research and Education study⁷ revealed that California's clean energy policies have been an “economic boon” to the region, resulting in a net gain of over \$13 billion, and over 37,000 jobs. According to University of California at Berkeley Labor Center, the construction of renewable energy infrastructure created 90 percent of 88,000 jobs in the San Joaquin Valley between 2012 and 2015. The demand for additional gigawatts of solar and wind energy, high-capacity energy storage systems, and better-connected power grid systems, creates thousands of new jobs, which means millions of work hours for the skilled building trades.

According to Iron Workers District Council of the State of California and Vicinity, over 15,500 megawatts of photovoltaic solar construction have been secured for union construction. Over 9,000 megawatts have been completed, and the rest is under construction.

Following the recession in 2008, when jobs were scarce, California's clean energy policies have been creating jobs for the ironworkers in solar energy since 2013⁸.



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IW local unions in California started working on solar projects that popped up across the valley - fueled by California's clean energy policies. They have been at the forefront of getting California on track to reach its goal of 100 percent clean electricity by 2045. They have worked on over 300 clean energy projects, and completed well over 1 million work hours on those projects since 2012. When oil barrel prices fell, the building trades unions in California put displaced workers back to work on solar and wind projects. They continue to recruit displaced oil industry workers for renewable energy projects. Far from being job killers, climate change regulations have helped California create thousands of new jobs, and a thriving clean energy economy.

Donald Zampa is the president of the Iron Workers (IW) District Council of the State of California and Vicinity. During his 40-year career as an ironworker, he served as an organizer, president and business manager of Iron Workers Local 378 in Benicia, Calif. He was appointed a general organizer of the Iron Workers International in 2006. He was appointed president of the California and Vicinity District Council in 2015 and vice president of the California Labor Federation and vice president of the Iron Workers International in 2016.

International Association of Bridge, Structural, Ornamental and Reinforcing Iron Workers /// www.ironworkers.org

¹ <https://apnews.com/71ab1abf44c14605bf2dda29d6b5ebcc>

² <https://www.nytimes.com/2018/09/10/climate/methane-emissions-epa.html>

³ <https://www.latimes.com/politics/la-pol-ca-renewable-energy-law-signed-20180910-story.html>

⁴ <https://www.hawaiinewsnow.com/story/29269793/gov-ige-signs-bill-setting-100-percent-renewable-energy-goal-for-state/>

⁵ <https://www.npr.org/2018/09/10/646373423/california-sets-goal-of-100-percent-renewable-electric-power-by-2045>

⁶ <https://www.marketwatch.com/press-release/energy-storage-to-play-key-role-in-reaching-california-target-of-100-zero-emission-electricity-by-2045-and-beyond-2018-09-11>

⁷ <http://laborcenter.berkeley.edu/pdf/2017/economic-impacts-climate-programs-san-joaquin-valley.pdf>


⁸ <https://www.washingtonpost.com/news/theworldpost/wp/2018/01/10/california-jobs/>



Renewable energy investment platform


Novasec Ltd. announced the launch of its investment platform, which connects investors with unique opportunities in the fast-growing renewable energy sector. Through a careful project selection process, Novasec's platform combines the renewable energy sector with digital securities, providing investors the potential for lower-risk, competitive returns. Novasec has developed an end-to-end platform for financing renewable energy projects through private placements for accredited investors, with Novasec managing the entire investment process. The goal is to maximize returns, minimize risk, increase availability, and incorporate the benefits of the flexibility, liquidity, transparency, fractionalization, and embedded compliance provided by digital securities. Crucially, Novasec locates the right projects for investors, conducting in-depth due diligence, establishing the legal and tax structure for each project the company agrees to finance, and ensuring that a capable local development team is in place. Then, the company sets the fundraising and distribution strategy, creating a smooth, efficient, and transparent operation.

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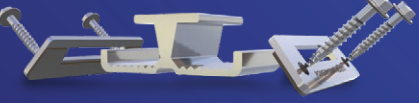
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Robust DC link capacitors

TDK Corporation has extended its portfolio of EPCOS film capacitors for DC link applications with the robust new B3277*M series. The new types are suitable for extreme environmental conditions at 185°F (85°C), 85% relative humidity with a rated voltage applied for 1000 hours. The capacitors of the new series are designed for rated voltages of between 450VDC and 1600VDC and offer capacitance values of between 0.33 µF and 120 µF. The maximum operating temperature of these RoHS-compatible components is 221°F (105°C). Depending on the voltage and capacitance, the lead spacings are 27.5mm, 37.5mm and 52.5mm, and a 2-pin or 4-pin version is available for each lead spacing. The service life of the self-healing capacitors is 50,000 hours at the rated voltage and an operating temperature of 185°F (85°C). Typical applications include DC links of converters for photovoltaic plants, as well as frequency converters and power supplies for industrial applications. The series is qualified in accordance with AEC-Q200.

TDK Corporation

/// www.tdk-electronics.tdk.com



Turnkey solar resource assessment solution

A new and complete solar resource assessment (SRA) solution has been introduced to the US market via a collaboration between ArcVera Renewables, NRG Systems (NRG), and Harness Energy. This end-to-end offering will provide solar project developers with the design, manufacture, shipping, installation, and operation of their solar measurement systems, including the delivery of independent campaign monitoring and finance-grade resource assessment reports. The ArcVera-NRG-Harness collaboration promotes independence in the three main areas of a solar energy assessment: equipment procurement, installation and maintenance, and data analysis. NRG supplies its highly integrated and standardized solar met stations for a repeatable measurement result; Harness Energy provides the installation and ongoing operations, including the maintenance of mission critical pyranometers; and ArcVera Renewables provides independent technical advisory services, ensuring the met stations are generating the quality data required to deliver accurate, bankable assessment reports. Each provider focuses on delivering excellence in their respective domains and when these offerings are combined, there are considerable benefits to customers.

ArcVera Renewables

/// www.arcvera.com

Harness Energy

/// www.harnessre.com

NRG Systems, Inc.

/// www.nrgsystems.com



Solar panel with integrated micro-inverter

The NeON R ACe is LG's latest solar power module for residential applications that produces a direct current power output up to 375W along with its newly integrated 320W micro-inverter. Recessed into the frame of the solar module, the integrated micro-inverter, designed by LG Electronics, allows for the NeON R ACe to be a solution for both installers and homeowners, saving time, space, and money. This integrated design eliminates the need for a separate inverter, thereby reducing clutter from outside walls and rooms within the home. Requiring only two types of accessories, it provides straightforward logistics and reduces the time needed for preparation and installation. The new LG NeON R ACe provides a premium, clean, and sleek aesthetic for residential and light commercial applications. The elimination of electrodes from the front of the module and relocation to the back creates a seamless array of panels. LG's 25-year limited warranty for products, parts, and performance applies to the NeON R ACe and covers both the panel and the inverter, giving homeowners and installers a great degree of investment security from a brand they can trust. For added convenience, the LG NeON R ACe provides a user-friendly app-based monitoring service system called EnerVu. Through this app, installers and homeowners can monitor the system's energy flow from any location and, if a technical issue arises, alert LG customer service to help address it remotely.

LG Solar /// www.lg.com/solar



Class 1 Div 1 and Class 1 Div 2 hazardous rated units

Endress+Hauser expands its product portfolio for device configuration by introducing the Field Xpert SMT77, a rugged tablet PC tool for commissioning and maintenance staff to manage field instruments and document the work progress. The SMT77 comes preinstalled with device configuration software and device library, so it is ready to go, right out of the box. The device enables plant asset management in Class 1 Div 1 hazardous areas. The Field Xpert device library has more than 2700 pre-installed device and communication drivers, allowing it to work with many different instruments from a wide variety of vendors. It can connect to field instrumentation devices directly via a USB or Bluetooth wireless modem, or via a gateway, remote I/O, or multiplexer to a bus system. The tablet PC has Windows 10 Pro software installed. It comes with an 10.1" LCD Multitouch HD display, 2x bonded Gorilla Glass, a 5MP auto focus camera, a 2MP front facing camera, and up to 128GB storage. Communication ports and supported networks include USB, Ethernet, HDMI, Wi-Fi, and Bluetooth, with 4G LTE and GPS available as an option. The battery runtime is five hours. The SMT77 comes in a general purpose configuration as well hazardous area configuration for Class 1, Div 1 and meets all the legal requirements of the relevant EU directives and is IP65 compliant.

Endress + Hauser

/// www.us.endress.com/SMT77

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www.kineticsolar.com



Better data = better designs

All Aurora users (premium and basic) will now have access by default to Google HD imagery. The new imagery is high-resolution, vibrant, and up-to-date. Premium and Enterprise accounts now have access to a large set of 3D data in a solar sales and design application, including international locations. With over 90% of the U.S. covered and some international locations, the new data allows users to get the design right the first time around.

Aurora Solar, Inc.

/// www.aurorasolar.com



New ground mount system

The Schletter Group introduces the next generation of its ground mount system, FS Gen 3 which uses less material per kilowatt output with the same or higher load-bearing capacity. In addition, the system is easy to assemble due to the targeted optimization of individual components. For the pile driven foundations, girders and purlins of the FS Gen 3, Schletter is using high-tensile steel, and instead of following a Z profile, the cross section of the purlins is formed as a downward opening, symmetrical trapezium. The new shape, in combination with the new material, significantly increases the load capacity of the purlins. The new purlins can support spans of up to 6.5m. The new geometry also allows the purlins to serve as cable tray, string cables are fed through the purlins and thus protected against wind and weather as well as UV radiation. In order to reduce the time needed to assemble the system, connections are based on clamps so no on-site drilling or pre-punching of holes is necessary, allowing for a maximum of flexibility during installation. To further simplify and accelerate module mounting, the modules are pushed in from below between the tilted rafters and then fastened with a slip guard, without the need for ladders or lifting platforms.

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



Roof integrated solar

Unirac, Inc. and Viridian Solar announced a new collaboration to bring Viridian's roof-integrated solar technology to the United States. Marketed as Clearline Fusion in European markets, the product is suited to the new-built residential sector. Viridian Solar has granted Unirac an exclusive license to manufacture, market, and sell its roof-integrated solar technology in the US and Latin American markets.

Unirac, Inc. /// www.unirac.com
Viridian Solar /// www.viridiansolar.co.uk

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High wattage, efficiency, and reliability

The SOMERA Grand Ultima Max Mono PERC half-cell modules from Vikram Solar range from 405 to 425Wp, have a 27-year linear power warranty, with shipment to the U.S. starting from January 2020. The module's technological advancements include a high-performance encapsulation which optimizes internal reflection and allows the module to harvest more light; lower interconnect resistance between cells, which minimizes power losses; and the use of three split junction boxes with individual bypass diodes to reduce internal resistance and improve heat dissipation.

Vikram Solar
/// www.vikramsolar.us

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Commercial solar finance quote tool

Open Energy offers an online finance quote tool, providing clear finance indications on the range of commercial finance products available to end customers, whose tax appetites vary, across different states, against different energy supply regimes. OEG Quote, OEG's online finance quote tool, provides solar sales professionals with the means to provide transparent financing offers to prospective customers, allowing sales cycles to shorten and become more successful as customers respond to recognizable sales processes, and the confidence from a sector delivering breadth and depth to solar finance options.

Open Energy /// www.openenergygroup.com



Edge clips with cable ties

BURNDY has launched the Wiley ACC-ECT line of Edge Clips with Cable Tie products. The ACC-ECT line of clips features a nylon-encased plated steel clip that installs onto the module frame flange (1mm to 3mm thickness) and allows a cable tie to be routed in both landscape (on the horizontal/perpendicular portion of the module frame) and portrait (on the vertical/parallel portion) orientations. The ACC-ECT product is a solution for routing cable bundles without the need for mounting holes or additional hardware. Offered in three standard cable tie lengths (8", 11", 14"), 50lb. tensile strength, in either Nylon 6/6 (UV resistant, high impact heat stabilized) or Nylon 12 (UV resistant, provides exceptional UV, Chemical, and Moisture resistance).

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Socomec Group



Easy-to-install solution for rapid shutdown PV arrays

Schneider Electric, together with Tigo, have announced the launch of Schneider Electric's MPPT Disconnect RS (Rapid Shutdown), an accessory for Schneider Electric's Conext MPPT Solar Charge Controllers for rapid shutdown PV arrays with Tigo TS4-F (Fire Safety). Schneider Electric's hybrid solar and storage solutions now offer enhanced flexibility to meet NEC 2017 requirements with both DC coupled and AC coupled PV arrays. For DC coupled arrays with Conext MPPT (Maximum Power Point Tracking) Solar Charge Controllers, the new MPPT Disconnect RS is an easy to install accessory that integrates a rapid shutdown transmitter and arc fault detection with a photovoltaic (PV) disconnect switch. The MPPT Disconnect RS is compatible with the Conext MPPT 80 600 and MPPT 60 150 Charge Controllers and is certified with Tigo's TS4-F (Fire Safety) for module level rapid shutdown using powerline communication.

Schneider Electric

/// www.sesolar.com



AC recombiners for string inverters

EPEC Solutions recently launched two new products for utility scale string inverter systems. The first is a UL 891 certified 4000A, 600VAC AC recombiner platform that provides a main breaker and up to thirty inverter feeds in a compact switchboard measuring 90" x 60" x 36". This unit also features a direct bus connection to the MV transformer. The 2nd new product is a UL 891A certified 2500A, 800VAC AC recombiner platform. This 800VAC product was designed in collaboration with string inverter manufacturers.

EPEC Solutions

/// www.epecsolutionsinc.com



Resilience and performance

NEXTracker, a Flex company, introduced a new smart single-axis solar tracker, NX Gemini. The next-generation two-module-in-portrait (2P) tracker is optimized for customer sites with hard soils, challenging terrain, irregular parcel shapes, and high-wind requirements. The combination of NEXTracker's flagship NX Horizon and NX Gemini offers customers a comprehensive solar tracker portfolio, providing flexibility to reliably configure systems at their project sites for maximum energy output across a broad range of site conditions. Engineered for resilience, NX Gemini's innovative 2P architecture results in shorter overall row lengths for design flexibility and contiguous solar panels for maximum array density. NX Gemini supports up to four 1500V strings and requires only seven foundation posts for typical sites, delivering a low number of foundations per megawatt. The ruggedized 2P tracker features a patent-pending self-locking, multi-actuator distributed drive system for maximum stability in all wind conditions. NX Gemini's installation-friendly array height and drive system allows the attachment of all modules on one side while the tracker is tilted, with the ability to rotate to complete the installation process on the opposite side. This feature delivers exemplary construction velocity for 2P trackers. The NX Gemini 2P tracker supports either monofacial or bifacial PV modules and is integrated with the entire NEXTracker software ecosystem, including the TrueCapture advanced smart control and energy yield enhancement platform. To maintain optimal performance and productivity, NX Gemini is backed by NEXTracker's global asset management and Digital O&M services.

NEXTracker /// www.nextracker.com



Dual-row, single-axis solar tracker

STI Norland, global supplier of solar trackers and fixed-tilt arrays, has launched the 4th generation of STI-H250, a dual row single-axis solar tracker. This solar tracker consists of two torsion beams positioned in a North-South direction on which the PV modules are mounted. The two beams are linked and rotate simultaneously following the path of the sun in the sky. They are moved by just one motor, cutting supply and maintenance costs. In addition, the 4th generation of STI-H250 considerably increases the adaptability to complex terrains and irregular layouts. The data collected during months of real experience on site allowed STI Norland's R&D department to keep applying improvements on the product and reach the current advanced version of the STI-H250.

STI Norland /// www.stinorland.com



Drone maintenance and repair tool kit

A compact new repair tool kit for commercial drones that includes a wire cutter, a thumbwheel-cam adjustable wire stripper, and needle nose pliers has been introduced by Xuron Corporation of Saco, Maine. The Xuron Model TK 4001-Maintenance & Repair Kit features three popular tools that can help inspectors keep their drones airborne and working properly with on-site electronics and mechanical repairs. Included are the Model 2175 Maxi-Shear flush cutter for soft wire up to 12AWG, Model 501 adjustable wire stripper for wires from 10 to 26AWG, and Model 485 long nose pliers. Packed in a handy canvas travel pouch with pockets to protect each tool, the Xuron Model TK 4001-Maintenance & Repair Kit can fit easily into a pocket or briefcase. Manufactured from high carbon steel and blackened to prevent glare, these industrial-duty hand tools have cushioned Xuro-Rubber grips, and a Light-Touch return spring.

Xuron Corporation /// www.xuron.com



Ultra-flat aluminum electrolytic capacitors

The new ULP Series of Ultra-Low-Profile aluminum electrolytic capacitors from Cornell Dubilier help engineers designing compact electronic devices. Designed specifically for applications requiring bulk capacitance and the lowest board profiles, type ULP offers high energy density. ULP technology allows the circuit designer to use a single component that saves space, weight, and cost while improving reliability. Due to its light weight, the ULP is a solution for use in portable devices and is well-suited for a wide range of applications where height profile, board space, and weight are critical design factors. In such situations, the ULP is not only cost-competitive, but it also improves circuit reliability through use of a single component versus an entire array of SMT capacitors.

Cornell Dubilier /// www.cde.com/ulp



US-based engineering and manufacturing with quality and reliability

Yaskawa Solectria Solar's new SOLECTRIA XGI 1500 grid-support utility interactive inverter features a DC oversizing ratio of 2.0 for its XGI 1500-125kW model. In addition, the SOLECTRIA XGI 1500 inverters are now SunSpec Modbus Certified, have PSCAD, PSLE, PSS/E, and PowerFactory models available, and also have an Independent Assessment Report from Black & Veatch. The XGI 1500 is also a solution for PV project developers, owners, and EPCs that want to secure the 30% Federal ITC before the step-down begins, using the 5% safe harbor method. By purchasing the XGI 1500 before December 31, 2019, project owners will qualify for the full 30% tax credit and have the flexibility to deploy the XGI 1500 inverters on any project. The SOLECTRIA XGI 1500 inverter is made in the USA with global components at the Yaskawa America factory in Buffalo Grove, Illinois.

Yaskawa Solectria Solar

/// www.solectria.com

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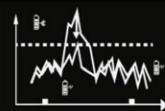
The pre-engineered BESS includes all local components except the EMS controller and Battery system. With standard MODBUS MESA compatible protocol, different kind of battery could be easily integrated and be used as a plug-&-play BESS.



30kW + 60kWh



10/20/40 ft container
500-2000kW + up to 2MWh



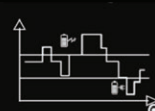
Demand Charge Management



Peak Shaving



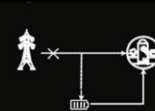
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Performance Monitoring

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

SEE AD ON PAGE 26



Socomec Group



Continental Control Systems

Product: WattNode Wide-Range Modbus Energy Meter

Voltage: 100-600 Vac, wye and delta, single-phase, and three-phase

Current: 5 – 6000 Amps

Power: 2W

Frequency: 50/60Hz

Warranty: 5-year warranty

Output: Requires 0.333 Vac current transformers

Sensitivity: 0.5 % when used with 0.3% current transformers

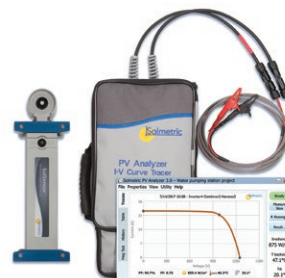
Certifications: ANSI C12.20, Sunspec

Key Features:

- Correct wiring errors remotely;
- Change a CT's polarity;
- Change a CT to a different line voltage;
- SunSpec, C12.20 certified;
- Updates readings every 100 ms;
- Class 0.5 accuracy.

www.ctlsys.com

SEE AD ON PAGE 29



Solmetric

Product: PV Analyzer I-V Curve Tracer

Voltage: 1500V

Current: 30A

Power: 45kW

Warranty: 1-year warranty

Certifications: TUV

Key Features:

- Measure I-V curves up to 1500V at 30A;
- Wireless interface to irradiance sensor with 300ft range;
- Highest measurement throughput;
- Large, easy-to-use user interface.

www.solmetric.com



Tigo Energy, Inc.

Product: TS4-A-2F (Fire Safety Add-on for 2 Modules up to 1000W)

Voltage: 16V - 90V per input

Current: 15A per input

Power: 1000W

Frequency: Powerline communication

Warranty: 25-year warranty

Spectral Range: Per module

Operating Temperature Range: -40°F to 158°F (-40°C to 70°C)

Certifications: UL, TUV, IP68, NEMA 3R

www.tigoenergy.com



Fronius

Product: Fronius Symo Advanced

Voltage: 600V - 1000V

Current: 25.0A / 16.5A

Power: Multiple

Frequency: 45 - 65Hz

Warranty: 10-year warranty

Logging Values: 10 - 24kW

Certifications: UL 1741-2010 Second Edition (including 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

www.fronius.com

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 IEC 61724-1 Class A Compliant

www.eko-usa.com



Spectrafy

Product: SolarSIM-G spectral pyranometer

Voltage: 12Vdc

Power: <1W

Warranty: 5-year warranty

Spectral Range: 280-4000nm

Measurement Range: 280-4000nm

Output: RS-485 ASCII

Sensitivity: <1%

Certifications: ISO 9080:2018 Class A

www.spectrafy.com

SEE AD ON PAGE OBC



Shoals Technologies Group

Product: BLM

Voltage: Systems up to 1500V

Current: 12A Isc

Power: Parasitic

Warranty: 5-year warranty

Logging Values: Voltage, Current Power, Temperature, and IV Curve

Certifications: UL

Key Features:

- String Current, Panel Voltage, and I-V Performance monitoring;
- Continuously monitor for underperforming panels; with wireless communication and parasitic power;
- No need to run cables; easy installation via integrated connectors.

www.shoals.com

SEE AD ON PAGE 30



Eppley Laboratory

Product: GPP Class A Pyranometer

Warranty: 1-year warranty

Logging Values: .1 Wm-2

Spectral Range: 285-2800 nm

Measurement Range: 0-2800 Wm-2

Output: 0-10 mV Analog or Modbus Digital Output

Sensitivity: 8 μ V / Wm-2

Certifications: Calibrated to World Radiation Reference (WRR)

Key Features:

- Class A Pyranometer for high measurement precision and low uncertainty;
- Global/Bi-Facial/Albedo measurements for PV Site Evaluation and Plant Performance;
- Bankable data, unprocessed and unfiltered;
- Flexibility to meet customers unique data requirements;
- Now with digital output.

www.eppleylab.com



Phoenix Contact

Product: SOLARCHECK

Voltage: Up to 8x 0-1500Vdc

Current: Up to 64x 0-20Adc

Power: Externally calculated

Warranty: Limited lifetime warranty

Logging Values: Modbus communications for external logging

Certifications: cULus Listed (UL 508 A), UL Recognized (UL 1741)

www.phoenixcontact.com



eGauge Systems

Product: eGauge Pro

Voltage: 1-, split-, or 3-phase 0-277Vac and +/-60Vdc

Current: 0-6900A (30 channels)

Power: Any current x voltage combination

Frequency: 50/60 Hz

Warranty: 2-year, or 5-year warranty

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

Certifications: ANSI C12.2 - 0.5% Accuracy, UL (IEC/UL 61010-1 Ed. 3.0 B:2010)

www.egauge.net



Electriq Power

Product: PowerPod Residential Energy Storage System

Voltage: 120/240

Current: 0-30A

Power: 5500W

Frequency: 50Hz and 60Hz

Warranty: 12-year warranty

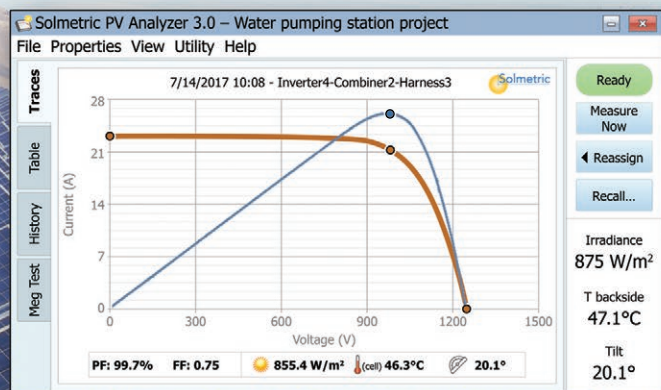
Logging Values: Dashboard (Electriq Power Software)

Output: 5500W

Certifications: UL 1741SA, UL 1973, UL 1642, CSA C22.2, IEEE 1547A, IEEE 1547.1, FCC Class B, HECO

www.electriqpower.com

1500 Volt 30 Amp I-V Curves



Solmetric PV Analyzer

Now shipping V2!

