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On our cover...

Wind turbine blades are stored and waiting for transport at a TP&L facility in Kansas, a North American wind power component distribution center. These blades, which can measure up to 67m long, are utilized in wind farms across North America for the production of clean energy.

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I HATE SHOPPING.

I'm okay with paying for things, but those little credit card machines are a continual source of stress in my daily life. You'd think something so simple and technologically advanced (supposedly) would be easy to navigate. Instead, I find myself waiting for

whatever actions the next screen will demand of me. Do I swipe? Do I insert the chip? Do I sign before or after I take out my card? Will it beep or flash to remind me that I'm holding up the line of people behind me? Don't pretend you've never gone through the same thing. I can safely say if I ever meet the person who created these things, I will smack them upside the head.

But that's the main problem - no one person did this. I can't hold a single company responsible for my incredibly unsatisfying, end user experience. Which makes me that much more hesitant to dive into the next big tech revolution. Case in point: electric vehicles. I already have enough to deal with remembering on which side of my car the gas cap opens. I'm all for competition. I understand the need for companies to differentiate themselves from similar offerings in the marketplace, but I'm inclined to wait until those EV companies get their ducks in a row on the basics: is the charger input always on the front? If I choose to recharge at stations run by competing companies, will I know what buttons to push and which handle to choose? Technology won't make our lives easier unless it's easy to use. That goes double for clean energy; the customer expects providers to have learned from their predecessors' mistakes.

While wandering the outdoor plaza at SPI in Anaheim, I tried my luck at charging an EV on display. Not wanting to look like I didn't know what I was doing, I asked someone in a nifty polo shirt to help me. Clearly, I wasn't the only adult that didn't want to look foolish, since my activity quickly drew a crowd of fellow show attendees. How hard could this be?

First, I didn't know which pump to choose. Granted, I had a 50% chance of getting it right, since there were only two, but I wondered why were there two? Why was one bigger and one smaller? Why did one have a yellow tag and the other a green tag? When I connected the charging port to the car, there was a green sliding button on it that said, "Okay". Did that mean, "Okay you're charging", "Okay you're connected", or just, "Hey, you're okay, and a good person for choosing clean energy!"?

The EV industry is still young enough for everyone to get on the same page. Chargers can be different colors or shapes, sport awesome company logos, and can even be price competitive, but the industry needs to communicate more clearly or consumers will throw in the towel and go back to big oil. Charging is gearing up to be a massive segment of the EV industry. Those chargers are a company's primary interface with their customer - every time drivers use a charger, they are bonding with that brand.

EV companies have a unique opportunity to shape their industry if they take the time now to figure out what's important to their potential consumers. They can ask current EV drivers about their biggest pet peeve when charging, and then fix it. Consumer research has been around forever for a reason - it works.

If we're all aiming to make green energy more mainstream, we need to approach our audience the way we would in any business; actively seek customer feedback to discover what they want, and then give it to them. Chargers in easily accessible locations? Check. Faster charging rates? Check. Simple to use? We're getting there. Think about your experience when you go to fill up your car at a regular gas station. There's a certain degree of comfort and familiarity in the process - if you've seen one, you've seen them all. You may choose one brand over another due to price, convenience, cleanliness, or loyalty points, but no matter where you go, you'll know how to use the equipment. Contrast that with EV charging "stations". With the exception of a brightly painted stanchion, nearly every other charging company challenges their users with a proprietary interface. For newbies, it can be daunting. For prospective EV buyers, it can be downright intimidating.

We all want the use of clean energy and green technology to become second nature, but until we make it feel as familiar and mundane as pumping gas, we won't get very far ... even if we're fully charged up.



Challenges of building a 403kW carport structure

The Building Department classified this project as "impossible", while the City of Irvine classified it not as a shade structure, but rather an additional floor on the building which triggered a host of invasive Planning / Building & Safety requirements. The site is next door to the John Wayne Airport which meant a full FAA review was required. The system was on top of a parking structure, but powering a building 500ft away. That distance had to be trenched through landscape, parking, and sidewalks. The building is occupied by high end offices with tenants who could not be disturbed during construction. The customer signed the contract in July but provided a hard deadline of 12/31. SunGreenSystems delivered with a final sign off on 12/28, ahead of schedule.

SunGreen Systems

www.sungreensystems.com



Solar-power boat expedition launches in Russia

The energy autonomous solar electric catamaran set off on its 5000km long journey across Russia. Following the launch from Saint Petersburg, the self-sufficient boat will make a series of stops on its trip including 40 cities in 20 Russian regions. The catamaran boasts 9kW solar power system consisting of heterojunction semi-flexible solar modules, manufactured by Russian PV module manufacturer and solar projects developer Hevel Group. Design and assembly of 130 micron solar cells were performed by Hevel's own R&D center in Saint Petersburg which well-equipped laboratory is a small copy of the company's 160MW PV module factory in Chuvashia republic. Besides supplying EPC services for utility-scale solar photovoltaic power plants Hevel Group develops variable engineering solutions for commercial transport and aviation, as well as for off-grid social and industrial infrastructure.

Hevel Solar | www.hevelsolar.com



Sustainable taxi lets you pay by singing

Fortum Singalong Shuttle is an environmentally friendly taxi that only accepts singing as payment. The 100% emission-free rides are operated on electric cars. The sustainable rides will be introduced in Finland in early July. Fortum Singalong Shuttle combines rideshares with Carpool Karaoke, and is purely run on electric cars. It is the world's first taxi that you pay by singing. Singalong Shuttle is provided by clean-energy company Fortum, who wants to engage its customers and the society to join the change for a cleaner world. The company offers a wide range of clean energy solutions and encourages its customers to live a more sustainable life. Fortum is also actively developing sophisticated EV charging solutions.

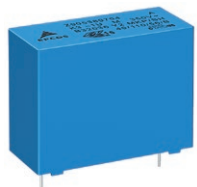
Fortum | www.fortum.com



Dual module microinverter

LeadSolar Energy, Inc. has announced the release of their LS600-Z series dual module microinverters. With a maximum power output of 700Ws, the LS600-Z can support two 60- or 72-cell modules exceeding 400Ws each. The integrated 10AWG trunk cable and current selectable option allows for 16, 20, or 24 panels to daisy chain on to one 30A branch circuit. Zigbee communication offers per panel visibility without the need for a hardwired communication channel.

LeadSolar Energy, Inc.
www.leadsolarenergy.com



New robust, high voltage capacitor series

TDK Corporation announced the EPCOS MKP Y2 series capacitors for EMI suppression. This new series is designed for rated voltages of 300 VAC, and offer a permissible rated voltage of 350 VAC. The capacitances of the B3203* series range from 4.7 nF to 1.2 µF. Even under harsh environmental conditions, the capacitors offer a stable capacitance value. They are certified according to IEC 60384-14:2013/AMD1:2016 and classified in accordance with "Grade III high robustness under high humidity Test B". This is verified by a temperature, humidity, bias (THB) test at 85°C, 85% relative humidity and 350 VAC operating voltage, at which a capacitance drop of no more than 10% may occur. The maximum operating temperature is 110°C. The capacitors are approved in accordance with UL and EN and qualified to AEC-Q200. Depending on their capacitance, they are available with a lead spacing between 15mm - 37.5mm. The case and the epoxy resin sealing comply with UL94 V-0. The possible applications of the new Y2 capacitors include EMI suppression in filters that are subjected to harsh environment conditions and demand higher rated voltages, such as those in photovoltaic inverters or automotive applications.

TDK Corporation
www.epcos.com/emi_capacitors



Tariff-free inverter

Yaskawa Solectria Solar confirms that its new SOLECTRIA XGI premium quality inverters are designed and manufactured in the U.S.A., and exempt from Section 301 tariffs. In addition to the tariff exemption, SOLECTRIA XGI inverters offer the following advantages: the XGI inverters are Buy America Act (BAA) compliant, provide cyber-secure communication with servers based in the United States, and are built of high quality and tested to extreme reliability standards. The SOLECTRIA XGI 1000 inverter production began in September and the SOLECTRIA XGI 1500 inverters will be available in early 2019. Yaskawa Solectria Solar is accepting orders on both inverters now.

Yaskawa Solectria Solar | www.solectria.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.

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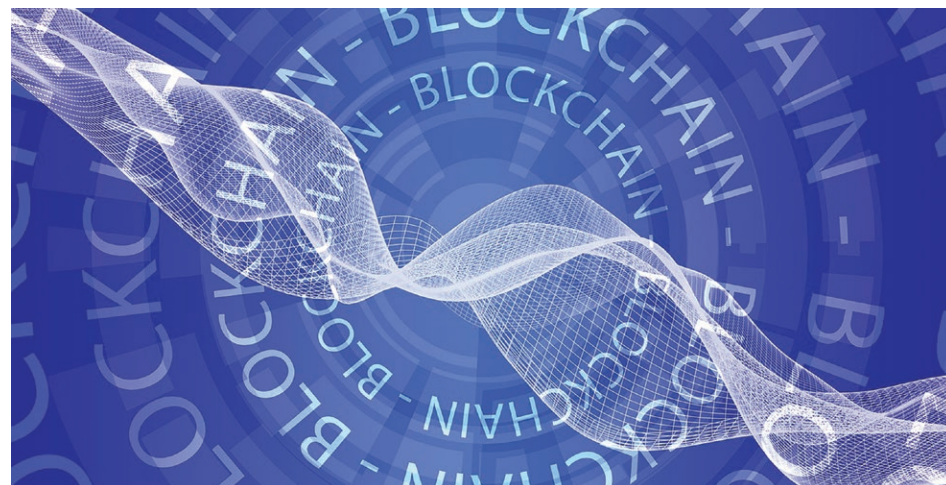
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Separating Hype from Reality

Blockchain-based, peer-to-peer energy trading

by Jesse Morris



Dozens of companies, from small startups to major utilities, have claimed that “peer-to-peer (P2P) energy trading” - enabled by blockchain technology - could transform the architecture of electric grids everywhere. Many of these claims are dramatically overstating the case for what their technology, and blockchain as a whole, is capable of today.

To date, most claims of local P2P energy trading typically involve selling and buying the equivalent of distribution level renewable energy credits (RECs), or guarantees of origin. The “trading” equates to the exchange of solar attributes, but not a fundamental shift in the way the grid is operated or balanced.

A fuller achievement of P2P energy trading would come much closer to grid-edge transactive energy, where local generation and consumption from distributed energy resources (DERs) are balancing the distribution grid in real time. That’s certainly on the roadmap, but as an industry, we have quite a way to go.

P2P hype about tomorrow’s potential distracts from real value blockchain can add today

Meanwhile, the heavy-on-marketing, light-on-substance claims surrounding P2P business models in the energy sector, are making it difficult for real applications of blockchain to break through the noise. Blockchain technology, although nascent, can accelerate the transition (already underway in grids around the world) towards energy efficiency and renewables. And, in the process, unlock significant value along the way.

Over the next several years, we believe blockchain technology can unlock value through:

- Transitioning analog or basic digital services to blockchain-based platforms to streamline accounting
- Offering new services and products on top of deployed blockchain-based platforms
- Enabling market participants to experiment with entirely new market models

Let’s consider a few examples.

1. Streamlining accounting in the electricity sector

Blockchains elegantly make mundane grid operations more efficient, transparent, and cyber-secure. Take the renewable energy certificates, or guarantees of origin mentioned above. These markets have noble intentions, but are highly manual, opaque, inaccessible for most smaller participants, and largely unable to support higher-level functionality (such as consumption-linked purchasing, or carbon-impact selective purchasing).

In a blockchain-based market, however, each generating asset can receive a digital identity that links to all production of that asset. This identity would also link to each owner of the corresponding credit. This record of identities and ownership would reside on the blockchain for all market participants to use. Smart contracts could then provide automated additional functionality, such as mapping kWh production to carbon offset, or automating credit purchasing based on a consumption profile.

Similar architectures can be applied to other utility operations, such as including customer billing and electric vehicle charging settlement. This isn’t some far-off reality; from RECs to EV charging, several Energy Web Foundation (EWF) Affiliates, from the UK to Southeast Asia, are experimenting with these use cases today.

2. Delivering new services and products using blockchain-based networks

As grid operations become increasingly digitized using blockchain technology, utilities and other market participants will find it easier to launch new products and services for customers. Most of these services create value by either: a) allowing customers to monetize their data, b) making it much simpler and easier to integrate and manage demand-side flexible resources, and/or c) creating new opportunities to finance and own energy infrastructure.

- Monetize data streams: Blockchains create unique identifiers for asset owners, assets, and the data produced by those assets. This allows direct data ownership, and selective permitting of who gets to access and use that data. The concept of personal data being “owned” and monetized by centralized service providers (think Google or Facebook) and the risk of subsequent exposure through a breach of centralized servers, is made largely obsolete. Instead, residential customers could anonymously bid out meter data to a range of retail providers to find the best rate, or sell their consumption profile to energy efficiency companies in exchange for the chance to offer goods and services.
- Better integrate and manage demand-side resources: By largely automating bilateral or multilateral contractual arrangements, blockchains have the potential to significantly reduce transaction costs associated with distributed energy resources (DERs). Imagine, for example, wholesale electricity market contract structures (including forward capacity, real-time energy, and ancillary products) being extended to the edge of the distribution grid. Automated dispatch, settlement, and reconciliation could enable many more contract types, for both individual and aggregated DERs. Multiple entities from the EWF ecosystem, including European TSOs and DSOs, have already designed pilot projects to do just this.
- Launch new services to finance and own energy infrastructure: Community solar provides renters and owners of multi-family buildings a way to benefit from solar energy, without installing solar panels on their own roofs. But the soft costs of financing and deploying such systems are proportionally higher than other types of solar. Blockchain technology can help reduce associated soft costs considerably. Using smart contracts, a community can establish partial asset ownership, governance, and profit division, so the entire process of owning one piece of a community solar farm is automatic, trusted, seamless, and much less costly.

3. Delivering on the vision of P2P energy trading

Years from now, assuming market participants have digitized most electricity infrastructure (using decentralized technologies and architectures, and unlocking value along the way) there may be an opportunity to rethink the way electric grids are constructed from the customer up. This future could realize the vision described by companies focused on creating true P2P electricity markets.

As the underlying technology of such future grids, blockchains are capable of creating value in the world as we know it. We invite utilities and innovators to join us in learning what the technology is capable of over the coming months and years.

Jesse Morris is chief commercial officer of Energy Web Foundation, and a former principal in the electricity practice at Rocky Mountain Institute.



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A New Frontier for Solar

Utility build-transfer agreements

by Frank Shaw and Sean Shimamoto

HISTORICALLY, ELECTRIC UTILITIES IN THE U.S. HAVE BEEN BUYERS

and sellers, but not producers, of solar energy. Largely due to tax and accounting constraints, vertically integrated, regulated utilities traditionally have entered into power purchase agreements (PPAs) to procure solar energy (and wind and other renewable energy) from independent power producers (IPPs), rather than building such projects and including them in their rate base. To many utilities, this has seemed like a lost opportunity; they generally earn a return on the equity invested in power plants, transmission, and distribution lines, but not on power purchased from others.

Dramatic reductions in the installed cost of solar panels, improved efficiencies, and the looming expiration of federal tax benefits, have led to a new openness to utility-owned generation. A spate of build-transfer transactions — where the utility hires a third-party project developer to develop and construct a project, then transfers ownership to the utility at completion — is creating new opportunities and challenges for developers, utilities, and equipment suppliers alike.

Challenges for Utility Ownership

Solar energy in the United States is heavily supported by federal income tax incentives, particularly investment tax credits (ITCs) and accelerated depreciation. These can account for nearly half of the capital cost of a solar project. IPPs are usually more efficient users of tax incentives, able to monetize such benefits early by partnering with a tax equity investor; this lowers the IPP's cost of capital and reduces production costs. Regulated utilities, however, may be required to spread such tax benefits out over the life of the asset under "normalization" rules, and other utility tax and accounting requirements. Because they can't use the tax benefits upfront, regulated utilities have been at a competitive disadvantage.

The recent price declines for solar energy, however, have encouraged a number of utilities and state regulatory commissions to take a second look.

Even after applying normalization rules and other tax and accounting constraints, direct ownership of solar energy projects can be an attractive alternative in the current market. Moreover, some utilities with limited tax appetite are co-investing with a tax equity investor, often combining such structures with a build-transfer arrangement.

Build-Transfer Agreements

A build-transfer agreement (BTA) is a hybrid between an acquisition agreement and a construction contract. The developer secures the needed land rights, permits, interconnection rights, and project contracts. When the project is "shovel ready," the developer (or its contractor) builds the project for the utility. The utility generally takes ownership just before the project has been fully tested, commissioned, and starts commercial operation - it owns the project before it has been "placed in service," for federal tax purposes. Thereafter, the project may be operated and maintained by the utility, the original developer, or a third party.

BTAs are fairly common for state-owned utilities outside the United States, but are seen less frequently in the U.S. Both developers and utilities have encountered challenges implementing the structure. However, some common themes have emerged from recent transactions.

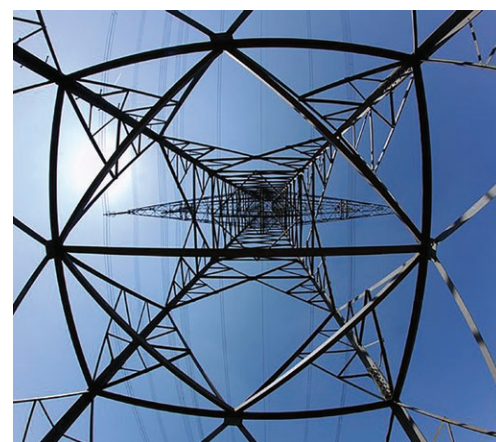
First, obtaining necessary state regulatory approvals may take a year, or longer. While some utilities may seek to acquire fully developed projects (agreeing in advance to a detailed scope of work and equipment specification), others may be more comfortable with a less structured arrangement that allows such matters to be worked out in a co-development process, while pursuing regulatory approvals. To optimize timing, the BTA may be signed before the project is fully developed, leaving certain features of the project to be defined later. The interconnection process, final site studies, final equipment selection, environmental permitting, and land-use approvals may run parallel with the regulatory approval process.

In such cases, the utility may seek to protect its interests — and those of its ratepayers — with cost caps or target-price contracts, pre-agreed standards (or approval rights) for remaining development tasks, and baseline functional specifications for plant equipment and performance. These are in addition to traditional features of an acquisition agreement or construction contract (delay liquidated damages, performance tests, an extensive set of representations and warranties, and detailed closing conditions).

The lengthy regulatory approval process can create its own challenges for developers. To maintain price and schedule - and meet IRS tests for "commencement of construction" to qualify for the maximum ITC - developers may need to make early deposits to equipment vendors. They may seek compensation for going at risk for these amounts through a signing payment, progress payments during the course of construction, or a termination fee for a busted deal.

These requests create countervailing pressures from the utility, which must decide how much it can put at risk to preserve the project timeline, and how to mitigate such risks if the project is canceled, or unexpected hitches arise in development or construction.

In a variation on this structure, the utility may agree to buy the developed project when it is shovel-ready - with required permits and land rights in hand and after obtaining state regulatory approvals - but before construction begins. The developer would construct the project under a



more classic engineering, procurement, and construction (EPC) contract. Depending on contract terms, this can shift some construction risk to the utility, because it pays for the project upfront in the acquisition price and through milestone payments under the EPC contract, rather than after the project has been completed. Some utilities, however, may prefer being an owner under a typical EPC arrangement, with the right to step in or terminate the contract and hire a new contractor, should the original developer default.

Tax Equity Investments in Utility-Owned Projects

In the typical BTA, the utility becomes the owner of the solar project for tax purposes, and claims ITC and accelerated depreciation. This may make economic sense, notwithstanding requirements to stretch out the tax benefits through normalization or other rate recovery principles. Some utilities, however, have recently structured transactions where the utility brings in a tax equity investor as a partner in a special-purpose project company. The investor is allocated a disproportionate share of tax benefits, and some agreed portion of the cash flow, in return for its upfront capital contribution. This contribution pays part of the cost of acquiring the project, reducing the cost to the utility and its customers. When the tax equity investor reaches an agreed target return, the utility has the option to buy out the investor, becoming the sole owner of the project.

The rules governing tax equity investments are complex, and frequently at odds with the utility's other objectives, so care must be taken to assure compliance with both tax and other regulatory requirements. For example, certain structures may implicate federal or state rules governing transactions between regulated utilities and their affiliates. In addition, approval of the Federal Energy Regulatory Commission, with its concomitant market power review, may be required if a project is to be transferred after it starts delivering electricity to the grid.

Implications for Solar

Increased utility ownership of solar, and other renewable energy projects, may have broad implications for the solar energy market in those parts of the country where vertically integrated utilities continue to own generating fleets to serve their customers. Similar market and regulatory drivers are encouraging broader utility interest in owning wind and other renewable energy projects, as well. While solar energy developers may face the paradox of more direct competition from regulated utilities, and fewer opportunities for PPAs, they

benefit from a larger pool of potential credit-worthy buyers. The end result would be more solar energy deployed, but under different ownership structures, with different challenges, risks, and rewards for the players.

Frank C. Shaw is Counsel on Energy and Infrastructure Projects for Skadden, Arps, Slate, Meagher & Flom LLP. His practice has focused for more than 25 years on the development and finance of international and U.S. power and infrastructure projects, and on the acquisition and sale of power projects and independent power companies.

Sean Shimamoto heads the Skadden, Arps, Slate, Meagher & Flom LLP West Coast Tax Group. He represents clients on a wide range of U.S. federal income tax matters, including mergers and acquisitions, partnership transactions, various types of public and private debt and equity financing transactions, initial public offerings and restructuring transactions.

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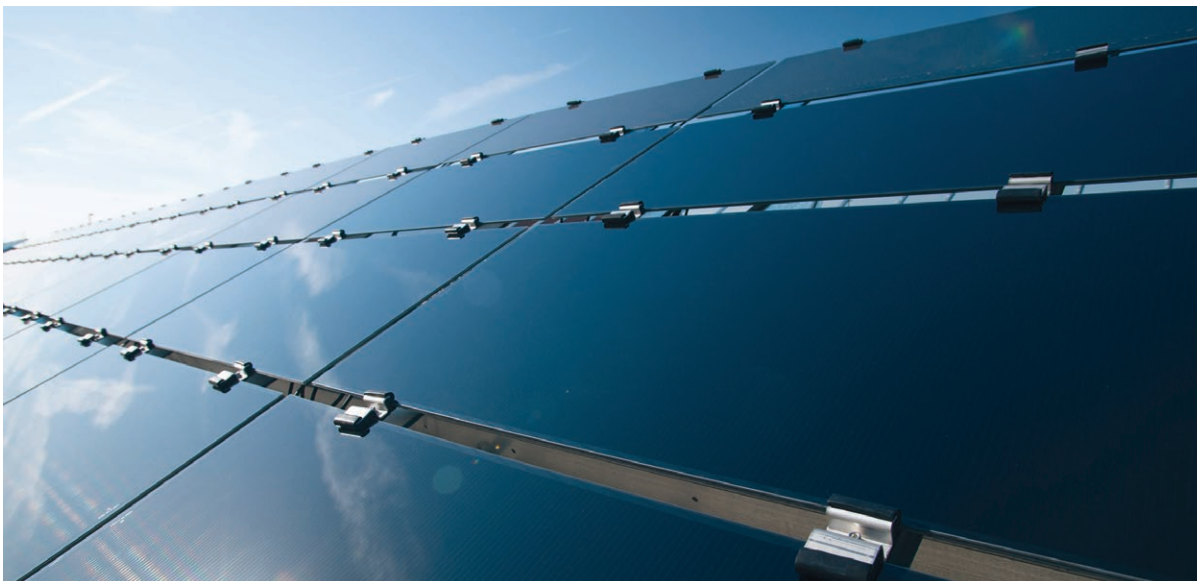
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Keeping Landfills Free of Solar PV Waste

by Andreas Wade



Advancements in the solar PV industry have come from all areas. Jumps in solar panel efficiencies have improved energy output, markets have matured, project financing has become readily available, and module prices have dropped exponentially. These notable developments have established the technology as a viable and cost-effective method of power generation; solar today is cost-competitive with fossil fuel generation. The industry has matured significantly over the past decade. With solar deployment expected to reach terawatt levels over the next decade, a greater focus will be on the materials and resources used to build these PV systems. The first significant amount of waste from PV panels is expected worldwide by the mid 2020s. The question is, what to do with PV when it reaches the end of its life?



