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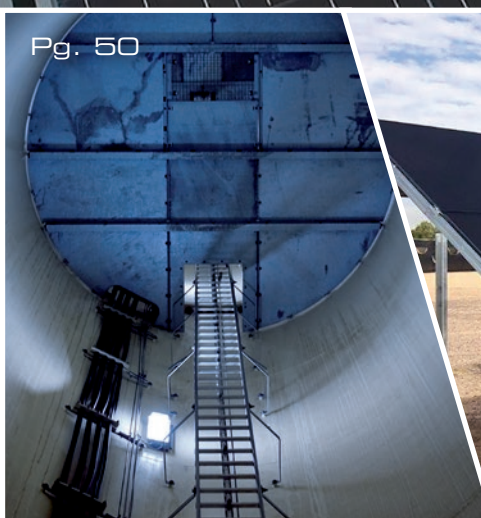
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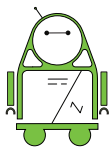
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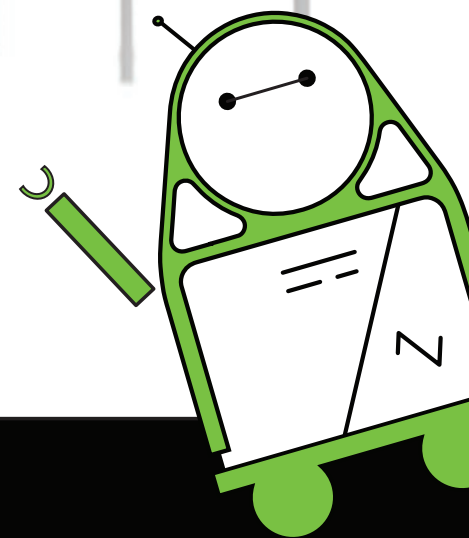
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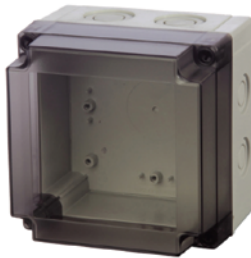
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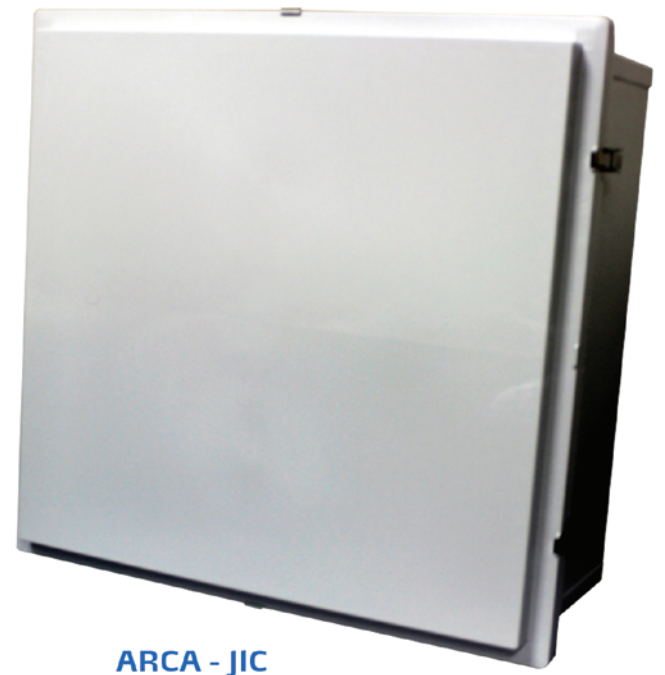
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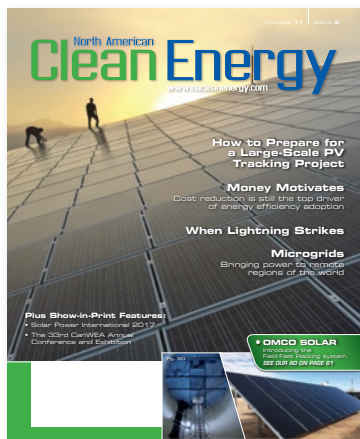


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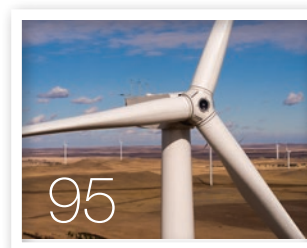
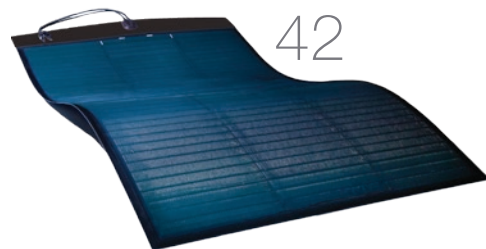
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On our cover...

Taken during the installation of a 78kW PV project on the roof of the new City Hall in Puerto Princesa, Palawan, Philippines. Vis Solis developed, financed, installed, and operates the Puerto Princesa City Hall Showcase Project in a Public Private Partnership with dena - The German Energy Agency, co-financed by the German Federal Ministry for Economics Affairs and Energy (BMWi) within the initiative renewables - Made in Germany. Engineering and design was provided by ARC Design & Consulting in Elmer, New Jersey with a collaborate effort around the world.

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WHILE LISTENING TO THE SPORTS REPORT ON THE RADIO

the other morning, I was surprised to hear, at the end of one baseball player's recap of the game, the words "by a translator". Here's a guy, from another country, enjoying a lucrative career in the Great American Pastime, and his English fluency is so poor that he needs a translator to convey his opinion. How the heck did we get to this point? And how can these guys all play the same game without speaking the same language? Then I realized, albeit slowly (after my third cup of coffee), that the game is the language.

You're currently reading a magazine called "North American Clean Energy". Although I try to focus on posting all of the happenings in the northern section of this continent, I can't seem to tear my eyes away from all of the innovations taking place around the world. There is a lot happening out there, by many people, with many ideas, in many different countries. It's pretty exciting to find news of the latest developments in green energy. After all, that's our game, our common language.

As far back as 1904, industry representatives recognized the need for adopting standards worldwide; the International Electrotechnical Commission (IEC) established a common guide to help societies collaborate, in order to advance technology for the betterment of all. We count on these codes every day to grow our businesses here and abroad, to build machines that can communicate with each other, and to retrofit those machines that are nearing the end of their lifespan. We're seeing an explosion in the industry for aftermarket parts; countries that are decades ahead of us in their progress with renewable energy will demand a strong supply of materials to refurbish and regenerate those assets - their wind turbines will most likely be spruced up with parts from all corners of the globe.

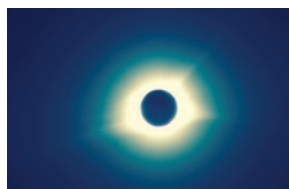
No man is an island. Maybe for microgrids, but not for sharing ideas in the name of progress. Cooperation is a keystone of society - it's one of the lessons Big Bird sings about on *Sesame Street* (or, if you don't have kids, think Charles Grodin and Robert DeNiro in *Midnight Run*). I'll frequently catch myself bouncing ideas off my husband (not that it always leads to my desired outcome, but give me credit for trying). You may have run into me earlier this year at the Intersolar North America show in San Francisco. Or I may have run into you - I have a dreadful sense of direction and tend to get turned around in the hodgepodge of elaborate displays. No matter where I went, however, I saw and heard groups of people talking with each other, sharing and comparing their ideas and thoughts on a common subject. Whether it was trackers, cables, foundations, fasteners, inverters, etc. And even though the show had the words "North America" in its title, I saw industry representatives from around the world joining the discussion. None of this could happen except for the fact that we're all using the same terms and reaching for the same goals, no matter our native tongue.

This enthusiasm and drive isn't unique to a single segment; it permeates every corner of the renewable energy trade. Try attending all of the 15+ upcoming energy storage shows around the world over the next year. It would be a Herculean feat, but you certainly would fill your brain with ideas, and may even stumble upon some solutions.

You'll find this theme throughout many of the articles in this issue - the more people in the world we can get to advocate for renewable energy, the better. We're one giant team, doggedly pursuing new recruits. Stay green and carry on.

Meg

'Many ideas grow better when transplanted into another mind than the one where they sprang up.'
— Oliver Wendell Holmes



All Elements Photography

Sustainability and celebration of the sun

On August 21, 2017, parts of North America experienced a total eclipse of the sun. Coinciding with that cosmic occurrence was the first annual Get Off The Grid Solar Expo and Sustainability Fair, which had the appreciation of the power and importance of the sun at its core. The two-day event attracted thousands of people who engaged with solar, wind, and hydro power providers, helping encourage a commitment to and an interest in solar living and energy independence. Participants were exposed to the concept of being off-grid not only in energy use and production, but also in areas relating to health and wellness, education, food production, music, arts, and crafts. Presentations were given by academics and earth scientists from area universities and colleges, while musicians, poets, and other artists focused their work on economic and ecological sustainability. Performance stages, presentation areas, and food vendor trucks were completely powered by portable solar panels.

Get Off the Grid Fest, LLC | www.getoffthegridfest.com



Energy Storage North America Announces Winners of ESNA Innovation and Champion Awards

Energy Storage North America (ESNA), the largest gathering of policy, technology and market leaders in energy storage, announced the winners of this year's ESNA Innovation and Champion Awards.

The ESNA Innovation Awards recognize candidates for their impact on the energy storage ecosystem, services supplied to customers and the grid, unique technology solutions, financing, or partnerships.

Centralized Storage:

SDG&E Expedited Energy Storage Project; Southern California Edison Hybrid Enhanced Gas Turbine (BGT)

Distributed Storage:

Marcus Garvey Village Solar+Storage+Fuel Cell Microgrid

The ESNA Champion Awards recognize individuals from the utility and policy sectors who have demonstrated significant leadership in advancing the role of energy storage to achieve a cleaner, more reliable and more resilient energy grid.

Utility Champion:

Ron Nichols, President of Southern California Edison (SCE)

Policy Champion:

New York Assemblywoman Amy Paulin (D-88)

Energy Storage North America | www.esnaexpo.com



Aussie designers crack secrets of solar drone

A father and son Australian company has developed a new process to create a lightweight, solar-powered drone, which they hope will be able to fly almost indefinitely during daylight hours. Praxis Aeronautics has worked out a new way to encapsulate standard solar cells in composite material without losing efficiency, thus solving one of the key problems that had been holding back solar-powered aircraft, the weight and cost of accommodating solar cells. The Praxis solution uses a laminating process to incorporate ordinary solar cells in the composite material of the aircraft, a process that Cameron Donaldson has used in the shipbuilding industry to encapsulate timber in the construction of high-end yachts. That process can give marine craft the glossy look of a classic timber boat, but with the durability of fibreglass. His patent attorney suggested that solar cells might be a profitable new application for the process, which others have tried and failed to achieve in solar aircraft. Applying the process to a drone also made sense commercially. The Donaldson's plans for their drone include a broad range of potential applications including aerial mapping, deliveries, environmental management, and a much cheaper alternative to piloted fixed-wing or helicopter shark patrols.