- Highest accuracy and throughput
- Largest display with best array troubleshooting features
- Database of 50,000 PV modules
- Measures up to 1500V at 30A
- 300ft wireless sensor range



www.solmetric.com

SEE AD ON PAGE 28



EKO Instruments USA

Product: Class A Spectrally Flat and Fast Response Pyranometer
Voltage: 0-1V output, 4-20mA, and Modbus over RS-485 (5-30VDC)
Current: 4-20mA Output
Power: (<0.2 W), Heater (7W), Ventilator (2W)
Frequency: <0.5 sec
Warranty: 5-year warranty
Logging Values: Solar Irradiance and sensor temperature, relative humidity, pressure, and inclination

Certifications: ISO 17025 Accredited Calibration, ISO9060:2018 Class A, IEC 61724-1 Class A

- Key Features:**
- Spectrally flat and fast response Class A sensor;
 - Immune to thermal offsets without expensive optics or active heating/cooling;
 - Low cost of ownership (5-year warranty and recalibration period);
 - Multiple signal outputs and sensor position information allow for fast installations.

www.eko-usa.com



Apogee Instruments

Product: Silicon-cell Pyranometer SP-110
Voltage: 0 - 250mV
Warranty: 4-year warranty against defects in materials and workmanship
www.apogeeinstruments.com



Hukseflux

Product: SR30 digital Pyranometer
Voltage: 5V - 30V
Current: 8.3 - 175 mA @ 12 VDC
Power: 0.1 - 2.3W
Warranty: 5-year warranty
Logging values: W/m² (GHI, POA, DIFF)
Certificates: ISO 9060 spectrally flat Class-A
www.hukseflux.com

Custom Built Precision Solar Measurement Solutions



EPPLEY

Since 1917

GPP-DIGITAL
Global Precision Pyranometer

- Bifacial / Albedo Measurements
- Class A Pyranometer
- Digital or Analog Output
- Bankable Data Unprocessed Unfiltered
- Designed To Your Requirements



Class A Instrumentation for Site Selection, Prediction and Performance Testing of PV Power Plants

www.EppleyLab.com

The Eppley Laboratory INC. USA +1.401.847.1020



Accuenergy (Canada) Inc.

Product: Acuvim II Series
Voltage: Voltage V1, V2, V3, Vlnavg, V12, V23, V31, Vllavg
Current: Current I1, I2, I3, In, Iavg
Power: P1, P2, P3, Psum
Warranty: 5-year warranty
Logging Values: F, V1/2/3/lnavg, V12/23/13/lavg, I1/2/3/n/avg, P1/2/3/sum, Q1/2/3/sum, S1/2/3/sum, PF1/2/3, PF, U_unbl, I_unbl, Load Type, Ep_imp, Ep_exp, Ep_total, Ep_net, Eq_imp, Eq_exp, Eq_total, Eq_net, Es, Epa_imp, Epa_exp, Epb_imp, Epb_exp, Epc_imp, Epc_exp, Eq_a_imp, Eq_a_exp, Eq_b_imp, Eq_b_exp, Eq_c_imp, Eq_c_exp, Esa, Esb, Esc, THD_V1/2/3/avg, THD_I1/2/3/avg, Harmonics 2nd to 63rd, Crest Factor, THFF, K Factor, Sequence and Phase Angles, DI Counter, AI, AO, Dmd P/Q/S, Dmd I1/2/3
Certifications: Revenue grade ANSI C12.20 class 0.2 & IEC 62053-22 class 0.2s

www.accuenergy.com/meter



Campbell Scientific

Product: SMP100
Voltage: 50V
Current: 20A
Power: 5mA
Warranty: 1-year warranty
Frequency: 1Hz
Logging Values: Soiling Loss Index, Isc, Module Temperature
Spectral Range: 50/60Hz
Measurement Range: -40°F to 275°F (-40°C to 135°C)
Output: ModbusTCP, ModbusRTU
Sensitivity: Can detect ~1% Soiling Loss
Certifications: All terminals tested to Class 4 levels (IEC 61000-4-5: 2013) for surge and (IEC 61000-4-2:2008) for ESD, ASTM D4169-09, ISO/IEC 17050:2010

www.campbellsci.com

Software

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



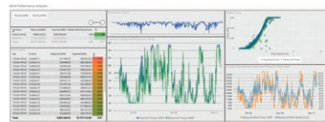
naak, Inc.

Product: carbonTRACK cT200i Gateway

Application: Residential, commercial, industrial, grid services

Description: The cT200i Gateway is an energy management and IoT hub that enables residential and commercial energy users to monitor, control, automate, and transact energy. A differentiator for this product manufactured by carbonTRACK, is its ability to control behind the meter loads and integrate with SunSpec certified battery storage systems, delivering an end-to-end energy management system. Comes equipped with 3 built-in relays for hard wired circuit level control, and a ZigBee Home Automation chip for pairing with and controlling smart thermostats, smart plugs, and other smart appliances. Reliable cloud connectivity is established with onboard CAT M1 cellular and Wi-Fi.

www.naak.io



Trimark Associates, Inc.

Product: SCADA

Application: Utility-scale PV, C&I, DAS

Description: Trimark's utility-scale SCADA system collects real-time data from inverters, trackers, meters, weather stations, and substation equipment. Operators can easily monitor and control performance for individual devices, a site, or an entire portfolio from intuitive Trimark's Vantage User Interface. Users can customize thresholds, alarms, dashboards, and reports to evaluate PV performance and power generation. The system's integrated advanced analytics include machine learning and deep learning algorithms to uncover operational issues. Real-time data, weather information, and historical patterns are analyzed to enable energy prediction and early detection of faulty or underperforming devices.

www.trimarkassoc.com



Cachelan

Product: SolarVu Monitoring Portal

Application: Commercial, utility, residential portfolios, energy storage, SCADA

Description: Cachelan is a solar monitoring solutions company that provides SCADA and DAS systems to help with O&M and Asset Management of solar and storage portfolios via their SolarVu platform. Manage portfolios of residential, commercial/industrial, and utility sized projects in one place. Receive high fidelity alerts of equipment issues and connect weather sensors, meters, site cameras. Easily compare inverter and string level performance. Cachelan interfaces with all major inverter and equipment manufacturers, and design to minimize their customer's cost.

www.cachelan.com



Solar Data Pros, Inc.

Product: Know True-Up

Application: Utility solar

Description: Know True-Up allows utility customers who also have solar to see how their energy usage habits and solar energy production combine to impact their utility charges. The software program also has a solar production monitoring component, which notifies the Know True-Up monitoring team when a solar system has not pushed any power to the grid within a 24-hour period. Utility customers are notified when a potential solar production problem is detected.

www.solarnegotiators.com



LevelTen

Product: LevelTen Performance Monitoring

Application: Commercial, industrial, utility-scale

Description: LevelTen Performance Monitoring includes a dashboard of comprehensive performance metrics including environmental data, economic data, and energy production data. In addition to providing a historical look at key performance metrics, Performance Monitoring is directly connected to the latest forward market curves, which means managers can see how a PPA is expected to perform for any given metric. This enables all internal stakeholders to take action (if needed) to reach their goals and manage their budgets. If a corporation has more than one PPA on the books, Performance Monitoring will compile data from all of the PPAs into a single portfolio view. This enables management to see how the corporation's overall portfolio of investments is performing, and how it could be improved with future investments.

www.leveltenenergy.com



GROUND SCREWS? REFUSAL HOLES? HELICAL ANCHORS?

Rock Drilling Attachments Get the Job Done.





wordrockdrills.com | 1.336.584.6700

Maintenance

Regular maintenance of solar farms and solar panels can dramatically improve energy output. It goes without saying, soiled solar panels can't produce as much energy as clean ones and it is just as important to keep the land under the panels maintained as well. Developing a cleaning and maintenance schedule for your site will increase plant efficiency, here are some companies who can help in that endeavor.

SEE AD ON PAGE 32



Superb Horticulture

Service/Product: Solar Farm Mower/Vegetation Maintenance

Description: A mower designed specifically for vegetation control between and underneath solar panels. The mowing disk is designed to make mowing around pylons efficient while also avoiding damage to electrical components.

Industries served: Vegetation Maintenance

Key Features:

- Low-profile robust construction;
- Large offset capability;
- Spring loaded cutting wheel.

www.superbhorticulture.com

SEE AD ON PAGE 18



Buffalo Turbine

Service/Product: Touchless snow removal

Description: Buffalo Turbine has been manufacturing turbine style blowers since 1945, which are made using high-precision machined components resulting in long-lasting dependable products. The newest of all the applications is touchless snow removal.

Industries served: Solar

Key Features:

- Touchless snow removal;
- No damage or wear on panels;
- Only requires 16 gallons per minute;
- Allows machine to be run on most skid steers;
- Immediate return on investment.

www.buffaloturbine.com



Renu Robotics

Service/Product: Vegetation management autonomous robot

Description: Renu Robotics develops and builds autonomous electric tractors for outdoor applications and specifically to fit utility-scale solar power plants.

Industries served: Utility-scale solar industry

www.renurobotics.com



Bitimec Wash-Bots, Inc.

Product: Bitimec Roboklin

Description: Bitimec's Roboklin is a solar panel washing machine able to wash 7,000-14,000 panels in one shift. A rugged all-terrain undercarriage and up to a 14' long brush, make this solar panel washing machine a high performer on utility-scale, ground-mount installations.

Industries served: Utility-scale, ground-mount solar

www.wash-bots.com



ProSolarClean, LLC

Service/Product: F Series brush

Description: Sola-Tecs F brush is designed for fast, effective cleaning of utility scale ground mount installations with a cleaning speed of up to 6600 sq ft per hour and an adjustable height design.

Industries served: Ground-mount solar

www.prosolarclean.com



- Low Profile Construction
- Large Offset Adjustment
- Unique Cutting Swing Arm Prevents Damage
- Heavy Duty

SUPERB HORTICULTURE
2811 Michigan Rd, Plymouth IN 46563

Phone: 800-567-8264
Email: sales@superbhorticulture.com
Contact: Keith Norman



SolarCleano

Service/Product: SolarCleano solar panel cleaning robot

Description: SolarCleano is a fast solar panel cleaning robot. It can be transported, set up, and controlled autonomously by one person. Battery-powered and remote-controlled, it works on all solar panels with its 2 wide brushes and fibers adapting to all dirt.

Industries served: Utility-scale, ground-mount solar

www.solarcleano.com

November 14th-15th, 2019
Palmer House Hilton
Chicago, IL

events.solar/midwest

Solar and Energy Storage Midwest is coming back to the Windy City with more leading education from thought leaders in the renewable energy industry. Experience a comprehensive education and exhibition program this year in Chicago, IL that includes solar, wind, energy storage, DERs, EVs, and more. Throughout the region, renewable energy is forging a new path forward for businesses and careers and Solar and Energy Storage Midwest will be there as your guide.

show in print

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



Versatile mounting system

SunModo introduces the Multi-Purpose System with SunTurf. The versatile system can be used as roof-mount, ground-mount, canopy, or multi-pole. The streamlined design combines the simplicity of a pipe-based system with next-level engineering. By spanning over roof obstructions, SunTurf Roof Mount takes full advantage of the available roof surface therefore maximizing the PV system size and increasing ROI. The system easily achieves 7ft leading edge height and provides convenient access to roof surface for maintenance and repair. Anchor SunTurf Ground Mount using one of SunModo's foundation types including ground-screw, auger, ballasted "Eco-block," or traditional post and concrete. The swivel pipe cap kit can accommodate terrains up to 27% slope east-west and 120% slope north-south. Optional bracing can provide additional structural rigidity for sites with high snow or wind load conditions. SunTurf is a solution for solar installers looking for a low-cost, high-performance system.

SunModo Corp.

www.sunmodo.com



New age engineering solutions

Exactus Energy provides new age engineering and permit plan solutions for solar PV projects of all sizes. Harnessing the power of drone technology, Exactus offers site surveys that are fast, safe, and accurate. Coupled with Structural and Electrical engineering expertise, Exactus offers a full turn-key solution for PV permit plan sets and designs.

Exactus Energy

www.exactusenergy.com

PV wholesale distribution

On a global level, Krannich Solar is prepared to support and service installation partners through all phases of their project with a dedicated sales manager for every client. Krannich Solar strives to fulfill all of the installer's solar needs from a single source by offering a wide range of solutions for every project, from a small 4 panel system to multi-megawatt commercial projects. Their close cooperation with leading manufacturers around the world allows Krannich Solar the buying power needed to provide customers with competitive product pricing and exceptional availability. In efforts to provide 24/7 service, Krannich Solar launched their web shop offering users access to view their entire product range, along with current prices, delivery time, and comprehensive technical documentation.

Krannich Solar

www.usa.krannich-solar.com



Increasing the ground coverage ratio (GCR) on PV projects

The low tilt and clearance design of the Dahlia system is engineered to maximize PV coverage on a given; creating a high financial return for project owners and integrators. With the simplified engineering of a fixed-tilt system, Dahlia requires fewer connections to be made in the field, making installation easy.

RBI Solar

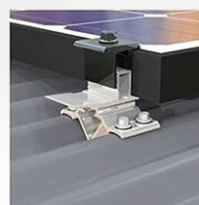
www.rbisolar.com

Low profile solar mounting with microflashing

The patented Low Profile QuickBOLT with Microflashing is a solution for mounting solar on Asphalt Shingle Roofs. It can be installed without lifting shingles or removing nails and staples, saving installers time and money. The QuickBOLT with Microflashing has multiple layers of protection that create a watertight seal. The Microflashing has passed standing and pressurized water tests and has been installed over 1 million times with zero reported leaks. The QuickBOLT with Microflashing is now also tested and approved for TPO roofs.

QuickBOLT

www.quickbolt.com



Simplified solar racking for every metal roof

Ecolibrium Solar's MetalX Simplified Racking System for Metal Roofs is designed to eliminate the costs and shortcomings of installing solar on metal roofs. MetalX delivers low cost per watt with 73% less aluminum, no long rails, fewer attachments, shortened install time, and small components to fit 30-50mm modules. The simplified racking solution works on corrugated, standing seam and R-panel roofs. Three small components make up MetalX racking: the roof mount, universal XClamps secure modules ranging from 30-50mm, and preassembled couplings join modules structurally and electrically to create continuous structure and integrated bonding. Utilizing EcoX Universal technology, no rails are needed and 300kW of racking fit on a single pallet. Developers who have used MetalX say the elimination of rails significantly reduces weight, costs, installation time and attachments, and provides an appealing aesthetic. To ensure every project is efficient and successful, Ecolibrium Solar's experienced project managers select the correct roof mount, do project calculations, layout, and bill of materials, and provide details for permitting and inspection. MetalX is backed by a 25-year warranty.

Ecolibrium Solar

www.ecolibriumsolar.com

New mounting for r-panel roofs

Solar Connections International is introducing their latest product which solves the complicated issues that arise when attaching solar panels to a r-panel metal roof. The new PowerMount Adjust for R-Panel roof profiles makes installation hassle-free. Featuring the ability to adapt to ribbed panels that range in widths of .75" - 3.00" and PowerWings with pre-applied EPDM - The PowerMount Adjust takes the guess work out of R-Panel installations.

Solar Connections International

www.solarconnections.com

December 12th-13th, 2019
Hilton Albany
Albany, NY

events.solar/newyork

Tapping into one of the top-10 solar markets, Solar and Energy Storage New York is the event to network with industry leaders and businesses doing business in New York. Discover best practices and the latest trends and challenges impacting the state in energy development. The 2018 event drew 300+ attendees, over 20 exhibitors, and featured interactive education focused on the changing landscape, obstacles, and policies influencing the industry in New York.

show in print

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



Innovative new mounting system

QuickBOLT is getting ready to introduce their most innovative system yet, the QB2. The new design eliminates a component, making the QB2 a simple and fast install for installing solar on Asphalt Shingle Roofs. The new L-Foot and Flange Bolt design work together to self-secure the L-Foot. This removes an extra step of the installation and leaves less room for human error. By coupling these new features with the leak-proof and over-shingle installation benefits of the Microflashing system, the QB2 saves installers more time and money than ever before. QuickBOLT will be showcasing this product at Solar Power Midwest and Solar Power New York. The QB2 will be available later this year.

QuickBOLT

www.quickbolt.com



Cost-effective support for utility-scale solar projects

TRC works with developers, utilities, and government agencies to provide efficient, cost-effective support for utility and distributed generation-scale solar projects. They offer the expertise and resources necessary to plan, permit, engineer, and support construction with services including: site selection and evaluation; environmental impact and permitting; infrastructure and civil engineering; power delivery engineering and interconnection; procurement and contract management; construction management; and commissioning and testing. They ensure full compliance with federal, state, and local designs, and a seamless transition through all phases of a project, from conception to closeout.

TRC Companies

www.trccompanies.com



Integrated PV solution for harsh conditions

GP JOULE is a global renewable energy company developing, engineering, constructing, operating, and financing commercial and utility-scale renewable projects. Globally, GP JOULE has installed over 550MWs of PV projects and manages 600MWs of assets across Europe and North America. Their full range of PV products and services is focused on delivering low installed cost in tough environments. Combining turnkey EPC expertise with its proprietary PHLEGON single axis tracker, GP JOULE offers a bankable solution with engineering, installation, and commissioning services. Designed specifically for harsh climates and challenging sites, the PHLEGON tracker uses heavy-duty linear actuators that intelligently integrate German-engineered control systems. This technology contends with heavy snow and high winds to ensure production 365 days a year. Cost-effective PHLEGON utilizes up to 50% fewer piles, has a low fastener count, and offers easy ground maintenance access.

GP JOULE

www.gp-joule.com



Black mono modules

Axitec's AXIblackpremium HC solar modules are suited for installations where the black exterior design must match performance. These high performance monocrystalline solar modules reach efficiencies up to 19.26%, guarantee high power output, and a spinning meter.

Axitec Solar

www.axitecsolar.us



Maximize every roof

Panasonic's HIT AC Series combines the module efficiency of Panasonic solar panels with the intelligence of Enphase microinverters. Extract maximum power production from every roof size and shape. A built-in IQ 7X microinverter helps deliver an all-in-one module offering design flexibility, reduced installation time, and a higher homeowner ROI.

Panasonic

na.panasonic.com/us/solar



Custom solar mounting structures

In 2017, OMCO Solar launched its proprietary Field-Fast solar mounting solution, with a manufacturing footprint in Ohio, Arizona, Alabama, and Indiana. In 2019, OMCO Solar launched its second Fixed-Tilt solution, the CHOICE Direct-Bolt Mounting System, a Fixed-Tilt racking structure designed specifically for large utility-scale projects.

OMCO Solar

www.omcosolar.com

Solar energy distributor

Soligent Distribution, a subsidiary of Soligent Holdings Inc., is a large pure play solar distributor in the Americas, supplying thousands of solar installers and contractors with solar energy equipment, engineering services, and project financing solutions. Soligent has been in the solar industry for decades and continues to provide innovative solutions ranging from materials management to project financing.

Soligent Distribution

www.soligent.net

2020 WIND BUYERS GUIDE

Logisticus Projects Group /// www.logisticusgroup.com

DIRECTORY

ADHESIVES, SEALANTS, & SURFACE TREATMENTS

ALUMINUM EXTRUSION & METAL FABRICATION

ANCHOR BOLTS | FASTENING SYSTEMS

BLADE | TOWER MANUFACTURER & REPAIR

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CONSULTING SERVICES

CONTRACTORS

CRANES | HYDRAULIC EQUIPMENT | AERIAL DEVICES

ECONOMIC WIND DEVELOPMENT REGION

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GENERATORS | MAINTENANCE & REPAIR SERVICES

LARGE WIND TURBINE MFG (OVER 100KW)

LIGHTING

LIGHTNING & SURGE PROTECTION

LUBRICANTS

OPERATIONS AND MAINTENANCE (O&M)

REMOTE MONITORING

RESTORATION

SAFETY EQUIPMENT | FALL PROTECTION

SAFETY WORK APPAREL

SMALL WIND TURBINE MFG (UNDER 100KW)

SOFTWARE SUPPLIER

STEEL SUPPLIER

TESTING | INSPECTION SERVICES

TOOLS

TOWER FOUNDATIONS

TRANSPORTATION | LOGISTICS

WIND ASSESSMENT | FORECASTING

YAW, PITCH & BLADE SENSORS

OTHER

Balance of Plant

Brake Pads

Control & Power Electronics Repair

Electrical Insulation

Electronic component, service repairs

Elevators

Labor Trade Association

Legal Services

Rescue & Safety Training

Sectionalizing cabinets

Telecommunications Provider

Adhesives, Sealants & Surface Treatment



Mankiewicz Coatings

Mankiewicz's two new advanced coatings products maintain turbine blade surfaces for optimal performance and efficiency. BladeRep5 is a fast setting putty that dries in one hour with the same profile-building and sandability traits of other Mankiewicz surfacing putties. And Mankiewicz's new ALEXIT Leading Edge Protection single-coat only requires one-coat application and provides substantial cost savings thanks to less application time. Field testing has proved significantly longer product performance. Mankiewicz's coatings also meet the requirements of the cosmetic blade maintenance market.

www.bladerep.com

Aluminum Extrusion & Metal Fabrication



Sotek

With 35 years of experience, Sotek manufactures precision stators and rotors for demanding highly specified applications in wind power generators. Sotek stamps and laser cuts electrical steel laminations using in-house equipment and tooling. They manufacture vent plates, end plates, stator bars, and related components to meet the increasing specifications of the wind industry serving all of North America and beyond from their Buffalo, NY facility. Sotek's skilled team of manufacturing and assembly technicians effectively utilize stamping, notching, stacking, pressing, welding, thermal shaft insertion, robotics, manual and CNC machining, and a variety of value added services to increase efficiency and streamline the process. Additionally, Sotek's supply chain partners provide value to suit the unique demands of each project.

www.sotek.com

Heico Lock
The HEICO Group offers a wide array of products. HEICO-LOCK WEDGE-LOCK WASHERS are a reliable locking system for demanding bolted joint applications including those under extremes of vibration or dynamic loads. The HEICO Group continues to expand its product portfolio with the addition of the HEICO-TEC TENSION NUT, which provides easy, fast, and reliable assembly of large bolted joints. HEICO-TEC TENSION NUT eliminates the need for complex, bulky, or heavy tools, and makes securing large bolted joints convenient and easy.

www.heico-group.com



NTC Wind Energy

NTC Wind Energy's patented IronClad bolt caps for the wind industry are made of UV resistant HDPE, manufactured specifically for the make and size of foundation anchor bolts. Bolt caps are intended to prevent water from intruding into the bolt sleeves, prevent the grease applied to the rod from dissipating by sealing it from air and water, and to mitigate the safety hazard of exposed bolts. All of NTC Wind Energy's caps are precisely sized to assure a good fit on the flats of the nut, thereby maintaining a positive seal against the tower flange at the flexible bottom "skirt" of the cap. IronClad foundation anchor bolt caps can be purchased in Standard Duty or Extreme Duty, and in multiple lengths.

www.ntcwind.com

Anchor Bolts | Fastening Systems



Cooper & Turner

Cooper & Turner is a manufacturer of high quality, high strength, safety critical, large diameter (M16 to M100) hex bolts, double ended studs, and thread rod. Employing automation (including in process NDT inspection) and robotics results in high quality and consistent products, having full lot traceability, for supplying the global wind turbine market, OEM's, and major tiers as well. Recently opening an anchor bolt manufacturing plant in Pueblo, CO., they use 100% USA material and manufacturing, producing anchor bolts to ASTM A615 Grade 75 and Grade 90, plus ASTM A722 Grade 150, with all accessories (nuts, washers, and PVC sleeves), with bolt caps and grease optional. All assemblies are tested in a USA independent lab.

www.cooperandturner-usa.com



Fastenal

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

www.fastenal.com



HellermannTyton

The UL Listed Ratchet P-Clamp delivers cable management performance in a wide range of environments. Wind farm operators are sensitive to the costs associated with repairs and routine maintenance, especially in tight spaces and under challenging conditions. Ratchet P-Clamp is a flexible cable management solution that can be opened and closed again without removal from the mount. It can self-adjust to bundles, with just four sizes covering diameters from 1/4" to 2". The mounting plates are available in different lengths and angled orientations for a more customized fit. They are offered in zinc plated and stainless-steel options to enhance corrosion resistance.

www.hellermann.tyton.com

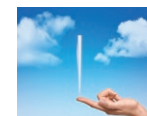


Nord-Lock Group

Nord-Lock Group provides secure bolting solutions, creating a safer world by focusing on the integrity of mechanical solutions that are critical to our way of life. The Group offers four key technologies: Nord-Lock original wedge-locking washers with wedge locking technology that makes unintentional loosening impossible, even when exposed to severe vibration and dynamic loads. Superbolt mechanical tensioners that can accurately and safely achieve high preloads while using only hand tools. Expander System pivot pin replacements that provide a permanent solution to lug wear eliminating the need for expensive welding and line boring, and Boltight hydraulic tensioning tools which can provide a low profile solution for space-restricted applications demanding high and accurate preloads, such as wind turbines. Together Nord-Lock Group is providing safe and innovative solutions to safeguard human lives and customer investments.

www.nord-lock.com

Blade | Tower Manufacturer & Repair

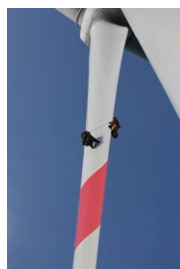


LM Wind Power

LM Wind Power is a designer and manufacturer of blades for wind turbines, with 15 factories on four continents. LM Wind Power produced the LM 88.4 P, for an 8MW offshore turbine, and produced the first wind turbine blade beyond 100m in length, the LM 107.0 P, to power GE's Haliade-X 12MW. Their unique technical know-how and manufacturing expertise, enables today's offshore wind turbines to capture more energy from the wind, and reduce the cost of energy.

www.lmwindpower.com

BUILDING TRUST



Sika Corporation

Sika Wind Repair solutions help turbines get back on line quickly and efficiently. SikaForce-7800 series fast-sanding surface fillers can be applied in a broad range of temperatures between 40°F to 90°F effectively extending the repair season. The fast 30 minute curing time allows for quick sanding time characteristics and finishing. Sikadur Blade Repair Kits are fast curing epoxy resin systems for structural laminating repairs. Sikadur Blade Repair Kits are GL approved and can reach OEM specified performance as little as 30 minutes. There is no special equipment required. Sika Wind Repair products are available in easy, ready-to-use packaging so there is no field mixing required.

www.sikaindustry.com/wind



we keep it turning



Rope Partner

Rope Partner is a provider of quality at-height tower and blade maintenance services domestically and internationally. By combining a highly trained work force and utilizing rope access, suspended platforms, and Bronto skylifts, they deliver a cost effective approach to their clients. They are committed to building safe, long lasting, mutually beneficial working relationships resulting in extending asset life.

www.ropepartner.com



CLOSER

ON THE COLUMBIA RIVER IN WASHINGTON STATE

FASTER

DIRECT CONNECTIONS TO MAINLINE RAIL & INTERSTATE HIGHWAYS

SMARTER

STORAGE OPTIONS & FOREIGN TRADE ZONE SPACE

BETTER

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TPI Composites

TPI is a U.S.-based independent manufacturer of composite wind blades for the high-growth wind energy market supporting global wind turbine manufacturers. TPI operates composite products manufacturing facilities in North America, Europe, and Asia. Their products provide high strength, light weight, and durability. TPI has over five decades of innovation and expertise in manufacturing large-scale composite structures of high quality at a competitive total delivered cost to their customers.

www.tpicomposites.com

Cable, Wire, & Conduit



AerosUSA, Inc.