Industry attitudes towards the recycling of modules and other PV system parts, have always been in favor of a responsible end-of-life strategy; the past year, in particular, has shown an increasing interest in the subject. Only a year ago, the topic was a mere footnote at the annual Solar Power International conference (SPI). This year however, recycling was a hot topic of discussion at SPI, with industry stakeholders recognizing recycling as a business model. With PV recycling in Europe starting to scale up to the necessary capacities, now is the perfect time for the American market to follow suit.

A recent paper published by the UC Santa Barbara Bren School of Environmental Science and Management, has confirmed the looming industry challenge. An estimated 9.8-million tons of PV waste is anticipated between 2030 and 2060 in the United States.¹ That is equivalent to roughly 10,000 cargo ships full of solar waste. Currently, solar PV modules make up less than 1 percent of annual global e-waste volumes; by 2030, that number is expected to rise to anywhere from 3-16 percent of total e-waste produced annually today.²

Many recycling initiatives are in their infancy, as is the market for such services. Inversely, the long lifespans of solar panels (25-30 years in most cases) have given ambitious players in the industry a head start on developing the necessary recycling processes and infrastructure. In Europe, where the first solar boom occurred, a global voluntary module collection and

recycling program was established in 2005. Today, a number of producers and independent entities have started to develop the necessary solutions the industry will need to maintain its current level of environmental stewardship, just in time for when the first systems start to be decommissioned, over the next couple of years.

Manufacturing the next generation of solar panels, using recovered materials from old panels, could significantly cut down on raw material costs. Recycling can significantly reduce the environmental footprint of PV electricity, making it even more sustainable

In Europe, the EU WEEE directive mandates the recycling of PV panels. Unfortunately, not enough manufacturers are





Speed, simplicity, and scale for C&I solar design

Aurora Solar released a new version of their software that increases the speed and simplicity of solar design, while offering support for multi-megawatt commercial solar projects. Aurora incorporated current graphics technology to deliver an increase in computing speed with a simple interface. The update combines Aurora's accuracy with lightning-fast speed, simplicity, and support for large solar projects. The system offers 10X performance upgrades for multi-megawatt, commercial-scale solar projects and the ability to simulate the solar energy production of a PV system while designing, allowing real-time assessment of design choices. A fully 3D design experience, with seamless transitions between different perspectives of the project site and automated tools to assist solar designers in determining the optimal wiring (stringing) configuration for connecting solar panels to inverters are provided in this system, which also offers support for large, multi-megawatt solar projects, and an enhanced "fill zone" functionality which automatically optimizes solar panel locations to maximize the number that fit within an available space.

Aurora Solar | www.aurorasolar.com

taking a proactive role in expanding recycling efforts into other regions of the world. It is important that the industry take an active leadership role to address the burgeoning challenge of solar PV waste - particularly in the maturing market of the United States. In 2016, the US Solar Energy Industries Association (SEIA) partnered with PV manufacturers and installer-developers to voluntarily launch a national PV recycling program, which has aimed to make affordable PV recycling solutions more accessible to consumers.³

All parties involved in the solar industry, whether directly or indirectly, are responsible for nurturing and enabling widespread adoption of PV recycling. Although things are moving in the right direction, it's ultimately societal attitudes towards reducing waste, and responsibly dealing with electronics as they reach the end of their useful life, that will be the catalyst to cement PV recycling. With industry leadership, the wide rollout of solar panel recycling could be just around the corner; with it, another piece of the clean energy transition will fall into place.

Andreas Wade is Global Director of Sustainability at First Solar. First Solar has developed, financed, engineered, constructed, and currently operates many of the world's largest grid-connected PV power plants.

First Solar | www.firstsolar.com

¹ Domínguez, Adriana, and Roland Geyer. "Photovoltaic Waste Assessment of Major Photovoltaic Installations in the United States of America". *Renewable Energy*, August 2018. <https://doi.org/10.1016/j.renene.2018.08.063>.

² S. Weckend, A. Wade, G. Heath and K. Wambach, "End-of-Life Management: Photovoltaic Panels," *International Renewable Energy Agency (IRENA), International Energy Agency Photovoltaic Power Systems Program Task 12 (IEA PVPS Task 12)*, Abu Dhabi, Amsterdam, 2016.

³ E. Butler, "SEIA National PV Recycling Program," in *Solar Power International*, Las Vegas, 2016.



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Outdoor Exposure

The anatomy of solar PV equipment tests

by Jim Crimmins

Solar photovoltaics (PV) has experienced strong commercial growth in recent years, evolving from a niche market of small-scale applications to a mainstream electricity source. This growth provides promise for substantial PV industry market opportunities across the globe. However, reliability and quality continue to be critical elements for the steady growth; this equipment is expected to reliably perform in the field for 25-plus years, without significant performance degradation, even in extreme environmental conditions.

Many PV modules manufacturers claim high performance and high reliability of their products, but those module specifications are restricted to the Standard Test Conditions (STC), that are often not representative of the real conditions in which the PV devices have to operate. A recent study out of Rome confirms that it is important to evaluate the real behavior of photovoltaic devices in outdoor conditions, through reliable and accurate measurements, and that PV modules performances depend on their technology, location, weather conditions, and mounting configuration.

To address this issue, CSA Group, along with industry stakeholders, worked to create the new CSA C450 "Standardization of Extended Stress Testing" standard. The CSA C450 will be the very first public standard available of its kind. This new standard, ANSI/CSA C450, will be publically available following the conclusion of the ANSI publication process, which will allow stakeholders the opportunity to contribute to ongoing changes, assuring that all parties' needs are met. The CSA C450 helps solve many of the challenges the industry was facing when verifying their product's long-term reliability.

Extended testing helps the industry in the following ways:

- **Quality Improvement**
There is a consensus that the quality of PV modules supplied to US utility-scale projects has improved significantly over the years, in large part due to the extended stress testing requirements.
- **Consumer Awareness of Materials Quality**
Project developers and investors have learned that modules of the same module type, but different polymer materials, can behave very differently in the field, which is often not visible in certification testing.
- **Manufacturer Awareness of Materials Quality**
Leading manufacturers now run internal extended testing programs to qualify new designs and materials.

PV performance gradually decreases with exposure to outdoor conditions. Environmental factors that affect PV module performance include moisture, UV irradiation, temperature fluctuations, salt, and extreme heat and cold. UV exposure and other factors such as high/low temperature, humidity, and mechanical stress, have been reported to degrade photovoltaic (PV) module materials. It has become increasingly important to evaluate the behavior and performance of various types of PV modules - not only under standard test conditions, but actual



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Zilla Corporation | www.zillarac.com

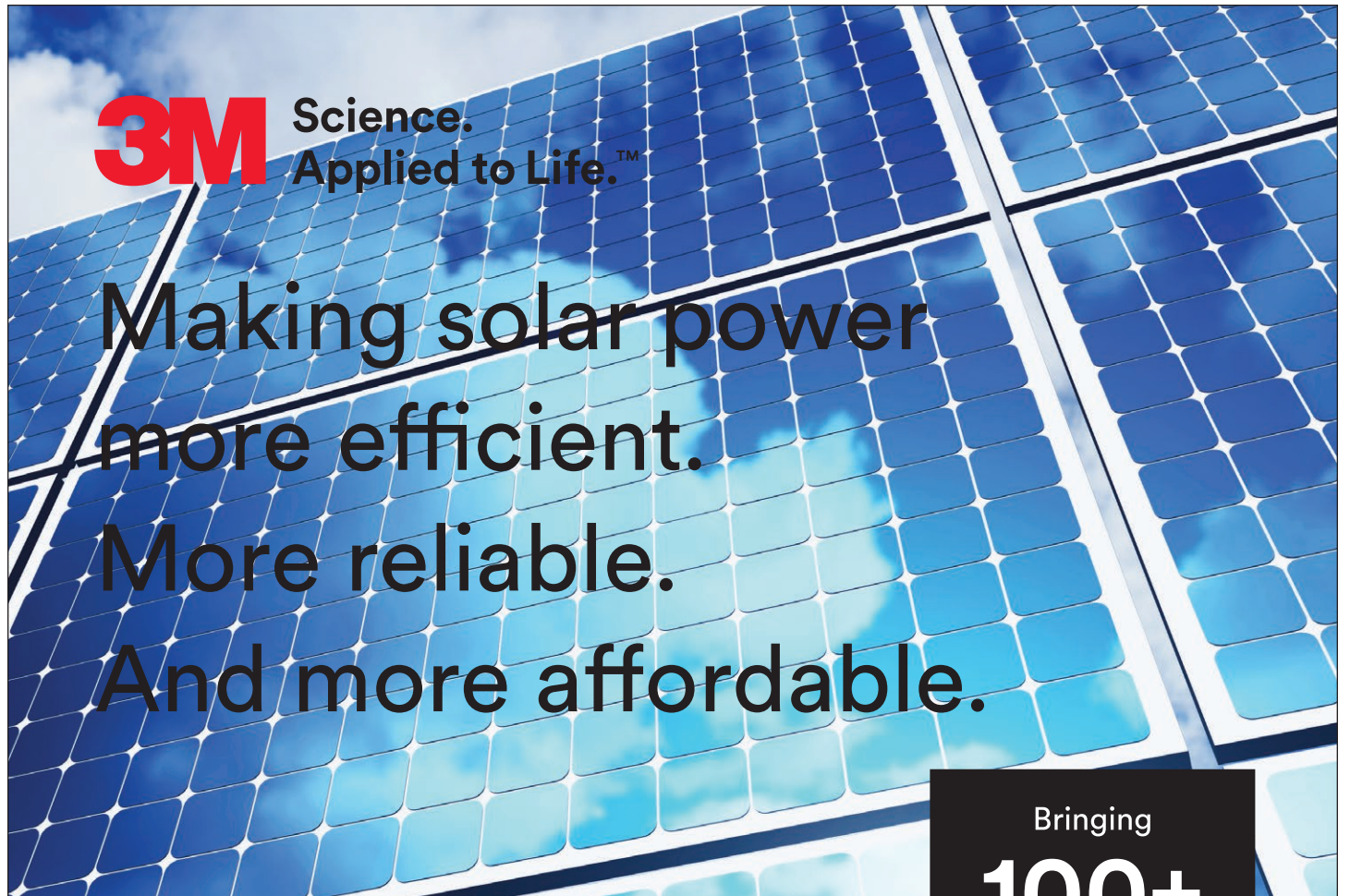
outdoor operating conditions. Accurately measuring the performance of PV modules under different environmental conditions is a critical requirement when predicting expected future energy output in the field. However, not all tests are created equal. Attention to detail is critical.

So, what should you look for in these "details"? From suitable space to advanced technology, here is a list of vital components and capabilities that should be present, to ensure that your PV equipment and components are rigorously tested against an array of outdoor conditions.

- Sizable and secure outdoor test, close to or attached to the lab, with a secure fenced perimeter and security cameras
- UV exposure chambers that can accept large modules, if required
- Custom UV testing chambers that can test for all angles of UV exposure, a higher than typical level of irradiance, as well as an outdoor exposure intensity much greater than a normal outdoor exposure level
- Dual-axis trackers, single-axis trackers, and fixed-tilt racking systems, along with a greater than 2,300 kWh/m² annual fixed rack irradiance
- String level monitoring and module level micro-inverter monitoring available for long-term exposure testing LID testing, with flashing at various intervals to assess performance degradation

PV equipment manufacturers who are competing in this growing global market have options for their testing & certification needs, but should exercise due diligence to make sure their service provider has checked all of the boxes, and can deliver thorough testing solutions.

Jim Crimmins is General Manager at CFV Solar Testing Laboratory, a jointly owned CSA Group lab. CSA Group is a global organization providing testing, inspection, and certification services for products in many market sectors, including industrial, healthcare, and emerging technologies. CSA Group also provides functional safety, cybersecurity, and management systems certification. CSA Group is one of the largest providers of safety and environmental certification for Canada and the U.S.



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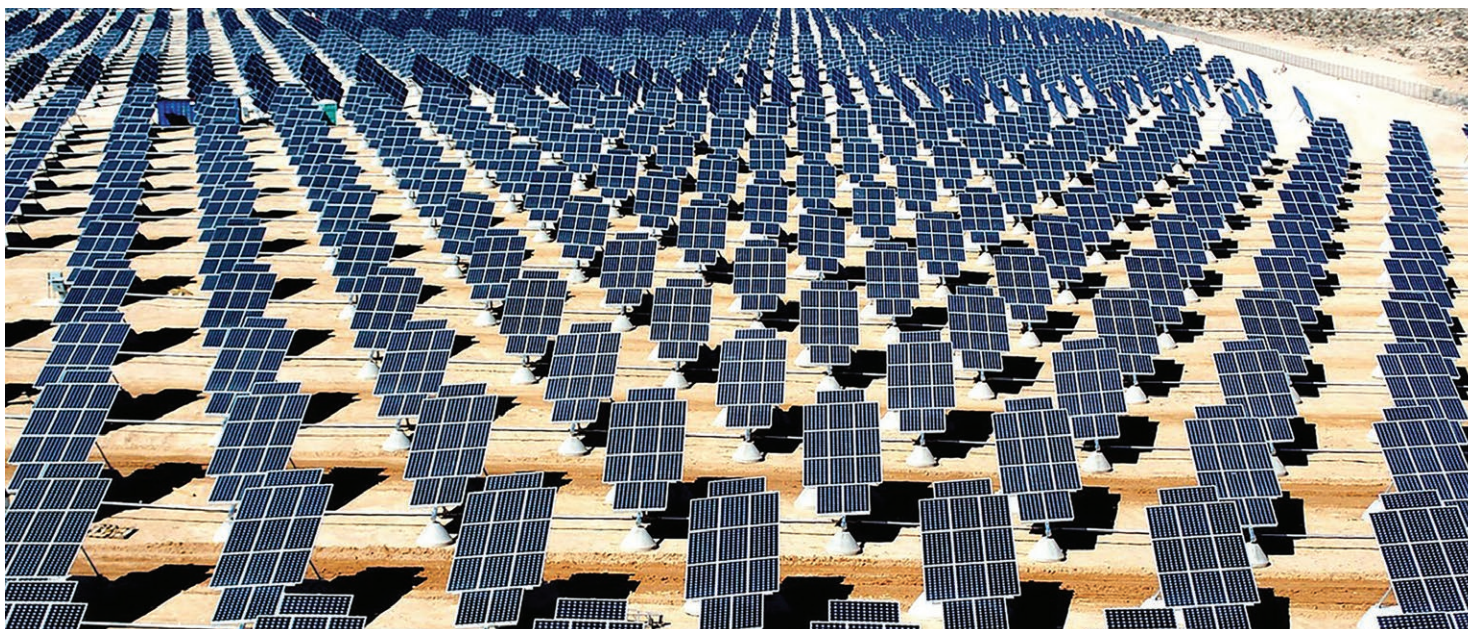
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Keeping an Eye on the Grid

by John Geiger

NEW APPLICATION GATEWAY TECHNOLOGIES AT THE network edge, enable highly-optimized industrial IoT solutions that enhance productivity of existing grid infrastructure. In other words, the traditional system utilities use to monitor DER and grid assets isn't quite cutting it. To increase reliability and grid capacity, they need a device that collects data from grid assets, and rapidly signals changes. The result? Improved real-time grid awareness, minimized network downtime, reduced operating costs, and heightened, layered security.

The tradition of managing the supply of power from large centralized generation is increasingly being augmented, or replaced, by distributed energy resources (DERs). The adoption of DER's is creating the need for highly distributed automation monitoring and control solutions, to maintain power quality on the medium-voltage grids.

DERs consist of physical and virtual assets deployed across the distribution grid, typically close to load, and usually behind the meter. Devices and systems, on both sides of the electric meter, can help the grid function more efficiently, and be more resilient under adverse conditions.

Limitations to Building-Out a DER Smart Grid

Traditionally, utilities have used a specific set of grid sensing, control, and automation functions tailored to the electric grid application space. The majority of these systems are rooted in aging technologies. Because utilities only replace technology products every few decades, the existing grid system lags behind today's Internet-based systems. Consequently, utilities have been slow to adopt cloud-based approaches. Instead, they transfer data from grid devices to their existing Distribution Automation head-end systems for operations, even if devices support cloud connectivity.

This results in an infrastructure that is dominated by legacy and proprietary systems, with a historical reluctance to adapt to new, open, standards-based paradigms:

- Connecting new line sensors to Distribution Automation head-end systems, so that existing infrastructure can be utilized and leveraged;
- Bringing sensing for DER to the cloud, to take advantage of the benefits of modern cloud platforms;
- Maintaining grid security to levels recommended in NISTIR 7628 *Guidelines for Smart Grid Cybersecurity*.

IIoT Application Gateways

A solution to these factors has been realized with the introduction of new industrial IoT application gateway technology. These new gateways provide a rich set of edge functionality, improving how utilities monitor critical grid data in environments such as substations and medium-voltage distribution networks. They enhance traditional monitoring systems, and increase reliability and grid capacity.

Connecting Line Sensors to Legacy Systems

Augmenting the existing grid infrastructure with application gateways enables older assets to meet the required performance of real-time, smart-grid applications.

Pushing Data in Real Time

Distribution Automation has relied on the centralized polling of sensor data. This results in significant latency and limited ability to scale. These IIoT gateways gather sensor data locally, create data models, perform analytics, and share the results using secure Internet connectivity methodologies, all while maintaining connectivity with existing Distribution Automation solutions.

Leveraging Cellular Infrastructure

Historically, connectivity to Distribution and Automation systems has been done using narrowband, non-IP-based, transparent private wireless networks. Extending traditional legacy polling over cellular was accomplished with secure tunneled IP-encapsulated polls through a cellular modem. IIoT gateways enable grid monitoring devices to take full advantage of cellular connectivity.

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Enhancing Sensing with LPFAN

The advent of IoT has brought many new standards-based, low-power, field-area-networking sensors, using connectivity standards including ZigBee, Thread, Bluetooth and WiSUN. The sensors are easy to install; they scavenge power from the power line, making them highly economical to deploy.

IIoT Gateways provide connectivity to these devices, and the ability to convert the sensor data to legacy protocols, enabling modern cloud-based connectivity. This allows gateways to incrementally add new sensing solutions to existing monitoring systems.

Leveraging DER to the Cloud

As complexity of the distributed grid continues to expand, there is a need to be able to manage many more devices, and define methods by which utility automation systems can securely discover, request, and manage resources on the grid. The need to rapidly scale is creating opportunities to monitor and control the grid using cloud-based application.

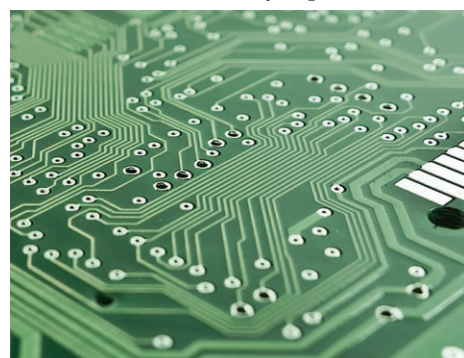
But the modern cloud speaks a different language from most grid legacy systems and devices. What has been needed is a way to translate legacy systems to the cloud, as well as communicate with existing back-end systems, without disrupting existing operations. Not only are IIoT application gateways able to connect to cloud-based infrastructure, but they share real-time data and analytics with cloud-based applications.

Enhancing Grid Security

Using legacy protocols for existing grid monitoring lacks robust cyber security, and is vulnerable to cyber-attacks. Application gateways can minimize legacy attack surface by locally polling the grid asset, limiting access of the data to systems using well-vetted, open standard-based security methodologies. In addition, application gateways support the ability to update and patch the security, to reduce physical and cyber vulnerabilities.

More Flexible, Secure and Cost-Efficient Smart Grids

These new application gateways help DERs move from legacy and proprietary solutions, to open and standardized web-based solutions that enable sharing of data across the enterprise, without abandoning the infrastructure already in place.



They provide many features that simplify the development of edge applications by reducing the time to create and integrate them, thereby reducing development time from months or years, to weeks (or even days). This enables innovative edge applications to be created and rapidly integrated to existing infrastructure and IIoT applications

Adding new line sensors to existing legacy devices on proprietary wireless networks brings tremendous value for DER grids, as well as legacy devices taken to the cloud for remote configuration, management and field force operations. Such gateways enable flexibility, security, and high cost-efficiencies within DER grids.

John Geiger is Vice President Business Development at Machfu, which connects data to the cloud and legacy enterprise systems for business analytics..

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New Tool Forecasts Local Power Generation

by Simon Engler

How much electricity did solar and wind installations generate in your area in the past 24 hours? How much power will they produce today and tomorrow?



SOLAR ELECTRICITY GENERATION			
	YESTERDAY	TODAY	TOMORROW
SOLAR POWER INDEX	10	6.4	2.5
% HOMES POWERED	6%	3%	1%
% DAILY COST SAVED	100%	65%	25%

Estimates based on Nielsen designated market area
Solar Power Index: Suitability of daily weather to generate solar electricity (Max=10)
Source: Climate Central Wind and Solar Electricity Forecast Tool

CLIMATE CENTRAL


The vast majority of Americans support expanding the production of solar and wind energy. But the average person has no easy way to understand how much power those energy sources actually generate in his or her community, on a day-to-day basis.

That has changed. In September 2018, Climate Central, a non-advocacy, non-profit research organization, released a free online tool that will let TV meteorologists across the United States share three-day estimates of local solar and wind power generation with their viewers, across a number of straightforward metrics. The tool is part of the Climate Matters initiative, which provides local, ready-to-use information about climate change—from broadcast-ready graphics to data analysis—to more than 600 TV meteorologists around the country.

Here's how the new tool works. Each morning, Climate Central downloads hourly historical and forecast data on local wind speeds and solar irradiance across the country, provided by MESO, an atmospheric modeling and consulting group. The tool takes this data and combines it with data on installed solar and wind electricity generating capacity (sourced from the Energy Information Administration, the Open PV Project, the Solar Energy Industry Association, and the U.S. Wind Turbine Database) to calculate the amount of wind and solar electricity generated in individual locations throughout the United States. Using yesterday's wind and sun actuals, along with projected weather data, the tool estimates yesterday's electricity generation, and approximates the likely generation levels for today and tomorrow. The results are freely accessible online to both TV meteorologists and the general public.

Specifically, the tool produces hourly results for every cell in a 0.05° latitude by 0.05° longitude grid across the United States. It then creates daily, regional results by aggregating the hourly figures into 24-hour periods, and by combining the cells into blocks that coincide with the U.S. TV market areas delineated by Nielsen. Television market areas are relatively small, and wind-generated electricity (unlike solar power) often travels long distances from its source to users; the tool also offers estimates for the Environmental Protection Agency's eGRID regions, within which electricity generated is usually also consumed. In the future, the tool may also provide information

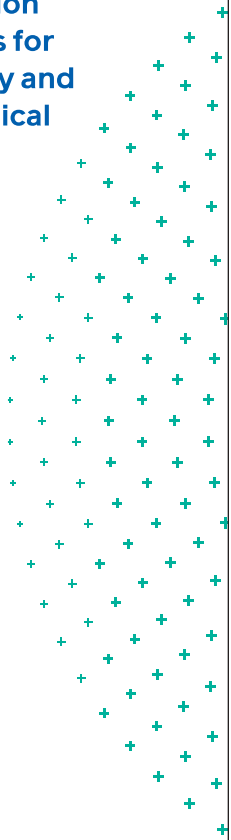




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for other geographic units, such as counties, states, congressional districts, and zip codes.