Praxis Aeronautics | www.praxisaeronautics.com.au

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How to Prepare for a Large-Scale PV Tracking Project

by Tim Murphy

LARGE-SCALE PV TRACKING PROJECTS (>100 MW) ARE

returning to the front in the USA, as the extended ITC reduction schedule deadline approaches. The challenges of these projects stem from economic and technical variables, but are also related to the tracker supplier's capacity and reliability to deliver the volume and quality on time. ITC build out construction will likely be starting as late as possible, and timely deliveries will be expected as soon as possible.

The preferred tracker supply company for large-scale customers is best prepared with a mature standard product, a reliable logistics system, appropriate supply capacity, and factory support for the customer. Moreover, they will demonstrate a company strategy to achieve high customer success, by focusing on both customer outcome and customer experience results.

The mature standard product is, of generational evolution, sufficient in time and innovative scope to achieve a repeatable and cost-effective design proven to reduce costs, increase performance, and provide options in application that inherently solve customer project challenges, without special costs or disruptive surprises.

Bifacial PV tracking is a good example of this, since it especially leverages the bifacial early and late-day performance characteristics. This application demonstrates product maturity by eliminating backside shading, while providing a higher mounting location (key to increasing bifacial performance). That maturity enables cost-effective innovation in place of special efforts that stray from project economics.

The bifacial tracking case is resolved simply by a standard feature of two-up portrait module mounting, whereby backside shading by the torque-axis is effectively eliminated, and bifacial performance is increased by height of installation. This feature also enables a lowest piles-per-MW spec, short-tracker site-filling options, the highest rates of array washing and vegetation control (MW-per-vehicle pass), higher and drier motor location, and wider aisles.

Tracker product maturity is further demonstrated by closing the gaps in revenue stream, due to array-gaps on the tracker and site-gaps on the ground. Complete tracker module-fill accounts for up to a 5 percent greater yield potential than gapped-trackers. Steep-slope tolerant trackers tilting towards the sun can increase yield potential, and reduce earth grading costs and environmental impacts, installing simply where others cannot.



All motorized trackers incur operational power demand. Self-powered trackers come in two types of autonomous PV power supplies: standalone, and series-string. The standalone PV module occupies viable PV active-area on the tracker, but will never contribute to yield. It will exhibit low-utilization due to overdesign, based on worst-day design criteria. The series-string type takes the minimum from yield stream to supply demand - the corresponding value is related to the yield selling price (as low as \$0.03/kWh at auction) plus the LCOE of the power supply (with no costly special PV module to install). The series-string power supply leverages string availability, and tremendous array/load ratio for reliable and cost-effective operational power, and enables complete tracker module-fill.

Reliable logistics operations of large-scale supply require synchronization of the tracker suppliers global manufacturing and warehousing capacity, with regional operations and the customer project schedule. Local content may be required regionally, presenting the opportunity to tangibly improve local economies, and increase customer success. Essential logistics elements that require factory direct management include: just in time arrival, minimal onsite handling, packaged for onsite distribution, and no intermediary handling companies.

Factory direct support of the customer is essential. To achieve customer success, the supply contract development and execution stages each require factory attention to project details. Large-scale PV tracking is a straightforward construction endeavor; the opportunity exists to leverage simplicity into a complex project environment. The preferred tracker supplier's team of factory experts will support the customer's development team to optimize the application. Also during construction, the customer's onsite A-team receives the measured dose of factory support in logistics, onsite handling, installation, and commissioning.

When first evaluating candidate tracker suppliers, customers rely to some extent on external ranking studies, usually in terms of annual shipments (MW) and revenue (\$). With time, customers have learned that typical ranking results may have an inherent bias of perception in favor of companies that ship partial tracker supplies, that count equally with complete tracker shipments in the ranking. A preferred supplier will practice transparency and honesty in providing actionable data to customers. Very early in supply contract development, it will become clear how the price reflects the content - the sooner the customer gets that information, the better.

Preparation for large-scale PV tracking challenges starts with a reliable tracker product and supplier that assume a project-partnership role, precisely focused on both scope and customer success. It's important to compare candidate suppliers by measuring both product and company attributes against project needs. This cost-effectiveness evaluation will usually favor the standard product of a manufacturing supplier that has a history of innovation, appropriate manufacturing and supply capacity, and a demonstrated track record in large-scale PV tracking equipment supply.



Tim Murphy is Communications Manager USA at Soltec America LLC.

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How Software Can Facilitate the Next Wave of Solar Growth

by Monette Meier



DESPITE THE SOLAR MARKET'S IMPRESSIVE TRAJECTORY OVER

the past decade there is still a significant amount of growth needed before solar, and renewables in general, make up a substantial portion of our energy generation. As the solar market continues to mature, the policy landscape becomes increasingly complex, with the implementation of new regulations, Net Energy Metering (NEM) rules, and less favorable utility rate structures. This complicates the solar value proposition, and drives the need for increased sophistication in how solar project developers model their projects. Advanced software applications that are designed specifically for solar development activities offer powerful tools to accurately analyze solar projects, despite these complexities. Software platforms enable developers to identify multiple savings opportunities, optimize system specifications, effectively communicate the solar value proposition, and streamline the sales and project development process. As the solar market continues to evolve at a rapid rate, innovative software tools will play an important role in contributing to the next wave of growth.

The solar software landscape

There are a variety of software offerings for different stages of the solar project development process. Between project conception and completion, software platforms can serve several functions, including lead generation, CRM, solar system design, utility rate analysis, financial analysis, proposal generation, and project management. Each of these tasks is a fundamental step in the project development process. Financial analysis and proposal software platforms are particularly important, as they enable installers to extract all possible savings opportunities from a solar project and transparently present these findings to customers. This is especially vital today, since many policy changes have begun to erode the solar value proposition. By identifying and communicating the economic viability of solar projects, best-in-class software tools can play a significant role in facilitating the adoption of solar on a larger scale.

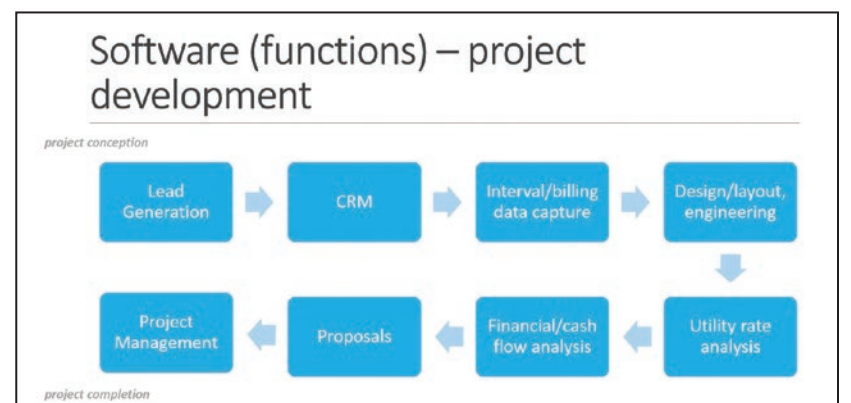
Sophisticated tools for a changing market

During the early days of the rooftop solar market, developers often utilized desktop software applications like Excel and Word to model projects and calculate savings. However, the complexity and rapidly changing nature of the industry have made it necessary to utilize tools specifically built for modeling solar project economics. Today's advanced financial analysis and proposal software applications enable project developers to model all types of projects, and achieve a level of rigor and granularity in their analyses that isn't as feasible when done on spreadsheets. Sophisticated software platforms cohesively integrate all project inputs – from the specifics of the solar system design, to a customer's utility bill and energy use profile, to financial transactions and incentives – in order to generate a reliable analysis of a customer's proposed savings.

Generating an accurate savings analysis, and extracting every possible savings opportunity from a project, is becoming particularly vital since, in many regions, savings from solar don't pencil out to the same degree they did a few years ago (or even as recently as a few months ago). Take California as an example. As of July of this year, all three major utilities – Southern California Edison, San Diego Gas & Electric, and Pacific Gas & Electric – have transitioned to NEM 2.0, which lowers the compensation rate for the energy that is exported to the grid. As policy continues to change, project developers have to be particularly mindful to identify and optimize every single savings opportunity for their customers.

Effectively proposing diverse value propositions

As the savings opportunity from solar grows increasingly complicated, it becomes even more important to communicate multiple value propositions. One especially compelling value proposition, particularly for solar-plus-storage projects, is the prospect of becoming energy independent, or "going off the grid." Deciding to go solar with storage can be more of an emotional decision than a financial one. Additionally, many customers may be motivated more by the environmental benefits of going solar, and the meaningful satisfaction of doing their part to reduce their carbon footprint, than in the energy bill savings alone. Successful developers seek to understand customer motivations, then tailor their messaging to speak directly to a customer's specific wants and needs. Comprehensive proposal software platforms allow for customization, which enables developers to tailor their proposals based on the value propositions that are most likely to motivate customers to make the transition to solar.



Streamlining the project development process

Advanced proposal software tools simplify the sales and development process. Some developers who choose to model projects on Excel sheets, often spend hours analyzing the economics of one single project. Keeping track of changing rate schedules, incentives, and complex financial transactions becomes a job unto itself, especially considering the fact that most utilities change their rates multiple times per year. Utilizing a software platform that maintains an up-to-date utility rate and incentive database can significantly reduce the time it takes a developer to perform their analyses. By streamlining the project development process, these software tools enable a company to free up their resources to focus on other important areas such as project implementation, operations, marketing, and customer acquisition.

In a market that is growing increasingly complex, solar developers need to be savvy as ever and able to leverage sophisticated software applications that adapt with these rapid changes. Advanced financial analysis and proposal software tools ensure that the value propositions offered by solar are easily identified, optimized, and communicated. As the solar policy and regulatory landscape continues to evolve, great software applications will be crucial to the market's growth trajectory, and to facilitating the widespread adoption of solar.

Monette Meier is the Marketing Communications Manager at Energy Toolbase, a software platform for modeling and proposing the economics of solar and energy storage projects. Prior to joining Energy Toolbase, she managed marketing programs for GCI Solar, a regional residential solar company based in California. She holds a Bachelor's degree from New York University and a Master's degree in Communications from California State University, Fullerton.

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High Voltage Under the Hawaiian Sun

by Bruno Bomatter

Kauai's energy provider is pursuing an ambitious goal: by the year 2023, half the island's electricity requirement is to come from renewable resources. This will be made possible mainly by an innovative solar power station combined with a battery farm. Dry, oil and gas-free terminations will be used here for a grid connection that poses no risks to the environment.

Sun-kissed beaches, tropical rainforest, and breath-taking marine fauna – Kauai, one of the eight main Hawaiian Islands, is also called the Garden Isle on account of its lush tropical vegetation and unique blossoms. Situated in the middle of the Pacific, this is where the waves first make land again after many hundreds of sea miles. This exceptional natural paradise has retained its original charm – even today, no house built on Kauai is allowed to be higher than a palm tree. For the public energy supplier however, the island location poses a challenge; no electricity can be drawn from the power stations on the American mainland almost 2,500 miles away. Instead, Kauai Island Utility Cooperative (KIUC) has to import fossil fuels by ship in order to operate its generating plants. This is inefficient, expensive, and contributes to increased CO2 emissions. KIUC faced this challenge with a ambitious project by setting an excellent example for environmentally friendly, cost-efficient, and independent energy production in remote regions. Their solution? A solar power station plus battery farm, where oil-powered generators are only connected if necessary.