AerosUSA offers a wide range of flexible polyamide non-metallic corrugated conduits, galvanized steel and stainless steel metallic conduits, metal and nylon fittings, and cable gland strain relief cable glands. Their products are designed for numerous applications within the wind and renewable energy, transit, robotic, automation, marine, offshore, mining, industrial applications, and especially where power and data cables require dependable protection.

www.aerosusa.com



American Wire Group (AWG)

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

www.buyawg.com



Cameron Wire & Cable, Inc.

Cameron Wire & Cable provides LV, MV, and HV (Aluminum and Copper) wind tower, nacelle, and site cables. Cameron offers cost-effective pricing and high performance cables for all applications, and will customize the cable package, offering cut-to-length or bulk cables, accessories, labels, and lugs supplied in kits. They also offer inventory management and will warehouse planned goods at no charge, shipping the same day to satisfy tight job deadlines.

www.cameronwire.com



CTC GLOBAL

CTC Global

CTC Global, in association with 30 international manufacturing partners, produces the High-Capacity, Low-Sag ACCC Conductor. The ACCC conductor carries twice the current of other bare, overhead conductors with 25% to 40% less line losses. The use of ACCC can help reduce upfront capital costs for the tie line, and improve the overall economics of the generation project—reduced line losses translate into more power delivered for any wind energy investment.

www.ctcglobal.com



HELUKABEL USA

HELUKABEL provides wind power system expertise for the entire turbine, rotor tip to base. In the nacelle they provide control cables that are both oil (Oil Res I & II) and heat-resistant. Cables for the loop have been torsion tested in-house for up to 18,000 cycles. Finally, they manufacture flexible aluminum, copper, and fiber-optic cables for the tower section. Their wind cable products provide quality performance in climate conditions from -67°F up to 293°F (-55°C up to 145°C) for CCV and offshore applications. They have been internationally approved by UL (WTTTC), CSA, CE, and VDE, and have passed the FT4 flame test.

www.helukabel.com



Petroflex N.A., Ltd

Petroflex is an extruder of HDPE (high-density polyethylene) duct and accessories. PNA CableGuard is a solution for both domestic and international clean energy initiatives. They provide cable-in-conduit for control and cabling at both wind and solar farms. Long continuous run lengths of fiber optic cable duct, up to 14000' on 1"IPS, minimize splicing. Cable or fiber installed in conduit at the factory ensures additional protection before, during, and after installation.

www.petroflexna.com



Prysmian Group

Prysmian Group offers an array of cables needed for wind turbines to generate, distribute and transmit energy from fiber optic and bare overhead conductors to EmPowr Link CL Advantage underground URD and wind-specific low-voltage power cable. Prysmian is positioned to rapidly respond to the needs of the evolving wind farm market with next-generation cabling systems. EmPowr Link CL Advantage is a cable for today's solar and wind farm collection systems. Featuring enhanced, ruggedized installation protection, this cable has a reduced weight and diameter and XLPE jacket technology. Its efficient fault current protection provides reliability and performance.

www.generalcable.com

Component Supplier



American Roller Bearing Company

American Roller Bearing Company manufactures large bore (200mm to 2400mm) anti friction bearings, including tapers, cylindrical, spherical, and balls. They offer complete engineering services and expert repair on all types and brands.

www.amroll.com



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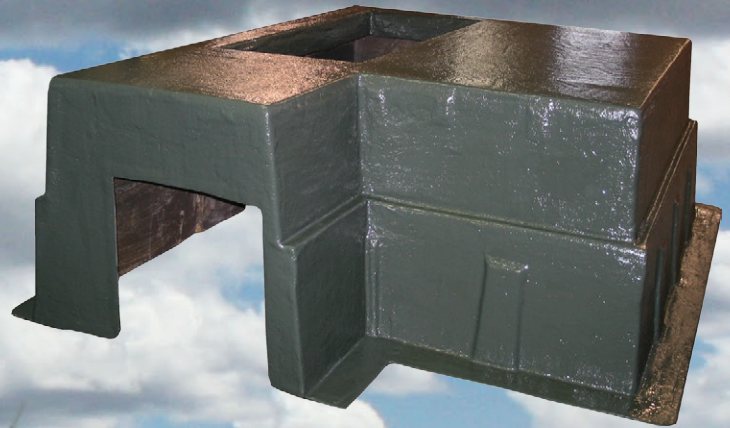
Anderson Power Products SPEC Pak Connector Series are rugged and environmentally sealed (IP68) certified connectors made from PC, PC/PBT material that is UL94 V-0 flame resistant. Available in wire-to-wire or wire-to-panel configurations that include either pin and socket or flat wiping contact technology. SPEC Pak connectors are intended for applications that demand a waterproof high-power interconnect solution for power, ground, and signaling capabilities such as for use in wind power, solar, lighting, marine, agricultural, or off-road equipment applications.

www.andersonpower.com

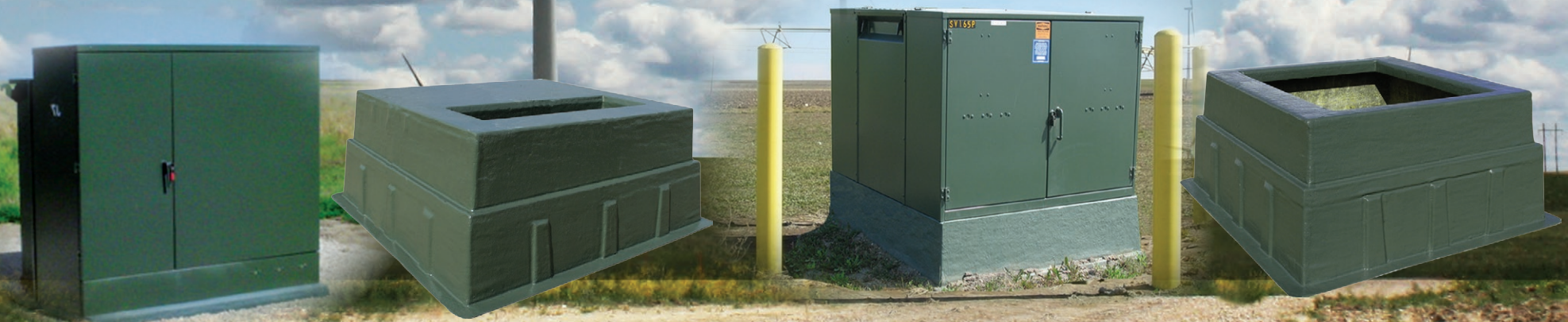
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Bal Seal Engineering, Inc.

Bal Seal Engineering, Inc. designs and produces sealing, connecting, conducting, and EMI shielding solutions that improve the performance and reliability of equipment used in wind, solar power, and other alternative energy production. Their solutions enable engineers to prolong service life, reduce maintenance, protect precision components, design more compact, efficient electrical connectors, and ensure consistent current/signal transmission. Their consultative engineering services streamline the design process, improving speed to market. Their products include the Bal Seal spring-energized seal, the Bal Spring canted coil spring, and the Bal Contact electrical contact. www.balseal.com



BURNDY

BURNDY offers a comprehensive selection of grounding products. BURNDY's grounding connectors are systems-engineered to provide system integrity as well as to withstand harsh environments. The BURNDY HYGROUND irreversible compression system meets stringent safety and performance requirements. The BURNDYWeld connection process is a simple, efficient method of welding copper to copper or copper to steel. All BURNDY mechanical grounding connectors have been designed for easy installation and for lasting durability. www.burndy.com



Continental Fan Manufacturing, Inc.

Continental Fan provides fans and blowers for nacelle ventilation, GCU (generator control unit) cooling, and tower ventilation. Whether axial fans for high air volumes and low pressures, centrifugal blowers for higher pressure applications, or TMK motorized impellers for ventilating electrical cabinets, Continental Fan has solutions for many applications. www.continentalfan.com



Cornell Dubilier Electronics

100% of Cornell Dubilier Electronics' 947D DC Link capacitors are conditioned at accelerated temperature and voltage before they leave the factory. They've demonstrated this process eliminates infant mortal failures and produces thermally and electrically stable DC Link Capacitors. www.cde.com



Eisele Connectors, Inc.

Eisele Connectors Inc. is a manufacturer of robust, all-metal push-to-connect fittings, multi-couplers, and tubing/hose for pneumatics, vacuum, gases, liquids, cooling water, paint, and electronics. www.eisele-connectors.com



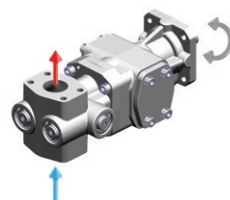
Ema Electromechanics, Inc.

EMA Electromechanics is the designer and manufacturer of the VDH/GSMI combined outdoor vacuum circuit breaker and high speed, mechanically interlocked grounding switch. 38kV class, 200kV BIL, 1200A continuous current and 25, 31.5, and 40kA interrupting capability ratings, VDH/GSMI is a patented system specifically designed for switching and grounding of wind and solar energy collection circuits and replaces oil insulated grounding transformers combined with conventional circuit breakers in every feeder of a wind or solar power substation, improving overvoltage mitigation and reducing costs. www.emaelectromechanics.com



Ingeteam, Inc.

Ingeteam offers solutions for wind turbines of up to 15MW, including power converters, Indar generators, turbine controllers, CMS, SCADAs, and O&M services for wind applications. Low and medium voltage power converters, optimized for DFIG and FC topologies. The power converters are specifically designed to increase reliability, boost efficiency, reduce maintenance costs, and fulfill strict grid codes. Air cooled, air/water cooled, and full water cooled solutions for harsh environments. Based on IGBT power semiconductors and are equipped with a web application service tool that allows monitoring and remote control. www.ingeteam.com



KRACHT CORP.

KRACHT CORP. is a subsidiary of KRACHT GmbH in Germany. KRACHT, is a medium-sized, family-run business with 370 employees. KRACHT is a manufacturer of transfer pumps (e.g. noise optimized for air containing oils), hydraulic motors, high pressure gear pumps, valves, pump units, gear type flow meters, and electronics. KRACHT CORP. is located in Maumee, OH. www.krachtcorp.com



Kuma Brake Pads

KUMA Brake Pads is a manufacturer of sintered friction material for wind turbine applications. The products are used on the hydraulic brake Galiper on the high-speed rotor. Designed according to OEM specifications for GE, Vestas, Gamesa, Siemens, Nordtank, Servion, and most turbines, KUMA sintered brakes pads and products are submitted to extreme conditions tests to ensure high quality. The product is manufactured in North America based on ISO 9001-2015 standards and is also approved by GE for its 1X and 2X turbine platforms. www.kumabrakes.com



Lighthouse Global Energy, LLC

Lighthouse Global Energy is a spareparts distributor specializing in OEM parts. With strong distribution partnerships, Lighthouse supplies across multiple turbine platforms. From mechanical yaw systems, hydraulic solutions, or specialized kits, Lighthouse is dedicated to providing solutions. www.lgnrg.com



Mersen

Mersen has made advances in the domain of generator slip-ring and carbon brush technology resulting in improved performance and reduced operating costs. The increased demand for additional power output or turbine up-ratings requires a deep technical understanding of the generator's dynamic behavior and rotor loads in Double Fed Induction turbines. The SR13-15 is an upgrade to one of the most common wind turbine generators in North America. Its robust and enhanced design accommodates high operating loads and boosts up the initial limitations of the turbine. It has proven to run cooler, improve brush life, and increase turbine availability in high winds. www.mersen.com



Morgan Advanced Materials

Bearing fluting from electrical current is a major cause of costly pitch motor failures. To protect these motors, Morgan offers grounding solutions which are fast and easy to install, even up-tower, and without the removing or disassembly of brakes. By shunting electrical current around the bearings, they maximize protection of this valuable equipment. Morgan designs are light-weight, compact, and can retrofit existing motors. Morgan pitch motor grounding solutions come equipped with a constant force spring resulting in consistent brush pressure and a silver/graphite brush for low contact drop insuring this is the path of least resistance for current flow. www.morganelectricalmaterials.com



Motion Industries, Inc.

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



Niagara Transformer Corporation

Since 1933 Niagara Transformer Corporation has been designing and manufacturing transformers in Buffalo, New York. They have shipped over 75,000 transformers to 90 different countries in their 85+ year history. Their products comply with IEEE Standards and government standards practiced throughout the world. Their customers include OEM and engineering, procuring and construction (EPC) firms, as well as end-users in private industry, government, utilities, universities, and others. Their diverse product line includes inverter duty transformers, substation collector transformers, step-up collector transformers, grounding transformers, and load tap changing transformers. Base ratings up to 50MVA, 138kV, and 650kV BIL.

www.niagaratransformer.com



SFP Hydraulics, Inc.

SFP provides design, assembly, and service of hydraulic accumulators used in various industries including the wind power industry. In collaboration with their customers, they provide value added solutions reducing costs, ensuring safety, and improving performance for all integrated hydraulic systems. SFP offers full service and repair of bladder accumulators both on-site and at their plant in Katy, TX. Their products are offered with wide range of approvals to suit the global requirements including ASME, CE, AS1210, CRN, and TR-CU.

www.sfphyd.com



SIBA Fuses

SIBA Fuses is a source for circuit protection applications, from solar power to wind power, and energy storage. They have been working for over 75 years in semiconductor fuses, including ULTRA RAPID, medium and high voltage, standard European, miniatures, electronic fuses, and a wide range of DC rated fuses (24VDC - 6000VDC) for all types of applications, including Power Conversion, Rectifiers, Inverters, Converters, Drives, UPS, and Traction Applications.

www.siballc.net



STEGO, Inc.

STEGO develops products that heat, cool, ventilate, illuminate, and control temperature and humidity for enclosed electronic control systems. For over 35 years, they have offered Thermal Management solutions, which ensure the electronics in their customers' installations are safe from extreme climatic conditions.

www.stegousa.com

Dialing up the power of your wind turbines?

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One of the most trusted configurations:

MERSEN'S BRONZE RING + CG677 THE PREFERRED BRUSH GRADE

Mersen has been recommending Bronze rings for decades.

Our new generation of components are designed to handle the additional rotor current.

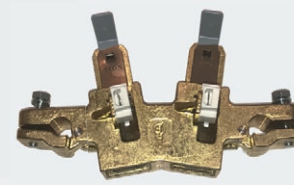
info.ptt@mersen.com



SR13-15 BRONZE SLIP RING



HCH-30X CG677 BRUSHES



BR09-13 BRUSH-HOLDERS

WWW.MERSEN.COM





United Equipment Accessories, Inc.

United Equipment Accessories manufactures low-maintenance, high-quality slip rings for OEM and aftermarket clients. These slip rings feature new brush technology designed to provide long life in harsh environments. UEA's design engineers work with their customers to custom build slip rings that meet their wind turbines' specifications. UEA can take current slip ring specs to design an interchangeable slip ring for the wind turbine. Single brushes can be replaced at any time, removing the need to replace entire units or sets of brushes. UEA products maintain superb functionality in a wide range of electrical/electronic circuits, environmental conditions, and rotational speeds.

www.uea-inc.com

Condition Monitoring



Dynamic Ratings

Dynamic Ratings' E3 and C50 units can be deployed to handle condition-based monitoring in wind and solar assets and station service batteries subject to NERC PRC compliance and reporting. DR's visualization software, DynamicMetrix, provides an asset health index and integrates monitored information. Customers have web access to view real-time information and to download historical data. Dynamic Ratings can also monitor the information and notify their customers when conditions fall outside normal parameters.

www.dynamicratings.com



Fluid Life

Using current technology and proven testing methodologies, Fluid life helps their customers reduce maintenance costs and improve equipment reliability. Offering a wide range of condition monitoring and reliability services backed by in-house labs, they deliver fluid analysis and reliability solutions accurately and on-time. At Fluid Life, their flexible approach is designed with their customers' individual needs in mind.

www.fluidlife.com

Construction Products & Services | EPC Contractor



Blattner Energy, Inc.

Blattner Energy is an EPC contractor in renewable energy construction with more than 35,000 megawatts installed across North America. Blattner provides complete EPC services for utility-scale wind projects, including post-tension concrete tower supply and installation. Blattner also serves utility-scale solar, energy storage, and high voltage transmission and substation projects. Blattner has a history for responding to client needs, delivering on aggressive project schedules, and self-performance on all major work activities to ensure high levels of safety, quality, and overall client satisfaction.

www.blattnerenergy.com



CONSERTEK LM Group, Inc.

CONSERTEK is involved in engineering, procurement, construction and sensors, and instrumentation/equipment commissioning, as well as maintenance as needed. Consertek LM Group also designs, fabricates, and supplies high-quality anemometric instrument supports and accessories. All of their supports can be fabricated to suit any type of towers and can accommodate all common instruments. Their supports and accessories are compliant to the latest edition IEC 61400.

www.consertek.ca



Contract Land Staff

Contract Land Staff (CLS) provides Right of Way land solutions for wind and solar, electric transmission, and distribution utility clients across the U.S. CLS services include easement acquisition, mineral and surface title, site scouting, crossing permissions, permitting services, land data records management, GIS and mapping, and construction support.

www.contractlandstaff.com



Pennecon

From the initial stages of project engineering to the final steps involved with commissioning, the Pennecon team maintains a strong portfolio of wind energy projects that not only showcase their depth of services but also their ability to achieve project success in challenging environments. Capabilities include: engineering, site development (roads, etc.), concrete base construction, tower and turbine erection, substation construction, collector installation, and transmission line development.

www.pennecon.com



Presto Geosystems

Presto Geosystems' 3D GEOWEB soil confinement system strengthens local fill, even sand, reducing cross section for building roads and pads for foundation construction, turbine component delivery and maintenance access. Over soft subgrades, one layer does the job compared to three layers typically required of geogrids. Confined infill remains stable under heavy loading. With 50% less cross section, use of onsite fill, and virtually no maintenance requirements, the system is a fast-built, low-cost road solution for stable access into the most challenging sites.

www.prestogeo.com



RES

RES (Renewable Energy Systems) is an international renewable energy company with experience in innovating and reducing costs for continued growth without subsidies. In the past 35 years, RES delivered 10GW of renewable energy projects in North America, including over 9GW wind, and a total of more than 16GW across the globe. They leverage their experience as both a developer and self-perform EPC contractor to deliver unique, value-added solutions to lower the levelized cost of energy (LCOE) for their customers. The RES team has domain expertise in wind, solar, energy storage, and transmission with a strong portfolio of EPC projects.

www.res-group.com/wind



Samson

For more than 140 years, Samson has been working with industry professionals to develop synthetic rope for energy operations. Samson has engineered products specific to the challenging conditions and demanding environments in energy applications.

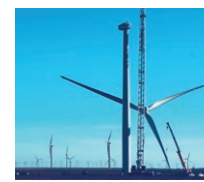
www.samsonrope.com



Signal Energy, LLC

Signal Energy has 8000MW of utility-scale renewable project experience and 1500MW of wind project experience. They support their customers with in-house capabilities including Preconstruction Solutions Group, foundation construction resources, and high voltage EPC capabilities. Signal Energy is active in new project construction and in the re-powering of existing wind projects.

www.signalenergy.com



Wanzek Construction

Wanzek Construction provides high quality general construction, including a wide cross section of industries: Power, Renewable Energy, Oil & Gas, Infrastructure, and Agriculture. Wanzek focuses on leveraging their skilled crews to construct, expand, and maintain renewable energy facilities across North America. They work closely with owners to balance organic growth with client demands to meet market needs. Through their involvement with reputable associations, such as the American Wind Energy Association (AWEA) and Solar Energy Industries Association (SEIA) they stay apprised of industry-specific details that positively affect their project approach.

www.wanzek.com

Consulting Services



DNV GL

DNV GL's energy experts support customers around the globe in delivering a safe, sustainable, and reliable energy supply. They deliver advisory, certification, and testing services to the energy value chain, including renewables, storage, and energy management. Their expertise spans onshore and offshore wind power, solar, storage, and energy management. DNV GL is recognized by developers, investors, and utilities for its integrity and technical rigor. With DNV GL projects run smoothly, from the initial design stage through project completion.

www.dnvgl.com/energy



Switch Power

As an Independent Power Producer (IPP), Switch focuses on capital deployment in long-term infrastructure assets through creative projects, creative financing, and creative commercial structures. Switch offers innovative and sustainable power generation solutions by meeting load customers needs by lowering electricity costs through physical supply with multiple technologies and filling grid capacity with low-cost electricity supply from sustainable sources. Switch provides resiliency and ancillary services to both physical customers and the grid with energy storage, as well as utilizes energy management and predictive market algorithm-based software systems.

www.switchpower.ca



Terrapro Solutions

With over 10GW of renewable energy developed, TerraPro Solutions supports the development of renewable energy projects. Their services include real estate, title, and ALTA survey. They assist developers in preparing projects for title insurance. TerraPro can analyze and review title commitments and provide curative services to the title issues that arise. Because of proximity to title, their ALTA survey services allow them to work directly with surveyors to avoid common problems that occur between title and survey. They have wind and solar experience in nearly every US state.

www.terraprosolutions.com



Vertex Resource Group, Ltd.