Users access the information by choosing a particular media market from a drop-down menu covering every state in the U.S. The tool then displays electricity generated for that market - in megawatt hours - by both wind and solar sources. In addition to megawatt hours, the tool offers context by providing several other metrics, such as the estimated percent of average homes in each media market those megawatt-hours could power. It also offers wind and a solar power indexes, each a number from zero to ten, that reflects how well-suited the current weather conditions are for solar and wind generation. Finally, the tool describes the percentage of the daily electricity the average homeowner would save with a typical rooftop solar installation (based on average local residential prices for grid electricity).

“Our goal is to provide an easy-to-understand snapshot of how much the weather is already contributing to meeting local electricity needs,” said Dr. Eric Larson, a senior scientist with Climate Central and a senior research faculty member at Princeton University’s Andlinger Center for Energy and the Environment. Dr. Larson helped build the new tool.

By enabling meteorologists to routinely inform their viewers about local generation of renewable electricity, the tool increases viewers’ awareness that low-carbon energy sources are already practical and increasingly widespread. Some 60% of Americans regard TV weathercasters as trusted sources of information about climate change; the tool lets meteorologists go beyond talking about climate impacts to address clean-energy solutions—ones powered by the weather itself. Meteorologists’ audiences are big and diverse, which gives them an ideal platform to illustrate the power of clean energy around the country.

Simon Engler is a researcher and writer at Climate Central, an independent organization of leading scientists and journalists researching and reporting the facts about our changing climate, and its impact on the public. Explore the wind and solar tool at <http://medialibrary.climatecentral.org/wind-solar-tool/>.

Climate Central | www.climatecentral.org



Customer-centric solar mounting solutions

Esdec, a European solar rooftop mounting solutions provider, is entering the U.S. market with the FlatFix system, a lightweight, clickable solar mounting system for flat roofs. Featuring a 20-year warranty and UL certification, FlatFix’s design enables rapid assembly, allowing commercial installers to significantly reduce installation times. FlatFix’s racking components, including bonding straps, are assembled by snapping into a locked position without the need for tools. The rails click together easily and quickly to form an interconnected, solid structure. Complete module installation requires just one tool and minimal parts, while power optimizers can be attached via snap-on clips in a matter of seconds. Using self-levelling baseplates, FlatFix is available with ballasted and hybrid attachment options. The flexible system can be oriented in a traditional south-facing direction or in a dual-tilt orientation. FlatFix’s materials and design compensate for thermal effects, reducing potential heat-induced degradation of the PV modules and protecting the integrity of the roof. Esdec is also introducing its ClickFit product to the U.S. market. A lightweight, fully adjustable rail-based racking system, ClickFit can be used on various types of pitched residential and commercial roofs. FlatFix and ClickFit are both UL-certified Class A fire-rated, having achieved fire mitigation for Type 1 and 2 PV modules.

Esdec | www.usa.esdec.com



Monitoring platform for PV plants and self-consumption systems

Ingeteam has developed a new monitoring platform directed at all sizes of solar PV plants, as well as PV self-consumption systems. The INGECON SUN Monitor platform makes it possible to monitor domestic and industrial systems alike, with or without batteries. The INGECON SUN Monitor application presents the real-time data for generation, consumption, and energy storage if applicable. Users can view this information on a daily, weekly, monthly, or yearly basis. Furthermore, the INGECON SUN Monitor application gives details of all the energy flows in each time slot, so users have real-time information on which electricity supply is being used to power their homes, the self-consumption ratio achieved, and the final use of the solar energy, which can either be direct consumption, battery storage for subsequent consumption, or delivery to the public grid where permitted. The application has also been designed to monitor large-scale PV plants. In this case, the tool proves useful for providing information on all the generation data, both in real time and also for daily, weekly, monthly, and yearly figures and to view the gain obtained with this energy production. Likewise, the application provides remote information on the status of any possible alarm present at the plant, so the user can monitor this situation. Moreover, all this information is compiled in a report that is emailed to the user on a daily basis.

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California's New Programs Advance Residential Solar

by Gary Liardon



SOLAR ENERGY GOT A BIG BOOST IN CALIFORNIA

recently, when the state government adopted new policies to establish a more progressive foundation for the use of solar power in residential buildings. It's all part and parcel of its pioneering "net-zero" mission.

The most recent policy, SB 700, signed into law by Gov. Jerry Brown in September, extends California's Self-Generation Incentive Program (SGIP) for an additional five years, from the current January 1, 2021 expiration date, until January 1, 2026. The SGIP provides substantial rebates to home owners, through the state Public Utilities Commission, for installing of energy storage systems that save solar power for use during off hours.

SB 700'S Path Forward

By storing solar generated power, the rapidly growing residential battery marketplace gives homeowners important benefits:

1. A storage system protects homeowners from solar downtime due to a utility operating problem (e.g. brown or blackout), or a long period without sun.
2. As demand increases, costs will decrease - the more battery systems that are sold, the lower the cost to builders and consumers.
3. By combining solar systems and storage batteries with "smart" software, homeowners can create intelligent home energy management systems that analyze historical energy consumption trends, develop efficiency recommendations that include the exact combination of stored and renewable energy required to power a home, and limit energy demand.
4. In some states, a homeowner can benefit economically by storing excess power generated by the solar system, and then sell it back to their utility.

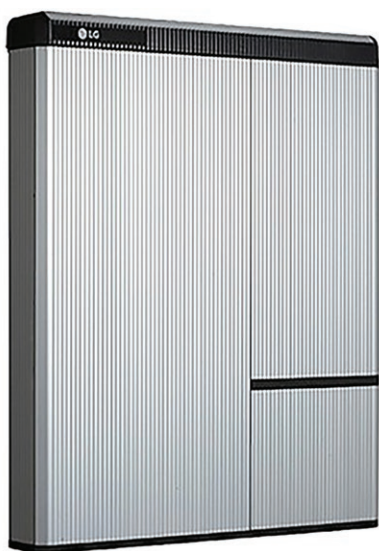
On a macro level, storage battery technology offers electric utilities the opportunity to create a smarter power grid that can give the utility better control over managing peak demand, thus reducing the need for new and costly generation plants to cover that demand. Considering all the changes required by utilities and regulatory agencies as these entities respond to the new energy age, this transformational storage technology provides energy producers more creative ways to connect with home builders and home owners, giving them greater control over their efforts to save money, while being environmentally friendly.

SB 700 brings us to the forefront of new energy partnerships that advance solar adoption. The energy storage market is being driven by improved energy efficiency, the declining cost of solar equipment, and higher capacity energy storage. All of which create a huge benefit for consumers.

Full Court Solar Energy

California has been a leading proponent of solar power for the past decade. Its net-zero mission dates to 2007, when the Energy Commission declared that "newly constructed buildings can be net zero energy by 2020 for residences and by 2030 for commercial buildings." Under this policy, solar energy was considered one component of building more energy efficient homes -- but was not required.

In May 2018, the California Energy Commission (CEC) adopted the 2019 Building Energy Efficiency Standards. This new solar mandate will apply to all houses, condos and apartment buildings (up to three stories) that secure building permits after January 1, 2020, making solar energy systems standard on virtually every new home built in California. "California is about to take a quantum leap in energy standards," states Robert Raymer, technical director for the California Building Industry Association. "No other state in the nation mandates solar, and we are about to take that leap." As solar costs fall with rising demand, other energy progressive states such as New Jersey, Colorado, and Virginia are expected to follow California's lead.





A new generation

At this critical energy threshold, the solar and storage industries must collaborate and partner at the highest level to keep the momentum moving ahead. The global energy industry is at the cusp of a new generation of intelligent energy production and use. By investing in solar plus storage plus smart management systems, builders and home owners can significantly help advance the sustainability efforts of our entire nation. This new paradigm of energy partnerships is a win-win, not only for solar energy providers and consumers, but for everyone. It's time to make the financial and human resource commitments to keep moving the energy industry towards a cleaner environment and healthier world.



Gary Liardon is President of the Consumer Group Nationwide at PetersenDean Roofing & Solar. PetersenDean specializes in new residential and commercial construction. The Fremont, Calif.-based company employs 3,000 workers and operates in 11 states: Arkansas, Arizona, California, Colorado, Florida, Georgia, Hawaii, Louisiana, Nevada, Oklahoma, and Texas.

PetersenDean
www.petersendean.com

The new CEC policy focuses on four key areas: smart residential photovoltaic systems; updated thermal envelope standards (preventing heat transfer from the interior to exterior and vice versa); residential and nonresidential ventilation requirements; and nonresidential lighting requirements. The standards also encourage demand responsive technologies such as heat pump water heaters, improvements to a building's thermal envelope to enhance comfort, and energy savings by inclusion of high-performance insulation and windows.

"Under these new standards, buildings will perform better than ever, and at the same time they contribute to a reliable grid," explained CEC Commissioner Andrew McAllister, the commission's lead on energy efficiency. "The buildings that Californians buy and live in will operate very efficiently while generating their own clean energy. They will cost less to operate, have healthy indoor air and provide a platform for 'smart' technologies that will propel the state even further down the road to a low emissions future."

Need for education

As alternative-energy policies become more prevalent in states across the U.S., builders must be in tune with the demands and requirements of structural design and implementation that optimize the performance of solar, as well as other clean energy systems.

While much has been written about solar energy and its benefits, education about system design and proper installation is, at best, lagging. Southern orientation of solar panels for maximum sun exposure, the location of a home, and its relative climate zone, are all critical to performance. Even something as basic as roof color can improve the performance of a solar energy system; combining a PV system with a "cool" roof (white or light colored) can boost the performance of the system by as much as 10 percent.



PERC and mono solar technologies

Mission Solar, a U.S. based supplier of high efficiency solar modules, has debuted four new solar panels. MSE PERC 60 is a 60-cell module which features five busbar technology, offering a power output of 310W. The sleek, all black design gives this module quality aesthetics, making its application a solution for residential and commercial projects. MSE PERC 60 incorporates a white back sheet to provide a power output of 315W. MSE Mono 72 features monocrystalline, five busbar technology with a power output of 350W. Commercial and utility scale projects are suitable for this product. Mission Solar Energy's highest performing module is a 72-cell panel, MSE PERC 72, featuring PERC, five busbar cells with a power output of 370W. Built to withstand extreme weather conditions, this product is best suited for commercial and utility-scale projects. Production of the new product line is expected to ramp up in Q4 of this year, making products available in early 2019.

Mission Solar
www.missionsolar.com



Residential roof mount system

SnapNrack's Ultra Rail System is a sleek, lightweight rail solution for mounting solar modules on the roof. Ultra Rail, a lighter rail profile, is an economical solution for projects in more average load conditions, especially when attachment spacing is already dictated by the existing roof structure and more mounts are needed to disperse the weight of the system. Furthermore, Ultra Rail is a cost effective solution for customers installing on a mix of roof surfaces rather than one roof type for every install. The new Ultra Rail Mounts include snap-in brackets for attaching rail. The spring-loaded roof mounts provide full rail leveling capabilities and all components come pre-assembled. SnapNrack's wire management solutions are compatible with the Ultra Rail System which features a large top rail channel, providing ample room for wires and cables. Furthermore, the system is compatible with all existing module clamps and maintains the same install experience installers are familiar with.

SnapNrack | www.snapnrack.com

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 <p style="text-align: center; font-weight: bold; color: #1a3d54;">UNIVERSAL POWMOUNT</p>	 <p style="text-align: center; font-weight: bold; color: #1a3d54;">L-FOOT COMPATIBLE (RAILED)</p>	 <p style="text-align: center; font-weight: bold; color: #1a3d54;">SCI KIT (RAILESS)</p>

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EN/UL dual listed and RoHS compliant cable

Prysmian Group introduces its new SunGen Global Photovoltaic Wire which features dual-listed certifications from EN 50618 (1500VDC) and UL 4703. SunGen's dual rating enables domestic OEMs to reach global markets while reducing working capital and supply chain complexities, thereby eliminating the need for OEMs to invest in and manage multiple inventories. SunGen Global is not only tested to be dual-listed and fully compliant with EN/UL standards, but is also halogen-free.

Prysmian Group

www.generalcable.com



Floating solar products

Introducing Floating Solar, a unique, new large-scale solar technology that Layfield can design and install on existing ponds, eliminating the need to use premium land space. Layfield now has three floating solar designs available. Layfield's three types of floating solar are; Tensioned Floating Cover Solar, Insulated Floating Cover Solar, and Open Water Floating Solar. Layfield provides full floating solar project development services including the solar and floating cover designs, procurement, installation, commissioning, and maintenance.

Layfield Group Ltd.

www.layfieldgroup.com

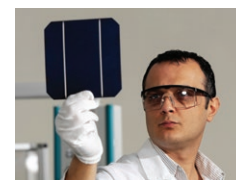


Advanced power quality meter

The PowerLogic ION9000 meter from Schneider Electric, is the latest generation of advanced power quality meters to build on the success of the ION7650. It offers advanced capabilities including an accurate Class 0.1S, 2X meter, cyber security ready, helping to eliminate vulnerabilities to critical power assets and systems, onboard power quality analysis which helps ensure safe, reliable, efficient power in large and critical buildings and infrastructures, smart power event analysis automatically correlates related trends, events, and waveforms based on time and type of incident, saving time and providing vital insight with pre- and post-incident data, and patented ION programmability, allowing for adaptable, customized power management capabilities. The ION9000 complies with all three of the latest power quality standards: IEC61000-4-30, IEC62586-1, and IEC62586-2.

Schneider Electric

www.schneider-electric.ca



Fluxes for the solar industry

Emil Otto is now offering fluxes that have to satisfy special criteria for the solar industry. The solar fluxes must thus be processable very residue-free in order not to affect the individual solar modules' efficiency in subsequent use. Emil Otto currently offers three fluxes: EO-S-001, EO-S-002, and EO-S-007. All fluxes have been developed for soldering solar modules, and tabber and stringer material as well as for connecting cells. Furthermore, the products involved are NO-CLEAN fluxes that are formulated to be halogen-free. As substantiated in process tests, none of the fluxes leave behind sticky residues. The activators are additionally designed for higher temperatures, which are required during the manufacturing of solar modules, without impairing the activators' effectiveness. This also applies to actual application in particularly sunny and hot regions. The solids content lies between 1.5% and 2.5%, depending upon the flux. Solar fluxes are offered as concentrate in addition to 5 L and 20 L canisters.

Emil Otto | www.emilotto.de



96-panel dual module microinverter

LeadSolar Energy Inc, releases the LS600X-Z series dual module microinverters. The micro is designed to support either 20 Panasonic 330W or 18 SunPower 360W modules on a single 30A branch circuit, but will work with other 96-cell panel as well. Zigbee communication offers per panel visibility without the need for a hardwired communication channel.

LeadSolar Energy, Inc. | www.leadsolarenergy.com



Options for commercial installations

SolarEdge is introducing the new, more cost-effective P850 2:1 commercial power optimizer for higher power modules. The P850 replaces the P800s power optimizer and can be used interchangeable with the P800s. P850 supports up to 850W and has a new bracket to simplify clearance requirements. It is backwards compatible with the P800s and can be used as a replacement for the P800s in all projects. The P850 connects 2 modules in series and is designed to support 2x 60-cell, 72-cell, bi-facial, or high current modules. The P850 power optimizer joins the P800p power optimizer enabling installers to connect two high power modules to a single power optimizer. The existing P800p power optimizer, is mainly for connection of 2 x 96-cell 5" high current modules in parallel. Together they address the growing use of higher power and higher current modules for PV installations.

SolarEdge | www.solaredge.com

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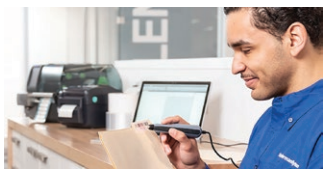
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SmartechOnline.com
704 362 1922





Print automation eliminates manual tasks and errors

HellermannTyton announces true print automation, a technology included in the latest release of its label creation software, TagPrint Pro 4.0. Print automation gives commercial label users, such as wire harness and control panel shops, the ability to automate most of their print workflow, boosting efficiency while reducing waste. With print automation, single- and even multi-label jobs can be stored along with print data, such as printer names, print quantities, and variable data fields within individual label files. Scanning a single bar code on a work order (or entering a job number in the absence of a scanner) can send multiple labels to print on separate printers in predetermined quantities. TagPrint Pro's proprietary technology allows every printer utilized to run simultaneously. HellermannTyton chose to include print automation with its label creation software so any shop, large or small, could benefit from the technology.

HellermannTyton
www.hellermann.tyton.com



Explosion proof solar LED strobe light

Larson Electronics released an explosion proof, solar-powered LED strobe light for flammable environments. The system carries a Class I, Division 1 & 2 (Class I, Division 2 panel assembly); Class I, Zone 1 & 2; and Class II, Division 1 & 2 ratings. A Group B rating allows the LED strobe light to be used in facilities where combustible gas and liquid-produced vapor can be found, such as hydrogen plants. The EPSLED-HBNM-SOL-80C-C1D2-20C is equipped with a Class I, Division 2 rated solar panel, which provides power to four, 12V 18aH sealed lead acid batteries. The power cell components are located inside of the panel and not the light. Operators may mount the panel outdoors for maximum exposure to sunlight. Included with this unit is a heavy-duty 80ft 10/2 SOOW cord, connecting the explosion proof solar panel and batteries to the explosion proof LED strobe light. The explosion proof LED strobe lamp is a compact, 10W device for signaling in flammable facilities. Featuring a strobe count of four seconds, the fixture offers 1,050 lumens of light during use. A 360° beam angle and strobing flood configuration ensures maximum visibility in the work site. Color choices include red, green, blue, amber, or white. Mounting options include ceiling, wall, or pendant. This solar-powered, explosion proof LED strobe light offers automated functionality and features for hands-free operation. Day-night sensing turns on the LED strobe lamp after sunset and turns off the unit at sunrise. Motion sensing features activate the explosion proof LED strobe fixture upon detecting movement within the range of the sensor. Suitable for wet environments, the EPSLED-HBNM-SOL-80C-C1D2-20C complies with UL 844, UL 1598 (Marine Type) and CSA C22.2 No. 250/137.

Larson Electronics LLC | www.larsonelectronics.com



Modular, scalable inverter solution for large-scale ground mount projects

SMA America's new Sunny Highpower PEAK3 inverter fulfills the increasing need for flexibility, simplicity, and performance in large-scale solar projects. Designed for larger distributed generation and utility-scale projects, the Sunny Highpower PEAK3 incorporates SMA's latest inverter technology. Using the PEAK3 inverter as a modular building block, customers benefit from a scalable, cost-effective 1500VDC solution for large-scale ground mounted solar installations. The Sunny Highpower PEAK3 is available in two models. The 125kW / 480VAC version can be used for interconnection to standard behind-the-meter commercial services, and the 150kW / 600VAC version offers a cost-effective solution for large projects with dedicated interconnection. Utilizing the Sunny Highpower PEAK3 inverter, plant developers will have a cost-effective, flexible building block providing scalability while reducing balance-of-system and installation costs. Sunny Highpower PEAK3 inverters are eligible for the SMA Smart Connected service, which offers proactive monitoring and O&M support which reduces plant servicing time and costs while maximizing system uptime, energy yield, and ROI. Plant communications with the inverter are supported by the SMA Data Manager powered by ennexOS, SMA's cross-sector energy management platform, providing an optimized interface for plant commissioning as well as intelligent monitoring and controls required in large-scale PV systems.

The SMA Group | www.sma-america.com



Affordable solar systems for smaller applications

Morningstar's new Essentials Series takes the technology and performance of the Professional Series and scales it to smaller, more price-sensitive systems and applications, in products offering more basic features. The Essentials Series is a solution for solarizing small vacation cabins, RVs for caravanning, and marine use with 'solar at sea'. In developing areas, Essentials charge controllers will also bring Morningstar solutions within reach for rural electrification projects as well as agricultural, lighting, and security applications around the world.

Morningstar Corporation
www.morningstarcorp.com

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Exclusive ground screws

APA has secured an exclusive U.S. distribution agreement for their APA Ground Screws which are available with APA racking or can be fitted with other ground mount and tracker systems. The ground screws are designed to APA's in-house engineering specs and backed by APA's quality guarantee. Customers will work directly with APA for all orders. APA will manage the entire process for in-house application testing, loading engineering, volume ordering, and inventory. The ground screws are available with standard depths of 40", 61", 73", and 85" to accommodate frost depths around the country. APA's standard screw diameter is 2.35" for better drivability, and a low cost point. Additional diameters up to 4.5" are available. APA's ground screws are designed with heavy wall tube, welded connections, hot dipped galvanized coating, and a forged tip, and are backed by APA's guarantee. These features allow massive amounts of torque and down pressure to be applied, penetrating the toughest soils. The APA Ground Screw is a solution for all APA racking systems and can easily be outfitted for other racking systems using either the set screw or flange connection. The ground screws are easy to install with a skid loader or mini excavator with an auger attachment or a pile driving rig with a rotary head.

APA Solar Racking
www.apalternatives.com



Optimized two-pole 1500VDC switch for UL and IEC solar industry

ABB has launched a fully optimized two-pole DC (OTDC) switch-disconnector for 1500V utility-scale photovoltaic power plants covering 315-630A IEC and 250-600A UL current range. The new design offers both a size reduction and an increase in efficiency and performance to help manufacturers of PV combiner boxes, inverters, and energy storage systems adapt to the industry's rapid adoption of 1500VDC solutions. The two-pole 1500VDC concept helps manufacturers improve system efficiency, reducing switch losses by up to 35%. Measuring just 150mm wide and 122mm high across the current range, the compact size of the new OTDC range makes it possible for manufacturers to reduce the size of combiner boxes and inverters. ABB's design makes it possible to operate up to two 1500VDC strings with just one switch. In addition to the standard connections, the OTDC's modular design also makes it possible for ABB to fulfill the non-standard requests that come from the quickly changing solar market. The OTDC range is a family of robust switch-disconnectors, designed for photovoltaic and Battery Energy Storage Systems (BESS) applications. The range is tested according to the UL, IEC and CCC standards to withstand the extreme outdoor conditions and sudden temperature changes that are usual in a solar farm.

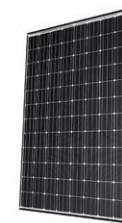
ABB | www.abb.com



Four-module 1200W microinverter

APsystems unveils the QS1, a four-module, single phase microinverter for residential applications which offers a 75% reduction in installation time, while providing high peak output power and up to 3X faster data transmission speed than PLC. A wide MPPT voltage range will result in a great energy harvest for homeowners. The QS1 is designed to accommodate today's high output PV panels up to 375W, offering 300W AC output per channel. The unit also reduces installation time and costs, taking the place of four conventional microinverters per each QS1 installed while still providing four independent MPPT. The QS1 utilizes a common AC trunk cabling with the dual-module YC600, offering flexible mix-and-match compatibility on the same circuit to enhance site design capability and maximize circuit capacity. Both microinverters also utilize the same gateways; installers can choose from the ECU-R, for single or multi-residential installations, or the ECU-C, for applications requiring consumption monitoring and advanced contact/relay features. A 2.4GHz wireless Zigbee mesh network offers enhanced data transmissions speed. The QS1 builds on APsystems' line of multi-module microinverters, offering reduced logistics costs, integrated communication and connection features, and a wide MPPT voltage range for greater energy harvest during low light conditions.