Solar power by night

Around 55,000 solar panels convert sunlight into electricity at this site. Surplus energy is temporarily stored during the day in 'power packs'. This involves using the latest technology in battery containers, each containing entire rows of lithium-ion cells. The peak load on Kauai begins in the evening, when the islanders return home after work and switch on their lights and electrical equipment. In the future, even after the sun goes down, clean solar electricity will be available from the battery farm to help minimize the use of diesel-powered generators.



Avoid environmental risks during the connection

Conservation and safety play an important role on the green island. The oil or gas-filled connection components typically used in US-American substations can present a risk of serious environmental impacts throughout the system's entire service life. Besides the risk of oil and gas escapes during the initial installation, or during future replacement and repair work, there is also the hazard of leaks, or even a component exploding. Kauai's utility companies no longer wanted to take this risk; instead, they opted for insulation with solid silicone. This pioneering technology not only optimizes total costs, but also ensures maximum safety, since the maintenance-free terminations do not require the handling of oil or gas at any time on-site in the substation. Since it is explosion-proof, the dry technology also offers extra safety against external influences, such as vandalism or extreme natural events.

"In opting for the dry terminations, we have deliberately chosen a new path and in doing so have taken an innovative decision for our industry, which has proven to be right in practice. The technology works perfectly and we can truly recommend it", says John Cox, a KIUC project engineer. KIUC had not completed any new cable projects for around 15 years. The company required extensive support, which ranged from consulting on the design of the earthing system, to the procedure and calculation of the test processes, all the way



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To protect the cables against lightning strikes and system faults, special link boxes were required. Multiple calculations were collected to build an extra compact shield surge arrester, and produced the earthing link boxes to KIUC's specifications. Inside the substation, three self-supporting cable terminations were connected with the overhead power line via the tap-changer mechanism. Outside, three more cable terminations make contact with the transformer on the line side, with a voltage level of 52 kilovolts. On the secondary side, the transformer is fed with 12 kilovolts from the solar power station.

Rapid installation in a green paradise

The installation was completed in a very short time. Immediately, the system demonstrated all its advantages due to its light, compact design. The terminations were assembled horizontally on the ground, immune to the weather conditions under canvas, and then lifted by crane. The installation was quick, precise, and inexpensive, partly because of the ready-assembled component groups, and the fully electrically and individually tested components. What is more, neither a scaffold nor special tools were required. Assembly on the ground was especially beneficial for safety reasons, since hardly any hazardous work at height was performed.

On the beautiful island paradise of Kauai, the proven outdoor cable terminations will ensure an operationally reliable, resource-conserving electricity supply, helping to make the Garden Isle a little bit greener.

Bruno Bomatter is project manager at PFISTERER IXOSIL in Switzerland, an independent manufacturer of cable and overhead line accessories from 110 V to 1,100 kV voltage levels. Since 15 years, Bomatter accompanies the customers from the start through to the completion of a project and to find end-to-end solutions, like on Kauai for example. PFISTERER is a valued partner to companies specializing in power supply, plant construction, and electrified rail transport around the world. The company operates production plants in Europe, South America, and South Africa, as well as sales offices in 18 countries across Europe, Asia, Africa, South America, and the USA. The Group employs around 2,700 employees following the recent acquisition of LAPP Insulators Holding.

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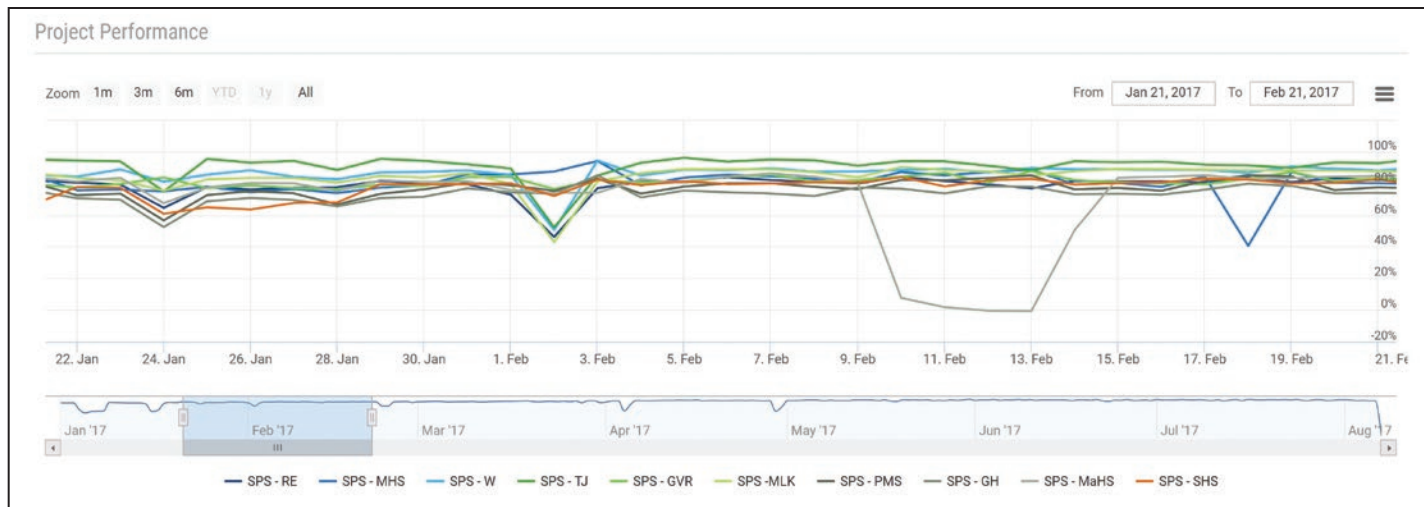
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Office Suites are Sucking Your Productivity

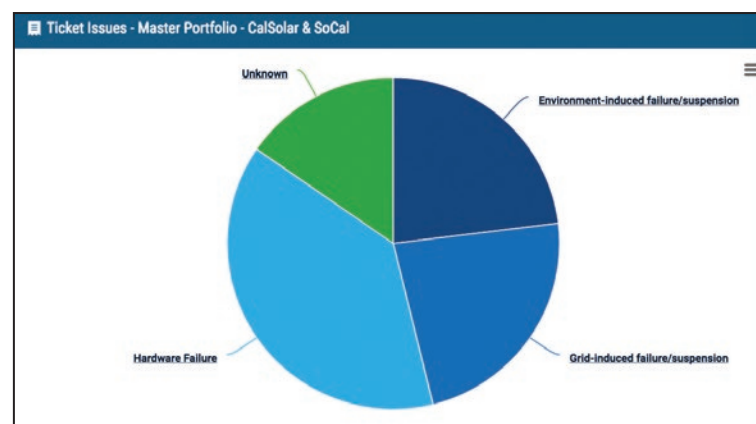
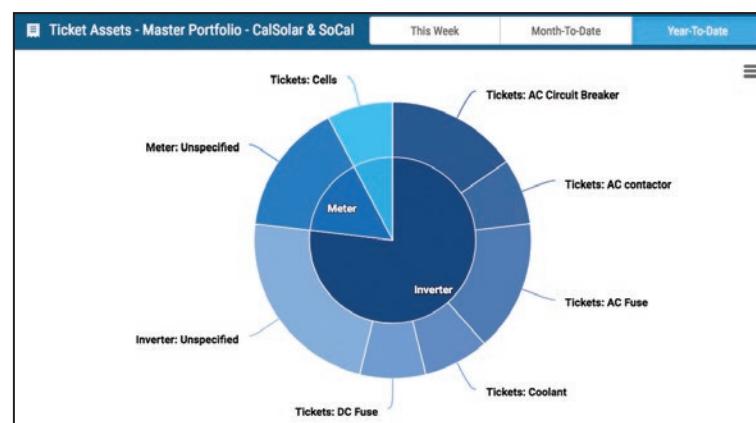
by Eric Baller

Office “productivity” suites have no place in solar asset management. It’s easy to start a spreadsheet, but by the time you’ve doubled your assets under management a couple of times, you’ll find these “low cost” tools are expensive – and risky.

All software markets mature. Solar-specific portfolio management now provides comprehensive features to improve the productivity of you and your team, giving you a better understanding of your portfolio, and lowering cost and risk.

Why should you consider solar asset management software? Consider how you manage the following:

Project Performance. Most projects are connected to one of several Data Acquisition System (DAS) providers, so you have access to near real-time production data. To compare this against your proforma kilowatt hour and revenue projections, you download CSV files and wrestle with Excel. Depending on who created the project spreadsheets, you may find one-off formulas and hidden overrides permeating different project sheets, or degradation schedules that are inconsistent over time. Instead of waiting for your ever-growing spreadsheets to load, look for software that consolidates data, and provides a consistent and auditable view of projects and direct roll up to portfolio and corporate levels.



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Weather Adjustment. Some DAS providers offer a weather-adjusted production forecast. If you acquire projects with different DAS systems, or have contract obligations to use a certain formula, you may find yourself adding yet another tab to that spreadsheet. If you have a detailed PVSystem model, your spreadsheet grows with each hour of data – but the headache of that comparison turns it into something that only gets done for the monthly report, instead of relying on it to characterize real time performance. You’ll have much better visibility if you look for software that offers a variety of built-in weather adjustment methodologies, and the flexibility to customize if your contracts require it. (Or, if you have only monthly models, allows you to adjust production

based on irradiance automatically every hour, automatically, as the data arrives.)

Task Management. Outlook features task lists that can be shared, but this risks missing a contractual requirement. Such “personal” productivity tools don’t support a growing team with shifting responsibilities. Solar asset management software should support simple creation and reassignment of recurring tasks, with direct links to the contract documents governing the compliance.

Workflow. Tracking a task doesn’t guarantee it will get done, and tells you nothing about what was delivered. Tasks workflow features allow the portfolio manager to set up what the task is, and the deliverables to be produced. Advanced software also offers built-in review procedures, and automated distribution, based on a single email list that can be updated for consistent use (instead of occasionally neglecting to include your new managing director).

Issue Tracking. Raising alerts is easy – too easy, based on the number of people that ignore inverter-generated alarm emails. Instead, look for software that allows you to characterize issues sent from the inverter – or any other source – and track the specific equipment involved, and the root cause. This allows for more interesting and complete reporting, both for monthly reporting, and for project history and organizational learning.

External Access. Cloud-based file systems can be used to share files internally, but what about external partners and investors? Look for a solution that lets you manage access and control visibility – a regional partner who can update tickets directly in the system, for example, without having to give them access to other regions or other parts of the system.