Since 1962 Vertex has been a North American Environmental Services company providing: Regulatory Compliance Monitoring & Site Assessments, Right of Way & Land Acquisition, Biophysical Assessments (Wildlife, Vegetation, and Aquatic), Soil Survey & Acquisition, and Phase I, II & III Environmental Site Assessments.

www.vertex.ca



Westlake Consultants, Inc.

WCI has provided civil engineering and surveying consulting for over 2 dozen wind and energy developments throughout the U.S. Services include feasibility review, land surveying, land use planning approval, permitting assistance, roadway and grading design, and construction phase services.

www.westlakeconsultants.com



Westwood Professional Services

Westwood is a multi-disciplined engineering and surveying firm with experience gained from supporting more than 50GW of wind projects across the U.S. since 1997. Their services include environmental studies, permitting, civil engineering, electrical engineering, geotechnical engineering, HV transmission line engineering, land surveying, aerial mapping, and construction support. They have offices across the country and are licensed in nearly every state.

www.westwoodps.com

Contractors



Caldwell Marine International, LLC

Caldwell Marine International, LLC is a marine construction contractor specializing in submarine cable installation and heavy civil marine construction. In operation for over 65 years, CMI has carried out the installation and repair of hundreds of submarine power and telecommunications cables worldwide, and have successfully built and rehabilitated many piers and docks, as well as unique marine structures that required advanced installation techniques. Caldwell has a wide range of specialized marine construction equipment, an Atlantic waterfront yard, and over 150 years of marine construction experience on staff.

www.caldwellmarine.com



SKYLOTEC.COM



ONE SHOCK ABSORBING LANYARD THAT COMPLIES WITH THE ANSI, CSA AND EN 6' & 12' PERFORMANCE REQUIREMENTS

Most shock absorbing lanyards only comply with 6' or 12' performance requirements. SKYLOTEC eliminates this confusion by offering the Skysafe Pro shock absorbing lanyard which covers both performance requirements in one product. This increases safety, eliminates the need for two different shock absorbing lanyards, simplifies employee training, and improves your bottom line.

CARABINER

Aluminium. Robust & lightweight 16kN / 3600 lbs steel gate. The Grey & Orange hardware assists in identifying left & right sides while in use and prevents twisting of lanyard legs.

RESCUE LOOPS

On both legs. Easy attachment of the rescue device. Ensures safe & fast rescue operations.

FLEX FUNCTION

No slack rope, reduces risk of tripping. Great handling. Flex length is 4 ft.

SHOCK ABSORBING SYSTEM Reduces the impact force to below 1349 lbf. (6kN) in the range from 110 - 340 lbs with a deceleration distance of max 48" according to ANSI Z359.13 when at a 6' free fall and max 60" according to ANSI Z359.13 when at a 12' free fall.

FALL INDICATOR

On both legs. Easy fall detection, Easy inspection.

PROTECTIVE COVER

Removable and replaceable protective cover. Enables 100% inspection of the entire device (ACS-0216).



L-0558-1,8

Works without limitation for user weights from 110 up to 340 lbs!* Meets ANSI Z359.13 for 6' & 12' free fall & CSA Z259.11-E6



L-0562-1,8



L-0623-1,8



L-0533-1,8

IGNITE PROTON WIND



RESCUE PRO 2.0



NEW CLAW



LORY PRO



NEW ACX POWER ASCENDER



SKYLOTEC offers you a highly innovative and functional range of fall protection, rope access and rescue equipment. The **IGNITE PROTON WIND** and **RESCUE PRO 2.0** Harnesses feature light-weight designs built for durability and comfort. The smooth running **CLAW** Vertical Cable Sleeve for 3/8 & 5/16 inch diameter wire ropes. The **LORYPRO** positioning lanyards allow you to work hands free with complete adjust-ability. The **ACX** power ascender allows for battery operated portable ascent and descent. These products are ideal for work at height in the wind energy, telecommunications, and electrical utilities industries. For more information please email us at:

info-us@skylotec.de. skylotec.com

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SKYLOTEC



Rosendin Electric

Rosendin is a U.S. electrical contractor and works in constructing underground and overhead collection systems, fiber optic SCADA systems, turbine and tower wiring, as well as substations and overhead transmission lines connecting generating power plants to utility grids. Over the last decade Rosendin has installed more than 20GW of clean, renewable energy, including more than 100 wind energy projects ranging in size from 1MW to more than 900MW, throughout the U.S. and Canada, with their commitment to safety, quality, and on-time performance.

www.rosendin.com



Sentry Electrical Group, Inc.

Sentry Electrical Group, Inc. constructs projects across the United States. They provide high and medium voltage construction of electrical infrastructure for private companies who require HV and MV solutions and electric utilities improving their electrical facilities. They also serve private companies in the growing renewable generation industry. Their offered services include engineering, procurement, or construction of HV and MV facilities. They offer complete turn-key solutions where all aspects of projects from planning to commissioning are required.

www.sentryelec.com

Cranes | Hydraulic Equipment | Aerial Devices



Bishop Lifting Products, Inc.

Bishop Lifting Products designs and fabricates below-the-hook lifting devices for wind energy components including universal nacelle lifting beams, J-hooks for lifting tower sections, counter balanced lifting beams, blade lifters and cradles, twin-path extra CoverMax slings, swivel hoist rings, and Crosby rigging hardware for wire rope and chain.

www.lifting.com



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Kardie Equipment (a TGM Wind Company)

Kardie Equipment, a North American distributor for Bronto Skylift aerial work platforms, has a fleet of Bronto AWP's ranging from 150' to 295' in working height. Features of their units include: 360° turntable rotation, working platforms of at least 3' x 7' (with some models reaching to 3' x 10'), integrated wind speed indicators, automatic outrigger leveling, remote diagnostic systems, and more. They also have a 24/7 dedicated parts and service hotline, and a North American maintenance facility with a large Bronto parts inventory.

www.kardieequipment.com



Leavitt Cranes

Krøll provides large capacity, free standing tower cranes which are an effective solution for wind turbine erection. Where there is restricted and limited access, small hardstands, high erection height levels, and large nacelle weights Krøll cranes have provided effective alternate solutions in conditions where crawler and mobile crane could not be applied. Leavitt Cranes is the North American Agent for Krøll Cranes A/S and is capable of working with wind turbine manufacturers, developers, owners, and erectors.

www.leavittcranes.com



LIEBHERR

Liebherr

Liebherr offers optimized crane concepts for diverse situations and requirements for the erection of wind power generators for highest efficiency and economy. Their cranes provide high capacities over the complete working range, variable boom systems for diverse requirements, efficient application due to optimized transportation components, comprehensive comfort and safety features, worldwide customer support by manufacturer, and optimized dimensions and weights for transportation.

www.liebherr.com



Mammoet

Mammoet's heavy lifting and transport expertise optimizes wind projects, specifically addressing O&M and repower requirements, and working with manufacturers and contractors on new construction projects. Their wind equipment services team brings projects to a safe completion and improves project efficiency by utilizing their experience and large fleet of equipment. With offices across North America, Mammoet is well positioned to provide the assistance where it is needed.

www.mammoet.com



Maxim Crane Works, LP

Maxim Crane provides lifting services for wind power projects on both grass root and maintenance projects throughout the United States. Crane lifting services range from 60 to 900 ton, All Terrain and Crawler Cranes, and 15 to 150 ton Rough Terrain Cranes support cranes.

www.cranerental.com

Economic Wind Development Region



Black & McDonald

Black & McDonald Inc. is an integrated, multi-trade service provider that safely delivers high quality construction, facilities management, and technical solutions. They are a family owned and operated company with over 5,500 employees working out of more than 30 offices across North America. With nearly 100 years of diverse market experience, they are a forward thinking organization with a strong track record of delivering operational excellence and customer-focused solutions that stand the test of time.

www.blackandmcdonald.com



Kansas Department of Commerce

Kansas is among the top states for operating wind farms, recently crossing the 6,000 MW threshold, and ranking 1st in wind as a percent of total energy. Cost effective Kansas wind is attractive to corporate off-takers, which are purchasing a significant percentage of wind energy produced in Kansas. Centrally located in the heart of the wind corridor, Kansas offers an advantageous operating environment for developers, wind turbine component manufacturers, logistics, and other service providers. The Kansas Department of Commerce is the primary point of contact to assist companies in learning about the state's wind industry and finding the ideal site for their operations.

www.kansascommerce.gov

Education | Research Development



Abaris Training Resources, Inc.

Abaris offers windblade repair training at both basic and advanced levels. Their courses are designed to provide skills to the engineer or technician looking to become proficient in structural repairs to skins, tips, spars, and leading and trailing edges. They have over 35 years experience in teaching advanced composite repairs and provide quality training resources to wind industry professionals.

www.abaris.com



Appalachian Energy Center

Appalachian Energy Center hosts a Hands-on Distributed Wind Energy Workshop annually at their Small Wind Research and Demonstration Site located on Beech Mountain, NC. Participants will experience a crash course in distributed wind energy, learn how to determine if wind is right for them (and others), and install a small wind turbine. The workshop includes continuing education credits for engineers and architects.

www.energy.appstate.edu



Iowa Lakes Community College

Providing wind energy education and training since 2004, Iowa Lakes Community College offers the AAS in Wind Energy & Turbine Technology and continues to adapt to the changing wind industry landscape. Competencies that enhance their student's resumes through advanced safety, realism, challenge, and mentorship, the team at Iowa Lakes Community College invests in student's development, providing a positive impact on America's energy and environmental future.

www.iowalakes.edu



Nergica

Nergica owns and operates a research site that comprises two Senvion MM92 CCV wind turbines, 16kW of solar PV panels, a microgrid comprising small wind turbines, diesel generators, and energy storage systems, two 413ft (126m) met masts, and two lidars. Their services are tailored to their clients needs, including technology development and assessment, operation and maintenance, applied meteorology and energy resources, energy storage and grid management, commercialization of innovations and cold climate suitability, and microgrids.

www.nergica.com



University of British Columbia

The Master of Engineering Leadership (MEL) in Clean Energy Engineering is a professional degree for engineers who want to excel and drive innovation in the field of clean energy. This hybrid master's program combines graduate-level engineering courses with UBC Sauder's Robert H. Lee Graduate School courses, giving students and professionals the skills and confidence to take their career in new directions.

www.apscpp.ubc.ca/programs/mel/clean-energy-engineering/

Electrical Equipment & Services | Power Generation



Alencon Systems

Alencon Systems builds a variety of power conversion products that can be applied to wind. The Alencon BOSS can be used to couple storage with wind projects in order to capture otherwise clipped energy and firm wind energy production. The Alencon SPOT can be used to collocate PV and wind.

www.alenconsystems.com



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Safety Technology USA, LLC

Safety Technology USA specializes in the delivery of GWO accredited training for technicians in the wind sector. Training modules include both the GWO Basic Safety Training and GWO Basic Technical Training. Training courses are delivered from facilities in Texas, Iowa, and Kansas as well as onsite, subject to risk assessments, at operators locations.

www.safetytechnologyusa.com



Electrical Consultants, Inc. (ECI)

Electrical Consultants Inc. (ECI) was incorporated in 1985. For over 34 years, their in-house portfolio of services, including overhead and underground transmission engineering, substation and switchyard design, industrial power systems design, land survey and construction staking, right-of-way services, environmental planning, project management, construction management, and procurement services have provided a key resource for hundreds of utilities. ECI brings extensive experience in power delivery services through 500kV to their clients.
www.electricalconsultantsinc.com



MacLean Highline

Maclean Highline manufactures fiberglass box pads and sectionalizing cabinets used on collection systems. They also have a complete line of polymer concrete pull boxes and splice boxes for running fiber optic cable.
www.macleanhigline.com



SPX Transformer Solutions

SPX Transformer Solutions provides medium and large power transformers up to 1200MVA, 345kV as well as power transformer, LTC, and circuit breaker components, including a line of Transformer Health Products. SPX Transformer Solutions also offers a variety of substation-applicable training classes for all skill levels and provides complete transformer service solutions for almost any manufacturer's units, including installation, maintenance, relocation, testing and engineering assessments, oil processing, dryouts and retrofits, corrective and preventative maintenance, load tap changer field retrofits, and repairs.
www.spxwaukesha.com

Composite Tooling for Windmill Blades

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

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

www.janicki.com
360.856.5143

Virginia-Georgia Transformer

Virginia-Georgia Transformer designs, manufactures, and markets products related to power generation, transmission, and distribution. A US based company manufacturing core form power transformer up to 1400MVA, 500kV, serving a range of markets including utility, commercial, industrial, mining, oil & gas, renewable, transit, and specialty Data Centers. They have been in the transformer industry since 1971 and produce both liquid and dry type power transformers manufactured from their four (4) facilities in North America. Their service division offers a full range of services and spare parts and provides lifetime extension programs for transformer assets.
www.vatransformer.com

Enclosures



Fibox Enclosures

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

Energy Storage | Grid Connection



Crown Battery Manufacturing Company

Crown Renewable Batteries are heavy weights with dense plates that use more active lead material, increasing battery performance and longevity. Crown currently leads the industry in lead content per ampere-hour of rated capacity. Their two-volt 2CRP3690 Power Module combines ampere-hour capacity availability to renewable energy system users. The battery delivers application flexibility, while providing an ideal solution for temperature management and electrical isolation.
www.crownbattery.com



e-On Batteries, Inc.

e-On Batteries, a Fort Worth, Texas area supplier with national scope, is developer of lithium iron phosphate (LiFePO4) based energy storage systems with a focus on product safety. The company's UL 1973 listed and CEC approved and listed modules are engineered as scalable building blocks to enable larger systems, and its 19" rack-mounted modular systems are easily configured from 12.8kWh residential systems to 4.8MWh container-based systems and more. With over 20 million deployed calls and zero catastrophic failures, combined with cell-level BMS monitoring and control systems, expert engineering liaison and certified installers, e-On Batteries provides full value to their customers.
www.e-onbatteries.com



EnerSys

PowerSafe ESG batteries by EnerSys are designed to provide 187-935 amp-hours (Ah) of capacity range to handle the challenging load profiles and service conditions of utility applications, including substations that support wind farms. The configuration of five multi-cell 4-volt units (185, 234, 281, 354, and 418Ah) reduces the footprint of the PowerSafe ESG battery to enable minimal occupation of floor space. Individual terminal posts on each cell facilitate integration of battery monitoring and test equipment used in routine maintenance and inspection. The Slide-Lock post seal accommodates natural plate growth over time for maximum reliability and reduced maintenance.
www.enersys.com



ESS Inc.

Energy Warehouse and Energy Center, ESS Inc's long-duration batteries utilize a non-toxic, non-hazardous, and completely recyclable iron-based electrolyte that provides over 20,000 cycles of power with little or no maintenance. A flow battery offers significantly more storage capacity, so users have the flexibility to shift both their energy flow and rate of storage as needed for more efficient energy management.
www.essinc.com



KORE Power

The KORE Power Mark 1 Energy Storage System delivers 110.7kWh in a standard 19-inch rack. Designed to lower energy storage installation and operation costs while optimizing performance, the Mark 1 system includes their propriety NMC cells, added safety features, and innovative modules, fully integrated with the Mark 1 BMS. Operating in the 1500V class, the Mark 1 has 6GWh of 2020 production capacity with deliveries available as early as Q1 2020. The Mark 1 is well-suited for pairing with wind systems.
www.korepower.com



Nel Hydrogen

Nel Hydrogen provides Alkaline and Proton Exchange Membrane (PEM) electrolyzers and electrolyser plants, built-to-scale to store excess electricity from renewable energy sources as hydrogen. This technology allows energy suppliers stable and flexible delivery of electricity. When required, New Hydrogen also integrates equipment components from other global suppliers into a customized Nel solution.
www.nelhydrogen.com

Engineering



Commonwealth Associates, Inc.

Commonwealth can provide assistance with owner's engineering, program management, power generation and energy services, interconnection, electrical system studies, routing/siting, land and right of way, environmental services, transmission and distribution line engineering, and substation engineering.

www.cai-engr.com



Metro Consulting Associates

MCA supports renewable energy projects (mainly wind and solar farm development) through their core consulting services: Land Acquisition & Title, Land Surveying, Ecological, Civil Engineering, and GIS. These services allow them to provide turn-key solutions to their client's development needs. MCA has the ability to support projects at very early stages with developers and utilities, but also through EPC's during mid to late stage development through ALTA surveys, design services, permitting, BOP design, environmental solutions, construction staking, and as-built surveys. MCA is headquartered in Plymouth, Michigan with 3 more full service offices in Traverse City, Michigan; Chicago, Illinois; and Cincinnati, Ohio.

www.metroca.net



Mott MacDonald

Mott MacDonald has participated in over 65 offshore wind projects over the last 15 years. They have worked on around 37GW of wind power production worldwide; roughly 10% of the world's capacity. Mott MacDonald's clients include owners, EPC contractors, power delivery utility companies, industrial facility owners, and independent power producers. As a multidisciplinary engineering and development firm, they have specific and recent experience providing design services for HV substations, transmission lines, and collector systems for key offshore clients.

www.mottmac.com



POWER Engineers, Inc.

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

www.powereng.com



Sargent & Lundy

Sargent & Lundy

Founded in 1891, Sargent & Lundy is a global company in power and energy with expertise in all forms of electric power generation including wind power; power transmission and distribution; grid modernization; energy storage; fuel infrastructure; energy consulting; and physical and cyber-security. Sargent & Lundy delivers comprehensive wind project services, from consulting, design, permitting, interconnection, construction management, commissioning, repowering, and operations/maintenance support, with an emphasis on quality and safety. Sargent & Lundy performs many roles on wind power projects, including full design architect-engineer, owner's engineer, lender's independent engineer/technical advisor, and consultant.

www.sargentlundy.com

Filtration Systems



Wahne Filtration

Wahne Filtration's low cost and high performance gearbox and hydraulic filters exceed OEM requirements. Veteran owned and operated.

www.whfilter.com

Financial Services



CleanView Capital

CleanView Capital's Clean Energy Ownership Program, uses a 3-page traditional operating lease to provide C&I customers with a low-cost path to ownership at an affordable price. The program appeals to companies which cannot benefit from a federal income tax credit within the company, as well as companies seeking to optimize value within budget and cash flow constraints. CleanView Capital's Government Finance Program uses a tax-exempt lease purchase agreement to provide municipal, county, and state governmental entities and their political subdivisions, such as schools and municipal electric companies, with financing at below commercial rates.

www.cleanviewcapital.com

TIMKEN

The Power Behind the Power

You bring us your toughest challenges. We bring you unrivaled technical support, superior engineering and manufacturing expertise.

Power on with innovations developed from the inside out.

timken.com/wind-energy

Gearbox Manufacturing, Services & Repairs



Bonfiglioli

Bonfiglioli's new condition monitoring system ensures a drastic reduction of down time with optimized maintenance intervals and electronic controls to reduce overloads. Their torque limiters monitor and measure gearbox performance, troubleshoot maintenance issues, and control and manage power for higher ROI and longer LTV. They design and manufacture an extensive range of wind energy products, including yaw and pitch drives, as well as a complete range of AC and permanent magnet electric motors with inverters. Bonfiglioli products are compact, lightweight, and versatile to help improve performance and minimize maintenance costs of 1MW to 12MW turbines in on- and off-shore installations.

www.bonfiglioli.com



Ernst Schad GmbH

Ernst Schad GmbH, gear producer in Dortmund, Germany, is an independent producer of gear components for the main wind turbine gearbox. They have more than 20 years experience in the production of gears for the original gearbox makers, as well as to service companies. They can produce gears according to customer drawings or reverse engineer according to their customer's sample. Producing planetary as well as helical stage, and up to module 45 and 8000 ton single item weight.

www.ernst-schad.com

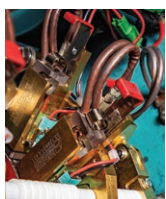


Milwaukee Machine Works

Milwaukee Machine Works is a North American manufacturer of wind turbine parts including, housings, torque arms, and gearboxes. MMW's machining of wind turbine gear boxes, torque arms, armature housings, and components spans close to two decades. They have the solution, technology, and machining expertise to satisfy their customer's stringent requirements. Their Leitz CMM also provides quality inspection capabilities for complex and large parts.

www.milwaukeemachineworks.com

Generators | Maintenance & Repair Services



Helwig Carbon Products, Inc.

Helwig Carbon is a manufacturer of carbon brushes, brush holders, and quick disconnect fittings for wind turbine generators. They offer complete wind generator upgrades for longer service life. They also make a wind pitch motor bearing protection kit designed to protect pitch motors from premature bearing failure.

www.helwigcarbon.com



SGL Gelter

SGL Gelter is a worldwide manufacturer and provider of carbon brushes for wind power. Their brushes for wind are now installed around the world in generators, pitch control, lighting protection, and protection of main shaft and bearing. RC 54 is a specific grade for the extreme environments found in wind turbines and has been designed to increase the lifetime of the brush.

www.sglcarbon.com

Large Wind Turbine Manufacturer (Over 100kW)



Goldwind Americas

Goldwind's latest GW 4S MW Permanent Magnet Direct-Drive (PMDD) series of turbines now features a 4.5MW rated capacity with a 155-meter rotor. The smart wind turbine designed for international markets and IEC wind classes IIC / IIB. The 4.5MW turbine is a direct evolution of Goldwind's portfolio of wind turbine generators that offer high energy production, smart controls, and availability.

www.goldwindamericas.com



Suzlon Wind Energy Corporation

Suzlon offers wind turbines from 2MW to +4MW class, with tower hub heights of 90m to 120m. Suzlon is a full service provider on all OEM platforms throughout North America and offers extensive training programs at their training facility in Elgin, IL, to cover all aspects of wind technician certification and they have the ability to customize programs to fit their customer's needs.

www.suzlon.com



Vestas

Vestas provides sustainable energy solutions. They design, manufacture, install, and service wind turbines across the globe. They have installed 105GW of wind turbines and have over 85GW under service. They use data to interpret, forecast, and exploit wind resources and deliver quality wind power solutions.

www.vestas.com

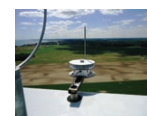
Lighting



DeTect, Inc.

DeTect developed the HARRIER Aircraft Detection Lighting Systems (ADLS) for automatic lighting activation of aviation obstructions such as wind farm turbines, high voltage transmission lines, and communication towers. The HARRIER ADLS provides continuous 360° radar surveillance of the airspace, automatically issuing signals to activate obstruction lighting when aircraft are detected at a defined outer perimeter. The FAA Performance Assessment Report on HARRIER ADLS states that the system met the performance requirements identified in Chapter 14 of AC 70/7460-1L and is published on the FAA Website. HARRIER is also fully compatible with all SCADA systems and turbines and is a widely deployed system with installations the US, Canada, and Europe.

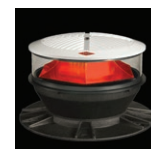
www.detect-inc.com



Flash Technology

From their Franklin, TN headquarters, Flash Technology offers innovative traditional and solar MET tower and wind turbine obstruction lighting solutions and the remote asset monitoring systems that support them. An OEM since 1970, they help clients mitigate risk and meet the day-to-day challenges of obstruction lighting operations. Their ETL-certified and FAA-approved LED products serve airport, broadcast, telecom, utilities, and wind energy markets. Their support services include component-level training, installation, troubleshooting, and maintenance.

www.flashtechology.com



Hughey & Phillips

The H&P HORIZON L-864 Red LED beacon has design features specifically for wind turbine applications. Light weight, compact, easy wiring, dry contact, field repairable, and integrated GPS/PCELL allows the fixture to be quickly installed on new or existing turbines. At 17lbs and 9" tall, the fixture can easily replace larger and heavier fixtures while typically using the same system wiring. Being field repairable, it reduces maintenance costs. The integrated GPS/PCELL provides sync and mode control without the need for additional controls. All HORIZON systems come with a full 4-year warranty.

www.hugheyandphillips.com

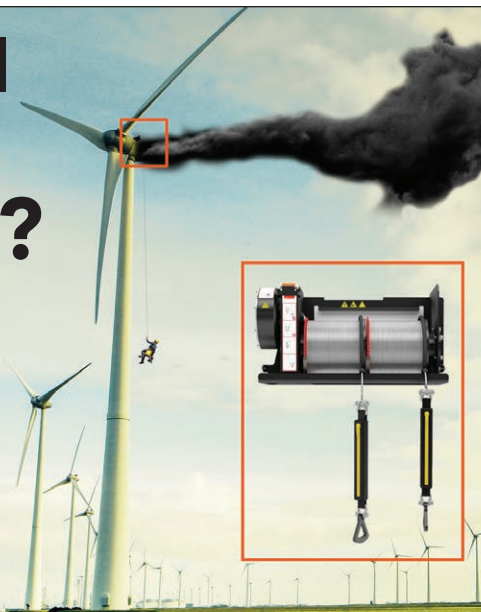


International Tower Lighting

International Tower Lighting (ITL, LLC) provides LED technology, advanced optics, and wireless GPS-based flash synchronization for wind turbine obstruction lighting. ITL provides obstruction lighting, management of installations and repairs, live technical support, and a 24/7 NOCC center.

www.itl-llc.com

How will YOU escape?