APsystems | www.apsystems.com



Increasing solar power module efficiency for homeowners

Panasonic Eco Solutions of North America unveiled new high-efficiency HIT series solar modules that offer increased module efficiency at high temperatures, enhanced module design, and durable long-term performance. The expanded Panasonic Photovoltaic HIT portfolio of 96-cell, 40mm modules include the N340/N335 HIT+ Series with 20.3/20% module efficiency, and the N335K/N330K HIT+ BLACK Series with 20/19.7% module efficiency, expected to be available in the U.S. in 2019. New HIT series module features also include; high module efficiency that enables higher power output and greater energy yields, a new 40mm frame designed to increase durability and strength, with the ability to handle loads of up to 5400Pa. Additionally, the module's enhanced design features a water drainage system providing rain water and snow melt a place to go, reducing water stains and soiling that enables sunlight to get through to generate more power, low degradation with HIT "N-type" cells, which result in Low Light Induced Degradation (LID) and zero Potential Induced Degradation (PID) to support reliability and longevity. This technology reduces annual degradation to 0.26% as compared to 0.70% in conventional solar modules, and a 25-year comprehensive warranty that covers module performance and workmanship.

Panasonic Corporation of North America
www.panasonic.com



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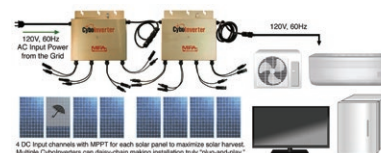
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AC assisted off-grid solar inverters

CyboEnergy, Inc. has developed a family of AC assisted off-grid CyboInverters that can run almost any kind of AC loads including air-conditioners, refrigerators, EV chargers, pumps, motors, appliances, lights, fans, TV, computers, etc., without batteries. This product allows a battery-less off-grid solar system to start and run heavy loads 24/7 with consistent performance under DC and AC power variations and load changes. It is well suited for areas such as California, Hawaii, Europe, and Caribbean Islands where electricity is costly, yet on-grid solar is no longer welcomed due to grid capacity limitations.

CyboEnergy | www.cyboenergy.com



Multifunction meter reads multiple electrical systems

Facility managers can easily measure and monitor power quality and demand via six critical parameters of their electrical systems with the VCFP96M Multifunction Meter from ATC Diversified Electronics. It is a complete single-phase and three-phase digital metering system, suitable for low-, medium-, and high-voltage control panels, gensets, load banks, building management systems, and power management systems. The VCFP96M can be used on single-phase, three-phase three wire, as well as three-phase four wire balanced or unbalanced systems. The six easy-to-access front control keys are used for scrolling up or down through the parameters being measured and displayed. They include voltage, current, power factor, power (active, reactive, apparent), energy, and frequency. The VCFP96M multifunction meter is permanently installed into the panel box. Output specifications include pulse output and RS485 Modbus RTU communication protocol compatible with PC, PLC, RTU, data loggers, and SCADA programs. The VCFP96M is available in a 96mm x 96mm housing (front panel IP65) with red LED display for easy viewing in a variety of conditions. It features an easy to read display with four rows, LCD backlight, and a convenient bar graph for current representation.

The Marsh Bellofram Group of Companies

www.marshbellofram.com



New inverter for utility-scale PV

The blueplanet 125 TL3 is available on all major global markets from November 2018. KACO new energy's new flagship is suitable for large solar parks and high technological demands. It meets the climatic conditions in very hot and marine regions, has an input voltage of 1500V and relies consistently on silicon carbide (SiC) semiconductors.

KACO new energy

www.kaco-newenergy.com



Half-cut cell module

The new high-density module technology from Vikram Solar is engineered to generate more power from advanced mono-PERC half-cells, thus achieving better Levelized Cost of Energy (LCOE). The innovative design principle minimizes shadow-loss through a series-parallel cell connection, when one-half of the modules are affected by shading. The high efficiency half-cell modules are a solution for all utility and rooftop projects. The new solar module consists of 144 and 120 half-cells instead of 72 and 60 full cells, yet keeps nearly the same dimension as standard 72 and 60 cell modules. It provides high energy yield through lower cell resistance. Half-cell modules have a high fill factor and high efficiency. The cells are cut with low temperature and lower kerf depth, maximizing cell yield with no junction damage. Module power mismatch loss is reduced by a factor of four as power loss is proportional to the square of the current. There is no hotspot degradation on the modules and the split junction box provides better heat dissipation, which improves the life of the module.

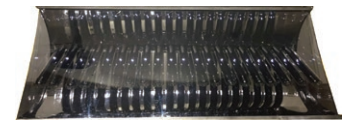
Vikram Solar | www.vikramsolar.com



Wind-load analysis method for solar trackers

RenewSys launches a PV Module Soltec presents Dy-WIND, a method for comprehensive dynamic analysis in tracker wind-design. To develop Dy-WIND, Soltec has teamed up with the engineering consultancy Rowan Williams Davies & Irwin Inc (RWDI), which specializes in wind engineering projects. RWDI already has the expertise and wind tunnels that use stereolithography technology, integrated data acquisition, storage and processing systems, computer-aided drafting, and a broad base of specialized instrumentation. Dy-WIND analysis is applied to tracker wind-design for accurate modeling that leads to precise manufacturing processes. This allows accurate economic calculations regarding the profitability and robustness of a solar tracker plant. The hybrid experimental-numerical approach accurately estimates tracker behavior under the action of wind in multi-row arrays, and allows flexibility in the design process that is generally not practical through full aeroelastic model testing.

Soltec | www.soltec.com



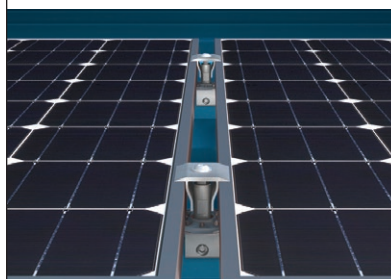
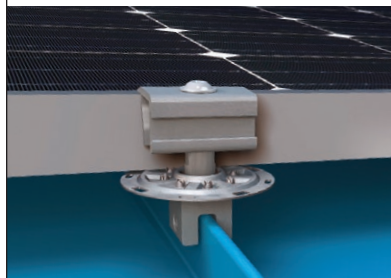
New thermal solar collector

Solar Hybrid Technology Corp's products use reflective mirrors to increase the sunlight and double the power of the solar collector. Solar Hybrid Technology new products are all stainless steel and used for residential, commercial, and industrial facilities. The new products are for high temperature applications and used for distillation, hot water, swimming pool, heating, and air conditioning. These solar collectors offer double the efficiency with higher temperature, less real estate, and less cost. They are protected against hail and snow, and are self-cleaning for max efficiency. The tank, lamps, reflector, and base are all in one unit so there is no need for elevated cold-water tank. The base provides for latitude adjustment and the focal point moves along the lamps with the change of seasons. The 20sq/ft absorber area has a reflector on the bottom and top allowing for continuous all year sun tracking without any moving parts. Available options are insulated water tank or heat exchanger, and different lamps and coatings.

Solar Hybrid Technology Corp.
www.solarhybridtechnology.com

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IMPROVED DESIGN. EASIER TO INSTALL.

S-5!® has introduced a new and improved PV Kit, boasting lower installation time and cost for PV flush-mounting. The kit comes preassembled with both MidGrab and EdgeGrab for easier and more efficient installation. A single tool drives the top bolt, eliminating several installation steps. The PV Kit 2.0 features more aggressive bonding teeth for better grounding. Fewer lugs/ground wires required.

- Pre-assembled components save time and money
- Only one tool needed for installation
- Bolt head uses standard hex bit tip which is provided
- Improved single piece EdgeGrab installs with ease
- Low profile bolt head provides a flush, clean finish
- Also available in black by special order
- One inch gap between modules, allowing load reduction per ASCE7
- UL 2703 Listed

The Right Way!™ | www.s-5.com | 888-825-3432



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 18



EKO Instruments USA

Product: MS-80, Secondary Standard Pyranometer

Voltage: mV Output (12-24Vdc Supply for 4-20mA and Modbus Versions)

Current: 4-20mA and Modbus Output

Power: 4-20mA (0.5W max) Modbus (0.3W max) Heater (7W) Ventilator (2W)

Frequency: <0.5 s Detector Response

Warranty: 5-year warranty

Logging Values: Solar Irradiance Measurements

Certifications: ISO 17025 Accredited Calibration, IEC61724-1 Class A Requirements

Key Features:

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

www.eko-usa.com

SEE AD ON PAGE 16



Continental Control Systems, LLC

Product: WattNode Energy and Power Meters

Voltage: 120/208-240V – 347/600V

Current: 5 amps – 6000 amps

Frequency: 50/60 Hz

Warranty: 5-year warranty

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

Key Features:

- Revenue-grade production and consumption energy metering;
- Single-phase, split-phase, three-phase kW / kWh sub metering;
- Modbus, BACnet, LonWorks, and pulse output;
- Low-cost, small footprint.

www.ctlsys.com

Energport Battery Energy Storage System

ESNA Booth: 1612

Driven By *Sinexcel*

AC RACK L3060



- 30kW Sinexcel PCS
- 64.5kWh Battery
- LFP Li-ion Battery
- Small footprint
- Easy install
- EMS included
- Remote monitor
- 480V 3p
- ETL Certified
- CA SGIP Approved

- Demand Charge Bill Savings
- PV Self-Consumption
- Backup Power for Emergency
- Turnkey Solutions
- In Stock Now in Bay Area
- Dealer / Installer Wanted
- 10 Year Warranty

Storage Inverters 30~500kW

- cETLus listed according to UL9540/UL1741SA/CSA22.2
- HECO CGS/CSS listed
- CPUC listed
- Grid-interactive & Grid-forming

Outdoor Commercial & Industrial Battery Energy Storage Solutions



Sinexcel Inc.

<http://www.sinexcel.us/>
henry@sinexcel.us

Energport Inc.

<http://www.energport.com>
info@energport.com



meteocontrol North America, Inc.

Product: blue'Log datalogger

Voltage: 24V

Current: 208mA

Power: 5W

Warranty: 2-year warranty

Logging Values: Polling Inverter Parameters, Meter Data, Weather Sensor Data, Combiner Box Data

Certifications: CE, UL certified

www.meteocontrol.com



NEXTracker

Product: TrueCapture

Warranty: Lifetime technical performance guarantee, closed loop performance feedback

Certifications: ITC/MACRS and Tax Equity Qualified, Independent Engineering Verified, Project Specific Bankability Reports Available, NERC-CIP Certified Network Communication Architecture

www.nextracker.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



GroundWork Renewables

Product: Albedo Measurement

Voltage: 12V

Current: 113mA max, 19mA standard

Power: 1.37W max, 0.23W standard

Frequency: LTE

Warranty: 5-year warranty

Logging Values: GHI, RHI, Albedo, Ambient Temp, and GPS

Certifications: Secondary Standard

www.grndwork.com



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



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



Navitus Strategies

Product: Navitus EC View
Application: Commercial
Description: Navitus Strategies EC View energy monitoring and distributed energy sizing software assists commercial and industrial clients with monitoring their energy use, verifying their interval use data, and calculating the right size battery storage banks for their facilities. EC View then provides dashboard control for the client for their energy storage installation including the ability to optimize self-consumption of stored battery bank electricity.
www.navitusstrategies.com



Phoenix Contact

Product: SOLARCHECK
Voltage: Up to 8x 0-1500Vdc
Current: Up to 64x 0-20Adc
Power: Externally calculated
Warranty: Lifetime limited warranty
Logging Values: Modbus communications for external logging
Certifications: cULus Listed (UL 508 A), UL Recognized (UL 1741)
www.phoenixcontact.com/us



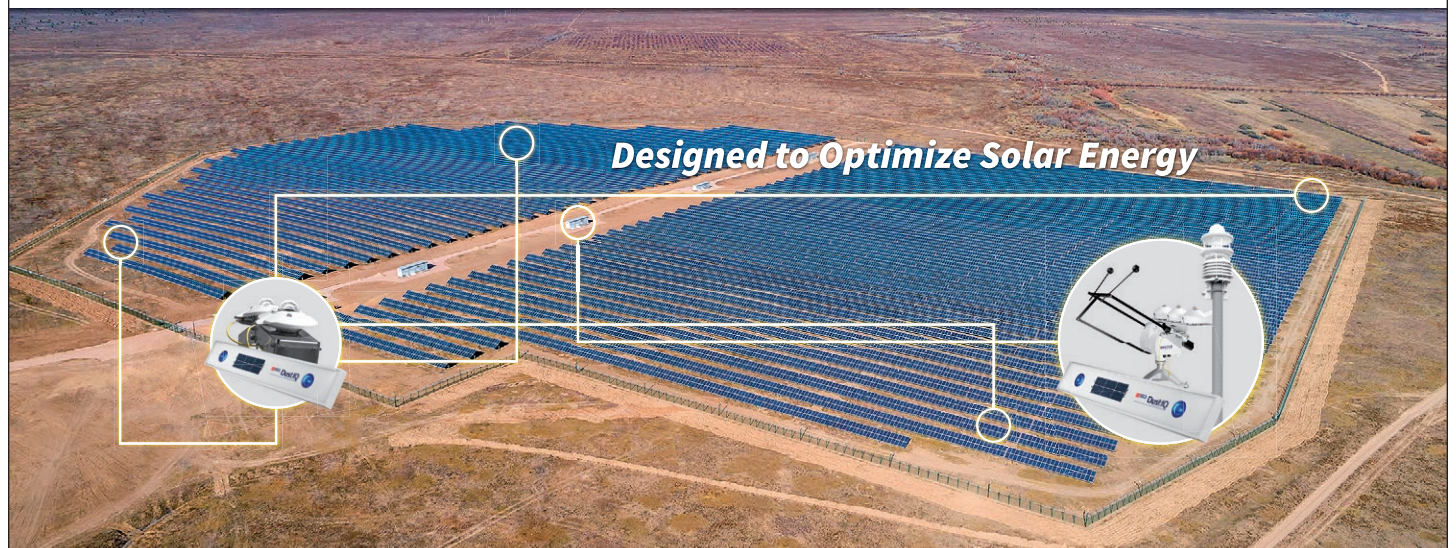
Solar Analytics

Product: Solar Analytics Monitoring
Voltage: Measured 50 to 280Vac
Current: 60 to 600A CTs
Power: Real power: 1% of reading from pf 0.8 leading to 0.5 lagging; Reactive power: 2% below 0.5 lagging
Frequency: 45 to 65Hz, 0.01Hz
Warranty: 5-year warranty
Logging Values: Power, voltage, current, power factor, reactive power, reactive energy, frequency
Certifications: PTCRB Approved, Safety IEC60950
www.solaranalytics.com



SolarEdge

Product: SolarEdge Cloud-Based Monitoring Platform
Voltage: Fixed voltage inverter
Warranty: Inverters have 12-year warranty, extendable to 20-years and Power Optimizers have 25-year warranty, monitoring portal is free for 25 years
Certifications: Inverters: UL1741, UL1699B, UL1998, CSA 22.2, IEEE1547, FCC part15 class B. Power Optimizers: FCC Part15 Class B, UL1741, RoHS, ANSI C12.20 with revenue-grade meter
www.monitoring.solaredge.com



The amount of solar radiation reaching your power plant cannot be changed; however, you can make the most of it by choosing high quality equipment. Not only by selecting efficient generating technologies, but by installing the industry's best instruments to monitor the environmental parameters affecting your solar energy project performance.

Whether it is to optimize yield, manage your assets, make investment decisions, schedule plant maintenance or to forecast the energy output reliably, we offer the instruments you need. From Kipp & Zonen smart pyranometers and Lufft weather stations, to the unique new DustIQ for continuous monitoring of module soiling, we have it all.

www.kippzonen.com/energy



Hukseflux

Product: SR15-A1
Voltage: 12Vdc
Current: 125mA
Frequency: 285 - 3000 nm
Power: 1.5W (for dome heater)
Warranty: 5-year warranty
Logging values: 0 - 50 mV (0 - 3000 W/m² max)
Certificates: ISO 9060 First Class - WRR traceable
www.hukseflux.com

SEE AD ON PAGE 27



Lufft

Product: WS510 multiparameter weather sensor

Voltage: 24Vdc, 12Vdc

Current: 145mA @ 24Vdc, 85mA @ 12Vdc

Power: Without heating 3.5W; with heating 24W

Warranty: 2-year warranty

Logging Values: Up to 119 channels can be logged

Certifications: IP66 Certificate, EC Certificate of Conformity

Key Features:

- All-in-one body is easy to install, only 1 mount needed;
- Key PV parameters collected via Modbus RTU output;
- No moving parts means nearly maintenance-free operation;
- Fan-aspirated air temperature meets $\pm 1^\circ\text{C}$ IEC standard at $\pm 0.2^\circ\text{C}$.

www.lufft.com

SEE AD ON PAGE IFC



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



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



Yaskawa - Solectria Solar

Product: SolrenView Web-Based Monitoring

Voltage: 12-24Vdc

Current: 1 channel

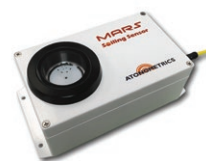
Power: 120v

Frequency: 60 Hz

Warranty: 10-year warranty

Logging Values: kWh, W, A, V

www.solectria.com



Atonometrics

Product: Mars Soiling Sensor

Frequency: Daily

Warranty: 1-year warranty

Logging Values: Soiling ratio

Certifications: CE

www.atonometrics.com



LI-COR Biosciences

Product: LI-200R Pyranometer

Warranty: 1-year parts and labor warranty

Logging Values: W/m^2

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

www.licor.com/solar



Socomec

Product: DIRIS Digiware

Voltage: Up to 400,000Vac

Current: Up to 7200A

Frequency: 50-60 Hz

Warranty: 18-month warranty

Logging Values: FIFO type, no limit

Certifications: UL 61010 Guide FTRZ File E257746

www.socomec.com



Campbell Scientific

Product: Meteopv Solar Resource Platform

Voltage: 9 to 30Vdc or Power Over Ethernet

Current: 30mA

Power: ~30mA at 12Vdc

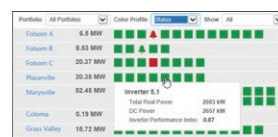
Warranty: 1-year warranty

Frequency: 1-second sample rate with 1-minute and 10-minute data storage

Logging Values: Solar Irradiance, Module Temperature, Wind Speed, Wind Direction, Air Temperature, Relative Humidity, Barometric Pressure, Sensor Metadata

Certifications: IEC 61000-4-2 Class 4 EMC Immunity, Modbus RTU, Modbus TCP/IP

www.campbellsci.com



Trimark Associates, Inc.

Product: Vantage

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

Description: Trimark Vantage HMI is a scalable and flexible visualization tool that provides real-time SCADA information and data from inverters, trackers, meters, weather stations, and substation equipment to determine if equipment at PV sites is operating and performing at expected levels. Operators can monitor and control performance for individual devices, a site, or an entire portfolio all in a single, intuitive dashboard. Users can customize thresholds, alarms, dashboards, and reports to quickly assess PV performance and power generation.

www.trimarkassoc.com



Tigo Energy, Inc.

Product: Tigo SMART Monitoring Website with Reclaimed Energy

Application: Residential, commercial, industrial, utility

Description: Tigo's SMART website is a module-level online monitoring system that manages residential and C&I PV systems with visibility into system analytics and tracks production, sends alerts, and suggests maintenance actions to keep systems operating efficiently. Tigo's SMART website can remotely power-off each module, eliminating high voltage for maintenance or safety issues. Tigo customers utilizing monitoring can also see the Reclaimed Energy recovered by Tigo's TS4 optimizers - the amount of extra kilowatt hours that a PV system with TS4 has harvested. This feature is displayed with the Total Energy so system owners can calculate the ROI by year, month, day, hour, or minute.

www.tigoenergy.com



SOLAR POWER MIDWEST

November 14th-15th, 2018
McCormick Place — Chicago, IL

New this year - Solar Power Midwest is co-located with Greenbuild International. Over 18,000 architects, developers, engineers, and solar and storage installers are going to meet at the McCormick Place in Chicago. The schedule includes access to the Greenbuild opening plenary, alongside the Solar Power Midwest general session, workshops, and networking events.
events.solar/midwest/

show in print

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



PV racking designs and solutions

TerraGen Solar is a solar PV mounting system engineering and manufacturing supplier focused on client relationships and continuous improvement to develop PV racking designs and solutions. To date, TerraGen has supplied racking solutions including their standard TGR flat roof ballasted system, their TGT tilted pitched roof system, their TGP flush mount system, carport and ground mount systems, and custom designs for various customers. TerraGen is able to overcome site-specific challenges and offer solutions to the market with their experience in manufacturing, engineering, construction, project management, and solar power plant design.

TerraGen Solar
www.terragensolar.ca



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



Aluminum alloy standing seam clamps

SunModo's EZ standing seam clamps make solar PV installations on metal roofs easy. Featuring rust-free aluminum alloy and roof-safe oval end set screws, the clamps work on a wide variety of seam profiles. The set screw of the 1" EZ Standing Seam Clamp can be installed on either the vertical leg of the clamp or on the 10-degree leg of the clamp. The 2" EZ Standing Seam Clamp installs in situ at the desired seam attachment location. No more sliding the clamp up the roof line with this two-part assembly.

SunModo Corporation | www.sunmodo.com



Integrated, high power smart modules

Panasonic and SolarEdge Technologies, Inc. recently introduced the HIT S Series Smart Module Optimized by SolarEdge, which represents the integration of advanced solar technology designed to simplify and accelerate installation, and deliver more power to homeowners. The HIT S Series Module is expected to be available in the U.S. in early 2019.

Panasonic Corporation of North America
www.panasonic.com



Inversion technology with design flexibility

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


Fronius | www.fronius-usa.com



Solar wire management clip

Nine Fasteners highlights their newest solar wire management clip; NFI-1701. The NFI-1701 was designed in conjunction with Enphase Energy for use with IQ series of microinverters. This clip is a rail mounted solution capable of securing one or two IQ cables to the rail. It is also capable of holding one or two standard gauge PV wires. The clip, as with Nine's entire product line, is manufactured right here in the U.S. Constructed out of .025" thick 301 1/2 hard stainless steel material and incorporating a rolled outer edge for maximum wire safety. The NFI-1701 is UL Listed for use within solar installations.


Nine Fasteners | www.ninefasteners.com





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THE INDUSTRY'S LIGHTEST AND MOST UNIVERSAL FIT

1 DEVICE FITS OVER 500 DIFFERENT SEAMS





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Patent Number: US D629.679
www.standingseamroofanchor.com

Watch for more deals/messages, up to 4 messages per month. Data/Messaging Rates may apply. Purchase/Consent not required to participate. Reply HELP for help or STOP to stop.

SOLAR POWER NEW YORK

December 13th-14th, 2018

The New York Marriott at The Brooklyn Bridge — New York, NY

Tapping into one of the top 10 solar markets, Solar Power New York is an event for solar policy updates and opportunities to network with regional companies for New York State. The 2017 event drew 400 attendees, over 25 exhibitors, and featured interactive education focused on the changing landscape, obstacles, and policies that are impacting the industry in New York.

events.solar/newyork/

show in print

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



High power producing solar tracker systems

GameChange Solar's single axis Genius Tracker provides high power production and low O&M cost. Additional Owner offerings include the technologically advanced WeatherSmart and PowerBoost. Installers will benefit from advanced design innovations with SpeedClamp, QuikClamp, and pre-assembled components. GameChange Solar also offers fixed tilt pile driven, ballasted ground and roof solar racking.

GameChange Solar

www.gamechangesolar.com

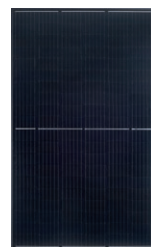


High efficiency AC modules (ACMs)

Panasonic and Enphase have unveiled the N330E HIT AC Series with Enphase IQ 7X, an all-in-one smart module that features built-in-intelligence with an integrated Enphase IQ 7X microinverter, enabling accelerated installation, lower costs, and more solar power. Additionally, the integrated Enphase microinverter is field-replaceable, removing the need to replace the entire solar module and yielding operation and maintenance costs savings that maximize return on investment (ROI) for homeowners. The N330E HIT AC Series is expected to be available in the U.S. in early 2019.