Reporting. Monthly reporting should not be a punishment. If you’re spending days assembling data and using copy-paste to generate reports, it’s time to change your toolset. Reporting should be automatic, customizable, and subscription-based; monthly reports can be generated on the first day of the new month, or even the first day of each week, if you prefer. Also, look for asset management software that builds in an optional review process that lets you enforce a process for review, and manual confirmation of the results, before distribution.

Are you being productive when you use office suites? Have you wasted time tracking down spreadsheet errors – and how many more are there that you

haven’t found yet? Do you worry about quarterly and annual tasks being forgotten as your portfolio and staff grow? How much time is spent producing reports instead of learning from them? If those reports could be updated hourly for you, would that information be actionable?

It’s time to move on from “productivity” suites. Solar has matured as an industry, and so have the tools available.

Eric Baller is Chief Technology Officer of Radian Generation. He has 20 years of experience in software, focusing on financial services, remote monitoring, and renewable energy. Eric holds an M.B.A. from the University of Rochester’s Simon School of Business, an M.S. in Electrical Engineering from Stanford University, and a B.S. in Electrical Engineering from the Rochester Institute of Technology. Radian Generation uses a proprietary cloud-based technology platform to optimize the performance of infrastructure funds, national utilities, developers, IPPs, and O&M providers.

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The advertisement features a man in an orange flight suit and green harness, smiling and holding a black helmet. In the background, a solar plane is flying in a blue sky with clouds. The Meyer Burger logo, a stylized sunburst, is in the top right corner. The headline reads: "Just imagine: photovoltaics got it off the ground." Below the headline, there are three paragraphs of text. The first paragraph says: "Flying around the globe powered only by solar energy! We are proud to be part of a project which achieved such impressive success." The second paragraph says: "We invest all our efforts into clean, sustainable technologies. Our ambitious people make a better future come true for all mankind. We know how to efficiently turn the infinite power of the sun into energy by spanning the entire process chain from the wafer through cell production to the complete solar module." The third paragraph is a quote: "Meyer Burger is on track into a decarbonized future." attributed to André Borschberg & Bertrand Piccard, co-founders of Solar Impulse. Below the quote is the website www.meyerburger.com. At the bottom left of the image, there is a vertical copyright notice: "© Solar Impulse | Revillard | Rezo.ch". At the bottom center, the Solar Impulse logo and website www.solarimpulse.com are displayed.

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Solar Shines In Delaware Training and sustainability side by side

by John Finnerty

Since its founding 50 years ago, Delaware Technical Community College (Delaware Tech) has focused on practical job training for Delawareans, educating at least one-fourth of Delaware’s population in one way or another.

It has long had a commitment to training the next generation of technicians for many fields, including solar, as well as offering an associate’s degree in energy management. It has long had a commitment to training the next generation of solar technicians, including offering an associate’s degree in solar energy. But, until 2010, it didn’t have on-site, functional solar arrays on which students could practice. That’s when a convenient pair of college goals came together.

In 2010, the school set aggressive goals for reducing electricity use and its carbon footprint at all its four campuses by 20 percent, and wanted to reach that goal by 2020. Solar electricity seemed the

logical choice: It would allow the school to reach its sustainability goals, and provide additional learning opportunities for its students.

To deliver for college and the state, they would need both an experienced partner and the project funding to execute this complex project.

Putting a Plan in Place

Delaware Tech wasn’t going to Google “solar companies” and pick the first name that popped up. It wisely conducted a rigorous bidding process, examining each company’s track record, and talking to former clients to make sure they were happy. After all, Delaware Tech would get one shot at this; they had to get it right.

In the end, school officials chose a leading solar energy company based in Rockville, Md. that specialized in the development and financing of solar electric systems nationwide. With its extensive experience in educational installations and financing capabilities, it had a proven track record of similar project successes.

After examining the four campuses, the company’s experts worked with Delaware Tech to devise a plan that included two phases. Phase One, a 2,645 panel solar-electric system, would include installations at all four campuses: a ground-mount system at Owens Campus, roof mounts at Stanton and Terry Campuses, and a roof mount and carport at the Wilmington Campus. All told, the 800 kilowatt (kW) system was expected to produce 1,075 megawatts per hour



(MWh) of electricity annually.

Phase Two included a 449 kW carport and a 296 kW rooftop array on Terry Campus, plus two rooftop arrays on Owens Campus that totaled 585 kW. Combined, the system would be 2.1 MW.

On Time, On Budget

The engineering and project managers remained laser-focused to keep the project on time and on budget, while still working with an aggressive deadline. Their diligence paid off when Phase One was completed and commissioned in December 2013. Each installation powers its own building and campus - utilizing aggregate net-metering provided by the Wilmington campus carport, to power its main campus buildings.

Ahead of Schedule

Shortly after Phase One was done, Phase Two began. With the completion of the second phase, combined with other campus wide energy efficiency measures, Delaware Tech was able to achieve a 25 percent CO2 reduction in 2017, three years ahead of schedule.

Combined across all four campuses, the Delaware Tech solar-electric system is one of the largest educational producers in Delaware. It's expected to generate more than 2,960,000 kWh per year, and offset approximately 12 percent of the annual total energy needs of the college's campuses.

This amount of power is equivalent to offsetting the CO2 emissions from 2,219,789 pounds of coal burned, or 220 homes' energy use for each year. It also helps the college contribute to meeting Delaware's renewable energy portfolio standard.

A Win-Win

Not only do the installations offset Delaware Tech's energy requirements and provide a hedge against volatile energy prices in the future, the solar electric systems add a new facet to the school's solar energy training programs; they allow students to see, first-hand, how a solar array works, how it is put together, how maintenance continues once the array is up and functioning, and how public policy can help generate results.

"It's been a pleasure to have such a great partner with during the past four years as part of the College's Sustainability Energy Management Plan," said Dr. Mark T. Brainard, Delaware Tech's president. "This project, combined with the implementation of over \$6 million in energy-conservation measures throughout the college and the good work of the Campus Energy Task Forces will result in exceeding our goal three years early."



John Finnerty is the Director of Business Development for Standard Solar. From financing, to final commissioning and beyond, Standard Solar bring projects from all around the U.S. to completion.

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Nature is Unpredictable

Ensuring your renewable energy project isn't

by Rebecca Chilton

The renewable energy industry is ripe with opportunity, as developers set their sights on new projects such as solar, wind, and hydro. As with any lending project, it's important to understand the potential risks up front, and protect against them proactively. With renewable energy projects, one particular risk is environmental issues – if not handled properly, these can take a toll on your timeline, and rack up unwanted delays. There are a few steps you can take to ensure that environmental issues don't impact your financing or project timelines.

Environmental issues and the lending process

The level of environmental complexity, and how it affects the lending process, depends on the type of renewable energy project involved. For instance, when a lender will take an interest in land, it's important to confirm that the property is clean from environmental hazards; if the lender must take over the interest in the land (either leased or owned), they don't want to assume unexpected liability for environmental issues.

What do some of those environmental issues look like?

- Solar projects don't produce as many environmental concerns, but ground mount solar installations can impact archeological sites and wetlands, even without digging deeply into the ground.
- For wind projects involving a windmill or turbine, it's important to consider how the span, height, speed, and motion of the blade interacts with wildlife, particularly the bat and avian populations.
- With hydro projects, which may require damming a river, environmental concerns can arise when changing the flow of water – this alters the movement of silt and pollutants, and can also block the natural migration of species, resulting in adverse effects on population.

These issues can impact a new energy project by requiring site modifications, the creation of new project scopes, or other financial issues that can delay the project, and affect its overall economics and energy production.

How to proactively mitigate environmental issues

Most environmental issues can be solved through a relatively easy and low-cost solution, or, if discovered early, can be avoided altogether. Good environmental due diligence during the early stages of development is essential to guarantee a tighter timeline, and avoid unexpected costs.

Specific to solar, it's important when acquiring or developing a site, to first determine whether the proposed project will involve ground disturbance. Ground disturbance expands the scope of environmental issues you might encounter, whereas rooftop systems, for example, have a fraction of those issues (if any).

With all projects, it's important to identify regulatory and environmental concerns early. For solar, this takes shape through a National Environmental Policy Act (NEPA) review, and also by conducting a Phase I site assessment, which will identify recognized



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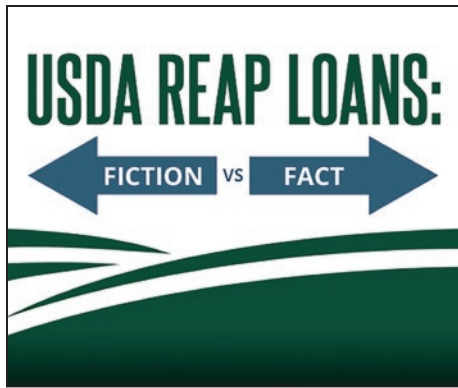
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Rebecca Rogers Chilton is a domain expert with the Renewable Energy team at Live Oak Bank, where she has helped build a team that deployed more than \$200 million in renewable energy financing in its first year. Prior to joining the bank, Rebecca was assistant general counsel and a commercial loan officer at Self-Help Credit Union, where she started the renewable energy lending practice from scratch, and a structured finance associate at Moore & Van Allen, PLLC. Rebecca is a graduate of Wellesley College and the University of North Carolina at Chapel Hill School of Law.

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environmental concerns that must be addressed during site development. Both should be completed early in your development process.

Even with good due diligence, it's possible for the cards to be stacked against you. For example, the existence of wetlands and other environmental concerns – even discovered in the 11th hour – could require that a site be resized, which would affect the resulting energy production and project economics. This is a risk, particularly for the construction lender, which is why it's important to factor in potential hiccups when building a project timeline.

How the right partner can help

Although environmental concerns are relatively rare in the utility-scale solar arena, when they do arise, it's invaluable to have a lender who can keep a level head and work to develop a plan to address the issue.

Financing parties that are open to being educated on environmental risks, and working with the developer to address concerns, are the best partners – patience and an eye for problem solving are also crucial. It's important, when developing a project that has environmental impact, to find a lender who is prepared to understand the regulations (at least at a high level) and how the project is designed to comply, which can be helpful in getting cost-effective financing.

Creative partners will have experience participating in several federal loan guarantee programs that require a thorough review of environmental issues, both from a hazard perspective and from the standpoint of protecting sensitive ecological, or historic land.

Overall, when considering a renewable energy project, be cognizant of the potential environmental issues and how they can affect the lending process, the project's timeline, and the financials - you'll be on a path to success.

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Thinking Ahead

Building the foundation for resilient distributed energy

by Tony Soverns



FOR MOST COMMERCIAL AND INDUSTRIAL BUSINESSES INSTALLING

on-site energy assets at their facilities, the primary goal is increased efficiency and sustainability. Renewables, energy storage, and other distributed energy assets provide essential functions like energy savings, peak shaving, and load shifting; these all deliver significant benefits for businesses looking to cut their energy overheads.

What often becomes an afterthought, however, is the resiliency of those on-site energy assets. When the grid goes down, business owners expect the PV modules on their roof, and the energy storage units serving their facility, to keep them up and running despite network disruptions. Unfortunately, due to how these systems are designed and deployed today, this is rarely the case.