The EVACUATOR Key Features:

- Escape & emergency descent solution
- Designed to save the lives of those working at altitudes ranging up to 300m
- Evacuator is fast & simple (click & go)
- Fireproof units, 1750°C for 30 minutes or 1200°C for 90 minutes
- Fully mechanical descent at 1m/sec
- Installed inside or outside of the nacelle, onshore or offshore
- Each unit has 2 reels, each reel can carry multiple persons up to total weight of 282kg
- The Evacuator is certified in compliance with ANSI Z359, CSA Z259.

TeSuCon
Technical Support & Consultancy
www.tesucon.com
519-885-9021
info@tesucon.com



Moltec Windpower Products

Moltec now offers brighter ways to illuminate critical areas in wind towers and nacelles. Their new LED lighting systems deliver high performance and are a cost-effective solution for wind tower lighting. All of their engineered lighting and electrical systems are pre-assembled, pre-tested, and ready to install per user specifications. The compact and lightweight Moltec LED Sabre Light achieves industry photo-metric requirements. This allows for easy handling and installation within limited space without sacrificing lumen output. The Moltec UFO Light utilizes high-powered, high efficiency LED technology to deliver optimal directional lighting. As a result, the desired lux values are achieved with fewer fixtures. This system is a solution for down-tower lighting or large workspace task lighting.

www.moltecinternational.com

TECHNO STROBE™



Technostrobe

Technostrobe manufactures obstruction lights for tall towers. Their mission is to help pilots fly safely by providing innovative, robust, and energy efficient lighting technologies. The LED lighting systems can be combined with their LIDS (Lighting Intensity Dimming Solution) Technology to ensure the intensity of the lights on a wind farm are adapted to the surrounding visibility, thereby helping the site become more community friendly. They serve customers in the broadcasting, telecommunications, and wind farm industries.

www.lidsinfo.com



TWR Enlightened Technology

TWR Lighting

TWR is a manufacturer of obstruction lighting, visibility sensor, and radar detection systems for wind turbines and tall structures that present a hazard to aviation. With thousands of systems installed around the globe, TWR provides FAA and ICAO compliant systems. TWR showcases their latest FAA L-810 temporary light, as well as their standard L-864 lighting system, visibility sensor and controller, and can provide information about their system compatibility with radar technology.

www.twrlighting.com

Lightning & Surge Protection

Raycap



Raycap

Raycap offers the wind industry a variety of Surge Protective Device (SPD) technologies for the protection of wind turbines. Their solutions are suited for remote and mission critical installations. Strikesorb, Raycap's premium protection technology carries a 10-year warranty and is available to protect various applications inside the turbine. Also available are SafeTec and ProTec products, reliable solutions for temporary overvoltages, surges, and transients. RayDat products are a recommended solution for surge protection on the signal or data lines that run throughout the wind turbine.

www.raycap.com

Lubricants



DEVOTED TO PROTECTION™



AMSOIL, Inc.

AMSOIL synthetic lubricants use sophisticated additives to provide cost-effective choices for prolonging equipment life, reducing maintenance, and increasing performance. AMSOIL PTN 320 is approved with all gearbox manufacturers, including Winergy/Flender, NGC, Gearbox Express, Moventas, and ZF, and their lubricants are used as a global factory run-in for Winergy, NGC, and ZF.

www.amsoilwind.com



Fuchs Lubricants

Fuchs is a full line global lubricant supplier to the wind industry. Fuchs has numerous OEM approved greases for bearing application and oil for gearbox usage. Fuchs has a full line of solutions for all wind related lubrication needs. Gleitmo 585K is a top performing pitch grease, and is widely used across turbine platforms.

www.fuchs.com



Hydrotex

SYN-Nth Gear Oil is designed to reduce wear in wind turbine gearboxes for maximum equipment life and reliability. SYN-Nth Gear Oil's protection against gear scuffing and micropitting has been documented with FZG testing and field-proven in wind turbines. SYN-Nth Gear Oil has a high viscosity index to maintain an ideal lubricant film thickness year-round. Its high oxidation stability extends drain intervals. Guaranteed ISO 4406 cleanliness: 16/14/11.

www.hydrotexlube.com

KLÜBER LUBRICATION



Klüber Lubrication NA LP

Speciality lubricants made by Klüber Lubrication help increase the reliability of wind turbines. Experts in tribology and development cooperate closely with original equipment manufacturers to push the limits of what can be technically achieved. Klüber Lubrication offers a full portfolio of lubricants for wind turbines and components: fully formulated gear and hydraulic oil, synthetic assembly pastes, grease for new and used bearings under extreme conditions, and services for removing aged lubricants and refreshing components.

www.klueber.com

Because it's a long way down.

PDQ2™ System

The PDQ2 is Sterling's lightweight evacuation system for use in all work-at-height environments. The PDQ2 descent-control device and the 6 mm XTEC™ heat-resistant Technora® rope form the core of this system whose total weight is under 10 lb. Rated for a user-load of 310 lb, the fully-assembled kit comes ready for deployment and its slim profile means it can be stored compactly and carried by each technician until needed.

For Sterling gear, talk to your employer or visit SterlingRope.com/Work



Shell Lubricants

Shell Omala S5 Wind fully synthetic gear oil offers lubrication performance even under severe operating conditions. The formulation is developed to protect a wind turbine's gears and bearings by minimizing wear, protecting against micro-pitting, maintaining effective fluidity at extremes of low temperature, and minimizing foam formation. Shell Omala S5 Wind is designed to meet or exceed OEM requirements of Siemens Wind Power, ZF Wind, Vestas, and Gamesa. It also meets or exceeds following OEM component requirements of Winergy, NGC, Bosch-Rexroth, Eickhoff, Moventas, SKF, Timken, Schaefflet, Hydac, CC Jensen, Mintai and Fredenburg.

www.shell.us

Operations & Maintenance (O&M)

bachmann.



Bachmann electronic GmbH

Condition monitoring, SCADA, grid measurement, and data portals are crucial to bring down the cost of energy by 30%. Bachmann's smart automation not only increases turbine efficiency, but helps structure and connect the ever-increasing masses of data. This saves valuable time. The controller no longer just processes individual standardized signals for the operational management of the turbine but is becoming more of an intelligent control center. Bachmann's solutions can turn 100 monitoring variables into 20 with ISO 10816-21.

www.bachmann.info



Cortland Company

To meet the technical lift specifications of larger and more challenging lifts, synthetic lifting solutions provide strength, weight, handling, and storage efficiencies. As an originator of fiber braiding and rope sling technology, Cortland Company has more than 25 years of experience engineering certified synthetic lifting sling solutions. They offer the combination of high tenacity: 1) Selantic round slings, and 2) Plasma braided rope slings. All Cortland synthetic fiber lifting slings are compliant with DNV, EN, or ASME listing standards and are tug-certified with appropriate product and lifting capacities.

www.cortlandcompany.com



EDF Renewables

EDF Renewables North America is an independent power producer and service provider with over 30 years of expertise in renewable energy. The Company delivers grid-scale power: wind (onshore and offshore), solar photovoltaic, and storage projects; distributed solutions: solar, solar-storage, EV charging, and energy management; and asset optimization: technical, operational, and commercial skills to maximize performance of generating projects. EDF Renewables' North American portfolio consists of 16GW of developed projects and 11GW under service contracts. EDF Renewables North America is a subsidiary of EDF Renewables, the dedicated renewable energy affiliate of the EDF Group

www.edf-re.com



HYTORC

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

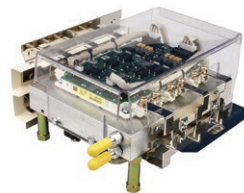
www.hytorc.com



Indji Systems

The Indji Watch solution partners with and delivers data from trusted and reliable sources to provide users with accurate real-time weather, and hourly-updating forecasts. Their Plan of Day dashboard will help users quickly identify rapidly changing weather at-a-glance, allowing them to be more proactive in mitigating potential impacts to their operation and employee safety. From a system-wide overview right down to an individual asset, Indji Watch will ensure that the team has the best possible picture of what the weather will be doing in the near future, as well as analytic capabilities to what happened in the past.

www.indjiwatch.com



Ludlum Wind

Ludlum IGBT assemblies are built to last. Assemblies utilize IGBTs with high ratings and enhanced internal construction, new buses, new insulators, new stand-offs, new mounting brackets, new fasteners, and an upgraded new AEBM driver board with surface mount parts. Parts are kept in stock so customers can quickly get the parts they need. All assemblies are shipped with custom steel shipping plates and custom reusable packaging so the parts always arrive safely. Ludlum IGBT assemblies are manufactured and assembled in the USA.

www.ludlumwind.com



Nearthlab, Inc.

Nearthlab provides AI solution for operations and maintenance of industrial facilities using autonomous drones. The company's autonomous drone software gathers and analyzes inspection data in various industries. Nearthlab offers efficient and reliable inspection service for renewable energy facilities such as wind turbines and works with governments and private companies in the U.S., Europe, and Asia. With capabilities in stable flight control in harsh conditions, autonomous flight based on artificial intelligence, and inspection data analysis through image processing and deep learning, Nearthlab provides fast and accurate decision making in industrial sites.

www.nearthlab.com

NORTHWIND

A SPARKPOWER COMPANY



Northwind

Established in 2004, Northwind, a Spark Power Company since 2013, has provided wind and solar operations and maintenance (O&M) services for over 75 wind farms, over 1200 sites, and 650+MW of solar assets. Across Canada and the United States, they've partnered with Original Equipment Manufacturers (OEMs), Developers, Owners, and O&M Managers to minimize downtime, maximize asset performance, and deliver solutions that keep customer's operations up and running today and equipped for tomorrow.

www.sparkpowercorp.com



Power Climber Wind

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

www.powerclimberwind.com



PSI Repair Services, Inc.

As an independent service provider (ISP) serving the wind energy industry, PSI Repair Services offers wind turbine component repair and upgrade services for GE, Vestas, Gamesa, Siemens, RePower, and Clipper turbines. They cover the critical electronic, hydraulic and precision mechanical components that drive a turbine's pitch and yaw systems and down-tower electronics. Commonly repaired components include printed circuit boards, pitch drive systems, inverters, IGBTs, PLCs, VRCC units, AEBIs, proportional valves, hydraulic pumps, pitch and yaw motors, encoders, slip rings, transducers, yaw modules, 3-phase bridge rectifiers, and more.

www.psi-repair.com



RM Wilson Company

RM Wilson Company, founded in 1966, is a product specialist supplying numerous European manufactured components and parts. RM Wilson can provide a variety of solutions and services to owners and operators of the wind energy sector. They can provide current technology in gear manufacturing as well as upgrade solutions for older gearboxes in the field. Headquartered in Wheeling, West Virginia, with locations throughout the United States, RM Wilson is able to provide services to the end user. Along with power transmission solutions, RM Wilson also represents Svendborg Brake, a global supplier in both yaw and rotor brake systems, and Thiele Chain, GmbH, a supplier of round steel chains and accessories for lifting, moving, and securing loads.

www.rmwilson.com



SkySpecs

SkySpecs offers a suite of Operations & Maintenance solutions including fully automated wind turbine blade inspections that are repeatable, precise, and take less than 15 minutes. Horizon is their asset management platform, allowing multiple stakeholders to collaborate and make the best decision about their assets every time. Their engineering services include risk assessment and auditing, root cause analysis, and blade services, and are run by a team of expert blade analysts and engineers ready to tailor projects to their customers' specific needs. www.skyspecs.com



TECHEOL Renewable Energy Technical Services

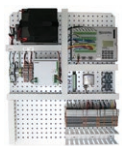
TECHEOL is a company specializing in wind turbine O&M services, providing preventive and corrective maintenance, major component replacements, up-tower drive train repair, and blade repair as well as performance optimization. Since 2007, its management team had established solid business relationships with wind farm owners in Canada, USA, and Mexico. www.techeol.com



WECS Renewables

WECS Renewables provides wind energy, commercial solar, and storage products for new construction and for long term O&M. Electrical, mechanical, and hydraulic solutions. For 35-years, WECS has been providing components exclusively in the North American renewable energy industry from conception to repower. www.wecsrenewables.com

Remote Monitoring



Campbell Scientific

The WMS100 provides precision measurement capabilities in a rugged, battery-operated package. It consists of a measurement and control data logger, communications hardware, and power supply. Standard operating range is -13°F to 122°F (-25°C to 50°C); an optional extended range of -67°F to 185°F (-55°C to 85°C) is available. Building on a Campbell Scientific data logger platform yields a versatile, robust, and accurate MET system. The WMS supports nearly all sensors used in the industry. The WMS100 supports sensors at any height, junction boxes, down-tower cabling, and many other customer-specific measurement configurations. www.campbellsci.com



Leosphere, a Vaisala Company

Leosphere lidars measure and assess wind in both the development and operational phases of a wind farm, onshore and offshore. The Windcube is a reference remote sensor in the wind industry, providing accurate wind measurements up to 656ft (200m). Scanning Windcube systems are versatile, high-precision instruments offering a range from 328ft to 2.17 miles, 3.7 miles, or 6.2 miles (100m to 3.5km, 6km, or 10km) as well as multiple scanning pattern choices. The Wind Iris is a nacelle-mounted lidar for turbine performance verification. The Wind Iris Turbine Control delivers reliable wind data hundreds of meters in front of the rotor plane enabling increases in capacity and opportunities to reduce wind energy LCOE. www.leosphere.com



Olympus America, Inc.

Olympus provides a portfolio of innovative test, measurement, and imaging instruments. Technologies include remote visual inspection, ultrasound, phased array, eddy current array, x-ray fluorescence, industrial microscopy, and optical metrology. Their products include ultrasonic flaw detectors and thickness gages, videoscopes, borescopes, microscopes, XRF analyzers, advanced nondestructive testing systems, and a large selection of industrial scanners, probes, software programs, and instrument accessories. www.olympus-ims.com



Phoenix Contact

Phoenix Contact's new wind turbine ice-detection system reduces power production loss and increases safety. The self-powered sensors used in this system transmit ice thickness and temperature information wirelessly from blade surfaces, without drilling or wires. A single receiving unit is installed in the turbine and receives information from sensing units, which are distributed over the surface of each blade. These sensing units are easy to install during regular blade inspections. Detection in a stopped rotor state allows automatic restart to minimize power production loss. The system also measures the direct surface temperature for precise heating control with blade de-icing systems. www.phoenixcontact.com/wind

Restoration



AmePower

AmePower is an ISO9001 certified engineering company specialized on delivering customized solutions to improve the efficiency and reliability of high-power electronics systems found in wind turbines, PV inverters, EVs, marine propulsion, and many other applications. Their area of expertise includes GTO to IGBT technology conversion, IGBT system upgrades, and form/fit/function custom converters. Their equipment is manufactured in USA, complying with buy America. Their services include repair and overhaul of old/obsolete high-power converters, contract manufacturing, retrofit/technology upgrade, pre-designed inverters, in-house testing, and engineering capabilities. www.amepower.com/wind-power



AREPA

AREPA provides technical equipment restoration and reinstatement solutions. They strategically restore and reinstate damaged equipment to help prevent business interruption, lost productivity, and decreased revenue potential. www.arepa.com

Safety Equipment | Fall Protection



3S Lift

The Climb Auto System is wind's new climb assist, improving health and safety, and reducing the cost of ownership. The Climb Auto System is a single technician (rated at 310lbs) ladder-mounted lift that completely eliminates the physical and mental strain of climbing. It features safety control switches on both handles, a remote mode for the easy transport of tools, and collapsible pedals for rapid evacuations in the event of an emergency. It offers an independent fall arrest systems for personnel and the Climb Auto System. The Climb Auto System can be easily retrofitted to any new or existing wind turbine ladder, often in only 8 hours. It has certifications from CE, UL, ANSI, OSHA, and more and has been installed in over 30,000 towers worldwide. The Climb Auto System is a safe and cost-effective way to ascend a tower and lets technicians keep their minds on the job and not on the climb. www.3SLift.com



SIBA
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West Caldwell, NJ
(973) 575-7422
info@sibafuse.com

SIBA Fuses is proud to introduce NEW True Full-Range HV Fuse Technology. Our 7.2kV & 12kV fuses are capable of operating at 100% full range tested voltage and rated currents. The 7.2kV fuses are available up to 180A in a single body and 12kV fuses up to 160A. For the increased levels of power used, such as in Wind Applications, SIBA developed NEW high-voltage SSK type fuse-links that extend the range of usage for switch-fuse combinations up to larger transformers.

For ALL your Wind, ES (Energy Storage), PV, Traction, Transformers and MCC circuit protection needs, SIBA Fuses offers the most comprehensive and innovative fuses. We're very confident you will appreciate our efficiency, product knowledge, superior technology, and the imaginative solutions that we can offer.



Call or email us for more information on our products and services!



Dakota Riggers

From tool lanyards and tie-off points to holsters and pouches, Dakota Riggers stocks a full selection of 3M tool tethering products 3M. With the recent publication of the ANSI/SEA 121-2018 Dropped Objects Standard, fall protection for tools is quickly becoming a necessity in the wind industry in order to protect those working below.

www.dakotariggers.com



Firetrace International

The Firetrace automatic fire suppression system is a solution for the unique environment in a wind turbine unaffected by vibration, dust, airflow, and temperature. Their systems can protect the control panels, capacitor cabinets, braking system, transformer, and other at risk areas of the turbine, without requiring power or excessive space usage.

www.firetrace.com



Petzl America

Petzl helmets focus on all-day comfort for technicians and at-height workers. The STRATO is a lightweight and comfortable helmet due to the dual inner foam construction. The liner incorporates an EPP (expanded polypropylene) and EPS (expanded polystyrene) foam to reduce weight and achieve superb shock absorption. The helmet comes in vented and unvented versions, as well as hi-viz yellow and orange for increased visibility. The STRATO is an ANSI Z89.1 and Type I Class E rated helmet. Multiple accessories are compatible with the STRATO helmets; eye shields, headlamps, nape protector, hearing protection, and name tag holder for personalization.

www.petzl.com

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- Cost effective
- Low maintenance
- Long life

You can **extend** the life of your motors and **prevent** costly damage to bearings!



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Ropes Park Equipment

Ropes Park Equipment provides safety and rescue equipment for work at heights, fall arrest, and rescues/evacuation needs. Products include Mark Save-a-Life Hero and Phoenix; 3-person rescue devices featuring redundant braking and fire resistance. These items can last up to 10-years maintenance free when stored in Seal-Pack.

www.ropesparkequipment.com



SKYLOTEC

The new SKYLOTEC CLAW Vertical Fall Arrest Cable Sleeve is designed to fit a wide variety of wire ropes and travel along the vertical system while providing fall arrest when needed. Engineered to fit 3/8 and 5/16-inch wire rope, this high quality, lightweight stainless-steel device travels smoothly up and down the vertical system without hanging up. The redundant safety features reduce the risk of improper installation and unsafe situations. The CLAW is independently tested to meet ANSI A14.3-08, CSA Z259.2.5-17 and OSHA requirements.

www.skylotec.com



Sterling Rope Company

The PDD2 is Sterling's lightweight evacuation and rescue system for use in all work-at-height environments. The PDD2 descent-control device and the 6mm XTEC heat-resistant Technora rope form the core of this system whose total weight is under 10lbs (for a 100M system). The fully-assembled kit comes ready for deployment, in a durable, weather-resistant carrying bag that can be comfortably carried by the technician until needed. Custom lengths and configurations available upon request. It is a lightweight, easily deployable rescue system and can be customizable based on rope length needs. The weather resistant bag keeps kit protected and carried comfortably. Certified to meet ANSI Z359.4

www.sterlingrope.com



Skysaver Rescue, Ltd.

Skysaver offers a professional line of products for immediate evacuation for wind turbine, construction, cranes, hotels, and cell towers. Using SkySaver's military-grade Controlled Descent Device [CDD], an entire rescue operation will take only a matter of minutes and eliminates the need for rescue professionals. Their CDD has passed all necessary outdoor tests (heat, fire, extreme cold, water, salt) and can be pre-installed on site. They also offer an injured evacuation kit for incapacitated workers which provides an immediate solution facilitated by only one rescuer.

www.skysaverpro.com



TeSuCon
Technical Support & Consultancy



TeSuCon Technical Support & Consultancy

Designed to save the lives of those working at altitudes ranging up to 984ft (300m), the Evacuator is a fast, simple, and easy-to-use (click and go) fireproof collective escape and emergency descent solution. Fireproof units, 3182°F (1750°C) for 30 minutes or 2192°F (1200°C) for 90 minutes, are customized for each turbine model and can be installed inside or outside of the nacelle, onshore or offshore. Emergency descent is fully-automatic and mechanically controlled at a speed of 3.2ft/sec (1m/sec), without use of electricity. Units are compact and easy to maintain. The Evacuator is certified in compliance with ANSI Z359, CSA Z259.

www.tesucon.com

Safety Work Apparel



Blaklader

Blaklader, a Swedish Company, manufactures functional workwear for all workers' needs. Within the clean energy segment, their FR styles 1636, and now 1676, are tested and compliant with NFPA 70E. 1636 and 1676 work pants are HRC compliant, with an 11 calories/cm² arc rating.

www.blaklader.com



Thrive Workwear

Thrive Workwear's protective work apparel has been providing solutions to the wind industry for nearly 10 years. Their line-up of clothing includes Flame Resistant work pants, FR work shirts, FR base layers, and FR outerwear designed specifically for wind technicians and construction workers. Their work pants feature full-time knee protection built-in with patented SQUISH pad technology.

www.thriveworkwear.com

Small Wind Turbine Mfg (Under 100kW)



Flower Turbine

Flower Turbine's aerodynamically advanced small vertical axis drag type turbines are efficient due to innovations in the turbines and how they are placed; they actually make their neighbors perform better. They are a solution for customers with a large flat roof or parking lot structure to build a small farm of 10 or more turbines. Each has a choice of 2, 3, or 5kw electronics. Residential Flower Turbines will be available soon.

www.flowerturbines.com



SD Wind Energy (formerly Proven Wind Turbines)

SD Wind designs, manufactures, and supplies small wind turbines across the globe. With over 5,000 wind turbine installations in over 70 countries, they can deliver small scale renewable energy needs world-wide. The SD Wind Energy product range covers a wide array of applications and has a unique downwind design and ability to operate in all wind speeds without the need to shut-down. With over 30 years experience of installations in harsh environments, the SD Wind turbine is a reliable small scale turbine. SD Wind's 3KW and 6KW wind turbines are manufactured in Scotland and sold through dealers and installers.

www.sd-windenergy.com

Software Supplier



BladeEdge

BladeEdge offers a customized approach to blade inspection data and analytics through EDDIE, an artificial intelligence (AI) engine designed to process, identify, and manage inspection data automatically. Regardless of which method chosen for capturing data, or who is used for inspections, BladeEdge can leverage EDDIE to deliver a solution. EDDIE's valuable insights inform strategic initiatives and revenue-generating activities. BladeEdge helps users minimize efficiency loss, stop drowning in data, and maximize time.

www.bladeedge.net



Clir Renewables

Clir Renewables is a Software as a Service company in the renewable energy industry, providing a solution developed by engineers for engineers. The cloud-based AI platform provides asset managers and owners with tools to maximize annual energy production and provide clarity on portfolio performance. Their proprietary algorithm cleans and analyzes ingested data providing actionable insights. Founded in early 2017, the company now supports over 5GW of assets worldwide, with clients typically seeing increases of up to 5% in AEP in the first year.