Panasonic Corporation of North America

www.panasonic.com



High performance PV cell technology

The Q.PEAK DUO BLK-G5 from Q CELLS has an aesthetic visual appearance and provides high performance on a small surface due to its Q.ANTUM DUO technology. Q.ANTUM's cell concept has been combined with circuitry half cells and a six busbar design, providing high performance under real conditions, with low-intensity solar radiation, as well as on hot, clear summer days. With power classes up to 320W on an all-black design, it is a solution for residential rooftops. Hanwha Q CELLS also provides a 98% power guarantee during the first year, and less than 0.54% annual degradation afterwards, with a 25-year degradation of lower than 15%.

Hanwha Q CELLS

www.q-cells.com/us



Penetration seal system simplifies solar installations

Chem Link, formulator and manufacturer of high-performance adhesives, sealants, coatings, and related products for application throughout the building envelope, announces the new 5" E-Curb penetration seal system, the newest size offering in the full E-Curb line of products. This new size allows contractors flexibility to create a durable, waterproof rubber seal around penetrations and extends Chem Link's current E-Curb offering for both steep and low slope roofs. Designed to better fit contractor needs, light-weight E-Curbs feature interlocking "slip-fit technology," which allows for quick assembly and easy installation. E-Curbs are designed for use on granulated modified bitumen, asphalt and coal tar built-up roofing applications, as well as PVC, PIB, and TPO single-ply roofing membranes.

Chem Link | www.chemlink.com

Kinetic
SOLAR RACKING AND MOUNTING

- Commercial and residential solutions
- Flat roof pitched roof and ground mount

www.kineticsolar.com



Technical services for solar assets

PV Pros provides nationwide technical services for investors and asset managers. Their team of professional engineers, licensed electricians, and NABCEP technicians manage their customers' technical needs and specialize in commercial and small utility solar PV projects. They offer Owner's Engineer and Operation & Maintenance services across the United States.

PV Pros | www.pvpros.com



Image provided by AMSOIL, Inc.
AMSOIL, Inc. | www.amsoilwind.com

2019 WIND BUYERS GUIDE

DIRECTORY

ADHESIVES, SEALANTS,
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ALUMINUM EXTRUSION
& METAL FABRICATION
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& REPAIRS
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LIGHTNING & SURGE PROTECTION

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WIND ASSESSMENT | FORECASTING
YAW, PITCH & BLADE SENSORS

OTHER
Balance of Plant
Core Materials
Economic Development
Electronic Component, Service Repairs
Labor Trade Association
Legislative & Regulatory Affairs
Met Towers
Precast Trench & Boxes
Rescue & Safety Training
Track Conversion
Ventilation & Cooling
Wind and Solar Measurement
and Consulting Services

Adhesives, Sealants & Surface Treatment



3M Wind Energy

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

www.3M.com/windenergy



American Polywater Corporation

Polywater products increase electrical reliability by keeping water, rodents, snakes, and insects from entering electrical equipment. Polywater InstaGrout is safe to use, won't collapse, and doesn't need water to mix. InstaGrout flows around conduits in transformers, sectionalizing cabinets, combiner boxes, and inverters to seal the windows and preventing intrusion in the structure. Polywater FST sealant seals conduits to prevent water, gases, and animals from passing through conduits causing outages. FST stops 22ft of water head pressure, is gas tight, and is re-entenable. Polywater has the right cleaners for medium voltage splicing, live line insulating tools and rubber goods, and up tower maintenance.

www.polywater.com



GS Manufacturing

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

www.gsmfg.com



H.B. Fuller Company

H.B. Fuller's high strength structure adhesives require little or no surface preparation. Five to nine minutes for fixture time, and reaches 80% ultra-strength in 20 minutes. This product achieves high strength of thermal aging, good toughness, and an easy-to-peel adhesive layer with high impact and peel strength. High strength structure adhesives offer resistance to environmental conditions as well as high tolerance to off-ratio mixing.

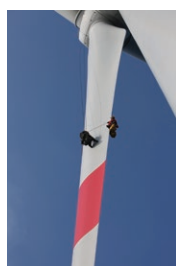
www.hbfuller.com/engineering-adhesives



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



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, Sika Wind Repair products are available in easy, ready-to-use packaging so there is no field mixing required.

www.sikaindustry.com/wind

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



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



HellermannTyton

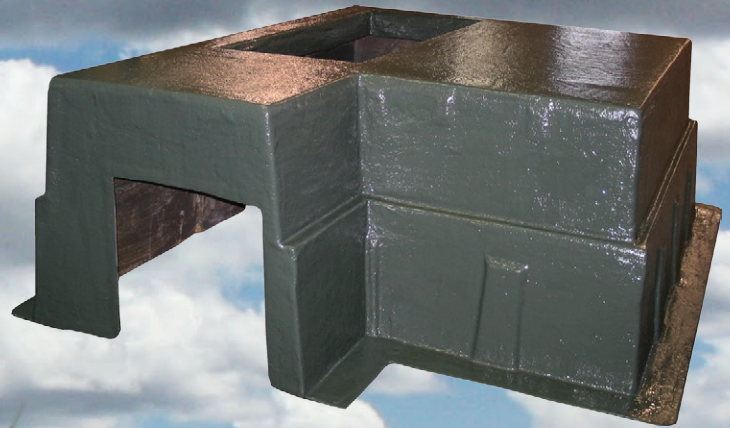
The UL Listed Ratchet P-Clamp delivers cable management performance in a wide range of environments. Wind farm operators are sensitive to the costs associated with repairs and routine maintenance, especially in tight spaces and under challenging conditions. Ratchet P-Clamp is a flexible cable management 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

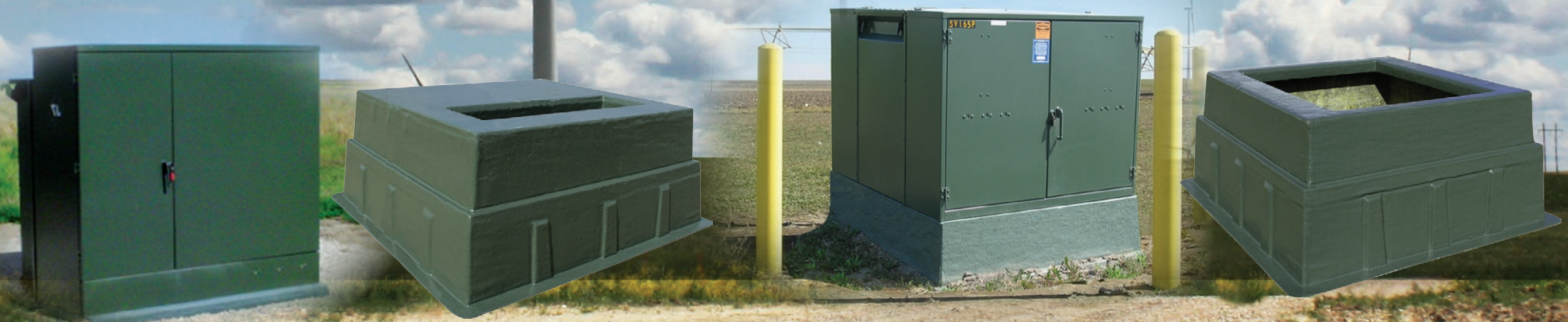
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35kV Junction Cabinets Protect Your Cable Components



Chuted Box Pads Support Your GSU Transformers



Box Pads Support Your Grounding Transformers & Switchgear



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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. They can be purchased in black or white, standard, or extreme duty, and multiple lengths.

www.ntcwind.com

Blade | Tower Manufacturer & Repair



LM Wind Power A/S

Capturing the wind in remote places, in all types of weather, calls for reliability. LM Wind Power's wind turbine blades are advanced creations: designed, manufactured, and validated with refined tools to ensure they can endure the forces of nature for more than 20 years. Technology plays a central role in the design of each wind turbine blade type, taking into account several factors such as materials, aerodynamics, blade profile, and structure. These factors define the performance and reliability of the blade and require a high degree of precision.

www.lmwindpower.com



MFG Texas

MFG Texas in Gainesville manufactures made to order composite components and provides year round in-factory repair and refurbishment services for blades. Their services include; factory repair of damaged turbine blades; blade reconditioning and repowering, including new lightning protection and tip extensions; recoating blades and leading edge coat protection; made-to-order replacement balance boxes, close-out platforms and flanges, root-band covers, flex brackets, hatch covers, and other components; and made-to-order edge protectors for lifting and transportation operations.

www.mfgtexas.com



MFG Wind Energy Services

MFG Energy Services provides wind blade maintenance and repair, wind blade inspection, as well as in-factory and field composite component (blades, nacelles, spinners) repairs.

www.mfgenergyservices.com



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



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



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

www.ctcglobal.com



HELUKABEL USA

HELUKABEL's HELUWIND WK line of copper and aluminum cables are made to be used throughout the turbine: rotor tip to the power grid. HELUKABEL offers an array of copper power cables, fiber optic and copper data cables, and communication cables to monitor the multitude of sensors in the nacelle. HELUWIND WK cables have been rigorously tested to withstand more than 15,000 torsion cycles. Their UL/CSA, CE, and VDE-listed aluminum and copper cables down tower cables are rated up to 35kV. An extensive connector range, which allows copper to copper, aluminum to aluminum, and aluminum to copper connections, ensures that HELUKABEL can provide the proper fit, no matter the conductor material used.

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. Prysman 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.

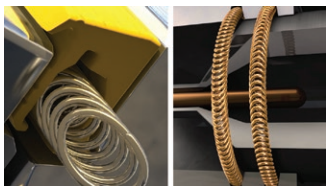
www.amroll.com



Anderson Power Products

Solar SPEC Pak is a multi-pin connector meeting the photovoltaic industry requirements specified in UL 6703A. It has power handling capabilities up to 1000V and features a locking latch that complies with NEC 2008 section 690.33 (C) requirements. Designed for wire to wire applications, Solar SPEC Pak is capable of handling up to 4 individual lines which reduces the number of traditional connectors needed in solar applications, minimizing the amount of space needed while lowering installation costs.

www.andersonpower.com



Bal Seal Engineering, Inc.

Bal Seal Engineering, Inc. works with OEMs and tier suppliers to design and produce sealing, connecting, conducting, and EMI shielding solutions which improve the performance and reliability of equipment used in wind, solar power, and other alternative energy production. Their solutions enable engineers to protect critical parts and systems, design more compact, efficient electrical connectors, and ensure consistent current and signal transmission.

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



RAD[®]

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ADVANCED BOLTING TECHNOLOGY

Light - Unsurpassed power-to-weight ratio

Accurate - Designed to provide a high degree of accuracy (+/-2.8%) and repeatability (+/- 2%)

Fast - Decreased tightening times by up to 300%

Quiet - Operates at 75 db reducing noise level

With torque ranges up to 15,000 Nm, the E-RAD BLU uses a patented gearbox design and the precision of an electric AC Servo motor. These tools deliver smooth continuous torque and are capable of torque and angle sequence. They also feature enhanced traceability with data collection.



WWW.RADTORQUE.COM

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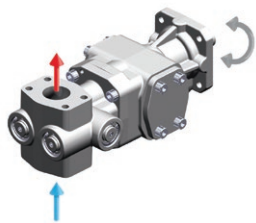
E-RAD BLU



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



KRACHT CORP.

KRACHT CORP. is a subsidiary of KRACHT GmbH in Germany. KRACHT, is a medium-sized, family-run business with 425 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, Senvion, 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.bbgroup.ca



Lightning Bolt and Supply

Lightning Bolt offers a wide selection of ISO-DIN-EU fasteners that are commonly used in the wind turbine industry.

www.lightningboltandsupply.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 lightweight, 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.

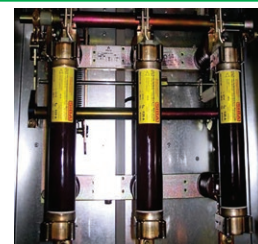
www.motionindustries.com



Nordic Fiberglass Inc.

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

www.nordicfiberglass.com/wind



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.siba-fuses.us



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



United Equipment Accessories, Inc.

UEA is an international manufacturer located in Waverly, Iowa. Their product lines include slip rings, hydraulic swivels, cable reels, and shift controls for a variety of industries and applications around the world. Founded in 1952, UEA is a family-owned company which solves problems through innovative design and manufacturing solutions. UEA is ISO 9001:2008 Certified for quality control throughout the entire company and is able to create custom solutions for each of their customers.

www.uea-inc.com



WECS Renewables

WECS Renewables provides substation equipment, balance of plant, electrical controls, as well as electrical, hydraulic, and mechanical devices.

www.wecsrenewables.com

Condition Monitoring

bachmann.



Bachmann Electronic

Bachmann integrates its condition monitoring solution in the automation and links the measured values to other operating parameters. This increases the diagnostic reliability of the condition monitoring; fault patterns can be compared to the current operating situation and interpreted with greater accuracy. A systematic control enables mechanical loads to be reduced. In this way, adjusted operating conditions can extend the lifespan of partly damaged parts up to the next plannable maintenance date. Besides the hardware and software, Bachmann's system offering includes worldwide Monitoring Service to evaluate the measured data collected with the CMS module in extensive analyses.

www.bachmann.info



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



LUDECAwind

The EASY-LASER alignment systems are specially configured with functionality and hardware suited for wind turbine alignment. No matter the manufacturer, coupling, or turbine type, EASY-LASER makes generator-to-gearbox alignment inside any nacelle easy. The EASY-LASER flange systems are a solution for measuring flatness on tower flanges regardless of diameter, as well as for solving flange deformation problems.

www.ludecawind.com

Construction Products & Services | EPC Contractor



Black & Veatch

The ever-increasing demand for renewable energy presents new challenges for power producers given the variable nature of generation and distributed nature of assets. Understanding the market, various regulatory program changes, and geographic considerations is critical to a successful project. Black & Veatch can assist with site selection, environmental permitting, financial due diligence for owners and financiers, transmission and interconnection support, and full EPC services in the wind market.

www.bv.com

BLATTNER ENERGY

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



Fagen, Inc.

Fagen, Inc. is a full service industrial contractor headquartered in Granite Falls, MN. Utilizing a database of over 10,000 employees, Fagen, Inc. has constructed a variety of projects including wind, solar, renewable fuels, and other industrial process facilities. Specializing in providing full EPC wraps to its client base, the company self performs civil, structural, siding, insulation, millwright, piping, instrumentation, electrical, and start up services.

www.fageninc.com

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The Portable, Powerful Videoscope

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www.olympus-ims.com/iplex-g-lite

Olympus offers rental equipment in the US.
Call 24/7 at (281) 922-9300.

Olympus and IPLEX are registered trademarks of Olympus Corporation.



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



Signal Energy, LLC

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

www.signalenergy.com



Walbridge

Walbridge provides full EPC Services for Wind Farms and self-performs foundation and turbine erection services.

www.walbridge.com



a MasTec company



Wanzek Construction

Wanzek Construction is a new construction general contractor, renewable service provider featuring a fleet of cranes to meet their customers' needs. With a portfolio of nearly 10GW of wind energy projects, Wanzek's wind team has installed a variety of turbine types and sizes. Wanzek's Renewable Services Division is an Independent Service Provider (ISP). They specialize in comprehensive wind power maintenance services using a regional deployment strategy, helping their customers maximize their investment in renewable power generation. They are GWO trained and NCCCO certified to perform the work in accordance with client specifications and industry safety protocols. They also provide their own safety-inspected, calibrated, and certified tooling for each job.

www.wanzek.com

Consulting Services



Center for Sustainable Energy

Center for Sustainable Energy (CSE) is a mission-driven, national nonprofit providing energy advisory services and program management to governments, regulators, utilities, and businesses that lead to sustainable, equitable and resilient transportation, buildings, and communities. CSE's solutions lower energy use and costs while increasing consumer accessibility to clean technology. CSE has substantial expertise in transportation, energy efficiency, building performance, R&A, emerging technologies, policy support, workforce development and marketing, education, and outreach. Headquartered in San Diego, CSE works nationwide with offices in Oakland, Los Angeles, and Boston.

www.energycenter.org



CWL Energy Management, Ltd.

CWL Energy Management is a project and asset management firm specializing in Renewable and Sustainable Energy development across Canada. Through their fee-for-service consulting business unit, they support clients in the development of projects, with a focus on project management, land management, environmental services, regulatory and permitting, technical analysis, and design. CWL Energy's Special Projects business unit deploys their own capital on their projects through unique community, technology, and indigenous project partnerships. In total, they have over 1.5GW of project experience both as asset owners and service providers.

www.cwlenergy.com



DNV GL

DNV GL's energy experts support customers around the globe in delivering a safe, reliable, efficient, and sustainable energy supply. They deliver testing, certification, and advisory services to the energy value chain including renewables and energy efficiency. Their expertise spans onshore and offshore wind power, solar, conventional generation, transmission and distribution, smart grids, and sustainable energy use, as well as energy markets and regulations. DNV GL is recognized by developers, utilities and financing institutions for their integrity and technical rigor. With DNV GL on the team, the design, permitting, engineering, and due diligence processes run smoothly.

www.dnvgl.com/energy



Lloyd's Register

Lloyd's Register started out in 1760 as a marine classification society. Today, they are a provider of professional services for engineering and technology, improving safety and increasing the performance of critical infrastructures for clients in over 75 countries worldwide. They have decades of experience across the global renewable energy sector. They solve complex problems for offshore wind investors, developers, and operators of fixed and floating wind farms. With their broad range of expertise, they can reduce technical, operational, and commercial risks while enhancing asset performance.

www.lr.org/offshorewind



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 35 GW of wind projects across the U.S. since 1997. Their services include site evaluation, permitting, civil engineering, electrical engineering, geotechnical engineering, land surveying, aerial mapping/LiDAR, water resources, GIS, and construction support. They have offices across the nation and are licensed in engineering and surveying in nearly every state.

www.westwoodps.com

Contractors



Rosendin Electric

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

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



Liebherr-Werk Eighen GmbH

Liebherr-Werk Ehingen GmbH manufactures Liebherr Mobile and Crawler Cranes for the wind industry. The economical, high-performance cranes from Liebherr have been used for decades in the construction of wind power plants. The cranes are available in various load capacity classes and are precisely tailored to the needs of the wind power industry. Liebherr faces the development of increasingly powerful installations and increasingly high towers by producing optimized cranes and new boom systems reaching especially high carrying capacities. Telescopic mobile cranes drive on public roads and can therefore be transported economically. Lattice boom crawler cranes offer high load capacity and lifting height. They can drive with a full load.

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



Kansas Department of Commerce

Kansas is ranked #2 in wind potential and has 5110MW of wind farms in operation and 1000MW in new projects announced. Kansas wind is cost effective due to high capacity factors and is attractive to out-of-state off-takers, which are purchasing a significant percentage of the wind energy produced in Kansas. Located in the heart of the wind corridor, Kansas provides access to key regions for wind farm development and a beneficial operating environment for developers, wind turbine component manufacturers, logistics, and other service providers. The team at Kansas Department of Commerce can assist companies in finding the ideal site for their operations.

www.kansascommerce.gov

Education | Research Development



Abaris Training Resources, Inc.

Abaris provides technical training in the area of structural wind blade repair using concepts adapted from nearly 40 years serving the aerospace composite repair community. They teach so the student understands the fundamentals but learns advanced methods and techniques. Most of their training is conducted in the workshop conducting real repairs on blade structures.

www.abaris.com



Appalachian Energy Center

Appalachian Energy Center combines the expertise of Appalachian State University with national experts to offer comprehensive clean energy-related professional development courses. Workshop topics include microhydro system design and installation, small wind hands-on workshop, photovoltaics, and more. The series runs from April to October every year and workshops are scheduled on Fridays so visitors can stay the weekend and enjoy the beautiful North Carolina mountains.

www.energy.appstate.edu



Lakeland College

Lakeland College offers online renewable energy and conservation programs which provide practical knowledge and useable skills for new career in trades, engineering, or architecture. 10 courses are required to earn a certificate, and an additional 10 courses will earn a diploma. Topics covered include wind energy, small wind energy systems, and integration of distributed energy systems. Programs may be completed part-time or full-time.

www.lakelandcollege.ca

SKYLOTEC.COM

NEW PRODUCTS FROM SKYLOTEC

NEW

CLAW

IGNITE
PROTON WIND

RESCUE PRO 2.0

SKYSAFE
PRO FLEX

LORY PRO

CONREST

SKYLOTEC offers you a highly innovative and functional range of fall protection equipment featuring the new smooth running **CLAW** Vertical Cable Sleeve for 3/8 & 5/16 inch diameter wire ropes. The **IGNITE PROTON WIND** and **RESCUE PRO 2.0** Harnesses are light weight designs built for durability and comfort. The **SKYSAFE PRO FLEX** Lanyard includes an energy absorber designed for 6 and 12 foot free fall applications. The **LORYPRO** positioning lanyards allow you to work hands free with complete adjustability. The **CONREST RESCUE** Stretcher is ideal for tight confined space rescues. These products are ideal for work at height in the telecommunications, electrical utilities and wind energy industries. For more information please email us at info-us@skylotec.de. skylotec.com

SKYLOTEC North America LP | Denver, CO USA | Tel: 1-303-544-2120



Nergica

Nergica is a centre of applied research that stimulates innovation in the renewable energy industry through research, technical assistance, technology transfer, and technical support for businesses and communities. Its mission is to create new opportunities for renewable energy. More precisely, Nergica specializes in developing solutions for renewable energy integration, optimizing wind farm and solar array performance, and supporting growing SMEs. Known until recently as the TechnoCentre éolien, Nergica has been active for nearly 20 years and is an official college centre for technology transfer (CCTT) affiliated with the Cégep de la Gaspésie et des Îles.

www.nergica.com



University College at the University of Denver

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

www.universitycollege.du.edu

Electrical Equipment & Services | Power Generation



ABB Installation Products, Inc.

ABB Installation Products, Inc. is a wind-power system component and connections supplier, dedicating to making wind power efficient, reliable, and economical. ABB Installation Products provides these solutions by ensuring its products are made from high-quality materials with designs that reduce the number of parts, simplify installation, and reduce maintenance costs. Some of the ABB Installation Products available for the wind power industry include metal framing, current-limiting fuses, connectors, conduit and fitting systems, and UV-resistant cable ties. ABB Installation Products Inc. also provides training for the correct installation and maintenance of these products.

www.tnb.com



Alencon Systems

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

www.alenconsystems.com



Electrical Consultants, Inc. (ECI)

Electrical Consultants Inc. (ECI) was incorporated in 1985. For over 30 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



Ingeteam, Inc.

Ingeteam offers solutions for wind turbines of up to 15MW, including power converters, generators (Indar), turbine controllers, Condition Monitoring Systems (CMS), Smart SCADA management systems, and O&M services. The company is an independent converter supplier for wind applications, including low and medium voltage power converters, optimized for DFIG and FC topologies; power converters, specifically designed to fulfill the strictest grid codes; air cooled, air/water cooled, and full water cooled solutions for harsh environments. Their offerings are based on IGBT power semiconductors and equipped with a web application service tool that allows monitoring and remote control.

www.ingeteam.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

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



G&W Electric

After over a century of service and innovation in electrical system solutions and products, G&W Electric fully understands the needs and goals of each customer's application. The engineers at G&W Electric deliver robust solutions built to help overcome application challenges. Whether mission critical, or requiring technologies for tomorrow's smart grid, the right solution can be found among G&W Electric's suite of medium voltage switchgear, system protection, cable accessories, and automation products.

www.gwelec.com



Energy Storage | Grid Connection



Analytic Systems

Analytic Systems manufactures digitally controlled intelligent pure sine wave inverters. It's a solution for any wind power supply; an SMP100 SolarMax Charge Controller and IPSi Series Inverter. Using the free-to-download Power Wizard software, the user can select output frequency, output voltage (within +/- 10% of the standard voltage), output frequency (50 or 60Hz), and low voltage shutdown parameters (to match the battery voltage) from any laptop through the standard micro-usb interface. Analytic Systems will work with their customers to provide solutions to their power conversion questions.

www.analyticsystems.com



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



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.