Solar, storage, and other distributed energy resources for commercial and industrial applications, conventionally work only in tandem with the grid, performing peak shaving and load shifting functions that remain dependent on the grid's normal operation. In the case of solar panels, few inverters have black start or grid independent capabilities to serve as an emergency power asset. In oversights like this, energy innovation has neglected to make uninterruptible power a priority. What's the missing link in distributed energy? Resiliency.

There are several factors today that make resiliency a bigger consideration: an aging grid; regular brownouts and rolling blackouts as a consequence of unprecedented peak demand; the specter of more frequent extreme weather events like Superstorm Sandy; and the

emerging threat of cyberattacks capable of taking out the grid. By strategizing to proliferate renewables and storage, but neglecting to empower those assets with resiliency from day one, the industry is missing the opportunity to proactively address the shifting realities of energy.

At the moment, short term power loss varies in cost to consumers. Critical infrastructure and facilities like military bases, hospitals, and data centers, can't afford for their systems to go offline for even a second, but for most consumers, a short term power outage is usually no more than a source of frustration or inconvenience.

We can't afford to wait for the next massive disruption to spark concern over energy security; we need to begin building resilient systems now. When the first cars began mass production in the early 20th century, it took decades of deadly accidents for driver safety to become a priority. Early braking systems rolled around in the 1920s, seat belts in the 1930s, and airbags were not built into cars for public sale until the 1970s.

We can improve on this timeline with our power infrastructure by building the foundation for resiliency into distributed energy, before we're facing some sort of

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power crisis. Rather than wait for another mass outage like the US Northeast's blackout of 2003, or a cyberattack on the power grid like the one that struck Ukraine in 2015, we can begin developing means of resiliency now.

Early on, intermittency made renewables an unreliable source of uninterrupted power, but innovation in energy hardware and software is making our current distributed assets predictable and manageable, opening them up as an ideal channel for resiliency. Microgrids, an increasingly popular and efficient energy solution, allow distributed asset owners to aggregate their PV and wind with energy storage, UPS, and generators, tying them all together into a singular cooperative system. When paired with advanced controls that monitor and manage assets in real time, microgrids empower owners to island buildings and facilities without latency, operating on their own means of power generation. Real-time microgrid control is essential to successfully remaining up and running when the grid goes down: If a microgrid cannot instantly address a building's loads as they come on or offline, the owner runs the risk of energy runaway, which would shut the owner's power down, and defeat the microgrid's entire purpose.

As we continue to push energy innovation to new heights, we need to put resiliency front and center. Owners of on-site energy assets often take uninterrupted power for granted – they assume it's provided for when, in actuality, it is not. Before we leave resiliency behind in the distributed energy race, we need to build a foundation for resilient distributed power that allows our facilities' assets to function as we need them to at all times, and in all situations.



Tony Soverns is the Chief Technology Officer at Go Electric, Inc., which develops customer side of the meter energy solutions that help facilities, communities, and military bases be energy resilient and sustainable.

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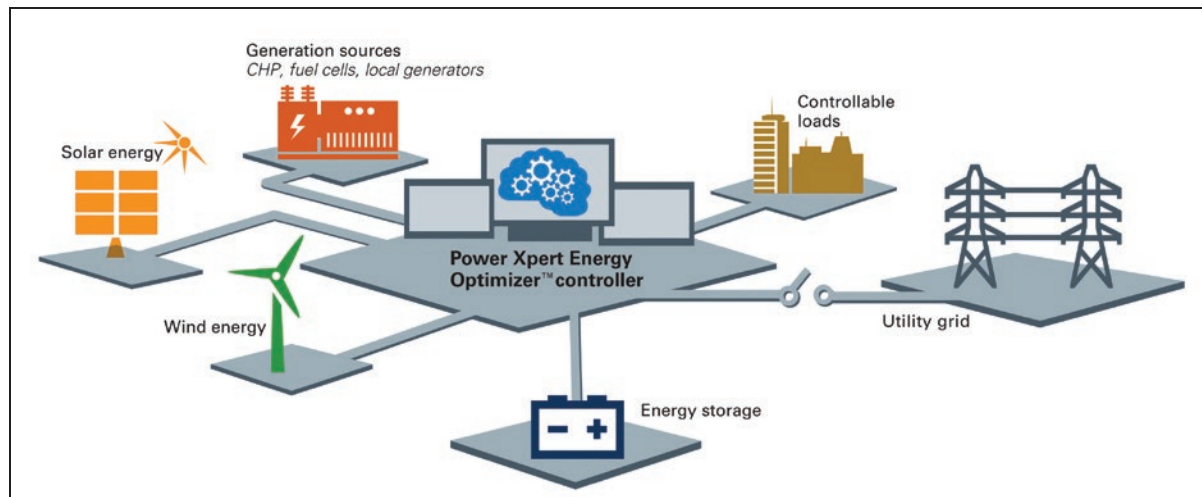


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Technology and Trends Advancing Solar-Plus-Storage Projects

by John Vernacchia



Solar plus storage systems can tap modular, scalable controllers to provide system intelligence and integrate other distributed energy resources.

Over the past decade, PV solar and energy storage technology has become readily available with dramatically decreasing costs – which is changing the way we produce and consume electrical power. Although the market for solar energy storage was less than \$200 million in 2012, IMS Research anticipates this figure will increase beyond \$19 billion by the end of 2017.

Combined solar and energy storage systems are providing utilities and project owners with not only new generation resources, but also with new means to defer major capacity upgrades. Ultimately, this can help our nation reduce dependence on fossil fuels while minimizing energy costs, and bolstering electrical resiliency.

Solar and energy storage market trends

In the first quarter of 2017, the U.S. installed 2,044 megawatts (MW) of solar PV, reaching 44.7 gigawatts (GW) of total installed capacity. Much of this new capacity was driven by growth in the utility-scale sector., which have added more than a gigawatt in the last year. As installations increase, equipment prices have decreased; utility-scale system prices have fallen below \$1 per watt for the first time, according to GTM Research and the Solar Energy Industries Association (SEIA) reports. Today, enough solar energy is generated to power 8.7 million homes. And analysts anticipate the industry will more than double installed solar capacity in the U.S. over the next five years, surpassing 100 GW.

Five years ago, the initial base of storage was just 0.34 GW. This year, industry analysts anticipate that 6 GW will be added, with installations reaching 40 GW by 2022. It is important to note that with the increased penetration of renewable energy resources, utilities are seeking to optimize these renewable assets to reduce grid impact and enhance stability – the sweet spot for energy storage.

Already, more than 60 million people in the U.S. Mid-Atlantic States and Washington D.C. are saving on their energy costs, and receiving reliable power because of storage systems in the region. The regional transmission organization, PJM Interconnection, has projected a 10 to 20 percent reduction in its frequency regulation capacity due to additional storage projects, which could save customers millions of dollars.

On the other side of the country, the California Public Utilities Commission (CPUC) approved a target that requires the state's three largest utilities, and other energy service providers, to procure 1.3 GW of energy storage by 2020. Just late last year, energy storage systems built in the southern part of the state added about 40 MW, on a fast-tracked timeline to provide critical grid support and capacity.

Higher voltage and fast-tracked electrical balance of system solutions

As more solar and storage capacity has been installed, electrical balance of systems components and architecture has remained largely the same, with a notable exception: systems have moved to higher voltage requirements. In particular, PV systems are moving from 1,000 Vdc to 1,500 Vdc systems. The higher voltage systems have reduced costs in utility and large commercial solar PV projects through reduced installation time, material and fewer components.

Project experience has also yielded a better ability to meet fast tracked project time frames and support complex, large-scale projects. With local expertise and manufacturing ability, vendors can also anticipate local requirements and meet them faster.

The electrical systems that support both solar and energy storage projects look largely the same. Energy generated at the solar panels is passed through inverters and aggregated in panelboards and switchboards. Padmount transformers step up voltage to the distribution level, which is connected to medium-voltage switchgear. On the storage side, the battery containers are connected to bi-directional inverters. Depending on the size and quantity of inverters, the inverters may either be connected to switchboards, or directly to the padmount step up transformers and medium-voltage switchgear. Energy storage projects also require energy

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management system controllers to charge and discharge the batteries, based on the intended application.

System intelligence and controls evolve to support more modular, scalable systems

While solar and storage systems have evolved, so have the controllers that enable adaptable and scalable control for solar energy storage applications, as well as the integration of other distributed energy resources.

Nearly five years ago, early U.S. Department of Energy Smart Grid Demonstration projects showed the technology was feasible to manage the utility-scale storage system and integration of renewables. However, at that time, the controller was a customized solution. Today, integrated, modular, distributed control architecture is readily available. Using lessons learned from early projects, new technology that is pre-engineered, factory-designed and tested, provides a replicable model that is designed for further customization to site-specific requirements. This approach can simplify storage plus solar and microgrid projects that use a variety of distributed energy resources, by making it easier to test the system and support forward compatibility as the system evolves. The easy configuration of the controller helps maximize the flexibility and scalability of the system.

When looking for a controller, remember that functionality should coordinate automated system sequencing in response to user commands, system status, limits or faults. Additional control functions could also include active control, data logging, alarm management and processing, as well as built-in security measures.

Finding the right project partner

If solar energy storage projects continue to meet analyst predictions, we will be relying more on stored renewable energy installations to meet energy demands. As projects increase, it's important consider supplier expertise, experience, and success with prior projects.

Proven power engineering, substation automation, and control experience is essential. Suppliers should also be able to provide rapid, dedicated, local support to help expedite projects, as well as on-the-ground expertise to address unforeseen challenges.

Vendors should also be able to provide more than the right controller. Because every project carries unique circumstances, look for a vendor that understands your challenges, and can plan for your individual project's needs.

Every installation is unique, and customized solutions can help optimize,

build, and maintain an automated, secure, and cost-effective solar and energy storage project. A vendor's past projects can be indicative of the depth of solutions experience. More often than not, those who offer turnkey capabilities can help you achieve your solar and energy storage goals in less time, and at a lower installed cost.



John Vernacchia is Segment Manager for renewable energy at Eaton. He has 30 years of experience in marketing, sales, channel management and operations, and has played a major role in the development of Eaton's

Renewable Energy solutions to help customers connect solar and wind energy sources to buildings and the utility grid.