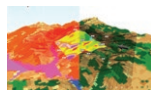
www.clir.eco



JobNimbus

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

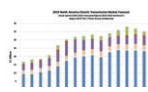
www.jobnimbus.com



Meteodyn

Meteodyn WT is a CFD software designed for wind resource assessment. It accurately estimates the wind resource, even on complex terrain (mountainous or forested) and allows users to design profitable wind farms. Meteodyn SPA is a SCADA data processing and analysis software for wind farm. Users can obtain the real production of the entire wind farm or for each individual turbine and compare it to the manufacturer's power curve. The software also detects the status of the wind turbine. Meteodyn Forecast is their service allowing customers to estimate the expected production of one or several turbines, from few hours to 14 days, to optimize plant maintenance. It uses CFD and machine learning, for higher accuracy.

www.meteodyn.com



The C Three Group, LLC

The C Three Group offers subscriptions to cloud-based databases with up-to-date project-tracking for North American infrastructure projects in transmission, generation, oil and natural gas, and telecom. Add-on services include customer reporting, market forecasts, and a deep dive segment analysis.

www.cthree.net

Steel Supplier



Leeco Steel

Leeco Steel, headquartered in Lisle, IL, maintains a large inventory of carbon, HSLA, and alloy steel plate, including EN steels such as S355 J2, K2, and NL, and all ASTM grades suitable for wind tower applications. Leeco's extensive stock is housed in 11 strategically located distribution centers in North America so as to serve wind energy customers with their steel plate needs.

www.leecosteel.com

Testing | Inspection Services



Megger

The MIT410/2 is a handheld field rugged instrument that performs the fundamental test of electrical system reliability, insulation resistance. It also performs a regime of corollary tests which help the operator fine tune the final assessment. It offers preventive and predictive maintenance on generators and cables up to 200 gig ohms. The unit is rated CAT IV 600 volt protection from arc flash/arc blast. It also measures ac and dc voltage.

us.megger.com



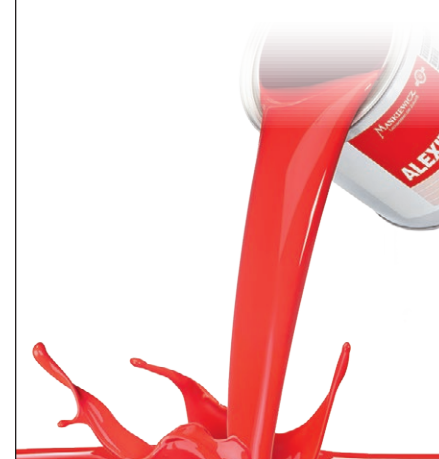
MISTRAS Group, Inc.

MISTRAS Group is a global OneSource provider of asset protection solutions for the North American wind energy industry. They provide inspection, light mechanical services, and condition-monitoring for turbine blades, towers, gear boxes, and transformers in onshore and offshore assets. MISTRAS offers rope access and drone capabilities, enabling safe asset protection at any height. Their solutions include non-destructive testing (NDT) for internal and external inspection, laminate and coating repairs, blade installation and repair support, fleet-wide condition monitoring, lab materials testing, and root cause analysis.

www.mistrasgroup.com



Whether you need a system for wind blade production or repairs, contact us today to learn how Mankiewicz can provide your complete coatings solutions.



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Europe: +49 (0) 40 / 75 10 30

www.mankiewicz.com



NTS

NTS provides lightning simulation and modeling services to wind turbine manufacturers at multiple labs throughout the nation. NTS facilities include a 20,000 square foot Lightning Center of Excellence in Pittsfield, Massachusetts, which boasts generators that can produce more than 200,000 amperes and 2.4 million volts. To meet individual customer needs, NTS provides a wide range of lightning services, which include direct effects testing, indirect effects testing, simulation and modeling, onsite engineering, custom wave shapes, electrostatic discharge, multiple burst, multiple stroke, near strikes, surge testing, and more. In addition, NTS subject matter experts are shaping industry standards, sitting on advisory boards, writing technical papers, and authoring textbooks used by NASA and the FAA. In short, NTS brings expertise to provide wind turbine manufacturers with a one-stop shop for robust design, analysis, and testing services.

www.nts.com



Q-Lab Corporation

Q-Lab Corporation is a global provider of material durability testing products. Q-Lab designs and manufactures standard test substrates as well as weathering, light stability, and corrosion testers. In addition, contract test services which include accelerated laboratory testing are available at Q-Lab Florida, Q-Lab Arizona, Q-Lab Deutschland, and Q-Lab China. Outdoor exposure testing for weathering, lightfastness, and corrosion are available at Q-Lab Florida and Q-Lab Arizona. Nature's elements can take a huge toll on outdoor use products. Q-Lab offers various products, testing services, and locations to ensure their customers' products will stand the test of nature and time.

www.q-lab.com



Small Wind Certification Council

The Small Wind Certification Council (ICC-SWCC), an independent ISO/IEC 17065 accredited certification body, certifies wind turbines that meet or exceed the requirements of specified standards. Designed to promote consumer confidence and mainstream acceptance of small and medium wind technology, ICC-SWCC certification standardizes North American reporting turbine energy and sound performance. ICC-SWCC certification also helps manufacturers to demonstrate compliance with certification requirements from numerous federal, state, and local incentive programs to qualify for rebates and tax credits.

www.smallwindcertification.org



WindGuard North America, Inc.

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

www.windguard.com

Tools



AcraDyne

AcraDyne's Gen IV Critical Bolting Platform is an advanced bolting/tool system. HT Series tools from AcraDyne are electric, high-torque bolting tools that provide accuracy, speed, and safety. The iEC controller/tool system measures traceable, dynamic torque directly at the square drive. The built-in transducer ensures accurate torque values. Combined with AcraDyne's Dual-Lever HT Nutrunners, the Gen IV platform provides an additional level of safety to protect the tool operator. AcraDyne's HT tools deliver high speeds in torque ranges 50 – 17,000Nm. The ergonomic, robust design includes five handle configurations. These tools are designed and made in the USA.

www.aimco-global.com



Atlas Copco

Atlas Copco offers products and solutions that increase productivity - the right solutions for all hydraulic torque, electric torque, pneumatic torque, manual torque, and hydraulic tension applications. Atlas Copco's SRB HA provides tightening with ergonomics and usability. It's durable, fast, and packed with smart features. Atlas Copco serves the wind power industry with assembly tools, equipment, calibration, repairs, and rentals.

www.atlascopco.com



Chicago Pneumatic



Chicago Pneumatic

The CP66 nutrunner series is suitable for flange-related and other bolting applications in the oil & gas, power generation, and wind energy industries. Operator comfort is an integral part of this pneumatic nutrunner's design, therefore, the CP66 series is recognized to have a vibration level close to zero. The torque set-up is defined with the CP Air Torque Control FRL which enables an extremely fine pressure adjustment. Small but powerful, the CP6613 is equipped with a robust gearbox and a high-performance air motor, like the industrial impact wrench motors. It delivers 960 ft.lbs in forward or reverse torque for high productivity. The max torque of CP6641 is 3100 ft.lbs.

www.cp.com



Einpart, LLC

Einpart, LLC has 20 years of experience in parts, tools and special equipment. They supply and support the North and South American wind market from their headquarters located in Plano, TX. Their main product lines for the onshore and offshore wind industry are FAA approved obstruction lights, torque and tension tools with a wide range of hydraulic, electrical, and mechanical tools. Personal protection equipment, certified lifting bags, WTG components, offline oil filtration, heat products, sensors, hydraulic parts, and consumables.

www.einpart.com



HD Electric

HD Electric's test, measurement, and safety products are a comprehensive range of products for testing electrical apparatus such as direct contact voltage detectors, voltmeters, phasers, underground cable fault tester, voltage indicators, proximity voltage detectors, handheld voltage detectors, voltage detection network, personal voltage detectors, insulator testers, arrester/leakage testers, ammeters, cable distance meters, phase rotation meter, cable identifiers, capacitor testers and transformer testers. Their controls and system monitoring products include local and communicating capacitor controls.

www.hdelectriccompany.com



Hi-Line Utility Supply

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

www.hilineco.com

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ITH[®] Bolting Technology



ITH Engineering

ITH Bolting Technology manufactures bolting tools and systems for thread sizes as small as M16 up to M510 and larger, including standard products and custom designs engineered based on customer needs. The full scope of tools includes hydraulic bolt tensioners, hydraulic torque wrenches, and torque multipliers ranging from electric, pneumatic, and battery driven. ITH offers standard bolting system packages including tools and fasteners, and the maintenance-free bolting system which specifically includes ITH bolt tensioners and IHF tension fasteners.

www.ith.com



JANICKI INDUSTRIES

Janicki Industries

Janicki Industries is a privately owned, full-service engineering and manufacturing company with facilities in Washington and Utah. Janicki specializes in manufacturing wind energy tooling, made of composite materials. Janicki is capable of large-scale projects, utilizing high-precision five-axis mills, curing ovens, autoclave, and large annealing oven. They have extensive experience using many composite systems, such as: 160°F (71°C) machined syntactic putty; 250°F (121°C) carbon/fiberglass hybrid molds; 350°F (177°C) carbon molds; and 350°F (177°C) invar and steel molds. This 100% in-house capability for the total tooling and parts solution enables a one-stop shop for customers.

www.janicki.com



McCann Equipment, Ltd.

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

www.torquetools.com



Rad Torque Systems

The B-RAD Select battery series torque wrenches comes with two simple buttons to increase or decrease the value by 10ft. lbs. At the four-digit display, the set torque value is displayed. The B-RAD select remembers the last set torque value even after the battery has been removed. The B-RAD is suitable for pre-torque and service jobs where electricity or compressed air are not available. Torque ranges up to 3,000ft. lbs, equipped with the latest Lithium-ion Standard.

www.radtorque.com



Snap-on Industrial

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

www.snapon.com/industrial



Stahlwille Tools, LLC

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

www.stahlwille-americas.com



Tech Products, Inc.

Tech Products, Inc. is a global source for quality identification products for the renewable energy industry including, cable tags, tower (aerial) markers, and signs. Their products range from adhesive transformer labels to long lasting substation signs following all of the latest ANSI, OSHA, and NESC standards.

www.techproducts.com

Tower Foundations



E-Chem, LLC

E-Chem, LLC specializes in the design, manufacturing, marketing, and supply of epoxy polymer resin products, offering project specific solutions for a variety of industries. E-Chem's epoxy grouting products are designed for high-stress applications subject to intense dynamic and static loading (up to 21,000 psi), making them suitable for supporting the extreme loads placed on wind turbine towers. In addition, a high resistance to impact and vibration makes this 100% solids material a solution for safely transferring loads from the tower to the foundation, preventing damage that could limit the life and performance of the structure.

www.e-chem.net

Transportation | Logistics



Anderson Trucking Services (ATS)

ATS is a worldwide transportation and project management resource and a manager of the logistical details of multifaceted and often multimodal energy projects. ATS also specializes in the physical transport of the oversized and over-dimensional components that come with them. Having safely moved more than 200,000 wind components since 2003, ATS currently provides transportation for approximately one-third of North America's wind projects annually. With nearly 65 years of experience in the transportation industry, ATS is a third generation family-owned company headquartered in St. Cloud, Minnesota.

www.atsinc.com



C.H. Robinson Project Logistics

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

www.chrprojectlogistics.com

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MADE IN GERMANY!

WWW.HEICO-GROUP.COM





CN

CN offers rail and transload services for dimensional loads and heavy equipment, supporting industries such as the wind industry, oil and gas, power generation, construction, and mining. Their network runs across North America from West to East, South from the Gulf coast into northern regions of Canada, and with direct access to strategic ports in the Great Lakes. They extend their reach by working with connecting carriers, partner shortlines, ports, and other parties to develop efficient routes, providing solutions for loading, offloading and marshalling their customers' freight.

www.cn.ca



Doleco USA, Inc.

Doleco USA provides a complete line of load securement and lifting slings and equipment for the wind industry. They are dedicated to providing a wide array of products including wire rope assemblies, web and chain slings, as well as all types of load securement. Doleco USA can also provide engineered solutions to any lifting and securement application needs.

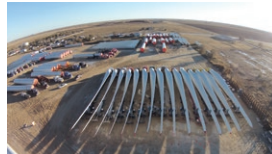
www.doleco-usa.com



DRIVING FORCE Vehicle Rentals, Sales, & Leasing

DRIVING FORCE rents, leases, and sells cars, light- and medium-duty trucks, vans, SUVs, cube vans, service bodies, and more to customers ranging from single truck landscaping companies to major municipalities and corporations. Equipment provided can include radios and buggy whips, tool boxes and hitches, fire extinguishers, and first aid. They can decal vehicles, deliver to site, and shift rental periods on short notice. They also offer used vehicle leasing, a selection of Certified Used vehicles, and fleet management services.

www.drivingforce.ca



Logisticus Projects Group

Logisticus Group is a supply chain partner specializing in project management, logistics, and fully-customized turnkey solutions for over-dimensional cargo, highly-complex projects, and operations. A wide range of solutions; off and on site civil engineering, route and feasibility assessments, standard and industrial warehousing, inventory management and GPS systems, lay-downs, staffing, and more. All LG service offerings are supported by Logisticus' proprietary advanced technology solutions, developed and 100% customized for each project.

www.logisticusgroup.com



Metro Ports

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www.metroports.com



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www.millertransfer.com



Port Milwaukee

Port Milwaukee handles a variety of breakbulk and non-containerized cargo, including wind turbine components, such as towers, nacelles, blades, and generators. Port Milwaukee's general cargo piers are paved with concrete and asphalt with connections to both Union Pacific (UP) and Canadian Pacific (CP) railways. Port Milwaukee's total general cargo capacity exceeds 20 acres (8.1 hectares); the Port can offer additional backup storage as requested. Federal Marine Terminals (FMT) is the Port's general cargo stevedore.

www.portmilwaukee.com



Port of Corpus Christi

Port of Corpus Christi, situated on the Texas Gulf Coast and located just 1 mile from Highway 37 and U.S. Highway 181, has 6 laydown yards, all highway accessible and most with rail capability, suitable for heavy lift cargo such as wind turbine components. The port provides a 47' deep ship channel (currently dredging to 54'); dockside rail; three class 1 rail carriers; an on-campus short line railroad; a knowledgeable labor force; heavy lift capabilities; Foreign Trade Zone #122, and open, covered, and dockside storages. The Port's Nueces River Rail Yard features 8 tracks each 8500' long. All of this provided with safety, security, and environmental management operations.

www.portofcc.com



Port of Longview

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

www.portoflongview.com



Port of Olympia

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www.portofstockton.com



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www.rainwise.com



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www.remtechinc.com



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Fountain of Youth

Secrets of active 24-year-old lead-acid batteries

by John Connell

WHEN IT COMES TO EXTENDING BATTERY LIFE,

some top installers do know more – and when they share their secrets, everyone benefits.

For end-users like off-grid homeowners, the benefits are obvious. For installers, competitive markets make it increasingly important to add battery life optimization to their knowledge base, as well. This benefits clients, builds trust, and increases referrals – a win for everyone.

One energy expert has managed to power his off-grid ranch with 24-year-old lead-acid batteries. He rescued them from a non-air-conditioned barn after 17.5 years of service and 18 months of neglect. After rehabilitation, these batteries still reach float (100 percent charge) at sunset, and 40-50 percent Depth of Discharge (DoD) overnight (running air-conditioning during an unusually hot California summer)!

Keep reading to learn how top installers get longer battery life, including:

- Strategies to reduce energy requirements
- How to select the right batteries for your system
- Confirming sizing
- Uncommon installation “tricks” of top installers
- Proven battery storage strategies
- Maintenance made easy

Step 1: Never start with batteries

Renewable energy clients are surprised by this. But if you’re sizing an off-grid or grid-tied backup system, the first thing to do is reduce your electrical requirements. Why? Every Watt-hour of usage you can safely reduce has a ripple effect on savings—it allows you to select smaller-sized solar panels, wind turbines, inverters, and batteries, which ensures greater safety margins for energy storage.

Some of the easiest ways to reduce electrical usage include replacing energy-guzzling appliances with Energy Star models, insulating the building envelope, removing vampire loads, and improving HVAC efficiency.

Step 2: Choose the right batteries for longer life

Lead-acid batteries are best suited to most renewable energy applications. They provide the highest ROI and recyclability (99 percent recyclable, according to the US EPA). In addition, lead-acid batteries have a track record of safety, proof, and innovations for more than 100 years.

What to look for:

- High-quality lead-acid batteries engineered specifically for deep discharge in RE systems
- Premium materials including heavy, gravity-cast plates and more lead (for more chemical reactions)
- Automated manufacturing, including robotic Cast-On-Strap (COS) welding, computerized pasting and curing, and aerospace vision systems

(To learn more about flooded and AGM batteries and compare chemistries, read “Find the Battery You Need” -- November/December 2017.)¹

Step 3: Confirm battery banks are appropriately sized

If you’re installing a system you didn’t design, make sure to review sizing calculations to protect yourself and the end-user.

Many problems are caused by inappropriate Depth of Discharge (DoD) calculations. This is often a sales ploy to make an “apples-to-apples” comparison between battery chemistries with drastically different costs per kWh. Regardless of the technology, however, batteries that discharge too deeply will compromise lifespan and reliability of electricity. Worse, inadequate power reserves could leave off-grid users without power.

In order to protect against damage from extreme discharge, and provide a safety margin for continuous operation, plan for 2X true amp-hours and 50 percent DoD.

Step 4: Try top installation tactics

Use stainless steel for bolts, washers, and nuts; it’s extremely durable, affordable, and corrosion-resistant. (Type 316 Stainless Steel fasteners are best.)

Install fuses as needed to shield batteries and other devices from short-circuit damage, overheating, and starting fires.

Use a non-hardening sealant to coat terminals, wire lugs, nuts, and bolts. Battery protector and sealer minimize corrosion, last a long time, and are easy to clean. Be sure to cover exposed wires at terminal lugs using rubber tape or other approved linings.

Consider a battery management system (BMS) to improve usable capacity and protect against temperature-related damage. Useful features include total and per-cell voltage, DoD, and temperature monitoring.

Search for a “wire gauge calculator” to identify your ideal cable size: Undersized cables can cause difficult-to-diagnose system failure – even generate heat and create fires. Specify no more than a 3 percent voltage drop.

For larger systems, consider microgrids for scalability, improved energy reliability, and enhanced ROI. (See “Central Asia’s Largest Off-grid Solar Power System: Bringing electricity & hope to Afghanistan” – November/December 2014.)





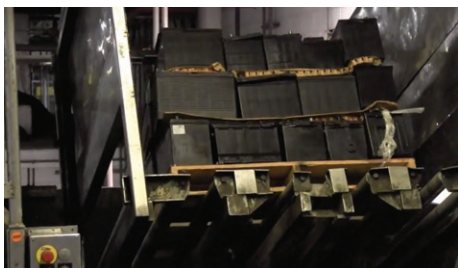
Step 5: Always store batteries in a cool, dry environment

Battery life is longest at moderate temperatures (77°F is optimal). Heat and cold weather cripple battery performance and lifespan—and batteries stored inside makeshift refrigerators and insulated coolers are subjected to even greater temperature degradation.

The solution? Protect batteries from the elements. Consider installing batteries off the floor in an enclosed, well-ventilated structure with adequate insulation, and a stable, moderate temperature. This extends cycle life because it protects against temperature-related damage.

Strong installation locations include inside the home/building or in a well-ventilated shed or garage. (See “Living the Dream of Net-Zero Energy & Storage” - March/April 2015 for an all-in-one enclosure strategy.)

Never install batteries near breakers, electrical outlets, or spark-causing devices such as hot water heaters. Lock your battery box, and keep a dry chemical fire extinguisher nearby. Consult the National Electrical Code, Article 480.9(A) to refresh yourself on ventilation standards.



Step 6: Maintenance made easy

Poor maintenance costs a fortune: Problems go unnoticed, batteries die early, clients blame installers or components, referrals go down, and unnecessary house calls go up.

Create an easy-to-follow system that helps clients build a maintenance habit to maximize battery life:

- First, demonstrate the BENEFITS, such as longer battery life, greater reliability, and lower costs year-round.
- Make it EASY. Provide maintenance schedule charts. And recommend the right tools make the job fast, easy, and frustration-free.
- Make it AUTOMATIC like brushing teeth. Show them how to program maintenance into their calendar.

If you're attentive and fortunate enough to have lead-acid batteries that last multiple decades, take note: With increasing electrical demands like water pumping and added solar, those older batteries will need more water (as often as every ten days).

You may not get 24 years out of your lead-acid batteries, but these strategies and tactics are guaranteed to boost your batteries' lifespan – and free up your time and money.

John Connell is the Vice President of Crown Battery's SLI Products Group. Crown Battery manufactures all its advanced technology lead-acid batteries at its ISO-9001:2015-certified plant in Fremont, Ohio. They're 99% recyclable – more recyclable than an aluminum can.

Crown Battery /// www.crownbattery.com

¹ <http://www.nacleanenergy.com/articles/29136/find-the-battery-you-need>

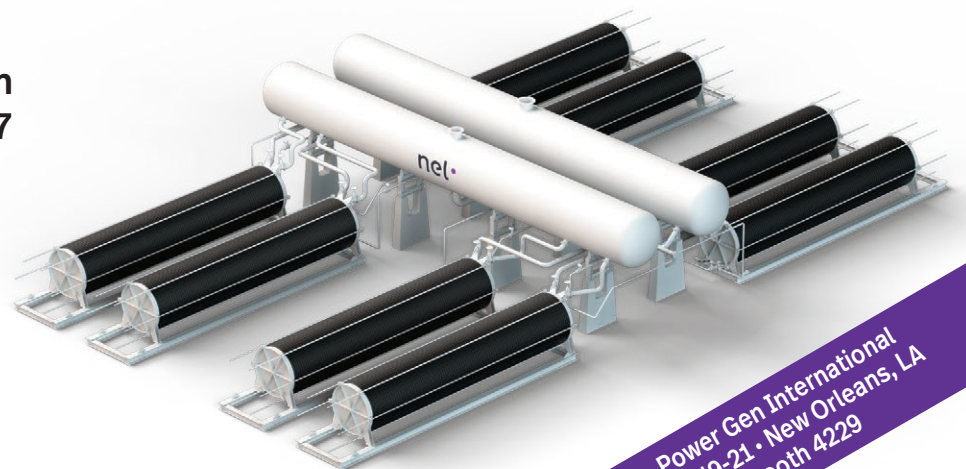


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Cleaner EV Charging Can Reduce Curtailment

by Christy Lewis and Peter Bronski



The first half of 2019 was record-setting for renewable energy, though not necessarily for good reasons: in May, California curtailed a record-high¹ 223,000 MWh of solar and wind power. Across the first five months of the year, solar and wind curtailments in the Golden State were more than twice what they were during the same period one year earlier.

Such curtailments—essentially throwing away perfectly good clean energy because there isn't a way for grid demand to absorb it—usually happen for two primary reasons²: 1) system-wide renewable oversupply or 2) grid congestion constraints that can't funnel renewably-generated electrons to where they're needed.

New analysis shows how smarter electric vehicle charging can help power grids absorb more renewable energy—thus reducing curtailment—all with the added bonus of making EV driving even cleaner.

Flexibility in EV charging can equate to reduced emissions

It's relatively common knowledge that EVs are cleaner than internal combustion engine (ICE) autos, even when charged on so-called "dirty" grids heavy in fossil-fueled power. But emissions-optimized EV charging makes going electric even more beneficial for the planet, slashing transportation emissions above and beyond the switch from gasoline- and diesel-burning ICE cars to EVs.