ESS' All Iron Flow Battery, Energy Warehouse (EW) uses iron, salt, and water for its electrolyte and simple off-the-shelf materials for battery components. The EW is a durable, environmentally safe, long-duration storage system that's specially designed for time-shifting renewable energy on a daily basis, managing a facility's demand or TOU charges and smoothing intermittency of renewables on a constrained grid. ESS has designed this all iron electrochemistry to allow the EW to operate at high efficiency over an unlimited number of deep charge and discharge cycles, with no capacity fade over a 25-year operating life, and with minimal annual (O&M).

www.essinc.com



NextGen NRG Pty., Ltd.

The Mini Power System (MPS), a renewable energy generation and storage system, enables users to generate, store, and consume their own clean, free energy. The system allows homes and businesses to take their electricity needs entirely off the grid. The MPS permits up to five simultaneous natural inputs (solar, wind, hydro, gas, and generator) with a single inverter, no additional controllers or complicated wiring required.

www.nextgennrg.com

Engineering



Ayres Associates

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

www.ayresassociates.com

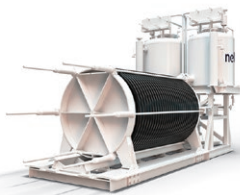


Commonwealth Associates, Inc.

Commonwealth provides consulting, owner's engineering, program management, detailed design, electrical system studies, and interconnection expertise for power generation and power delivery projects. Supporting their generation, substation, and transmission and distribution line engineering services are environmental experts, battery storage experts, licensed land and right of way brokers, and licensed drone pilots, to meet all of their clients' project needs.

www.cai-engr.com

nel



Nel Hydrogen

Nel Hydrogen manufactures both utility scale Atmospheric Alkaline Electrolysers and Proton Exchange Membrane (PEM) Electrolysers to capture curtailed power in hydrogen for energy storage and grid management. The Atmospheric Alkaline systems are economical and a solution for carrying the base load. While the PEM systems are also able to carry the base load, they are able to react instantaneously to fluctuations in energy output from the resource (solar panels, wind turbines, etc.), making them suitable for grid balancing as well.

www.nelhydrogen.com

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Wanzek delivers excellence through our
commitment to safety, expertise in construction
planning, exceptional services and outstanding teams.



EMA Electromechanics, Inc.

EMA Electromechanics, Inc. is a designer and manufacturer of the VDH/GSMI grounding breaker. This patented equipment is designed for the operation and protection for MV collection circuits of wind and solar plants.
www.emaelectromechanics.com



FDH Infrastructure Services

FDH specializes in nondestructive testing for the conditional assessment of wind infrastructure. Foundation failures can occur as a result of under-designed foundations, construction issues, soil conditions, turbine modularity, and additional loads. FDH services for wind turbine foundations include baseline condition assessments, analysis and modification design, and construction management. FDH's structure solutions help support repowering efforts, life extension, asset management, and due diligence efforts. FDH engineering professionals work nationally with offices in ten states.
www.fdh-is.com



Metro Consulting Associates

MCA supports wind projects thru title research and land acquisition with land owner negotiations for lease and real estate agreements, participation agreements, and access permissions. MCA provides desktop analysis for fatal flaws, environmental data, and county GIS info. They also offer engineering support and analysis thru turbine siting, site planning, permit facilitation, and construction plan development in cooperation with EPC contractors, pre-construction ALTA/NSPS Land Title Surveys for the project footprint, construction layout and staking, and post-construction ALTA/NSPS Land Title Survey and as-builts. MCA completes all field environmental inspections, including wetland delineations, endangered species studies, and mitigation plans.
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



SNC-Lavalin

SNC-Lavalin is a global player in the design, engineering, and construction of wind projects specializing in EPC, development support, feasibility studies, and analyses, e.g. geotechnical analysis, turbine and equipment selection, interconnection, underground or overhead collection systems, generation tie-lines, substations, turbine foundation, site, and project management. Their offshore experience includes monopiles, jackets, gravity base solutions, semi submersibles, spars, tension leg platforms, and offshore substation design. They work on projects from 50MW to 500MW+. SNC's Capital group will also provide both project development funding and equity.
www.snclavalin.com



UL, LLC

UL is an independent technical advisory, testing, inspection, and certification body to the renewable energy industry. Their comprehensive portfolio of services empower trust throughout the project lifecycle and across the value chain. UL's technical advisory services help stakeholders plan, design, finance, build, invest, operate, maintain, and manage renewable energy projects. Services range from verification, inspection and risk assessment to testing and certification for materials, components, products, and systems. Their comprehensive understanding of codes and standards enables active assistance issues and potential conflicts between codes and installation requirements.
www.aws-dewi.ul.com

Environmental Consultants & Business Services



Civil & Environmental Consultants, Inc.

CEC provides biological monitoring services that support 401/404 permit applications, reducing the need to hire additional consultants. CEC's federally approved bat surveyors and wildlife biologists maintain an excellent rapport with numerous U.S. Fish & Wildlife Service regions while serving as advocates for clients.
www.cecinc.com

Filtration Systems



Filtration Group

The filtration performance of Filtration Group's multi-layered PulseShield element remains constant even with increasing differential pressures. The compression sleeve secures the pleated star geometry firmly to the inner core and guarantees uniform pleat separation for the life of the filter element. The compression sleeve combined with up to three Premium Select fiberglass layers increases the dirt holding capacity by as much as 30%.
www.filtrationgroup.com

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Sargent & Lundy

Sargent & Lundy brings the knowledge, experience, and resources to help their clients tackle all aspects of wind energy projects from planning to commissioning, and from due diligence to complete design and grid interconnection solutions. They have been providing engineering, consulting, and support services to the wind power industry for over 15 years. Their experience spans the spectrum of geographic sites, wind turbines, complex terrain, and grid interconnection requirements as well as integrating battery energy storage into renewable generating facilities. Clients include utilities, developers, lenders, constructors, and manufacturers worldwide.
www.sargentlundy.com



Kaydon Filtration

Kaydon Filtration's patented TURBO-TOC coalescing technology keeps turbine rotating components protected by providing quick and efficient water removal from turbine oil. Their TURBO-TOC technology was developed to remove water to less than 150ppm in a single pass at process rates exceeding 100GPM (380LPM). Turbo-TOC KL and portable KLP systems for single pass high flow water removal can significantly decrease bearing failures and extend turbine oil life for the life of the turbine. Available flow rates: 3, 5, 20, 30, 50, 60, and 100GPM.

www.kaydonfiltration.com



National Filters, Inc.

Utilizing high quality components, National Filters Inc. single and dual stage filters are designed for wind turbine use. Elements meet the ISO cleanliness levels wind systems require, at a fraction of the cost of the OEM.

www.nationalfiltersinc.com



Solidification Products International, Inc.

SPI has a variety of wind products such as their Petro-Pipe System and Petro Barrier System. Each has been designed to allow rain water to drain, while completely filtering out all vegetable oils or fuel sheen to non-detectable levels. In the event of a major spill, the Petro-Pipe/Petro Barrier Systems will totally shut down and prevent all flow from discharging. It will then back the spill into the containment area preventing an environmental release. SPI products are currently being used at wind farm locations and solar installations around the world.

www.oilbarriers.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

Gearbox Manufacturing, Services & Repairs



Bonfiglioli

Bonfiglioli designs and manufactures an extensive range of products for the wind energy sector, including planetary gearmotors and gearboxes for nacelle yaw control, blade pitch, and small wind main drives (up to 200kW), as well as a complete range of AC electric motors and inverter drives. Bonfiglioli products are compact, lightweight, and versatile and help improve wind turbine performance and minimize maintenance costs of 1MW to 12MW turbines in on- and off-shore installations. New product features such as a torque limiter and integrated load cell help to monitor and measure gearbox performance, troubleshoot maintenance issues, and control and manage power, resulting in higher ROI and longer LTV.

www.bonfiglioliusa.com/wind



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



Integrated Power Services (IPS)

IPS provides wind repair services, field services, and distribution for fleet owners and operators across North America. They back everything from wind generator repair, generator unit exchange, up-tower, or in-shop service and repair with one standard for safety, quality, service, repair procedures, and commercial terms. Their single-source wind turbine service capabilities make owning or managing wind power fleets more predictable and profitable.

www.ips.us



SGL Gelter

SGL Gelter, member of SGL Carbon is a world-wide 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.

www.sglcarbon.com



Svendborg Brakes

Svendborg Brakes has created a cooling system for wind turbines, delivering a compact, simple to operate, cost effective, and reliable system. Specifically designed for cooling the generator and converter, Svendborg Brakes' system uses materials that are lightweight and offer corrosion resistance. The system meets criteria set out by turbine manufacturers for global on and offshore applications. The pump unit has a simple operating principle and maintenance is easy to perform. The water/glycol cooling system is controlled by a mechanical thermostatic mixing valve which allows it to run constantly without the need for complex sensors and control circuits. A heating system helps avoid condensation forming in the components and operates across temperatures ranging from -4°F to 122°F (-20°C to 50°C). Every system is tested for leaks, pressure settings, flow rates, and general operation. Svendborg Brakes' technical support can provide advice on specifications and installation.

www.svendborg-brakes.com



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Hybrid Systems



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X3 Energy/Van Straten Enterprises, Inc.

The X3/CAT Microgrid Hybrid Power Module is designed for immediate power for disaster relief, military applications, small villages, construction sites, etc. It provides renewable energy in a single module that can quickly be dispatched to site. The module contains 36 auto-deployed photovoltaic modules which provide up to 10.62kWp DC power as the primary power source with 78kWh of energy storage, and a standby diesel generator set for power when PV energy is not available. The bi-directional inverter provides reliable power conversion and energy storage management is provided by intelligent controls for charging, discharging, equalization, and state of charge estimation for the batteries.

www.x3energy.net

Inverters



Rhombus Energy Solutions

Rhombus Energy's Power Converter Systems enable batteries to be optimally used by converting power from AC to DC to charge batteries, and from DC to AC to use the energy stored in the batteries. Every Energy Storage System (ESS), depending on type of batteries, operates at different voltage ranges and charge/discharge rates. Rhombus Power Converters are an essential and core part of an ESS, and are tuned to optimize each ESS.

www.rhombusenergy.com

Large Wind Turbine Manufacturer (Over 100 kW)



ENERCON Canada, Inc.

Established in Germany over 30 years ago, ENERCON is an international provider in wind turbine design and manufacturing. With its gearless generator technologies, high manufacturing standards, and comprehensive long-term service agreements, the company's solutions are reliable and high performing. ENERCON's product line ranges from 800kW to 4.5MW. To date, the company has installed more than 28,800 turbines worldwide representing more than 49.4GW of installed capacity.

www.enercon.de



Goldwind Americas

Goldwind's GW 4S MW Permanent Magnet Direct-Drive (PMDD) wind turbine capitalizes on the scalability of the 3-megawatt platform to bring a turbine with a rated power of 4.0-4.2MW. The latest Goldwind turbine for international markets is designed for wind class IIA and features rotor diameters up to 136 meters. Goldwind's E-farm system has been integrated as a standard system in the GW4X turbine. Using LAC (Lidar Assisted Control) technology, E-farm can help increase efficiency of the turbine by adapting to changing wind conditions and optimizing the turbine power curve to achieve higher AEP.

www.goldwindamericas.com



Vestas

Vestas provides sustainable energy solutions. They design, manufacture, install, and service wind turbines across the globe, and have installed 94GW of wind turbines in 79 countries. Through their smart data capabilities and more than 78GW of wind turbines under service, they use data to interpret, forecast, and exploit wind resources and deliver quality wind power solutions.

www.vestas.com

Lighting



Flash Technology

From their Franklin, TN facility, Flash Technology offers innovative MET tower and wind turbine obstruction lighting solutions and the remote asset monitoring systems that support them. An OEM since 1969, 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 5-year warranty.

www.hugheyandphillips.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



Phoenix Contact

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

www.phoenixcontact.com/us



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

Lightning & Surge Protection



EMP Defense, LLC

Effective against lightning and electromagnetic pulses, the CMCE120 is an advanced lightning protection device. With over 8000 installations worldwide utilizing this technology, and no reported strikes in over 15 years, the CMCE120 is providing a new standard in global lightning protection. The CMCE120 continuously balances the protected areas electromagnetic field, draining excess current harmlessly into the ground, eliminating upward streamers, and preventing the development of lightning within a 393ft radius.

www.empdefense.us



Raycap

Raycap

Raycap has enhanced the performance of its Strikesorb 30 Surge Protective Device for wind turbines. The enhancements upgrade the Strikesorb 30 to a Class I Surge Protective Device, in addition to its present Class II rating, per IEC 61643-11. The enhanced Strikesorb 30 provides systems designers additional installation flexibility with its compact footprint, in locations experiencing both direct and indirect lightning currents. The modules have UL Type 2 Component Assembly certification and feature a patented technology capable of handling multiple lightning surges without failure or performance degradation while offering continuous protection of the wind turbine.

www.raycap.com



AMSOIL, Inc.

AMSOIL 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. With over 30,000MW of installed capacity in North America alone, AMSOIL has yet to have a warranty claim, and in this near-decade of service, not a single customer has switched from AMSOIL PTN 320 to any other lubricant.

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

Special gear oil is required to maximize the efficiencies and longevities of large gear systems. Klübersynth GEM 4-320 N reaches high standards for cleanliness, anti-foaming, service life, and resistance to wear. Recent evolutions of the formulation help to extend the lives of older gearboxes. Klübersynth products and services can be integrated for reliability and protection of old and new gear drives.

www.klueber.com



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)



BayWa r.e.
renewable energy

BayWa r.e. Wind, LLC

BayWa r.e. is a global Developer and Asset Manager with 5GW currently under management. Striving to meet customers' goals, they protect their client's investment to generate sustainable and reliable returns. With multiple turbine platforms under management and strong partnerships with specialized providers, their Asset Management team can proactively resolve any potential issue that may arise. BayWa r.e. builds lasting relationships that prepares projects for long-term operational success.

www.baywa-re.us

Lubricants



American Chemical Technologies

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

www.americanchemtech.com

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EDF Renewables

With over 30 years of experience and 13GW of energy under contract worldwide, EDF Renewables Asset Optimization group helps optimize plant performance, maximize availability, and minimize downtime. With services including full O&M, Blade Services, Asset Management, and 24/7/365 Monitoring, they bring an owner-operator sensibility to all projects. Their Development group has over 10GW of wind, solar, bioenergy, and storage developed in North America.

www.edf-rs.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



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Measure UAS

Measure UAS provides turnkey aerial inspections for wind turbines. Advanced drone technology and big data analytics identify hub nose and blade defects on wind turbines precisely, quickly, and safely. Measure's aerial intelligence solutions improve inspection efficiency, reducing inspection downtime, and providing actionable information that can be used to optimize turbine productivity and minimize expensive repairs. High resolution imagery, damage identification, and damage classification are provided in an interactive web portal to enable site-by-site analysis, as well as comparisons across sites and over time.

www.measure.com

NORTHWIND

A SPARKPOWER COMPANY



Northwind Solutions

Northwind is a progressive, customer-focused service organization that delivers asset monitoring, performance analytics, and operations and maintenance (O&M) services to the renewable energy industry. Their mission is to minimize asset down time and maximize the value of renewable energy assets today, and for the long term. They have been providing wind O&M services, full time technician support services, major component services, and third party commissioning throughout North America since 2004.

www.northwindsolutions.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



Sentient Science

DigitalClone is a cloud-based platform that helps return 13% of the revenue from wind turbines back to the operator, using advanced prognostics on the health of individual wind turbines and life extension actions to extend wind turbine life. Through a centralized system, the platform connects the component replacement forecasts of operators with service providers and OEM suppliers to compete for the life extension action business. The platform enables Buy on Life transactions based on a unique fusion of materials science and data science modeling of the wind turbines. Operators are able to make buying decisions based on life extension and improvements in business value reducing the cost of O&M, asset management, and supply and inventory management.

www.sentientscience.com



SkySpecs

SkySpecs offers automated, robotic blade inspections, and Horizon - the data management and analytics software that enables customers to view, annotate, and compare data over time. Offshore and onshore turbine inspections take 15 minutes to complete, making turbine downtime and human oversight minimal.

www.skyspecs.com



BY BRAND SAFWAY

Spider

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

www.spiderstaging.com



TECHÉOL, Inc.

With over 120 technicians, TECHÉOL has performed various repairs on more than 2000 wind turbines across Canada, USA, and Mexico. TECHÉOL is a company specializing in wind farm O&M services. They have forged their expertise in harsh conditions, providing quality preventive and corrective maintenance, major component replacements, up-tower drive train repair, blade repair, and optimization since 2007. Their objective is to insure comprehensive wind turbine inspections, maintenance and repair services.

www.techeol.com

Remote Monitoring



Electro Static Technology

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

www.est-aegis.com

Safety Equipment | Fall Protection



Corgo Industries

Corgo Industries provides robust, long lasting lift bags to North America and Europe. Featuring cold crack to -40° and sizes up to 1000lbs are available as well as COR-061786 200lb bags, buckets, and tool kits. Corgo Industries has been manufacturing lift bags since 1989, and will work with their customers on special orders, smaller tool bags, personal equipment bags, and rope bags.

www.corgoind.com



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



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



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.skysaver-wtg-safe.com



Sterling Rope Company

The new PDQ2 is Sterling's lightweight (<10lb) evacuation system for work-at-height environments. The PDQ2 descent-control device and the 6mm X-TEC heat-resistant Technora rope are the core of this system. The redesigned PDQ2 descent device has an improved full stop anti-panic function, increased holding power on the auto-lock, and an increased certification distance, from 120m to 150m. With a user-load of 310lb, the fully-assembled kit comes ready to deploy, can be stored compactly, and carried until needed. Adding of one of Sterling's Raise and Rescue Kits will convert the PDQ2 to a mechanical-advantage system for simple and efficient victim raising, and multidirectional transfers.

www.sterlingrope.com



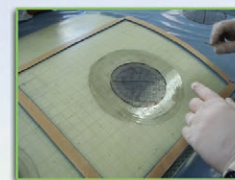
Tractel

The Tractelift climb assist was designed with two pulleys, a continuous belt loop, and a maximum pull force of 150lbs to assist technicians while climbing to the top of the wind turbines. With a Tractelift installed, there is a lower risk of accidents and employee fatigue and injuries are reduced. The Derope emergency escape/controlled descent device enables the evacuation of one or two persons from an elevated position to the ground at a controlled speed of 235 ft/min (72m/min). Tractel's Derope descent device can also be used for one man or two-man rescue operations. Victims can be lowered alone or accompanied by the rescuer following the standard procedures for rescue applications.

www.tractel.com

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Safety Work Apparel



Blaklader

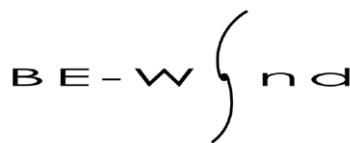
Blaklader, a Swedish Company, manufactures functional workwear for all workers' needs. Within the clean energy segment, their FR styles 1636, and now 1676, are tested and compliant with NFPA 70E. 1636 and 1676 work pants are HRC compliant, with an 11 calories/cm² arc rating.
www.blaklader.com



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)



BE-WIND, LLC

BE-WIND has been developing small urban wind turbines for clients around the world. They use aerospace technology and materials for ensured structural and longevity in their products. They have introduced a small, maintenance-free turbine with never brake technology. Also available are new composite materials and low cost structural installation options.
www.be-wind.com



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

Software Supplier



Indji Systems

Designed specifically for wind farm operations, Indji Watch provides awareness of significant weather events that endanger employees, disrupt operations, and impact profit. The intuitive interface allows users to monitor weather events and threats specific to their farm in real-time, on their desktop or mobile device, enabling them to make quick, intelligent decisions. Indji Watch uses NOAA high-resolution models and lightning prediction tools to assist in day-to-day operations and maintenance scheduling. The daily reports and Lightning Fault Analyst enables users to save time and money by finding damage early.
www.indjiwatch.com



Isotrol USA, LLC

Bluence, by Isotrol, is a complete suite of solutions to monitor control and manage renewable energy plants. Designed for all activities of power plant owners, assets managers, operators, technicians, and investors to get the most out of a single plant or a mixed portfolio of renewable energy plants.
www.isotrol.com



JobNimbus

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

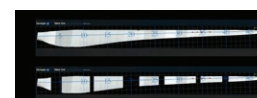
Steel Supplier



Leeco Steel

Leeco Steel, headquartered in Lisle, IL, maintains a large inventory of carbon, HSLA and alloy steel plate, including EN steels such as S355 J2, K2, and NL, as well as all ASTM grades suitable for wind tower applications. Their extensive stock is housed in 10 strategically located distribution centers in North and South America, able to serve wind energy customers with their steel plate needs.
www.leecosteel.com

Testing | Inspection Services



BladeEdge

BladeEdge takes a proactive approach to blade lifecycle management with capture, compute, and consume methodology. BladeEdge assists in providing effective wind farm management by adopting an entire process to ensure efficiencies across the board. Starting with a piloted drone inspection to capture data on every square centimeter of every blade, they then compute the data with BladeEdge Analytics, an artificial intelligence-driven software portals which transforms big data from aerial inspections into actionable intelligence that informs maintenance and repair decisions. Lastly, they enable their clients to consume the inspection data with the easy-to-navigate BladeEdge User Dashboard.
www.bladeedge.net



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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](http://www.us.megger.com)



MISTRAS Group, Inc.

MISTRAS Group is a provider of asset protection services for the North American wind energy industry. Their Rope Access Center of Excellence performs at-height inspections, light mechanical services, and condition-monitoring on wind turbine blades, towers, gear boxes, and transformers all over the continent. Their solutions include non-destructive testing (NDT) for internal and external inspection, laminate and coating repairs, drone inspections, blade installation and repair support, and fleet-wide condition-monitoring.

www.mistrasgroup.com



NTS

A provider of analytical modeling and test services for lightning phenomena challenges in wind turbine systems and structures, NTS helps reduce project lifecycle testing costs and provides valuable insight for key design decisions.

www.nts.com



Olympus America, Inc.

Olympus' new IPLEX G Lite ultra-portable industrial videoscope helps provide fast, easy visual inspections of small or difficult-to-access locations. The lightweight, 2.5lb (1.15kg) videoscope features powerful imaging and measurement tools and is rugged enough to pass U.S. Department of Defense drop test standards (MIL-STD-810G). Dynamic image optimization, LED illumination, 60-frames-per second video, and interchangeable illumination sources (LED, UV, or IR) contribute to excellent image quality, while Responsive TrueFeel articulation and an oil-clearing tip facilitate faster, easier inspections.

www.olympus-ims.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, and Q-Lab Deutschland. 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



WindGuard North America, Inc.

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

www.windguard.com

Tools



AIMCO

The HT Series from AcraDyne is an electric, high-torque bolting tool that provides accuracy, speed, and safety. When combined with AcraDyne's controller, customers have a high-torque critical bolting system that can handle tough and important bolting jobs. An accurate high-torque tool, it can deliver high speeds, and 50Nm - 12000Nm in an ergonomic, robust design with five handle configurations. With over 300 models to choose from, 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 Tensor Revo HA (High Access) 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

Designed for aggressive use, the CP3850 is available in both 7 and 9 wheels. With a high performance 2.8hp motor, and weighing less than 6lbs., these robust tools provide a high power to weight ratio and ergonomics. Safety features include a double action safety lever and 220° guard to protect the operator from debris. Operators will find the 2.8hp governed motor, with their choice of a 6000, 7700, and 8500 rpm free speeds, to deliver high torque for maximum productivity. The CP3850 series grinders and sanders were engineered for contouring, deburring, cutting, and sanding in the metalworking, transformation, manufacturing, and energy industries.

www.cp.com



Hi-Line Utility Supply

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

www.hilineco.com



ITH Engineering

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

www.janicki.com



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



Norwolf Tool Works, Inc.