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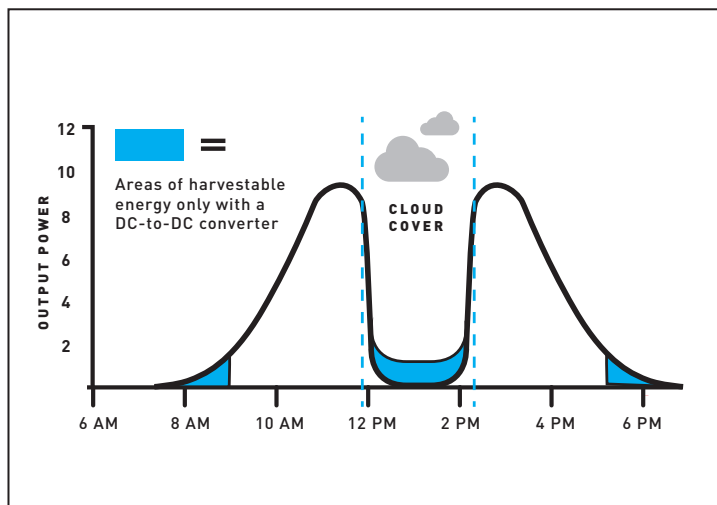
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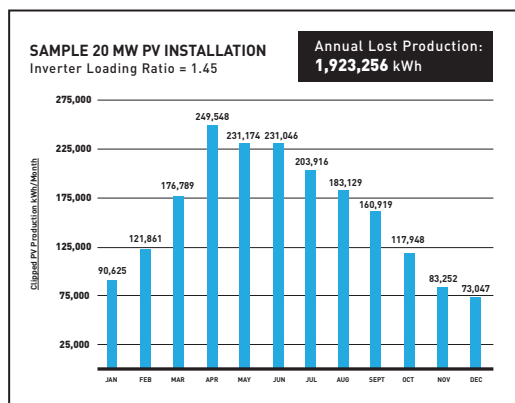
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The DC Approach to Solar Plus Storage

by Chris Larsen



With over 25 gigawatts of utility-scale solar deployed, and more coming online annually, the solar industry is demanding that energy storage rapidly scale to help manage the integration of this massive surge of PV-generated energy into the grid. DC-coupled storage is entering the discussion, and the timing is right. With leadership coming from some of the most influential solar IPPs, the advantages of DC-coupling are about to be unlocked.



Among its advantages, a DC approach to coupling energy storage with utility-scale solar makes adding storage, to both existing and new solar installations, easier from an interconnection perspective, and more cost-effective on the balance of plant. On the revenue side, DC-coupling increases overall kilowatt per hour harvest from the array. At the same time, it reduces claw back risk associated with the federal investment tax credits (as applied to storage). Moreover, with the applicability to retrofit situations, DC-coupling is expected to accelerate conversations around adding storage to the massive, already installed solar fleet.

Installation Costs Reduced

The cost side cannot be ignored, and leaders in the industry are taking note. According to an EPC expert, “By coupling distributed energy storage to the DC PV bus, equipment and installation costs may be reduced, especially so for new-builds. In contrast to centralized, AC coupled storage, DC coupled storage eliminates the need for AC switchgear or a substation interconnection. Perhaps more importantly, there should not be a need for additional interconnection studies or modifications to the existing interconnection agreement.”

Increase PV Power Generation

The revenue opportunities are compelling and might be viewed as true optimization of the array. Clipped energy recapture remains the most obvious advantage of DC coupling. Given common inverter loading ratios of 1.25 up to 1.5 on utility-scale PV, there is opportunity for the recapture of clipped energy through the addition of storage on the DC bus. What’s interesting is that the conversations we are now having with developers and system designers are focused on potentially much higher DC:AC ratios, particularly where a hard AC interconnection limit would otherwise not allow a developer to maximize available land.

As another value example, DC-coupling enables an installation to capture energy earlier and later in the day, given that PV inverters typically require a minimum threshold DC bus voltage to operate. On a 1,500VDC nominal system, this ‘wake up’ voltage may commonly be around 800VDC, below which the system is not harvesting available PV production. This period of time at end of day or beginning of day, when the array has potential but the inverter is not awake, can be over 30 minutes on each end. While clipping recapture and increased efficiency are the biggest drivers for the DC-coupled topology, these other advantages enable the capture of additional revenue at the edges - these are all slices the industry needs to optimize the long-term value of PPAs.

Manage Energy for Maximum Return

It’s worth remembering some of the core reasons why the industry is moving to add storage to solar in the first place. Perhaps most importantly, utility-scale installation owners are looking to participate in more lucrative day-ahead markets, where firming with storage makes the asset dispatchable. Obviously, energy storage also allows bulk energy shifting of solar generation to take advantage of higher PPA rates in peak periods, or to allow utilities to address daily peak demand that falls outside periods of solar generation. While these benefits



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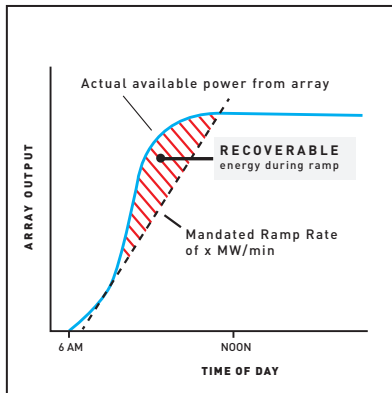
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Chris Larsen heads eastern US and international business development for Dynapower's Energy Storage Group. He joined the renewables and storage industry in 1996, heading up the North Carolina Solar Center's grid interconnection program advising utilities and regulators on interconnection policies. Chris spent 10 years with ABB, starting in ABB's renewable energy R&D laboratory, focused on power electronics and renewable energy, and had roles in product management and channel program strategy. He earned a masters in mechanical engineering through NC State University's Program in Renewable Energy and graduated magna cum laude in economics from Princeton.

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are highly dependent on local and regional markets and bilateral PPAs, this is usually the starting point for conversations around adding storage.

An overlooked advantage of adding storage, and one that also drives the DC approach, is curtailment. CAISO caught the industry's attention earlier this year; it estimates that 6,000 to 8,000 MWs of solar and wind will be curtailed this year to deal with overall excess production on the grid. With a DC-coupled energy storage system, PV energy harvest continues while storing energy for discharge post curtailment. The same logic applies for scheduled or unplanned outages: When storage is on the DC bus behind the PV inverter, and the system is properly configured, then the energy storage system can operate and maintain the DC bus voltage when the PV inverter is off-line.

In a similar vein, the traditional need for storage to modulate the fluctuating solar output is worth re-visiting in the context of the DC-coupled approach. Storage enables operators to modulate power flow, and ramp rate control is often required by utilities and ISOs for PV and wind systems. To take one example, a ramp rate of 1MW/minute has been required by HECO in Hawai'i. This is a well-understood application of storage for solar or wind. What's interesting in the context of the DC-coupled discussion is that, with storage behind the inverter, energy otherwise effectively curtailed during a self-regulated ramp-up limitation can now be stored for later use. Again, energy gains at the edges and true optimization of the array.

So, here we are in 2017, moving through that critical inflection point when the concept moves from the chalkboard to the installation site. As an equipment designer and manufacturer, it's exciting to work with some of the industry's most forward thinking developers and owner-operators to move the ball forward on solar plus storage.



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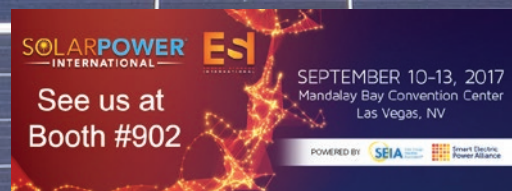
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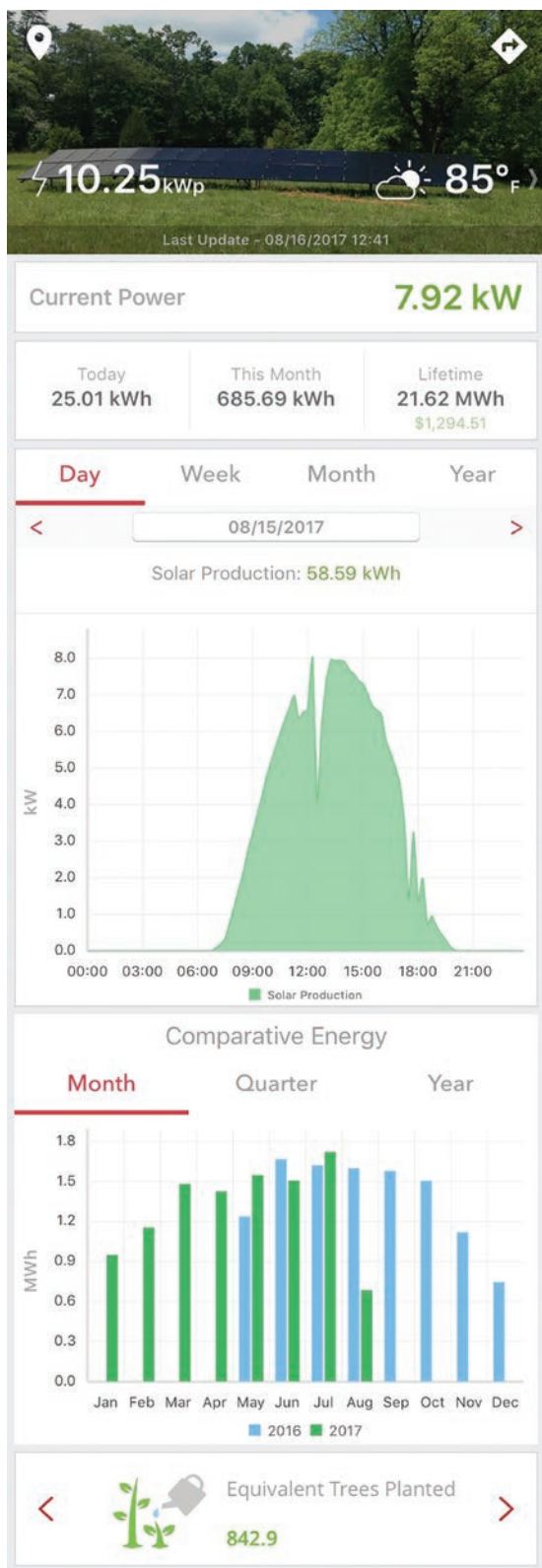


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Using Monitoring to Improve Customer Acquisition

by Lior Handelsman



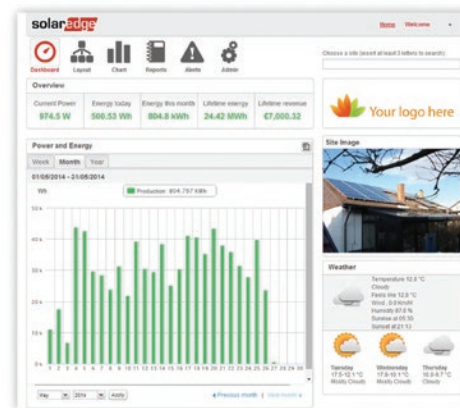
ACCORDING TO THE ANALYST PROJECTIONS, GROWTH IN THE US residential PV market has decreased by 20 percent in 2016, from 2015¹. At the same time, module prices are at record lows, with installation prices dropping. Despite this pricing pressure, we are seeing the emergence of a curious trend: the growth of the giveaway. In their quest for the latest competitive advantage, installers are reversing their course on hardware pricing, and shifting their focus to customer acquisition. A new metric is at the heart of this strategy. While pricing for residential PV is decreasing, customer acquisition costs have actually risen, by around 30 percent, from 2013 to 2016. If that's one of the biggest costs of installations, it almost makes sense to give away the panels for free to help close the deal!