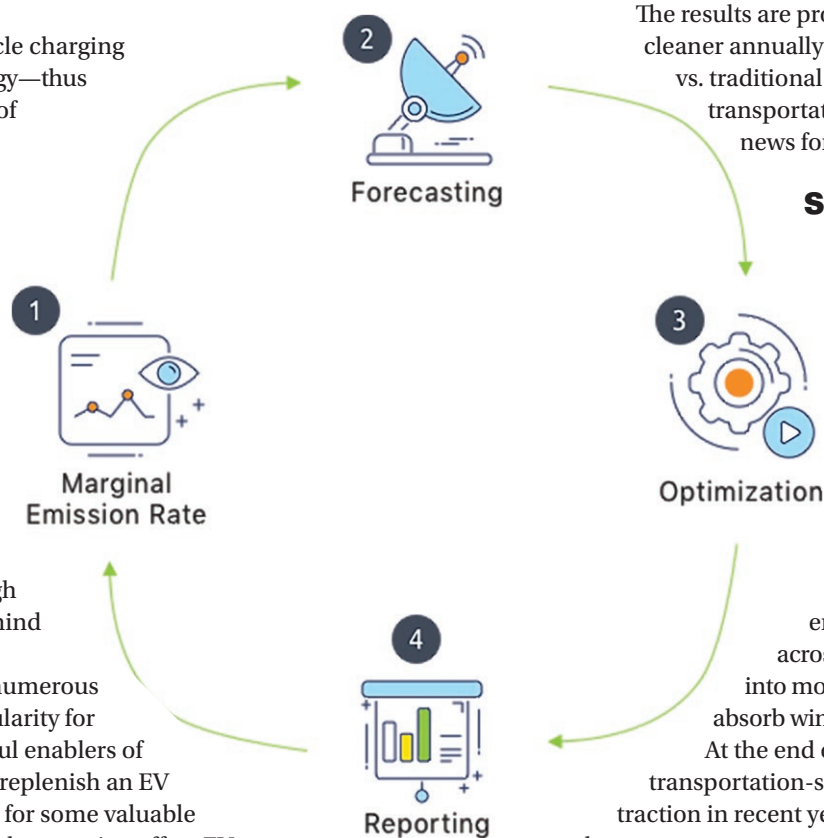
The idea is wonderfully simple in theory, though it takes some sophisticated software wizardry behind the scenes to implement in practice.

Level 2 EV chargers are the most popular and numerous types of public EV chargers, and are gaining popularity for residential use. They're also proving to be powerful enablers of charging-related emissions reductions. They can replenish an EV battery faster than Level 1 chargers, which allows for some valuable flexibility. Their faster charging capability means that topping off an EV battery usually doesn't require the full charging time window, especially in workplace daytime and at-home overnight charging scenarios.

That difference - between the time needed to charge, and the overall time the EV remains plugged in to the grid - offers an opportunity to optimize. The majority of grids in the U.S. have a mixture of both renewable and fossil-fueled power, which means that they're "cleaner" at some moments of the day than others. For example, charging your EV 15 minutes earlier than you normally do (at 9:00 am instead of 9:15 am) can be the difference between consuming wind energy or electricity from a coal plant. New technology is making it possible to automatically sync charging with those cleaner moments, and pause charging at times when you would be hooking up to dirtier energy. All of this can be achieved without negatively impacting the end result: a fully-charged battery ready to go when you need it.

To see just how much cleaner EVs could be with smart emissions-optimized charging vs. traditional "dumb" charging, we looked at four grids across North America, a representative spectrum of fossil-intensive, renewables-rich, and blended generation mixes.

The results are profound: we found that EVs can be up to 18 percent cleaner annually, and up to 90 percent cleaner on individual days vs. traditional "dumb" charging. That's good news for slashing transportation-related carbon emissions. But it's also good news for taking a bite out of renewable energy curtailment.



Smart EV charging provides a simple way to avoiding renewable curtailment

As legacy fossil-fueled grids add more and more renewables, we're seeing the emissions rates of grids become ever more variable. That variability is continuous, as the real-time mix from moment to moment changes and the marginal generator that responds to fluctuations in demand changes.

Although grids with the most variability provided the greatest opportunity for reducing emissions, smarter EV charging can make a difference across the country. By "pulling" more EV charging demand into moments of renewable energy supply, EVs can help grids absorb wind and solar power that might otherwise be wasted.

At the end of the day, "emissions-optimized EV charging" is a transportation-specific name for a term that has gained increasing traction in recent years: demand flexibility. And it's a concept that will become even more powerful as more devices electrify. In a future world in which we have a renewables-rich and variable grid supply, and a robust fleet of electric vehicle demand, flexibility and emissions-optimized charging will take on an important role at the dynamic interface between them.

Christy Lewis is an analyst and Peter Bronski is a cleantech consultant for WattTime, a nonprofit that offers technology solutions to let anyone achieve emissions reduction. The above-referenced report can be found here³.

WattTime /// www.watttime.org

¹ <https://www.publicpower.org/periodical/article/calif-sets-record-solar-renewable-curtailments>

² <https://blog.ucsusa.org/mark-specht/renewable-energy-curtailment-101>

³ <https://www.watttime.org/news/report-201909-emissions-optimized-electric-vehicle-charging/>



All-in-one ESS

ABB introduced its collaboration on the new 10/4 Residential Storage System powered by Humless' 48V Universal Energy Management (UEM) and ABB's UNO-DM-TL-PLUS-Q line of residential inverters. This all-in-one ESS intelligently manages the flow of electricity from any source for any use. It integrates with any existing residential grid-tied solar system and works with any manufacturer's panels. Humless Universal enables simultaneous AC/DC Coupling and is very expandable. The advanced intelligent energy controls in the Humless Universal paired with the ABB UNO-DM-TL-PLUS-Q line of digitally enhanced inverters give the customer options to match grid needs/requirements; for example, load shaving, time of use, generator auto start, and smart outputs. This provides intelligent energy management for customers' power needs, lowers electrical costs dramatically and extends battery life.

ABB /// www.abb.com







Virtual battery software to reduce demand charges and improve ROI

Extensible Energy has released DemandEx, an inexpensive "virtual battery" for reducing demand charges and increasing ROI for commercial solar projects. The SaaS solution, offered through Extensible Energy's solar installation partners, is easily integrated into new or existing commercial solar systems and can be used to decrease the cost and size of energy storage. DemandEx uses proprietary AI algorithms to analyze real-time solar production, weather data, utility rates, and building usage patterns. It then dynamically controls the building's flexible loads for optimized demand charge and Time-Of-Use (TOU) savings. After a one-day installation, the software automatically anticipates and prevents peak demand spikes, delivering 30% savings on the demand charge portion of the utility bill. DemandEx works best with existing or new solar installations in non-residential buildings, such as offices, schools, universities, churches, retail, and municipal buildings. Building owners can achieve higher solar ROI and a reduced payback period without the extra expense, permitting, and fire mitigation requirements of energy storage solutions. When DemandEx is installed with new PV systems, the cost can also qualify for the 30% solar investment tax credit, providing further savings. Solar plus DemandEx can achieve demand charge savings with or without batteries. Battery storage can be added for backup power and resiliency.

Extensible Energy

/// www.extensibleenergy.com

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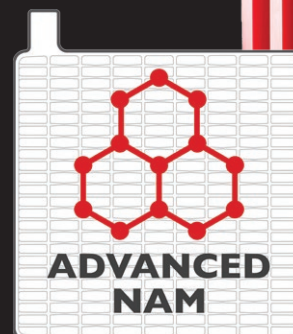


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How Batteries Will Drive RE Peaker Plants

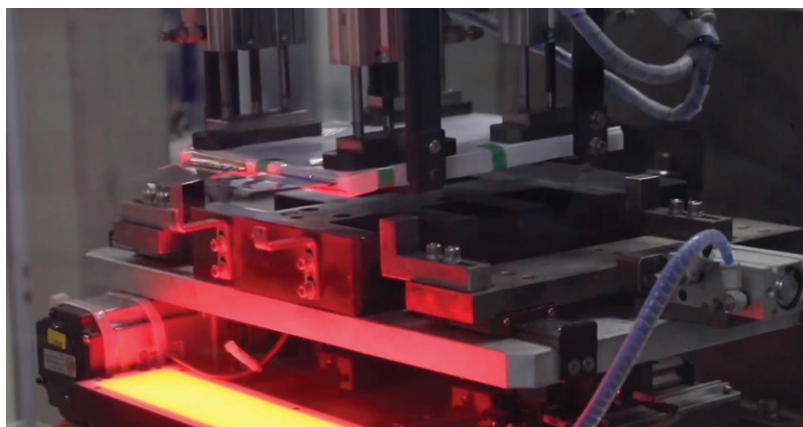
by Lindsay Gorrill

MANY PEOPLE ARE UNAWARE OF THE MASSIVE

fluctuations in power grids all over the country. There is a spike in power demand when people around a city wake up each morning - we begin to turn on lights, TVs, showers, and many more household electrical items. The spike is even greater in the evenings, when everyone gets off work, comes home, and proceeds to cook dinner, wash clothes, and do all the other things we do when we get home from a long day.

Enter the fossil fuel peaker plant. Designed to ramp up electricity production during periods when normal production isn't sufficient, peaker plants are used by utilities as a means of covering the gap between the grid needs and the available electricity supply. Peaker plants have long been the reliable backstop across the country, when the grid's baseload capacity (or minimum energy demand) is exceeded. Peak energy use is not always predictable or certain, and utilities need to constantly be prepared for increased and short-term energy strains on the grid. Battery Energy Storage Systems can act as both a replacement for fossil fuel peaker plants, as well as standalone energy storage systems charged by excess energy from grid resources like wind, solar, or traditional power generation facilities.

With the advent of new energy storage solutions and advancement of battery technology, the need for traditional fossil fuel peaker plants is rapidly diminishing. This has not gone unnoticed by utilities and legislators. Renewable energy sources, including wind and solar + battery storage technologies, are now able to bring a higher degree of certainty and reliability to peaker plants, ensuring that clean energy can and will be available during peak usage times.



The challenge with renewables and peaker plants

Peaker plants are unique in that they do not have to continuously generate energy to meet the grid's everyday demand. However, they do need to be constantly available for when baseload capacity is met and demand spikes. This can occur as frequently as every evening when people return home, or as sporadically as when a heat wave occurs and everyone blasts their air conditioners for days at a time.

Peaker plants have traditionally relied upon gas, diesel, or other fossil fuels, as they've granted utilities far more control and certainty over the energy generation process. For example, when a utility needs to generate additional energy to power the grid, they simply burn more natural gas to meet that demand.

Compared to gas resources, renewable energy sources like wind and solar are unpredictable; they lack the ability to deliver continuous, reliable power during peak demands. This unreliability has made it difficult for utilities to accept and incorporate renewable energy into their integrated resource planning efforts. Fortunately, new advancements in energy storage are rapidly breaking down those barriers.

Energy storage solutions enhance renewable reliability

Battery storage is becoming increasingly competitive with coal and gas energy generation, from both a cost and reliability standpoint. Since 2012, the cost of electricity from batteries has decreased 76 percent; the cost for standalone systems now averages about \$209 per kilowatt hour (kWh). The cost of utilizing a state-of-the-art energy storage system, with the additional benefit of zero emissions, is extremely competitive compared to running a fossil fuel peaker plant. Despite the infrequent and short runtimes, fossil fuel peaker plants are incredibly expensive to run and maintain, costing even more than baseload power plants. For example, residents in New York City are spending over \$268 million annually¹ to help sustain older plants, many of which only run a few hours each year. High costs, coupled with the option to utilize cleaner energy within the grid, are pushing utilities to opt for large scale solar + storage and wind + storage for peak demands.

In addition to cost benefits, today's lithium-ion energy storage solutions also allow utilities to continuously collect and store excess energy - be it from wind and solar, or traditional methods like hydro power, gas, and coal. This energy can then be used during the intermittent peak times.

States crack down on fossil fuel peaker plants

Utilities aren't the only ones that have taken notice of the growing potential of solar/wind + storage applications. State legislators are also looking to drive use of renewables as a replacement to fossil fuel peaker plants. Over the last couple of years, states including Minnesota, California, New York, and Texas have started to take action to eliminate fossil fuel peaker plants.

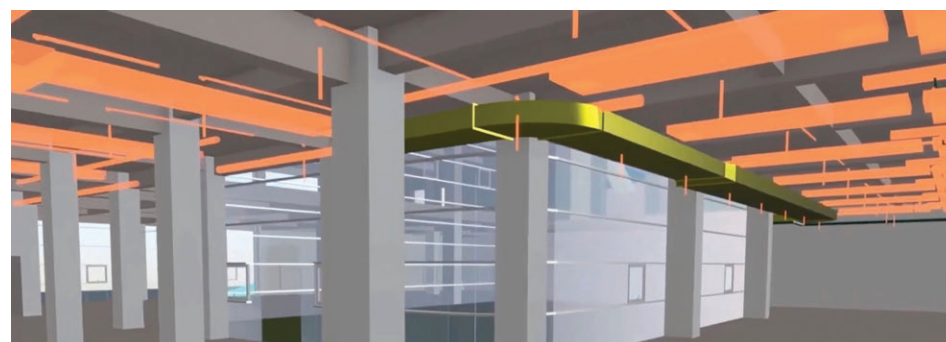
In May 2019, Minnesota passed a law that requires utilities to either include energy storage as part of their integrated resource plans, or prove that energy storage cannot meet customer demand in a more effective way. This decision stems from a study by the Energy Transition Lab, which found that solar + storage applications are "becoming increasingly cost competitive" to fossil fuel peaker plants. By 2023, storage costs could be less than building new fossil fuel peaker plants.

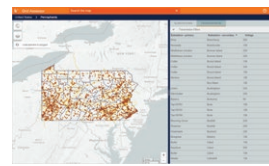
In California and New York, state-wide initiatives to reduce greenhouse gas emissions continue to lead utilities to incorporate more renewable energy sources. California's largest utility plans to replace three Northern California natural gas peaker plants with battery storage. In Southern California, the main utility opted to build a battery system for excess solar and wind storage, instead of a new fossil fuel peaker plant.

Whether utilities embrace it due to cost benefits or mandates to reduce emissions and incorporate renewables, large scale energy storage will eventually replace fossil fuel peaker plants. New energy storage technologies have drastically cut costs for implementation, and increased the reliability of these solutions, even with unpredictable renewable sources.

Just as fossil fuel peaker plants have historically smoothed the energy production gap, battery storage will be the new paradigm connecting intermittent power production and protecting from electricity shortfalls from wind, solar, and traditional generation resources.

We should not only have the confidence that when we flip a light switch, the light will come on, but that we can literally breathe easier knowing the power isn't coming at the expense of that air we're breathing.





Inverter for solar and energy storage plants

Power Electronics has presented the HEM HYBRID, its latest solution for largescale photovoltaic plants, a solar inverter that allows interconnection with battery-based storage systems through the DC / DC integrated in the same enclosure. The HEM HYBRID integrates up to six DC / DC converters of 500kW each, without the need for additional connections. In addition, its structure incorporates medium voltage equipment, transformer, and protection cell, as well as offering the advantages of a central inverter and the modularity of a string architecture. The HEM HYBRID obtains the maximum benefit of photovoltaic generation by charging the battery system when the solar inverter is limiting the output power due to a high DC / AC ratio. This energy is stored and can be exported to the electricity grid when the price per KWh is higher. Its modular structure, based on easily replaceable power stages, (Field Replaceable Units) allows users to maximize its availability and performance. On the other hand, the use of this inverter in solar plants represents a considerable saving in CapEx and simplifies the design of the installation, achieving a low LCOE. Maintenance is also easy thanks to the front access that allows the modules to be replaced in the field, reducing the MTTR and obtaining a low OpEx.

Power Electronics /// www.power-electronics.com

Search and filter ideal project locations for grid-connected solar and storage

Kevala Analytics' Grid Assessor solution offer new features including, updated state distribution feeder coverage for over 20 states, improved parcel selection tools, better parcel management and download capabilities with the ability to export selected parcel information as a CSV, KML (Google Earth) or GEO JSON (GIS) file and parcel section in Data Panel tool for parcel export allowing click-through for only those parcels users are interested in, and value enhancing filtering and maps including wetland percentage filter for parcels based on data from the National Wetland Inventory, topographic lines, and insolation and Superfund sites.

Kevala Analytics


/// www.kevalaanalytics.com




Lindsay Gorrill is CEO of KORE Power, a North American company that produces and installs high density, high voltage battery energy storage systems.

KORE Power /// korepower.com


¹ <https://www.strategen.com/reports-1/09-20-2017/new-york-best>




RHOMBUS EV CHARGERS & POWER CONTROL SYSTEMS (PCS)




60kW PCS



125kW PCS




500kW PCS



- Smart Grid Connected (UL 1741 SA)
- Bi-Directional - V2G Compatible
- Open Source Communication Protocol

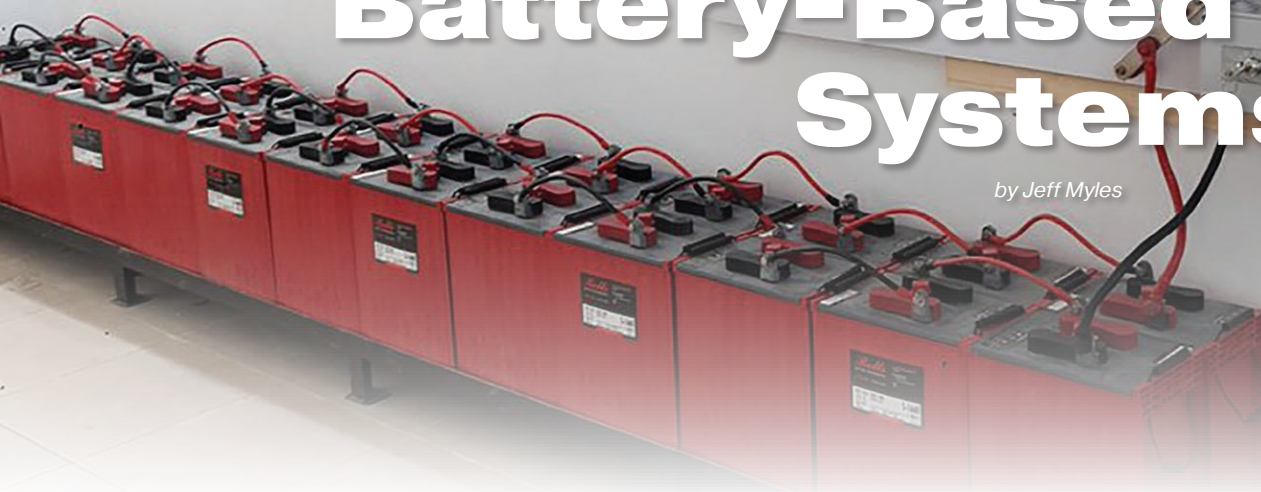
- Scalable / Stackable for High Density
- Standards Based OCPP
- Telematics w / Dynamic Power Control

- Multiple Configurations / Connections
- Customizable for Specific Requirements
- Robust - Continuous Industrial Operation



Fall Maintenance for Battery-Based Off-Grid Systems

by Jeff Myles



For several decades, battery-based PV systems have provided reliable and affordable alternative energy storage solutions for residential and commercial use - in remote locations as well as developing countries. Exposure, and the incentive of lowering or eliminating rising utility costs, has driven the popularity of these systems for homeowners worldwide. Now, many year-round and seasonal property owners install battery-based renewable energy solutions.

Renewable Energy is now one of the fastest growing industries in Canada and the United States, with thousands of new jobs created annually in manufacturing and distribution of system components, as well as PV installation. Access to experienced, reputable system installers and affordable components has made the decision easier for homeowners seeking a long-term solution to save on utility costs by living an off-grid lifestyle while cutting down on their environmental impact.

Deep cycle lead-acid batteries continue to be the most affordable option for residential energy storage. When properly sized, charged, and maintained, traditional flooded deep-cycle batteries offer the best value for homeowners. Upfront cost and product life span are two main reasons a flooded lead-acid deep cycle battery may be chosen over other technologies. Additionally, lead-acid batteries are almost fully recyclable when they've reached end of life and are ready for replacement. Deep cycle lead-acid batteries are the most recycled consumer product in the world, boasting a 99.3 percent recycle rate in North America.

Battery-based PV systems must be properly sized to meet the specific requirements of the home; energy usage, climate, and weather all play a factor in operating efficiency.

All systems, whether traditional flooded or sealed AGM deep cycle batteries, require ongoing maintenance and care. System adjustments may be necessary as seasons change. Ensuring that proper charge time and voltages are used - as well as general maintenance such as cleaning and watering (flooded models) - is necessary to maintain the life of your investment. These steps are generally carried out by a professional PV Installer as part of an annual maintenance service, but may also be performed by the homeowner.

Testing specific gravity with a hydrometer or refractometer is the most accurate method to confirm state of charge and health of flooded deep cycle lead-acid batteries. Perform these tests regularly to identify and address charge imbalance, sulfation buildup, and capacity loss.



Fall Checklist for Full-Time & Seasonal Off-Grid Systems:

- Inspect all batteries for leaks or damage, including swollen or cracked cases, damaged terminals, and/or cable connections.
- Properly torque all terminal connections to the manufacturer's specifications. Connections often loosen over time as the batteries heat and cool during charging. Loose terminal connections increase the change of spark or arcing, which is a potential fire hazard.
- Disconnect, clean (remove dirt and corrosion), grease, and re-torque each terminal connection 1-2 times annually.
- Test individual battery voltage.
- Add distilled water to cells (flooded) as necessary.
- Test specific gravity in each cell (flooded models) while resting at Float voltage to confirm charge balance.
- Ensure the battery temperature sensor is properly mounted to allow correct charge voltage adjustments
- Follow the manufacturer's recommended charging parameters to adjust charge voltage and times, in order to compensate for shortened daylight hours or changes in system usage during off-season.
- Perform a controlled overcharge (corrective equalization) to help balance charge across the battery bank, prevent prolonged sulfation build-up, and lessen any capacity loss.
- Seasonal Properties:
 - Fully charge and disconnect the battery bank from the system while not in use. Deep cycle batteries will naturally self-discharge, and should be recharged regularly (every 90 days or less) to prevent heavy discharge and/or freezing in cold temperatures. Rate of self-discharge will depend on ambient temperatures; *or*
 - Maintenance the battery bank on Float charge, disconnecting all loads, to hold the battery bank at full charge while not in use. To prevent heavy discharge, the charge source (ex: solar) must be kept clear, operational, and unhindered by snow or ice buildup.



Slim form factor battery

The Darfon B09ULF is a battery solution for those who need quite a bit of energy storage but have limited space. The B09ULF is a 9.6kWh battery with an enclosure design which allows it to be wall-mounted or floor-standing, and is IP55/NEMA 4 rated. The enclosure installs empty, keeping the installation weight minimal and making it easy for one person to install. All the wiring is installed with quick disconnects to speed up the installation process. If more reserved power is needed, the B09ULF can be stacked for 19.2kWh. Since the B09ULF uses safe LiFePO4 chemistry, it has a long life span. The B09ULF are available with black or white doors through authorized distributors.

Darfon Electronics /// www.darfonsolar.com



Scalable, fire-safe commercial energy storage solution

Hawai'i-based Blue Planet Energy has expanded its Blue Ion line of safe, scalable energy storage solutions with the introduction of Blue Ion LX for commercial and industrial (C&I) applications. The Blue Ion LX is built on the same fire-safe Lithium Ferrous Phosphate (LFP) technology as the Blue Ion 2.0, which provides lithium-ion safety and reliability. The new product uses a modular 64kWh dual-cabinet energy storage block that scales to system capacities of 2MWh+ for ease of integration in commercial storage markets, such as those in remote locations or areas with an unreliable grid demanding robust and high-quality systems. Blue Planet Energy provides services for Blue Ion LX including project design and sales support; component compatibility testing and assurance; system-level component configuration and integration; installation support; and O&M services. Backed by a 15-year performance warranty, Blue Ion LX delivers an 8,000 cycle lifespan at 100% depth of discharge.

Blue Planet Energy /// www.blueplanetenergy.com



In cooler climates, it should be noted that partially discharged deep cycle lead-acid batteries (flooded or sealed) may freeze in very cold temperatures. To prevent this, the batteries should be fully charged and disconnected from any loads, or remain connected to an active charge source to maintain a full resting float charge when not in use.

**caution: If the battery case appears swollen or cracked, do not attempt to charge the battery as this may be a sign of freezing or excessive overcharge. Never attempt to charge a frozen battery.*

It is important to follow the specific charge voltages, charge times, and care outlined for the chosen battery make and model. Refer to the battery manufacturer for installation, operating, and maintenance instructions, as well as warranty terms and conditions.

Jeff Myles is Marketing Manager at Rolls Battery Engineering. The exclusive manufacturer of Rolls batteries is the Surette Battery Company Ltd. Established in 1935, Surette produces a wide range of deep cycle batteries for use in Renewable Energy, Marine, Motive Power, and Railroad applications.