The Norwolf X-Driver hydraulic bolting system is a fast, safe, thin, and versatile wrench. With one-piece piston design, no loose shroud, it's totally enclosed. Made from all alloy steel, the X-Driver power head includes interchangeable drives to fit all bolting applications. The M drive fits narrow confines while the V drive offers versatile reaction capabilities in a square drive tool. The standard A drive fits in tight spaces and is fast as well. A full line of accessories are available to suit specific bolting needs, including extended reaction arms and a variety of custom drives.

www.norwolf.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



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



GT USA Wilmington, LLC

GT USA Wilmington, LLC provides 24/7 marine terminal operations with wind project handling experience since 2001. The Port offers two independent stevedores, prompt and efficient State permitting and police escort services, logistics coordination, Class 1 rail, local towing co. and ship agencies, onsite CBP and USDA, and FTZ. It has 6 open, project friendly berths, heavy lift capacity to 100 MTs, and 50 acres of outside storage with immediate access to the interstate highway. The Port services the Mid-Atlantic US and is the first deep water terminal on the Delaware River. It maintains 360 Quality, C-TPAT, and AWEA membership

www.gulftainer.com



Logisticus Group

Logistics Group provides services including, but not limited to: turnkey transport, route feasibility and site assessment, project and risk management, warehousing, reverse logistics, fixture refurbishment and retrofit, owners representatives, and repower technology solutions. They also offer GPS tracking of assets, transportation management system, and materials management system services.

www.logisticusgroup.com

Transportation | Logistics



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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www.AIMCO-GLOBAL.com **AIMCO**



Metro Ports

Metro Ports is a contract stevedoring and marine terminal operator specializing in dry and liquid bulk cargoes, breakbulk and project cargoes, forest products, wind energy, and a variety of other marine cargoes. Metro Ports operates in the U.S. states of Washington, California, Texas, Indiana, Georgia, North Carolina, and South Carolina. www.metroports.com



PORTCORPUS CHRISTI®



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 Olympia

The Port of Olympia's 66 acre terminal is situated in Puget Sound in Washington State. ILWU #47 longshore labor is available 24/7 to discharge wind component vessels and to load out to truck and rail. Easy truck access is available, with access to Interstate 5 in less than one mile. On-dock rail is supported by both BNSF and UPRR with switching by OYLO, their shortline carrier. A wide variety of heavy lift equipment is on-site for operations including top picks and a 140-ton Gottwald mobile harbor crane. www.portolympia.com



Port of Stockton CALIFORNIA

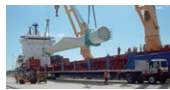
Port of Stockton

The Port of Stockton is an inland facility located in the extended San Francisco Bay Area that has handled breakbulk cargo since 1933. They have around the clock security and uniquely offers customers 24/7 access to their freight. The Port has 2.5 miles of on-dock rail connecting to the UP and BNSF that offer service throughout the United States. It is adjacent to uncongested highways, I-5, CA-4, and CA-99, and is an hour from I-80. The Port of Stockton has handled numerous shipments of clean energy cargo of all shapes and sizes. www.portofstockton.com



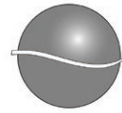
Port of Vancouver USA

To support transportation of wind energy components, the port has two Liebherr mobile harbor cranes that can lift 140-MT each and 210-MT in tandem, a multi-purpose crane with 51-MT capacity, and crane operators certified in tandem and engineered lifts. Stevedoring equipment includes trailers and reach-stackers to efficiently move cargo. They have over 100 acres of laydown space and their completed rail expansion project triples capacity and increases velocity on the mainline by 40%. www.portvanusa.com



Ports America

Ports America, headquartered in New Jersey, is an independent marine terminal operator and stevedore company. The company currently operates in more than 42 ports and 80 locations. Ports America handles all types of cargo, including wind component projects, heavy lift projects, containers, bulk, breakbulk, automotive, military, and cruise. The company typically handles 10.1 million tons of general cargo annually. www.portsamerica.com



Stewart WORLD PORT

Stewart World Port Services, Ltd.

Stewart World Port is a deep sea multipurpose port located in Stewart BC. As Canada's most northerly ice-free port, Stewart is ideally located at the end of the Portland Canal and has paved access to British Columbia and Alberta. The location provides up to a full day advantage to Asian markets over southern ports and has favorable climate, low winds, and good anchorage. www.stewartworldport.com



Transportation Partners and Logistics

Currently serving a variety of OEMs, project developers, and supply companies, TP&L provides logistics and transportation management for a variety of industries across the entire supply chain. Since 2012, TP&L's one-stop-shop for logistics and management solutions has assisted more than 75 wind farms, multiple oil/gas drilling projects, and agriculture throughout the United States, Canada, and Mexico. TP&L's team of in-house engineers are top-load certified and ready to take the lead when it comes to any logistical needs. From port to pad they deliver economically, safely, and on time. www.tpandl.com

Wind Assessment | Forecasting



EAPC Wind Energy

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



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RainWise

RainWise, an employee-owned company, celebrates 45 years as a global provider of meteorological measurement for commercial/utility PV solar monitoring solutions. Rainwise also delivers professional grade weather instruments for agriculture, commercial, fire/weather, storm/flood water, outdoor event and transportation applications, with seven PVmet weather stations including their new PVmet 500 Series. In 2019, they released their MK4 Weather Station. RainWise has obtained creation patents for the tipping rain bucket, digital weather station, and wireless weather station. RainWise is known for durability, quality, and high level of accuracy. www.rainwise.com



Remtech

Since 1982, Remtech has been refining wind profiling RSD's. Their standard warranty is 3 years with affordable extensions available. This is made possible by their software oriented design, thus minimizing the hardware. Their efficient software allows Remtech to offer a small and light RSD, the PA-XS, which can achieve a 3000m AGL average altitude range, the PA5. www.remtechinc.com



WPred

WPred's Nowcasting service allows for highly accurate short-term (12 hours) wind and power forecast to help users make up-to-date decisions. Various statistical and machine learning algorithms combine numerical weather prediction models with on-site real-time measurements in order to produce a forecast that is continually adjusted, creating forecasts of the highest quality. Nowcasting is useful for quick and key decision making, for instance, when selling energy on the electricity market or during crucial O&M operations. www.wpred.com

Yaw, Pitch & Blade Sensors



Micronor, Inc.

Micronor specializes in fiber optic and electromechanical position sensors, e-stops microswitches, and limit switches. Fiber optic sensors are a solution when immunity to EMI, RFI, and lightning are desired. MR200W series represents yaw position transducer solutions developed specifically for the wind turbine industry. Micronor offers semi-standard/semi-custom solutions efficiently and cost effectively with their MR200 modular rotary cam-based components and design concepts refined over 50 years of experience. Transducers can be engineered to integrate any combination of feedback technology, including absolute/incremental rotary encoders, rotary limit switches, potentiometers, and/or resolvers. www.micronor.com

**POSITAL
FRABA**



POSITAL-FRABA

POSITAL is an international supplier of position and motion sensors with applications in the renewable energy industry. The company's rugged and reliable IXARC rotary encoders are suitable for wind turbine control systems, providing feedback on nacelle orientation (yaw), blade pitch, and turbine shaft rotation speed. POSITAL sensors are designed for harsh conditions and are available with environmental protection up to IP69K. Communications interface options include Modbus SSI, CANopen, analog, and industrial Ethernet. With a wide variety of mechanical configurations available, POSITAL encoders are a good fit for projects of any size or budget. www.posital.com

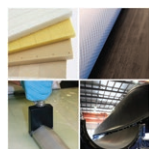
**Other
Balance of Plant**



Exo

With over 100 years of experience in structural inspection and remediation of T&D infrastructure, Exo offers asset management, inspection, and field repair services for utilities and renewable companies. Their engineering expertise and time-tested capabilities provide comprehensive in-facility inspections during manufacturing of towers, NDT field inspections for corrosion and welds on in service assets, and field repairs for coatings, welds and other structural issues. www.exoinc.com

Core Materials



Gurit

Gurit serves wind turbine blade manufacturers with a complete offering from tooling (i.e. the design, production, and supply of wind turbine blade moulds and related equipment), the development, production, and supply of advanced composite materials to technical support and solutions for the repair of installed wind blades. www.gurit.com

**Electronic Component, Service
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Industrial Repair Services can repair pitch controls, uninterruptible power supplies, programmable logic controllers, human machine interfaces, touchscreens, printed circuit boards, thyristors, proportional valves, hydraulic pumps, encoders, transducers, servo motors, filter units, circuit breakers, AC drives, and AC converters. www.industrialrepair.net

Labor Trade Association



**Ironworker Management
Progressive Action Cooperative
Trust (IMPACT)**

IMPACT is a labor management partnership designed to provide a forum for union ironworkers and their contractors to address mutual concerns and encourage reasonable, balanced solutions. Their members are committed to increasing the competitiveness and market share of the union ironworking industry. Their primary mission is to expand job opportunities through progressive and innovative labor management cooperative programs, providing expertise in ironworker and contractor training, construction certifications, safety, marketing, and construction project tracking and bidding. www.impact-net.org

Legislative & Regulatory Affairs



**Advanced Power Alliance (formerly
The Wind Coalition)**

Creating a market to deliver cleaner, cheaper, American-made energy is the goal of The Advanced Power Alliance. They are working to promote the United States' vast and diverse energy resources, while expanding the energy economy by leveraging its energy expertise and workforce. The Alliance deploys a team of technical, legal, and governmental affairs experts as they engage in deliberations at the Southwest Power Pool (SPP), the Electric Reliability Council of Texas (ERCOT), and in the halls of the state capitols. www.poweralliance.org

Precast Trench & Boxes



Concast, Inc.

Concast's precast concrete products have been used in the windfarm, utility, and general construction industries since 1969. Trench systems, pull boxes, and handholes are utilized for below-ground substation control, communications and power cables, waste water recovery systems, and industrial piping distribution. Concast's Box Pads, Flat Pads, MGS, and Vaults are an underground solution for routing cables to padmount, padmersible, and submersible apparatus such as transformers, switchgear, inverters, and sectionalizing equipment. www.concastinc.com

Rescue and Safety Training



TEAM-1 Academy, Inc.

TEAM-1 Academy, Inc. specializes in training for Working at Heights/Fall Protection, Confined Space, HazMat/Spill Response, many forms of Rescue, and much more. They provide Professional Safety and Rescue Training, Equipment Sales + Service + Inspections, and Consulting Services for the renewable energy sector, utilities, energy sector, Fortune 500 companies, industry, construction, health care, fire services, police, EMS, military, MOE, government, and numerous others. www.team1academy.com

Ventilation & Cooling



Continental Fan Manufacturing, Inc.

Continental Fan provides fans and blowers for nacelle ventilation, GCU (generator control unit) cooling, and tower ventilation. APK Panel Fans, AFK Flange Fans, and ELTA Impellers are useful for nacelle ventilation. TMK motorized impellers provide a compact solution for cooling power conditioning and switchgear cabinets. For wind turbine tower circulation and ventilation, AFK Flange Fans can be used for non-ducted applications, and TCD Centrifugal blowers are suitable for ducted applications www.continentalfan.com

**Wind and Solar Measurement and
Consulting Services**



Vaisala

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

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Closing the Circuit on Electrification

Why smart energy efficiency must support the electrification of vehicles and buildings

by Amy Egarter and Greg Hopkins

AS THE ENERGY FIELD CONTINUES TO

rapidly evolve, two emerging but persistent trends could have dramatic implications for our power grid infrastructure: the electric vehicle (EV) transition, and the electrification of buildings. These trends will help us achieve a low-carbon future as the grid inevitably becomes cleaner, but they will also create added demand on top of already-high growth in electricity consumption. How can we avoid excessive grid infrastructure build-out and ensure grid stability? The most cost-effective strategy is to accelerate the deployment of smart energy efficiency technologies, which will require leadership from both policymakers and market actors.

Growing Electricity Demand

Baseline forecasts expect EVs to comprise more than half of all annual car sales and one-third of all cars on the road (550 million in total) by 2040, globally. Over the same timeframe, electricity demand from buildings is already projected to grow nearly 70 percent worldwide, with relatively conservative assumptions for building electrification rates. To put that in perspective, the United States alone may have to invest roughly \$2.5 trillion into electricity infrastructure to accommodate that demand.

Building electrification converts the primary end-uses in residential and commercial buildings that consume fossil fuels (such as space heating and water heating) to high-efficiency electric units (such as heat pumps). Although the building electrification trend is not yet fully mature, countries like the Netherlands have already set targets for phasing out fossil-fuel use in buildings, and large cities like Los Angeles, Vancouver, and New York City are currently considering creating electrification targets for buildings. According to recent America's Pledge recommendations for ten high-impact, near-term climate actions that local jurisdictions should prioritize, building electrification is near the top of the list.

In the Northeast and Midwest regions of the United States, where building electrification is most cost-effective today, building electrification retrofits are estimated to save over 800 Tbtu of building energy

use by 2025 - enough to power 25 million homes for a year. Despite the overall energy use reduction, estimates predict that when electrifying new and existing buildings, there will be anywhere from a 10 to 15 percent increase in electricity use compared to a standard fossil-fuel consuming building - and that is when paired with aggressive building-envelope and internal-load efficiency measures.

Smart Energy Efficiency Through Demand Flexibility

With these two trends gaining momentum, power grids across North America will need to be more proactively managed. Fortunately, increasing the deployment of smart energy efficiency in new and existing buildings represents the most cost-effective and beneficial path to avoid massive grid infrastructure costs, meet global climate targets, and maintain grid stability.

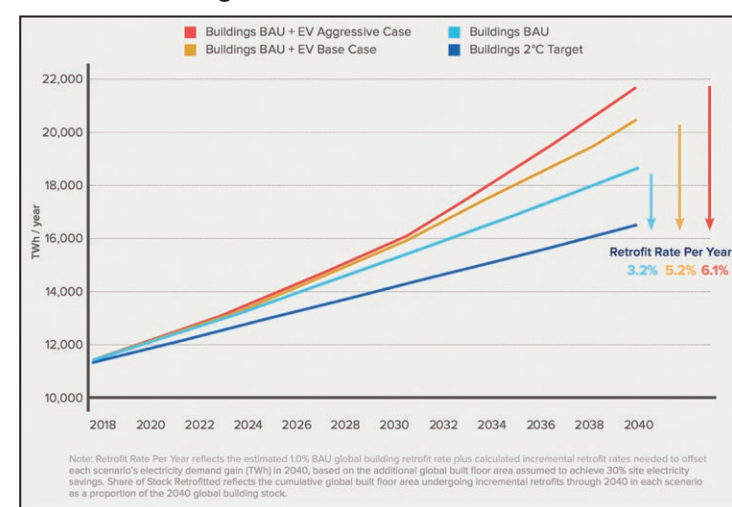
Energy efficiency also offers a number of other benefits that can be captured local:

- The creation of 380 jobs per TWh of electricity saved (versus 110 jobs per TWh of electricity generated by coal-fired power plants)
- The direct pocketing of energy cost savings by local consumers and businesses
- Increased resilience and energy security

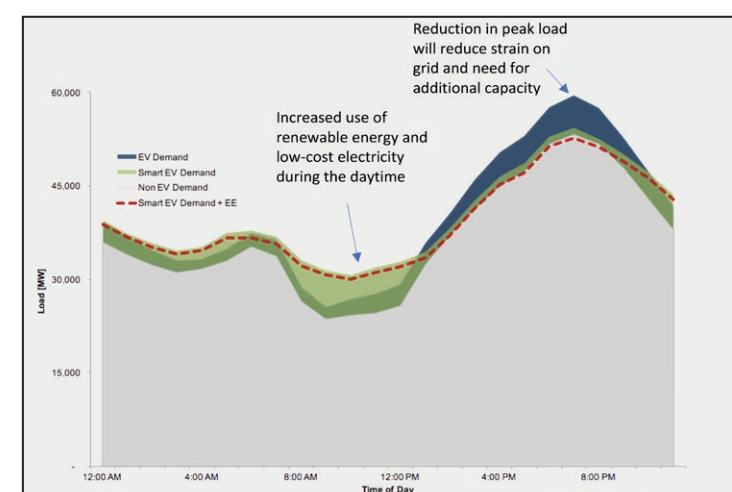
Smart energy efficiency offers even greater benefits because, in addition to saving energy, it allows for loads to dynamically respond to the availability of renewable energy through the use of demand flexibility technologies.

Demand flexibility technologies are essential to achieving high-penetration renewable grids; shifting loads to better match variable renewable energy generation limits curtailment and improves value. While smart EV charging is a critical component of this strategy, a new generation of automated building communication and control technologies (including smart thermostats to control air conditioning, dryer timers, grid-interactive water heaters, and battery energy storage) can further enable demand flexibility for residential and commercial building loads that do not require fixed schedules.

Global Building Retrofit Rates Required to Offset EV Demand and Meet 2°C Targets



Hypothetical Effect of Smart EV Charging and Building Energy Efficiency on Peak Electric Load



Source: CAISO projections and CA EV projections; Energy analysis of LED lighting, appliance replacements, and retrocommissioning across 50 percent of the existing building stock in CA at an average hourly savings of 7 percent; assumes 50 percent of non-EV load is from existing buildings.



Large-scale battery inverter-charger

Victron Energy's MultiPlus-II comes with a stylish steel enclosure, a large internal electronics redesign, and a low production cost, which makes the product much more competitive, especially in large-scale energy projects. Victron MultiPlus-II is a 48V inverter-charger that connects with a wide range of energy storage systems, from lead-acid and lithium-based batteries to zinc-bromine flow batteries. The unit is easy to install with AC connections accessible via a single plate on its base. The 18kg MultiPlus-II draws just 11W of standby power. The MultiPlus-II is a transformer-based system, which can immediately deliver backup power if the grid drops out, including start-up supply for high-demand devices such as air conditioners and freezers. The MultiPlus-II has optional Internet-enabled remote monitoring, both through a secure Victron portal or authenticated third-party applications. This remote monitoring enables the 24/7 performance logging of connected batteries.

Victron Energy | www.victronenergy.com

Energy Retrofits as a Solution

Policies like building energy efficiency codes help new constructions capture these benefits, but what about existing buildings? The global average retrofit rate is estimated to be only 1 percent of the building stock each year, which means that the deployment of these upgrades can be massively increased with ready-to-be-installed, widely available, and noninvasive energy efficiency technologies. By increasing the global average retrofit rate to just over 5 percent per year (a fraction of its cost-effective potential), we can welcome all expected EVs through 2040 - with minimal added grid infrastructure - and meet the 2°C target set by the Paris Agreement.

Any potential increases in load can also increase the capture, and use, of renewable energy. Germany and California have both progressed deep enough into their energy transitions to realize the importance of demand flexibility as the next necessary step in achieving deep decarbonization. The load profile must be manipulated to match generation. Thus, demand flexibility is essential to meeting clean energy goals. As grids become more saturated with renewable energy, they'll need to shift big loads, such as EV charging, to come on during the day. Pairing these types of controls with other energy upgrades, or requiring them in new constructions and major renovations, can aid the grid in achieving more flexibility.

Ignoring these issues, or delaying solution development, presents major risks. Although they offer tremendous climate and public health benefits, EV charging and building electrification can have a sizeable impact on increasingly strained power grids, potentially affecting power reliability and quality, and possible cost increases for consumers. This is all the more reason why policymakers, industry, and the public should make concerted efforts to more quickly deploy smart energy efficiency technologies. Managing load growth in this way may be one of our best opportunities to modernize the grid, minimize costs, and improve our quality of life.

Amy Egarter and Greg Hopkins are senior associates with Rocky Mountain Institute's buildings practice.

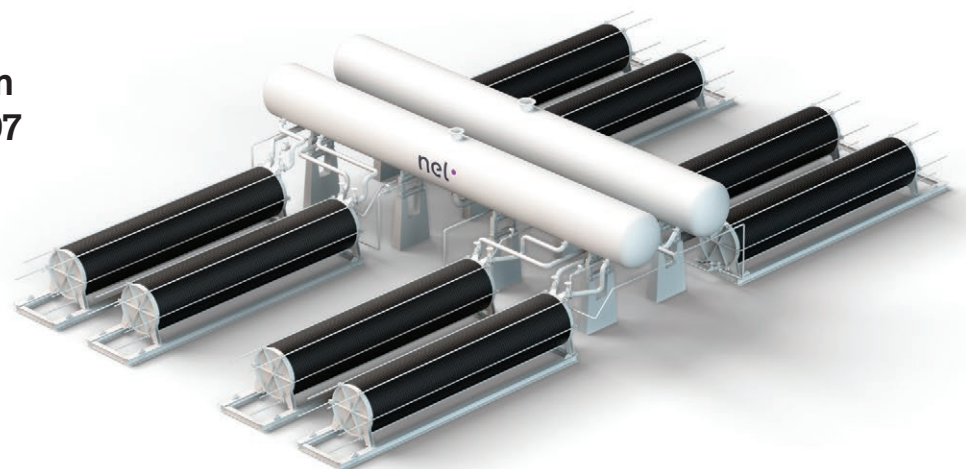


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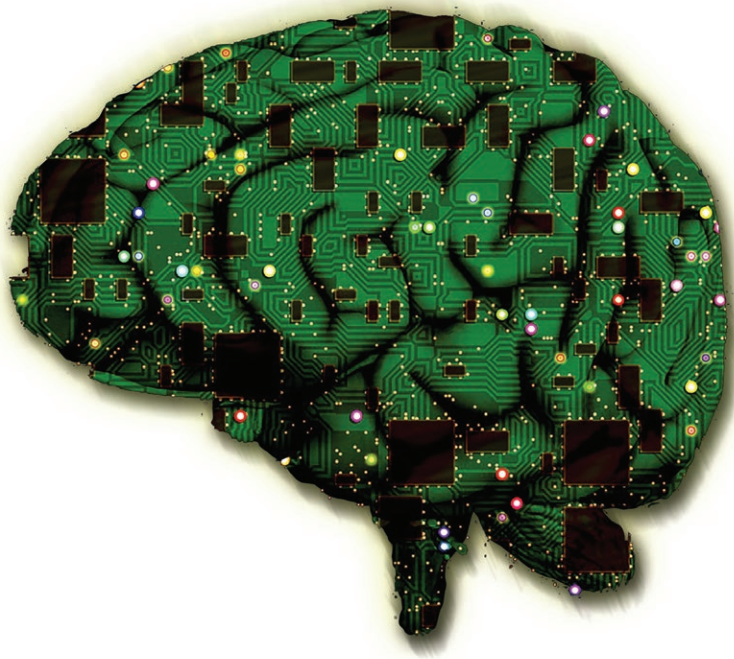
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AI-Driven Storage

How solar developers can ensure incentive program compliance

by Alan Russo

Artificial Intelligence (AI)-powered energy storage is enabling the rise of “intelligent” solar, where solar deployed with storage will soon dominate the market.

The reasons are myriad: energy markets are shifting, supply chains are becoming more competitive, and electric rates and solar remuneration rules are changing. As a result, the economics of distributed solar projects are getting skinnier, and riskier, for solar developers. Adding energy storage to solar projects allows solar developers to maximize project value and returns, reduce the impact of rate changes, and expand sales opportunities.

At the same time, renewable energy on the grid is increasing, coupled with increasing customer demand to control their decisions on energy sources and costs.

Both are necessitating new tools for utilities and grid operators to manage variable generation and distribution grid congestion, without building costly infrastructure.

These two changes are opening up new utility contracts and market revenue opportunities, for non-residential customers who invest in network-integrated energy storage; note the 13 different services from distributed energy storage for the customer, the utility, and the grid.