Are there other options available to help installers to lower customer acquisition costs and boost sales? Let's look at a basic marketing funnel: Prospective customers engage at the top of the funnel, journey through, and then become buying customers at the bottom. Now consider leveraging advanced monitoring technologies to widen the marketing funnel, communicate advanced technology, improve service, and simulate a "test drive" for customers. Using monitoring to visualize system benefits can potentially help widen the marketing funnel, increase traffic, optimize customer acquisition costs, and boost sales.

Cast a wider net

Many installers note that referral business is the lowest cost of customer acquisition. The sales benefit of former customers as advocates and influencers is well known in the industry. Installation companies may offer referral bonuses to customers in order to increase sales. However, by using social media, installers have the opportunity to boost referrals even further. As more system owners proudly share their PV system photos and monitoring screenshots to their networks on social media platforms, the marketing funnel widens, reaching exponentially larger audiences.

Homeowners typically don't handle the hardware of their PV systems; their main experience comes in the form of lower electricity bills and PV monitoring. However, systems that include monitoring applications for smartphones let homeowners interact with their systems, and create referrals for installers. When installers put monitoring in the homeowners' hands, the homeowners gain confidence in their system performance and are more motivated to share it on messaging apps, email, Facebook, and Twitter. In fact, monitoring applications now let owners share at the push of a button.



validate their system's performance day to day. Monitoring also illustrates how PV energy is distributed to all these elements into the battery or electric vehicles. In order to improve early stage conversions, be prepared for more technical discussions with these homeowners.

Service sells the second system

Service is an important aspect for a B2B company. This is also true for many B2C sales. During the sales process, many homeowners look for online reviews of installers; it's an important part of their decision-making process. Great reviews are like gold. One of the best ways to generate this kind of support is to make sure that your current customers are content with their systems and level of service. Installers can provide superior service, and higher system uptime, by using monitoring platforms that provide automatic alerts and remote monitoring. This allows installers to provide proactive maintenance before the system owner even experiences a problem. Imagine the impact of a proactive service call on a homeowner, and consider the boost this practice would give to a company's quality and service record.



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Know your audience

Today, many homeowners do their research online, and can get quotes from multiple installers before a salesperson ever gets a foot in the door. It's not enough to tell them they'll save on their electricity bill – they know that already. Often, homeowners are making decisions on systems that they intend to own outright. What was traditionally thought of as the top of the funnel has moved further into the sales process. As more homeowners are self-qualifying, the traditional sales pitch won't work. Prospective buyers want to know about options like enhanced energy production, improved safety features, monitoring, battery integration, and even EV chargers. They want to better understand their investment, and are looking for any advantage to boost their payback. Monitoring gives them the confidence of being able to



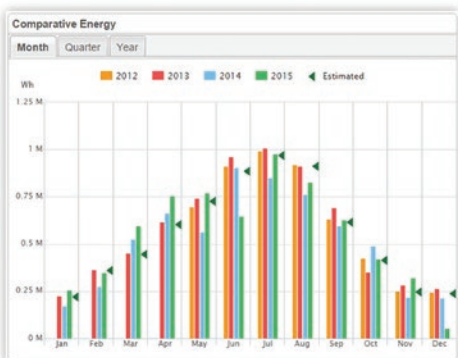
Lior Handelsman, VP of Marketing and Product Strategy, founded SolarEdge in 2006. He currently serves as Vice President, Marketing and Product Strategy, responsible for SolarEdge's marketing activities, product management, and business development. Prior to founding SolarEdge, Mr. Handelsman spent 11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

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The importance of the test drive

Most people don't buy a car without test driving it. It's one of the more enjoyable experiences of purchasing a car – and usually the time when emotions take over, and people get excited about the purchase. It's a key part of closing. But how do you take someone for a test drive in a PV system? The answer is to focus on the experience. System owners experience their system through lower bills and monitoring. Monitoring services offer a window into the benefits of a PV system. By using monitoring, salespeople can use their smartphones to demonstrate financial savings, energy production, and environmental benefits.

In addition, by selecting a few systems with different hardware, salespeople can also offer options packages. Imagine the impact of comparing a basic system to a system with home consumption metering that shows whole home energy usage, or a system with an inverter-integrated EV charger, or even a system with an integrated battery – all from your smartphone! Selling the experience of monitoring lets owners "test drive" their PV system. Homeowners can also download a version of the monitoring platform, and see demos of system performance. And with FREE monitoring application, they can be used at no cost and in scale. Customer acquisition is now a main target for cost reduction for US installers, and has become the focus for many profitable businesses. By leveraging advanced monitoring to "test drive," installers can boost their referrals, demonstrate different technology, improve service, optimize their marketing funnel, and grow their businesses



¹ Annual U.S. PV Installed Capacity, Cumulative Pre-2010-2022E, GTM Research/SEIA U.S. Solar Market Insight



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Solar Resource Assessment

Improving accuracy and enhancing project performance

by Gwendalyn Bender and Francesca Davidson



On-site observations from ground stations help further reduce project uncertainty.

Accurately assessing how much power a solar project will produce is a crucial factor in securing financing, and seeing a project from development to operations. As solar capacity grows worldwide, an increasing number of operational projects are performing outside the range of initial expectations. As a result, the industry is beginning to take greater interest in resource assessment, how solar energy estimates are calculated, and how the process can be refined.

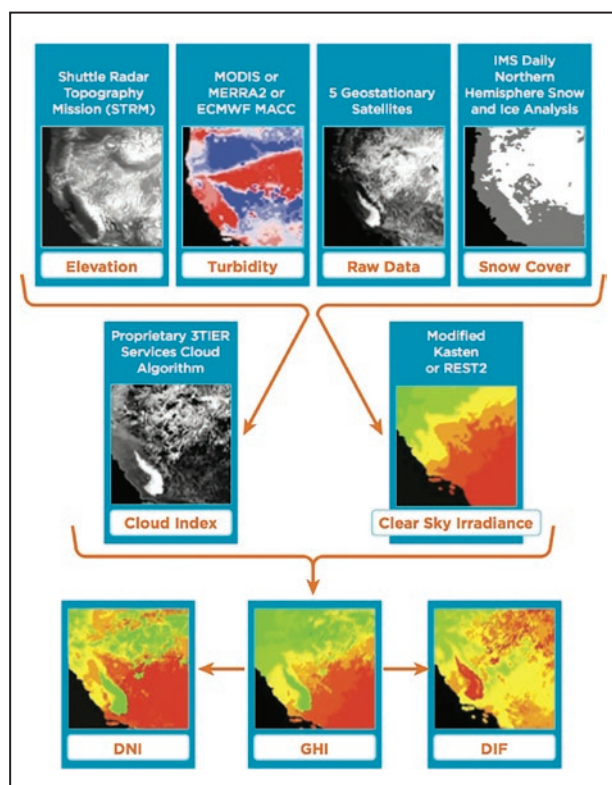
The financial consequences of errors in solar resource estimates are considerable, equating to reductions of up to 5 percent in energy produced, and millions of dollars in lost revenue over an asset's lifetime.

In terms of performance variability, the single greatest influence is weather. It is, of course, impossible to predict weather conditions onsite throughout a project's lifecycle with 100 percent accuracy. However, developers have many options throughout the pre-construction phase to improve resource assessment accuracy, and overall solar plant performance.

Combining site-specific analysis with longer-term performance data

When prospecting for sites, developers typically carry out GIS analysis by overlaying transmission and energy pricing data with solar irradiance, temperature, and wind speed information, which is often publicly available.

While this method enables the selection of a site, it is important to combine it with more accurate, long-term data that accounts for solar performance at hourly intervals. Data of this kind provides the best indication of how a project will perform over its lifetime, and allows for the 1-year P90 calculations required for financing. This value indicates the production value the annual energy output is expected to exceed 90 percent of the time.



Satellite processing methods use a variety of inputs and models to calculate solar conditions at ground level.

Assessing satellite data sources

Due to the scarcity of long-term direct observation networks, a number of companies provide satellite-derived solar resource datasets, each of which offers essentially the same information. However, these datasets vary in their inputs and how they calculate surface irradiance. As a result of different methods, the scope for error and uncertainty can vary significantly between sources.

For instance, information gleaned from public sources typically has a high degree of uncertainty. NASA's global dataset has a 20 percent uncertainty, while, depending on the version, the uncertainty for NREL's datasets for North America can range from 5-12 percent. By contrast, high-quality data from a paid provider will reduce the degree of uncertainty by half.

How well data has been kept up-to-date is another critical factor in selecting a weather data source. This is important because aerosols, such as air pollution, substantially influence solar power performance, and have grown dramatically over the past ten years in parts of the world, particularly China and India.

Evaluating dataset validation and site-specific accuracy

Developers must evaluate how the dataset they employ was validated, and its accuracy in the region where a project is located. Data providers demonstrate accuracy by comparing datasets with direct observations from publicly available ground stations.

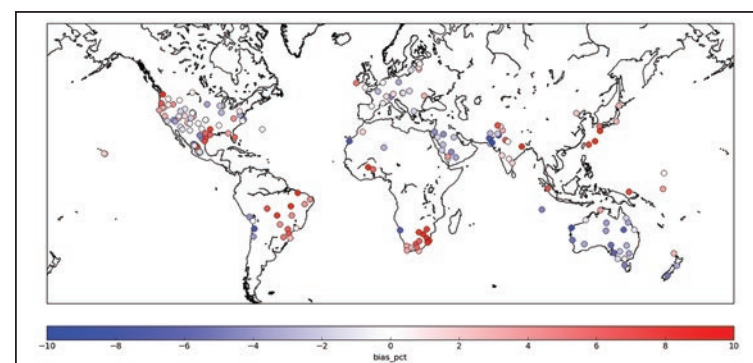
In some cases, data providers have also used these ground stations to calibrate or enhance the accuracy of solar resource information. A fair and unbiased verification study reserves at least a subset of ground station data exclusively for validation purposes, to provide users with an accurate estimate of how the data will perform at their project locations. As a user, it should be clear to you which validation points are independent and which are not.

As solar spreads around the world, ensuring the availability of accurate, consistent data is increasingly importance in driving development. When selecting a data source, it is vital to ensure it has been validated against ground stations in the site's vicinity, since regional factors – such as pollution, dust, or seasonal variation – have considerable influence on solar resources and power generation.

Ideally, developers collect long-term weather data from the same provider during the initial evaluation phase as will be used during financing. In doing so, they avoid any difficulties caused by sudden and dramatic shifts in energy yield estimates related to a change in the resource data source.

Driving down resource uncertainty

In addition to sourcing high-quality data, further measures to reduce uncertainty can and should be undertaken. This is particularly useful in



The bias map above shows validation results.

situations where a comparison of multiple solar data sources indicates a wide spread in the numbers obtained.

Debt-financed projects, where a direct improvement in uncertainty is tied to better finance terms, can benefit from installing a privately-owned ground station at the site. The observations collected capture micro-scale features that may be overlooked by satellite-derived datasets, but significantly affect power performance. Stations provide real-time condition monitoring of irradiance, but also typically measure wind, precipitation, and temperature, and sometimes soiling rates. In addition, developers can use historical information from ground stations to make engineering decisions and budget maintenance costs.