Rolls Battery Engineering

/// www.rollsbattery.com



Eco-friendly flywheel system

VYCON's VDC-XXT flywheel model is paired with three-phase uninterruptible power supplies (UPS), and brings DC power capacity using the kinetic energy of the high-speed flywheel for instantaneous and reliable power backup. The capability of operating at temperatures of up to 104°F (40°C) with a 20-year operational life results in substantial savings in cooling costs. Also, due to the small footprint, valuable real estate is freed up for more profitable data center and critical process equipment. The VDC product line offers the flexibility to select the power level and run time combination which meet specific application requirements. Upon a power failure, the VDC-XXT will supply seamless DC energy allowing the UPS to gracefully transfer to a facility's backup generators. For applications without an engine generator-set or for customers who still use batteries, the VDC-XXT can easily operate in parallel with batteries. In this configuration called "battery hardening," the VDC is the first line of defense against power disturbances – saving the batteries for prolonged power outages. By absorbing the power anomalies, the VDC systems significantly increase battery life by handling over 98% of the discharge cycles that shorten useful battery life. VYCON flywheels incorporate a host of advanced features that make the systems easy to use, maintain and monitor such as self-diagnostics, log files, adjustable voltage settings, RS-232/485 interface, alarm status contacts, soft-start pre-charge from the DC bus, and push-button shutdown. Available options include DC disconnect, remote monitoring, Modbus and SNMP communications, and real-time monitoring software. Tested and compatible with all major brands of three-phase UPS systems, VYCON's flywheel systems are capable of thousands of full charge and discharge cycles over the life of the system with no degradation in voltage, power, or storage.

VYCON /// www.vyconenergy.com



Single-phase solution for EV charging

Single Phase Power Solutions introduced the 1-to-3 Microgrid Power Source, a single-phase solution for Electric Vehicle (EV) Charging Stations. Suitable for remote areas without access to three-phase power, the 1-to-3 Power Source uses Written-Pole Technology to generate solid and reliable 3-phase, 480V input from existing single-phase infrastructure. This allows EV charging stations to be installed across a variety of rural locations where 3-phase power is unavailable or cost-prohibitive to install. A CSA 3R enclosure (outdoor rated, rain protected) allows these robust units to be placed in public-facing areas like rest areas, national and state parks, historical sites, tourist areas, and more. The efficient Written-Pole motor driving the 1-to-3 has a full load system efficiency greater than 88%, which can significantly reduce energy costs. Since it runs at unity power factor, there is no power factor penalty charge, which may generate additional savings for the operator. This unique technology allows weak single-phase utility lines to deliver strong three-phase power with excellent voltage regulation and precise 60 Hz frequency. The generator output voltage provides well-balanced three-phase power for quality-sensitive electronic controls like those used in EV rapid chargers. Built with rural applications in mind, the SPPS 1-to-3 rides through momentary power loss and can accommodate voltage fluctuation in single phase lines while delivering solid three-phase power. A compact footprint, utility-friendly design, and quiet operation are well suited for sensitive public spaces

Single Phase Power Solutions

/// www.sppowersolutions.com



**ENERGY STORAGE
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November 5th-7th, 2019
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www.esnaexpo.com

In 2018 less than 20GW of energy storage was deployed around the globe; by 2040, nearly 1000GW is predicted to be deployed. Experts predict that energy storage will grow to a point where it is equivalent to 7% of the total global installed power capacity, representing an estimated whopping \$620 billion investment opportunity for utility scale and behind-the-meter energy storage through 2040. North America is the world's leading energy storage market. Energy Storage North America (ESNA) is the largest conference and expo for grid-connected energy storage in North America.

show in print

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



Custom energy storage enclosures and cabinets

Maysteel designs and fabricates custom energy storage enclosures and cabinets. Their in-house engineers and manufacturing capabilities ensure these units are scalable to meet market demands and durable to protect internal technology from outdoor elements. They also help their customers reduce time to market by combining prototyping, their dedicated Innovation Center for new product development, and the industry expertise of their engineering team.

Maysteel

www.maysteel.com



Delivering tomorrow's energy transformation today

Rhombus Energy Solutions builds a complete line of charging solutions for medium and heavy duty EV fleets, including custom dispensers and multiple power conditioning systems (PCSs). Their charging solutions are fully bi-directional, and are vehicle-to-grid (V2G) ready. Their products support standards-based OCPP management, and are designed for high reliability and ease of maintenance. All systems are NEMA 3R rated and UL 2202/2231/1741SA rated.

Rhombus Energy Solutions

www.rhombusenergy.com



Expertise across the entire energy storage lifecycle

DNV GL discusses the latest findings from their 2019 Battery Performance Scorecard, which provides independent ranking and evaluation of battery vendors. Their experts can support their customers across the entire energy storage value chain—feasibility, testing, development, and engineering, construction, and operation. Through their dedicated labs and expertise around the world, they have created a combination of analytical and testing experience that gives them a unique advantage in finding energy storage solutions.

DNV GL

www.dnvgl.com/ESNA



Turnkey solar + energy storage system

Whether going off-grid, adding backup power or looking to avoid peak rates, OutBack's SystemEdge packages take the guesswork out of selecting the right combination of solar + energy storage. Each package is designed with value in mind for distributors, installers and end-users. Because batteries drop-ship from the manufacturer, SystemEdge simplifies inventory management for distributors. Installers get a single-brand, turnkey system that is a solution for streamlining and simplifying the sales and installation process. Each package includes a pre-wired FLEXpower Radian or SkyBox with either Lithium-Ion or EnergyCell batteries. Specific bundles are designed to meet the most common power scenarios for end-users. All SystemEdge packages are designed with OutBack's reliability in mind.

OutBack Power

www.outbackpower.com



Advanced pure lead carbon batteries

Leoch's new PLC+C180FT batteries have been specifically engineered to withstand the rigorous conditions of energy storage applications by combining Advanced Carbon with Pure Lead Technology for superior battery life and performance. Leoch's PLC+C180FT batteries offer exceptional partial-state-of-charge (PSOC) performance, 3000 cycles at 50% DoD and fast recharging - 90% SoC in 1 hr. These batteries are a solution for use in a variety of renewable energy storage applications.

Leoch Battery Corporation

www.leoch.us



Battery Energy Storage Systems

From the Leader in Safe and Reliable
Lithium Iron Phosphate Technology

Full Service: Consult - Design - Install - Maintain



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Battery rack-based charging in a centralized solution

Alencon Systems LLC's new approach to deploying the BOSS offers DC-coupled Solar + Storage projects as well as stand-alone grid scale storage projects the the granularity of battery rack charge and discharge with the convenience of a single, outdoor rated, pad mounted cabinet for ease of installation along with the flexibility of galvanic isolation. The standard outdoor, cabinet-based package is designed to hold four BOSS units and is rated at 320 – 350KW, all in a slender, easy to install package. Each BOSS unit in the cabinet can be easily replaced and installed in the field, allowing for easy O&M with no field serviceable critical parts. The BOSS's galvanic isolation offers a great deal of flexibility in deploying Solar + Storage. Each BOSS cabinet comes integrated with the Alencon Communication Environment, allowing for unprecedentedly powerful and secure communications and control with a battery energy storage system (BESS) and plant controllers.

Alencon Systems LLC
www.alenconsystems.com



Autonomous string inverter

The PowerBRiC is a 125kVA autonomous string inverter for energy storage that can operate as a standalone string inverter or be packaged into a "central string" configuration. The PowerBRiC has a wide DC operating range of 200 to 1500VDC, and an AC operating range from 380 to 690VAC, allowing for compatibility with most DC storage technologies and generation technologies at virtually any scale and configuration. A PowerBRiC based system can be right-sized in 125kVA blocks to more precisely deliver the optimal power-to-energy ratio for a specific application. One of the core advantages the PowerBRiC is the ability of the system to seamlessly continue running at a de-rated power level even if individual inverters go down to maximize uptime. The PowerBRiC is suitable for use in both behind-the-meter as well as front-of-meter applications including microgrids with ability to do seamless transfer from Grid Following to Grid Forming and back.

LS Energy Solutions
www.ls-es.com



High density, high voltage energy storage solutions

KORE Power is a developer of high density, high voltage energy storage solutions for utility, industrial, and mission-critical markets. Designed to lower energy storage installation and operation costs while optimizing performance, the 1500Vdc Mark 1 energy storage system includes their proprietary NMC cells with added safety features and innovative modules, fully integrated with the Mark 1 BMS. With support from manufacturing partner, Do-Fluoride Chemicals, KORE Power enhances the quality control and visibility across the entire supply chain. The Company serves the growing demand for applications such as energy storage peaker plants, solar + storage projects, microgrids, front-of and behind-the-meter storage, mining energy solutions, and military applications. The 1500Vdc Mark 1 energy storage system has 6 GWh/year production capacity and availability starting Q1 2020.

KORE Power
www.korepower.com



Turnkey storage inverter station

Ingeteam's turnkey storage inverter station is a UL 9540 and UL 1741 SA compliant MV solution. Comprising one, two, or three bidirectional battery central inverters for both grid-connected and stand-alone systems, it combines Ingeteam's overall expertise in the power conversion field (+54GW supplied worldwide), plant control technology, and monitoring solutions. With a flexible design, Ingeteam's storage inverter offers a high-power density in a single power block, providing different configurable operating modes. It is available in two different series, 1000Vdc and 1500Vdc (610kVA to 4,920kVA per block), and features advanced battery control technology which extends the maximum life of the storage system. Ingeteam also supplies the Power Plant Controller and SCADA systems, as well as commissioning and O&M services

Ingeteam
www.ingeteam.com



NEMA rated metal and poly enclosures

Continental Control Systems is now offering fully assembled WattNode Energy Meters in UL 508A NEMA metal and poly enclosures. Enclosures are available with a three-phase circuit breaker, a fuse block, or without circuit protection. Any model of the WattNode; the revenue-grade meter or standard accuracy meter comes preinstalled when ordered with the enclosure. WattNode communication protocols include BACnet, Modbus, and LonWorks, or as pulse outputs and are available fully assembled in one easy to install enclosure. Designed for indoor and outdoor installations, the enclosure complies to UL 508A Type 3R, 4, 12 and 13.

Continental Control Systems
www.ctlsys.com



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Like you, we are driven by the promise of a brighter tomorrow. Our solar + storage systems enable adaptive energy management capabilities for any residential or commercial user on and off the grid.

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Simplifying Distribution Automation in Substations and Pole-Tops

by Caroline Fricks Wood

Technological advances in “all-in-one” communication and automation processors allow distribution of information in many protocols, while performing sophisticated logic functions and alarm annunciation.

Utility substation automation schemes are typically complex, involving a variety of intelligent electronic devices (IEDs), microprocessor-based relays, meters, and monitoring devices. The information collected is then sent to communication processors or RTUs, before being passed on to proprietary HMI interfaces, SCADA Master Stations, Energy Management Systems (EMS), and/or enterprise networks.

Within this scheme, the component parts are often cobbled together by utility automation groups from a multitude of competitor options, with varying protocols (some proprietary), configuration options, wireless transmission bands, and interconnections.

Given that utilities may have hundreds of substations, and even more pole-tops, to monitor and control remotely, the complexity of distribution automation has traditionally been staggering. Fortunately, over the past two decades, substation automation has evolved.

“In the past, the design of the substation was a patchwork of many different devices,” says Russ Fanning, a P.E. with over a decade experience in the automation group of a large utility.

“Once you finally got the patchwork figured out, you could replicate that pattern, but when you went to the next substation and you wanted to bring in something new, you were starting from scratch again and trying to patch that new piece in.”

Today, Fanning says the focus is on stripping out as much of the complexity associated with substation automation as possible.

Recent technological advances have reduced the need for all that hardware. Instead, “all-in-one” communication and automation processor units interpret and distribute information in many protocols - while performing sophisticated logic functions and alarm annunciation - without the need for PLCs and racks of RTUs. These all-in-one devices even eliminate the need for security-risk PCs and proprietary HMI interfaces.

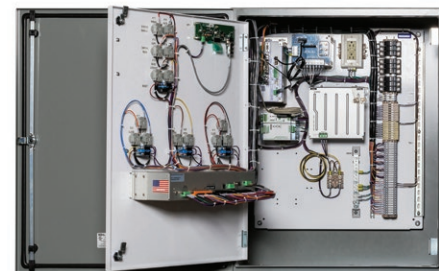
The communication and automation processor can connect to nearly any substation device in its native protocol, perform advanced math and logic, and securely present the source or calculated data to any number of clients in their preferred protocol.

For utilities concerned about support, looking to install equipment in new greenfield substations, or upgrading aging legacy technology, this is a welcome development.

Interpreting Communications and Protocols

Fanning started his career as protection technician. After getting his engineering degree, he worked in substation engineering as a protection engineer, then R&D engineer, then became a principal engineer in the substation automation group.

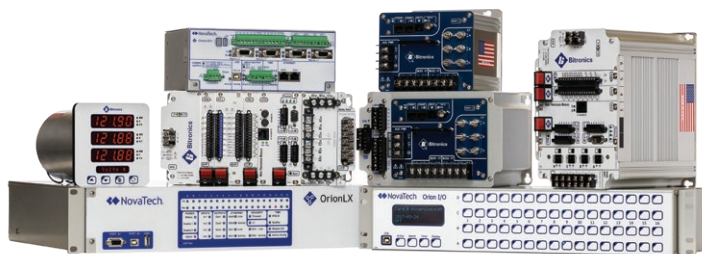
“In my last 5-6 years at the utility, I was responsible for distribution automation and substation integration, utilizing a system that interfaced with all the IEDs that were inside



the substation and at the pole-tops. I integrated pole-top device IEDs into the distribution automation systems when they were enabled with communication capabilities,” says Fanning.

Over the years, the utility has installed more than 500 distribution automation systems to improve the operations of both old and new substations. An algorithm designed to automate the switching of substation breakers and pole-top devices works to restore power and/or avoid power outages and equipment damage.

The challenge was having to work around ways to retrieve the data from the IEDs and other devices. Multiple protocols are often used for distribution automation, including proprietary protocols with custom communication links. “In a typical substation set-up at the time, there was often different software in each device, and I would have to manipulate the data just to be able to share it,” says Fanning. “One system needed a proprietary protocol and software just to communicate to the device.”





In most modern substations, microprocessor-based relays involve a proprietary protocol, so the communications processors must be able to retrieve real-time fault event data and records by speaking to the relays in their native protocol.

Another standard protocol used by SCADA Master Stations, RTUs, IEDs, and also for relays, is DNP (Distributed Network Protocol). The IEC 61850, an international standard defining communication protocols for IEDs, aims to promote interoperability of IEDs from different vendors. Older IEDs may still use Modbus or other legacy protocols.

According to Fanning, using a hub for all the data collection, both in collecting and interpreting, or taking action, allows the system to send that off to the control center to change setting, trip a breaker, or switch a feeder.

“There is a wealth of information that is being created inside newer IEDs, microprocessor-based relays, and meters that, until recently, has been left behind because it was too challenging to collect and distribute it,” adds Fanning. “Today, you can drill down into those IEDs from a remote location using a secure connection.”

One of the biggest incentives in automating the substations was reducing the driving time to remote sites – traveling between utility headquarters, home, and substations often meant a 2 to 3-hour drive.

The automated system gave Fanning access to the IEDs in a substation so he could get a clear picture of what was happening. This improved overall efficiency because he knew what had to be done before making the trip and, in some cases, could delegate the work to someone in the area.

Today’s open-source web-based SCADA and HMI solutions eliminate the need for a substation PC and its inherent software and cybersecurity concerns, at a fraction of the cost.

In this approach, engineers can build interactive screens accessible from standard web browsers. For example, a browser can be used to view data from connected IEDs and RTUs. The software comes with pre-configured pages for data

archiving, sequence of events recording, alarm annunciation, alarms, trending and communications diagnostics. Customized screens could easily be built for one-line diagrams, IED faceplates, and control screens.

As for HMIs, web-based systems provide a direct-to-touchscreen connection out of the box without a PC as an intermediary. Information can also be accessed by smartphone, which will bring up a substation and graphically show the faceplate of each device, complete with push buttons as if the technicians were physically there.

“The HMI is served up through webpages that are easily constructed with graphic software. It’s all integrated in one package, so building an HMI is so much simpler than it used to be,” says Fanning.

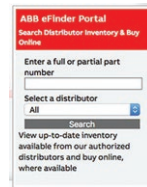
If there is a physical manifestation of the reduction in complexity, Fanning points to the substation. He worked in many substations that had racks or cabinets of devices with hundreds of wires and blinking lights.

“Today, substation layout is much cleaner. You can probably eliminate entire writing racks and cabinets – or at least make it much smaller – depending on how you are handling your I/Os to the IEDs,” says Fanning.

Caroline Fricks Wood is the Director, Corporate Communications for NovaTech, a supplier of automation and engineering solutions for electric utilities and process manufacturing industries for over 30 years.

NovaTech

/// www.novatechweb.com



Online portal to locate distributor stock

ABB now offers the new ABB eFinder portal on the Installation Products website (formerly Thomas & Betts) to enable end users to search for and purchase products from participating distributor inventory. The ABB eFinder portal simplifies the process of locating inventory from ABB’s selection of products used for connection and transmission of electrical power. Customers may now search online for ABB Installation Products and can purchase them from the distributor who has the products in stock. Once the product is located, the customer may buy it from the distributor by connecting directly to the distributor’s e-commerce page and placing the products in an online shopping cart for the final purchase transaction. The product portfolio from ABB Electrification business (Installation Products) is available on the portal. ABB eFinder provides instant access to industry-recognized brands like Ty-Rap, Blackburn, and T&B Liquidtight Systems. All products are available through the ABB distribution channel.

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Current affairs podcast series

Building on the DNV GL Talks Energy podcast, DNV GL has launched a new spin-off current affairs podcast series, Face the Facts. On a weekly basis, global energy experts will be sharing their insights on important news stories about the energy transition, responding to live news and events each week, and sharing their thoughts and opinions on the facts at the heart of the issue. The short format is designed to inform and inspire, and each episode will bring the latest information on renewable energy technologies to a senior global audience. Content will include the climate emergency, wind and solar, electric grids, electric vehicles, the power system, energy storage, management, financing, innovation, and digitalization.

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Insuring a Renewable Future

by Carl Angelo Dill

WITH CHANGE COMES RISK.

This is true of any business, and especially true as we watch the evolution of technologies, distribution methods, and business models in the renewables industry. Prototypical or unproven equipment, such as specialized blades, gearboxes, and new maintenance concepts, requires constant technical evaluation and greater underwriting expertise. At the same time, new financing and ownership structures and cost-saving measures impact operational efficiency, and may result in challenges to long-term loss performance. If these aren't perilous enough, climate change (associated with more intense windstorms, hailstorms, and flood events) tends to make renewable energy a risky business for insurers and investors alike.

Evolving risk scenarios

Loss trends vary widely by industry sub-segment. For wind, the causes of losses are different between onshore and offshore wind farms. With onshore risks, turbines can suffer from gearbox failures. These are sometimes associated with costly serial losses and fires, similar to those that recently caused insurance claims in the Euro millions, forcing insurers to review their portfolios. Natural perils are another major concern. Events like lightning strikes can cause blade delamination, while windstorms can result in turbine collapses.

Additional risk comes with the constant evolution of technology. Larger rotor diameters and tower heights can result in higher dynamic loads and complex vibrations, which increase rotor blade stress and impact the drive train. Along with aging equipment, pressure on maintenance budgets, and reduced subsidies, these exposures may affect loss patterns and long-term profitability.

Causes of offshore wind project losses include sub-sea cables, which account for 70-80 percent of those losses in terms of overall claims amount incurred. From losses

of entire cables during transport, to bending of cables during installation, and damage caused by anchors and vessels, sub-sea cable losses have driven multi million Euro claims in offshore wind. While technology risk is a driver in offshore wind, losses tend to be aggravated by complicated logistics such as vessel availability and the need to wait on fair weather conditions to venture out to make repairs. The cost ratio between on- and offshore claims can reach 1:10.

Solar photovoltaic (PV) panels are subject to a wide range of natural hazards such as windstorm, flood, hail damage, wildfires, and snow load, but are also susceptible to theft, as they are worth from \$100 to well over \$1,500 each. Other sources of large losses include transformer fires, which can result in business interruption (BI), and frost heave that can damage racking and modules.

Finally, there are storage and distribution risks like undersea interconnectors that bear the risks of sub-sea cables, and battery storage systems (BSS) exposed to thermal runaway (when Li-ion cells overheat and catch fire).

Insurance trends and challenges

As a growth market, the renewable energy insurance sector has attracted significant capital, leading to a soft market and many challenges for insurers. Premium has developed in line with installed capacity in the industry, which has grown at an annual rate of around 8 percent since 2010. However, recent loss trends in many segments of the renewable energy industry have raised concerns over deductible and rate adequacy. From large hurricane losses to PV plants in Puerto Rico during Hurricane Maria in 2017, to fires devastating onshore wind turbines and repeated theft claims, the renewable energy industry suffers from frequency as well as severity events. Apart from this, challenges include a mix of risk engineering, price modeling, digital distribution, and comprehensive product innovations – all above and beyond traditional insurance solutions.

Risk consulting and engineering are challenged by rapidly evolving technologies requiring close monitoring of different elements (e.g. new wind turbines being developed and upgraded in ever shorter cycles). Keeping up with international engineering standards, as well as certifications for equipment and projects, is also challenging.

Predictive maintenance and data analytics will drive innovative concepts for the evolving risks, eventually opening up opportunities for tailored insurance solutions.

Digital distribution continues to be influenced by the smaller size but higher numbers of risks. While utility-

scale PV and onshore wind plants can reach installed capacity in the gigawatt range, many installations are on the smaller end; these require more efficient handling. PV and onshore wind continue to be standardized through broker facilities and digital trading platforms. Larger, more complex segments like offshore wind, geothermal, or concentrated solar, require thorough, case-by-case underwriting.

Due to its complex financing and ownership structures, renewable energy demands a comprehensive insurance product offering. Traditional products are often bundled across project phases and lines of business; non-traditional products, such as protecting against a lack of wind or sun, aren't fully exploited by customers yet, and require further product integration. If implemented before financial closing, these can reduce financing costs and free-up capital. Other products cover upfront decommissioning costs for assets, and lower capital requirements at the start of a project.

Traditional insurance solutions cover renewable energy "all-risks" across multiple products and lines of business, as well as across project phases: planning liability for architects and engineers during the development phase; cargo all-risks and delay in start-up (DSU) during the transport phase; erection all-risk, advance loss of profit and project liability products during the construction phase; and operational all-risk, BI and public- and product-liability covers, as well as environmental liability, during the operational phase.

Recently, there has been an uptake in multiline demand (marine, liability, engineering) and the tendency to pool them into one policy, as well as an increased interest for alternative risk transfer solutions such as so-called "proxy revenue swaps." These are financial derivative contracts offered to wind farm developers and other renewable projects guaranteeing revenue to fall within a certain range, regardless of meteorological factors.

Insurance will continue to evolve with the renewables industry as we move forward to a greener, more sustainable world.

Carl Angelo Dill is Global Senior Underwriter, Renewable Energy for Allianz Global Corporate & Specialty. He manages the global Green Energy initiative for AGCS.

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- 05** **3rd Annual California-Germany Bilateral Energy Conference (CGBEC)**
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- 05-07** **2019 Fuel Cell Seminar & Energy Exposition**
Long Beach Convention Center – Long Beach, CA; www.fuelcellseminar.com
- 12-13** **Clean Energy Means Business Buyer's Summit**
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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

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- 12-13** **Solar Power New York**
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Vancouver Convention Centre – Vancouver, BC; www.globeseries.com
- 12-13** **The Energy Expo**
Miami Airport Convention Center (MACC) – Miami, FL; www.theenergyexpo.com
- 19-20** **Solar and Energy Storage Northeast**
Westin Boston Waterfront Hotel – Boston, MA; www.events.solar/northeast/
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f. Total Distribution:	32,269	32,058
g. Copies not Distributed:	512	790
h. Total:	32,781	32,058
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16 a. Requested and Paid Electronic Copies	22,569	22,902
16 b. Total Requested and Paid Print Copies + Electronic Copies	39,817	38,729
16 c. Total Requested Copy Distribution + Requested/Paid Electronic Copies	54,838	54,960
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