What AI Means

Battery hardware alone does little to unlock the value of energy storage. The fundamental key to transforming the returns of a solar investment is artificial intelligence.

In order to size the system correctly and maximize the returns from a solar plus storage system for the customer, AI is needed to perform the predictive analytics, machine learning, and grid-edge computing.

Data is captured every second on customer load, solar generation, weather, nearby grid congestion, electricity rate options, and more. That data feeds the AI to make the best decisions about when to buy, generate, or store energy.

Artificial intelligence delivers value by accurately predicting the customer’s solar-affected load. Then it optimizes numerous related variables and makes real-time economic decisions that maximize the benefits for the customer, the project owner, and the grid.

Value, Value, Value...

There’s already widespread agreement that, in addition to capturing more value from the Investment Tax Credit (ITC), adding AI-powered energy storage will maximize value and returns for the solar customer. It also gives them greater control and flexibility throughout the 20-year project lifetime. During the life of a solar project, most customers will face between five to six rate changes, in addition to regulatory and financial changes, that could affect the value of their investment. Adding AI-powered storage to solar projects early on can hedge against these changes.

Unfortunately, not enough solar developers realize that AI-based storage enables the customer to access new value streams and market opportunities - turning the solar system into a dispatchable grid-facing asset. AI-driven storage can deliver these other services, and “value stack” the additional contracted revenue. For example, the customer could access additional capacity payments from a utility, or receive grid services

payments in the wholesale market by contributing the unused stored energy to aggregated load reduction.

Depending on a variety of factors, energy storage can potentially contribute between five and 30 percent additional returns for the solar customer; these come from demand charge reduction, load shift, and grid revenue opportunities—and that’s not even counting the additional future value of decreased risk from rate changes. For the solar developer, AI-driven energy storage typically offers 40 to 50 percent higher margins.

...And Resulting Optionality for the Customer

Whether it’s a wholesale market, utility program, demand charge management, or a tariff-based savings opportunity, the real gamechanger surrounding AI is its ability to optimize within a minute, based on varying value streams. It’s also making these calculations while considering ITC charging and market participation rules; the AI prioritizes between competing value streams to maximize the economic results, while reconfiguring the dispatch of the system and the aggregated network in real-time.

In other words, when the solar economics are suboptimal (such as the tilt, orientation, insolation, load shape, or local tariffs), the customer has additional savings and market opportunities via the energy storage network.

Utilities and grid operators can contract services from the network to provide firm, reliable, and cost-effective energy precisely where and when it’s needed, avoiding the need for new peaking power plants or other costly infrastructure.

Therefore, AI-powered energy storage can make projects that otherwise would not pencil, both possible and profitable.

Bottom line: everyone wins.



But, You'd Better Get the Compliance Right

As new incentives and value streams emerge, it becomes increasingly complex to maximize returns while ensuring program compliance. ITC benefits come with charging requirements; state incentive programs have their own charging rules, along with cycling and throughput requirements, operational rules, warranty obligations, and so on. Wholesale market bids and utility contracts have even more performance metrics.

Compliance becomes so complex, in fact, that realizing the full value of solar plus storage is only possible with AI. Solar developers and their financiers that are unfamiliar with storage programs and their policies, will need to work with the best AI and most experienced storage operators to ensure compliance.

Many factors will change over the life of the solar investment: load behavior, incentive program rules, hardware degradation, and new market opportunities. AI enables the developer and financier to nimbly alter algorithms as those factors change, to ensure projected or greater returns. As more solar financiers recognize the potential residual value of energy storage from future contract revenue streams, AI-backed solar plus storage will be able to access that added value today, and tomorrow.

Alan Russo is the Senior Vice President of Global Marketing and Sales at Stem, Inc.

Stem, Inc. | www.stem.com



Industrial lithium battery chargers

Delta-Q Technologies has released four new high frequency lithium battery chargers in the ICL Series – the ICL1200 and ICL1500 in 85V and 120V models. The ICL1200 and ICL1500 respectively provide 1200W and 1500W. The 85V models designed to optimally charge lithium battery systems of any lithium-ion chemistry from 14 to 24 cells in series, where the 120V models charge from 21 to 34 cells in series. Delta-Q's new lithium chargers are suitable for use on any electric machine including scooters, light electric vehicles, aerial work platforms, and sports and utility vehicles. The Delta-Q Technologies software offerings include CAN bus communication for BMS and telematic integrations with CANopen and SAE J1939 protocols. Delta-Q's software team has also built over 200 custom algorithms, ensuring users experience better runtime and flexibility for different lithium battery chemistries. The ICL1200 and ICL1500 in 85V and 120V are part of the ICL Series which share a set of standard features. This includes a wide AC input range, where the any ICL Series charger can operate on any single-phase electrical grid around the world. With a fully customizable, field replaceable cable design, and the ability to act as both an on or off board charger, the ICL Series provides original equipment manufacturers (OEMs) with flexibility in design and deployment. The ICL Series is IP66-rated to protect against dirt and fluids, while its mechanical design and component selection resists vibration, shock and temperature extremes.

Delta-Q Technologies | www.delta-q.com



Fully integrated energy storage system

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Dynapower Company, LLC
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California and Beyond

A timely fix to decarbonize the fast-growing energy storage market

by Katie Ryan

Here's a Family Feud-esque scenario: Imagine asking 100 energy sector experts the question, "What's needed to reduce emissions from the energy sector?" Survey says... "Energy storage!" And rightfully so.

The grid has become a more and more complex orchestra of parts: demand has grown more flexible with smart devices; customers have installed more on-site generation, storage, DERs, and EVs; the bulk power system has replaced more baseload fossil-burning plants with utility-scale wind and solar. No matter the complexity, however, the grid still must abide by the old rules of balancing supply and demand.

Energy storage can allow us to store and dispatch energy from wind and solar, providing constant, zero-emission electricity even after the sun sets, or the wind dies down. Without energy storage (as well as sufficiently robust demand-side flexibility), we'll continue to face our current energy system challenge: electricity must be produced at the exact moment it's used.

This leads to an odd quirk of electricity markets: because power plants have to supply energy when consumers ask for it, the exact moment a consumer uses electricity determines which power plants get to sell it. While it's hardly a simple exercise, with precise-enough algorithms, it is possible to detect which power plant will supply the electricity if consumers use it at a particular time and place. That power plant is known as the "marginal"



plant; the options vary widely, from coal-fired plants to those generating renewable energy.

In this equation, energy storage has become an essential component of emissions reductions because it has the ability to hold on to surplus when wind and solar are over-producing (relative to demand), and then dispatch at times when a polluting energy plant would otherwise need to respond. This process ideally gets put on repeat, at an increasing scale, to support grid management as renewables grow and flood the system.

No state is more at the frontlines of this opportunity than California. The state is leading the world with its aggressive clean energy target: to source 100% carbon-free electricity by 2045. Through California's Self-Generation Incentive Program (SGIP), the state has already installed record-breaking levels of energy storage towards reducing the state's greenhouse gas (GHG) emissions. But is it working?

In the 2016 and 2017 SGIP Advanced Energy Storage Impact reports commissioned by the California Public Utilities Commission (CPUC), data showed that battery storage actually increased emissions in both the residential and commercial sector. Each time batteries charge, they increase total amount of demand on the grid; when they discharge, they decrease demand. This increases or decreases corresponding output at the marginal power plant. The key to ensuring a battery charges with clean energy requires knowing which plant is on the margin in real time. If that battery is storing and dispatching dirty energy, it's contributing to emissions.

Until recently, there was no way to know when and which power plants were marginal. Today, access to real-time, location-based marginal emissions data make clean battery storage a reality. Equipped with this information, and the right software to leverage it, we can prevent what the CPUC reports showed - batteries often store more dirty energy than clean.

The CPUC convened a GHG Signal Working Group to address this very issue. The Working Group, made up of diverse stakeholders, explored thousands of scenarios for GHG reduction strategies of energy storage systems. They found that the use of real-time emissions data, combined with a quality forecast to dispatch batteries, could eliminate emissions and preserve customer cost savings of up to 60 percent.

Following the findings of the Working Group, the CPUC staff issued a proposal (R1211005) for new GHG rules for both residential and commercial projects. The proposal is still open for comment, and won't be implemented before the CPUC





issues a final ruling, expected in the first quarter of 2019. In the meantime, the lessons learned can be applied at scale.

For example, one important part of the proposal (relevant for other states planning similar large storage mandates) is the call for a public, real-time GHG signal, based on marginal emissions data, and built upon a transparent and vetted methodology. By using this as the starting point, states can avoid increased emissions before their mandates come into effect, and battery storage can live up to its image as the kingpin in a low-carbon energy future.

Katie Ryan heads up the Partnerships team at WattTime, a non-profit subsidiary of the Rocky Mountain Institute, which catalyzes a movement to give anyone the freedom to choose cleaner energy easily and automatically. WattTime builds technologies that enable electronic devices to automatically sync the times they use power to moments of clean energy. WattTime created Automated Emissions Reduction (AER) technology, and participated in the CPUC's GHG Signal Working Group to help find a decarbonization solution to build into California's energy storage plan. Katie has 10+ years of diverse career experience in corporate sustainability and communications. She serves on the non-profit board of Hill Country Conservancy and hco-founded the first 1% for the Planet mobile game company, The Path to Luma.

WattTime | www.watttime.org



Whole-home back-up and smart energy management

Panasonic Eco Solutions of North America and Pika Energy introduced a significant upgrade to the Harbor Smart Battery portfolio with the Harbor Plus Smart Battery, a powerful and efficient smart battery with 17.1kWh of capacity and real power output of up to 10kW. Additionally, the Harbor Plus Smart Battery delivers 21% more energy and 30% more peak power, enabling homeowners to extend solar power longevity, better manage energy around peak-rate periods, and withstand off-grid scenarios at a more cost-effective price per kWh of storage. The solar-ready Harbor Plus Smart Battery is powered by six Panasonic Lithium-Ion (Li-ion) battery modules connected in series for built-in redundancy. This robust design, coupled with 17.1kWh of usable energy and up to 10kW of power can support homeowners for long-term grid outage and off-grid scenarios, and can also power heavy equipment such as well pumps and air conditioning units. Paired with the Pika Energy Island, the Harbor Plus Smart Battery offers solar system owners enhanced and expanded features, including: Self-supply Mode, which maximizes self-consumption of stored energy captured by solar panels to reduce the home's dependence on the grid; Zero-export Mode, which prevents any solar energy from transferring to the grid, enabling homeowners to reduce grid dependence as well as remain in compliance in states where exporting solar power to the grid is prohibited; Time-of-Use Capability, helping homeowners who live in areas with time-of-use rate policies efficiently manage solar power and reduce costs with an optimized schedule that reduces or eliminates grid use during peak-rate periods; Clean-backup Mode, which stores clean solar energy in the smart battery for use when the grid is disrupted. Load transfer is instantaneous, taking as little as 1/60th of a second; Priority-backup Mode, which charges the smart battery from the grid at the full capacity of the system, allowing homeowners to prepare for an expected grid outage such as in the event of an impending storm; and Dark-start Capability, with the ability for Pika smart batteries to commission without the grid and restart using only solar power should the batteries exhaust their reserve energy.

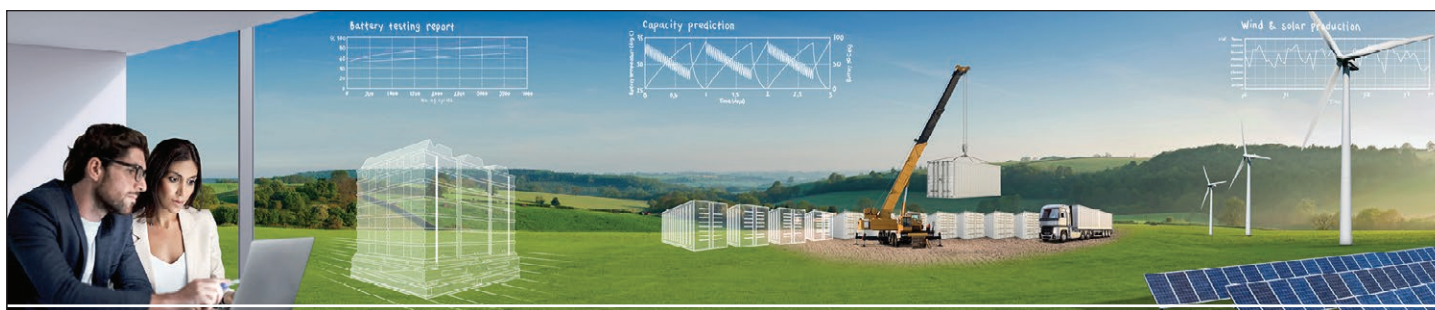
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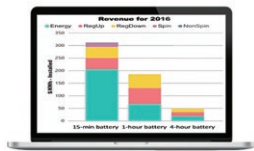
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Decision analysis tools

Ascend Analytics provides the energy industry with analysis tools which enable optimal decisions from the next hour to the next decade and beyond. Their enterprise-ready analytic platform provides for integrated physical and financial decisions. The BatterySimm valuation tool identifies configurations and operating strategies to maximize value for battery storage projects. BatterySimm finds the most cost-effective battery configuration for a given node or utility system, and discovers the optimal dispatch strategy by co-optimizing between energy and ancillary services. BatterySimm's advanced algorithms help developers, investors, and utilities define and implement strategies to co-optimize the joint value for both energy and ancillary services markets. It has three different modules to maximize project value through any point of the project life: optimal sizing for energy cycling capabilities and duration specifications; evaluate projects under both perfect and imperfect foresight of energy and ancillary service prices; and determine optimal operating strategies for ISO bidding and integrated utility operations.

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Three-phase bidirectional storage inverter

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Space Invaders

Protecting America's power information systems from outside interference

by Dan Didier

LEGACY SYSTEMS. COMPLEX NETWORKS. TIGHT BUDGETS.

These are just a few of the vulnerabilities that position the energy sector as a hot target for cyber criminals. Unlike many other industries, where financial losses are the top concern, an attack on our nation's critical infrastructure will not only have an economic impact, but could be detrimental to the health and safety of workers and residents in nearby communities. Don't think malicious actors aren't paying attention - attacks on electrical and energy companies are on the rise.

From nation-states and politically motivated hackers, to script kiddies and disgruntled employees, threats are coming from an entire host of adversaries, each looking to take advantage of the industry's pitfalls and recent shift toward digitization. Adding fuel to the fire, the energy industry has a unique set of security requirements. This leaves many energy companies struggling with a tough choice: Do they want to be compliant, or secure?

Unfortunately, most power organizations are so laser focused on compliance that they lose sight of what must be done to actually improve their security program. Why? For one, this compliance-based approach predates the modern age of cybersecurity; it's been a part of the energy sector for so long that it's baked into the operations. With security risks becoming greater and greater, it's time for energy companies to make the switch from a compliance-based approach, to one that uses risk to guide their security programs.

Ideally, power companies should focus on both compliance and security, where compliance is a byproduct of the security program. There isn't a single way of doing this, however, and it all depends upon the potential risks of each organization. Here's a closer look at how energy companies can vastly improve their security programs, while maintaining compliance at the same time:

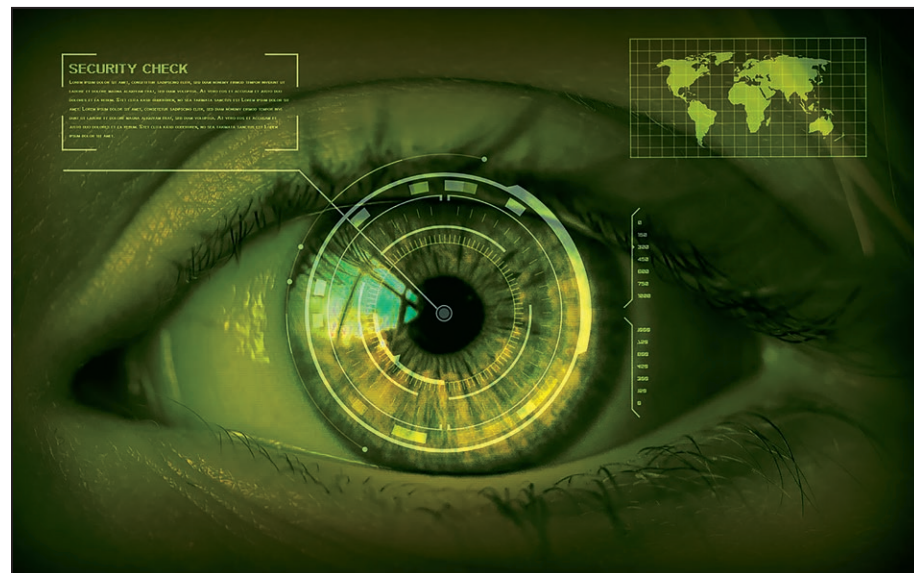
Expand Approach: The security issues of an organization cannot and should not be addressed only by the compliance or IT departments - nor should security be pigeonholed into any other department. If a security program is going to be successful in today's increasingly digitized environment, it must be elevated to a business decision that includes all departments; security threats impact the entire business - not just a single department.

One problem with leaving it up to compliance is that, like all departments, the compliance department has many other issues to focus on. Plus, when security decisions are made within the bounds of existing compliance functions, it prevents the organization from

making risk-based decisions, instead relegating the security function to a checkbox in a long list of checkboxes that all share the same budget. Likewise, the IT department is trained to look at cybersecurity as a technology issue when, in fact, many of a company's top risks have nothing to do with technology, and everything to do with people and processes.

Focus on Risk: More than half of executives within the energy industry concede that they have not fully identified the risks they could be exposed to. This is alarming on all levels, because understanding an organization's unique risks is the only way a company can begin to implement a comprehensive security plan to address those vulnerabilities. If a risk management capability is not established early on, companies will be solving the wrong problems, wasting valuable resources, and leaving critical assets under protected. On the other hand, establishing and prioritizing risk can help companies can gain much more value from their resources, all while reducing the risk to their business.

Have a Corrective Action Plan: Once priorities have been established using risk, companies should develop a corrective action plan that can be successfully carried out with the company's available resources. This plan should clearly identify top risks, the individual (not department) responsible for the execution and planning necessary to remediate the risk, how much it will cost the organization, and a target date for remediation. Not only does the plan help provide visibility to senior leaders and the board, but it allows everyone to agree on the cost, and path to resolution.





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Plan for Failure: Not all risks are known, and not all risks - known or unknown - are managed in a way that eliminates failure. Because of this eventuality, companies must have a disaster recovery plan to ensure operations continue when there is a failure. It's a simple idea, but it escapes most people due to their complex work environments. In the energy sector especially, energy systems are becoming increasingly intertwined not only with communications and information technology, but also with the natural environments in which they serve. It doesn't help that most of today's technology is already confusing for many people. As human beings, we tend to respond emotionally under critical situations. On the other hand, a good disaster recovery plan will remove the confusion that arises in a crisis, and provide a process that helps to quickly identify the steps a company can take toward recovery. The plan should also provide visibility to the process at the highest levels, so the board of directors can look at it, understand it, and approve it.

As the energy sector continues to evolve toward digitization, the vulnerabilities will only increase, and the attacks will become much more sophisticated. It's only a matter of time before a major, full-blown attack will be successful in penetrating the defenses of our critical infrastructure. We must take a hard look at the relationship between compliance and security; compliance does not mean we are secure. Success depends upon our ability to understand the risks, prepare for likely impacts, and take swift action to mitigate the damage when our risk management capability does fail.

Dan Didier (MSIA, CCSP, TSS) is an entrepreneur, speaker and Vice President of Services for GreyCastle Security. With nearly 20 years of security experience in a wide range of industries including critical infrastructure, finance, healthcare, manufacturing and other prominent industries, Dan brings extensive expertise as a technical security engineer and business-focused risk manager.

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Beyond Politics

A project manager's argument for clean energy

by Michael Lumbley

In business, when you need something done right, project management ensures a thorough and systematic approach. It organizes people, tasks and deliverables to make sure that each step delivers the desired results, and keeps the whole process on schedule and on budget.

There is a moment in project management, however, in which everything you believe you know about a system becomes irrelevant, and you're forced to admit one thing: the system is out of control. This is called the Rule of Seven: When seven key performance indicators show up outside your "control range", the limit of what is normal or acceptable. Perhaps there was a specific skill set needed that wasn't accounted for in the initial plans, or the scope of the project swelled beyond its budget.

It's never pleasant. Good project managers understand that, at this point, the time for ego has passed. With the exception of diagnosing the source and determining a solution, ascribing blame is useless. The only thing that matters is avoiding a catastrophic failure. If the issue is avoidable and the right steps are not taken, it isn't a failure of the system - it's a failure of the stakeholders.

We can apply the lessons of the business world and project management, to stewardship of our planet. When it comes to climate change, pointing fingers is a waste of time. The data is clear: The greenhouse effect of carbon dioxide is the lead culprit, and energy production is the leading source of CO2 emissions on the planet. Mounting data—the hottest years on record, the most powerful cyclones, and the worst droughts and wildfires ever recorded—indicate the global climate system is out of control.

The time has come to use the same logical and systematic approach to problem solving that we would use in any business case.

1. Do we have lower, scalable CO2 emission energy production options?

Yes. Renewable energy sources such as solar, wind, geothermal, and hydro produce power with very little emissions attributed to their manufacture and ongoing operation. Advances in natural gas production (like the ability to use the waste heat from burning natural gas to produce energy) affords the opportunity to magnify the production, by not wasting the heat energy of the exhaust coming out of the generators themselves.

2. Can we maintain our quality of life utilizing these options?

Yes. With the maturation of energy storage, it's possible to balance the production of these combined resources to function like traditional baseload resources (such as coal and nuclear) to supply the consistent, on-demand power on which our lifestyles depend. Beyond that, there are numerous advantages to deploying distributed multi-resource microgrids.

3. What are the pros and cons of implementing the new strategy? Can it solve the problem?

This is where the magic happens. By bringing a multi-resource solution to the problem, you not only create a diverse portfolio of production options, you also build in redundant safety to reinforce the power grid in case one resource is compromised. When it is cloudy, the wind is usually blowing. When sunshine seems relentless, excess energy can be stored for use when the sun goes down. When there is no sun or wind, Natural gas can still provide a lower emission option than coal. Hydro and geothermal power are both essentially based on gravity (creating downward pull on water and the internal heat of the Earth's core). Gravity isn't going anywhere.

With these details in mind, the need to deploy possible solutions becomes apparent. But, what do detractors say?

"The data is flawed."

This argument belies the evidence what we are all experiencing personally and witnessing firsthand: Summers are hotter. More people than ever are dying from heat waves each year, and our favorite coastal locales are being inundated by flooding from big events, and even lunar cycles.

"It's too hard/too expensive/too complicated"

This argument is usually posited by those who directly benefit from the status quo.

Every critical infrastructure—medical, transportation, communications, commerce, transportation—depends on reliable energy infrastructure. By engineering a system that depends on one vulnerable component, you are effectively creating a design flaw.

Large distribution networks are hard to secure, difficult to maintain and expensive to operate. With large portions of the grid's hardware dating back upwards of 40 years, the cost of maintenance and repair could actually be more than replacing the system with more modular, modern technologies. These smaller, distributed microgrid resources offer redundancy in case of failure, and allow for targeted delivery to address a given region's specific needs.

Distributed energy resources (DERs), such as solar and storage, allow for energy infrastructure deployment in a way that protects against single vulnerabilities. New technology, like blockchain, can enable the entire operation of the grid by using a transparent, authenticated, identity-based grid management platform. These systems will help speed integration by tying in newer modular technologies, as well as communicating with older legacy power generation assets.

When a system is out of control, your options are either to come with answers and solutions, or be held accountable for its failure. Fixing the global energy system is beyond a question of politics. It's inherently a question of survival.

Michael Lumbley is Director of Development at Alternative Resource Group, a company that works with conventional and renewable resources, battery storage and state of the art delivery systems to provide stable and cost-effective power generation.

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