Site-adapted estimates by investing in high-quality equipment

To produce a “site-adapted,” or corrected, record of solar resources, a technique known as model output statistics (MOS) is used to combine long-term satellite data with direct measurements. This is the gold standard in solar resource assessment, and has proven to reduce resource uncertainty by up to 50 percent.

However, measurement equipment reliability and maintenance practices are imperative to the success of the approach. Investing in a low-quality system, or failing to maintain one of higher quality, can be counter-productive, since it adds time and drives up costs associated with quality controlling the data and screening out erroneous readings.

Anticipating extreme weather

Finally, as solar development enters into regions prone to extreme weather, it is increasingly worthwhile for developers to factor in the susceptibility of their projects to severe conditions. Analyzing the possibility of equipment or site damage in areas where lightning, hailstorms, or high winds are common is essential when evaluating insurance options. Snowfall and smog from volcanic eruptions or wildfires also hinder solar energy production. Instances of extreme weather, while hopefully rare, should be accounted for when making energy projections.

As discussed here, there are a number of factors underpinning the accuracy of solar assessments that developers need to consider. In order to maintain the growth of solar, the industry must ensure resource assessments are carried out in line with best practice, or risk paying higher financial and reputation costs down the line.



Gwendalyn Bender, Head of Solar Services at Vaisala, has been supporting solar developers and operators since 2009 and played a critical role in the development of Vaisala's 3TIER global solar dataset. Ms. Bender is active on a number of educational solar committees and has given numerous technical solar presentations at industry events around the world.



Francesca Davidson, Energy Communications Expert at Vaisala, has nearly nine years of professional experience within the renewable energy sector and a deep knowledge of the solar and wind project lifecycle. Ms. Davidson's primary areas of expertise include, strategic planning, technical writing, project management, and media relations.

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High density 5 degree solar racking system

Ecolibrium Solar announced the new EcoFoot5D High Density 5-Degree Racking System. Built on the EcoFoot Modular Platform with more than 200MW installed, the EcoFoot5D combines a small 7" x16.7" roof-friendly modular Base and dense 9.9" inter-row spacing. The result is a tightly packed array, delivering 18.4% more power than 10-degree systems. EcoFoot5D is comprised of five preassembled components and requires only one tool for installation. Bases fall into alignment as modules are placed. Preassembled parts eliminate the need for PV panel preparation. The combined effect is an organized workflow and non-stop installation process from box to roof. System advantages include streamlined logistics due to the low part count and stacking bases to deliver 290kW of bases on one standard pallet. Installation is easy from start to finish, aided by accessible and protected wire management. Wires are covered by the system yet easy to access throughout the life of the system via a removable wind deflector. Ballast blocks are easily placed between rows in the ballast tray, eliminating under-module ballast placement and awkward reaching. Suited for modules ranging from 32-50mm, the clean aesthetics and low profile are designed for residential and commercial flat-roof installations. EcoFoot5D is backed by a 25-year warranty.

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Secondary warranties for solar panels, without deductibles

SolarWorld Americas Inc. announced the SolarWorld Assurance Warranty Protection Program, featuring supplemental protection plans for residential and small commercial customers. SolarWorld Americas' standard coverage includes a 20-year product warranty and a 25-year performance guarantee for most solar panels. In addition to SolarWorld Americas' product warranty and performance guarantee, the SolarWorld Assurance program provides supplemental, third-party-backed warranties to the system owner with no deductibles. The Dual Warranty protection plan is for solar panels installed 2017 and later, and SolarWorld covers the premium. The Extend Warranty plan covers solar panels installed from 2012 through 2016. The SolarWorld Assurance Warranty Protection Program is backed by an A.M. Best "A"-rated company and covers systems from 3 to 20 kilowatts. The warranties immediately go into effect in the event the original factory coverage could no longer be supported; they also are transferable to new system owners.

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Asphalt shingle roof mounting system

Solar Connections International has incorporated many features into their Solar Connection Kit for Asphalt Shingle Roof Systems. Starting from the base, the PowerPlate is made from durable 0.040" thick aluminum and includes reference marks for easy alignment. It also features their PowerSeal, which uses an easy peel-and-stick installation to form a water-tight seal with the roof. The PowerAttachment secures the system to a roof with 4 angled screws to provide maximum strength and uplift protection. It also features 3 layers of water protection by utilizing stainless steel single piece cap and seal screws with EPDM washers. The PowerMount is made from solid 6061-T6 aluminum and provides 2" of adjustment. The 6061-T6 PV Cube features a robust design and is compatible with all of Solar Connections' PowerMounts. Use the Universal L-Foot for a railed system, or go rail-less and utilize the Solar Connection Kit with GroundBonding Technology, which is UL 2703 listed and approved.

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www.metalmaster.com



BIPV panels

M10 Industries' photovoltaic panels for building integration (BIPV), the frameless glass-glass panel "Saphir-Skin", is specifically suited for the design of facades. The solar manufacturer, specializing in special module design, uses "Saphir-Skin" to apply color to the facade. The solar module offers a multitude of color variants and the front glass, which is printed with a special pattern, appears as a homogeneous colored surface. The individual solar cells are almost invisible, but the remaining power yield of almost 90% is very high.

M10 Industries AG | www.m10ag.de



Extended range of power capacitors

TDK Corporation has extended its range of EPCOS single-phase power capacitors for industrial electronics. The capacitors of series B32370* through B32374* are designed for rated AC voltages of between 250 Vrms and 600 Vrms, cover a capacitance range from 5 μ F to 600 μ F, and feature a maximum current capability of between 15A and 60A, depending on the type. The can diameter ranges from 40mm to 136mm, with heights from 64mm to 265mm. One particular feature is the high reliability and long service life of 100,000 hours.

TDK Corporation | www.epcos.com



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Aluminum lug expansion

BURNDY announces the addition of 4 standard width tongue variations to their aluminum compression lug portfolio. The new BURNDY catalog numbers (YA34A8, YA36A17, YA39A13, and YA44A8) accommodate 500 kcmil, 600 kcmil, 750 kcmil, and 1000 kcmil conductors respectively. Offering an alternative to the existing narrow width tongue pad, these recently introduced terminals feature 2-hole NEMA pad drilling, are UL Listed, CSA Certified, and dual rated for use with copper or aluminum conductors.

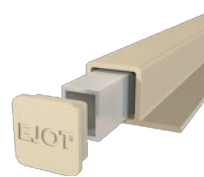
BURNDY | www.burndy.com



Solar wire management clip

Nine Fasteners, in conjunction with Enphase Energy, announces their newest solar wire management clip; NFI-1701 – Enphase's 150-00044. This new clip, as with all of Nine Fasteners' clips, is manufactured completely in the United States. It is produced using 301 ½ hard stainless steel and incorporates rolled outer edges for maximum wire safety. The NFI-1701 is a rail mounted clip for use with Enphase's new IQ series of microinverters capable of holding 1 or 2 of the IQ wires. It is also capable of holding 1 or 2 standard gauge PV wires.

Nine Fasteners | www.ninefasteners.com



Non-penetrative solution for flat roof membranes

EJOT is launching a multi-purpose fixing system, developed specifically for TPO flat roofs. EJOT's new 'membrane friendly' EJObar has been designed to create a non-penetrative fixing base for a range of applied systems; typically mechanical and electrical essentials such as pipework and cable trays, through to lightweight solar PV and solar thermal installations. Almost anything needing to be secured to, or rest upon the flat roofing system works with this versatile and cost effective system. EJObar comprises of a high quality membrane encapsulating a strong aluminum box insert. The profile is then sealed tight by two bonded endcaps. The product's strength has been fully tested in EJOT's application labs.

EJOT Fastening Systems L.P.

www.ejot-usa.com



Compact, low-cost option for HMI and visualization

Beckhoff has introduced the new CP6906 Control Panel display. Offering a 7" touchscreen with 800 x 480 WVGA resolution, and a robust housing consisting of an aluminum bezel and sheet steel rear cover, this passive display answers applications with pronounced budgetary constraints, without sacrificing quality. Manufactured in Germany, the CP6906 is intended for engineers seeking to add a reliable, compact interface at a low cost. Once combined with a controller, such as a DIN rail mounted CX series Embedded PC or a cabinet mounted Industrial PC (IPC) from Beckhoff, the result is an inexpensive and compact control and HMI solution for machines, plants, buildings, and other equipment. For maximum installation flexibility, the CP6906 integrates DVI/USB Extended technology, enabling remote operation as far as 50m away from the PC.

Beckhoff Automation LLC

www.beckhoffautomation.com

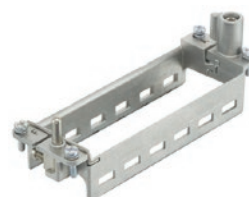
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Richard Stephens • (850) 523-0954 • rstephens@ene.com



Hinged frame for easy assembly

With the introduction of a new spring-loaded frame to the Han-Modular building block system, HARTING is making it even easier and faster to create a modular connector that precisely fits each application. The Han-Modular lineup now includes over 100 different modules for power, data, and signal that can be combined virtually without limitation. The new "hinged frame plus" for Han-Modular connectors features an additional stainless steel spring that holds the frame in the open position during assembly so modules can be easily fitted into their proper position for faster assembly, and time and labor savings. All module positions (A to F) are evident at a glance; while an additional marking, a black triangle, indicates the orientation for proper insertion of modules into the frame. The frame windows have been optimized so the modules are automatically centered as the frame is closed. Upon locking, there is a clearly audible "click" and the spring holds the frame securely together. Since the general design of the previous hinged frame is maintained in "hinged frame plus", the new design is fully compatible with all Han-Modular connectors. No compromises need to be made in terms of mechanical stability.

HARTING, Inc. of North America | www.harting-usa.com



ecology and environment, inc.
Global Environmental Specialists
www.ene.com



Versatile insulation tester

Extech Instruments' Extech MG320 is a CAT IV 20GΩ/1000V insulation tester with integrated True RMS multimeter. The MG320 is a solution for industrial predictive maintenance programs which include routine insulation testing of electrical and electronic equipment, and cables. The rugged new tool puts insulation testing up to 1kV (1000V) and a 20GΩ range in a portable tester and offers users five test voltages (50V, 100V, 250V, 500V, 1000V) and step voltage in 10% increments from 50% to 120% of range. For advanced insights, the MG320 features both Polarization Index (PI) and Dielectric Absorption Ratio (DAR) modes as well as continuity and low resistance testing with 20kΩ range and zero function. The comparison mode permits technicians to customize Pass/Fail values for the varying requirements of insulation tests on gear around a job site. Insulation testing length can be configured with a programmable timer. A locking function mode enables hands-free use while readings are displayed on a large, backlit dual display with digital readout and analog bar graph. During testing, up to 99 readings can be stored and readings on the display can be frozen using Data Hold. After testing, the meter internally discharges the voltage test signal. Technicians can also measure AC and DC voltage. The meter comes complete with tilt stand, test leads, alligator clip, six AA batteries, and soft storage case. The meter is backed by a Category IV 600V overvoltage safety rating and a one year warranty.

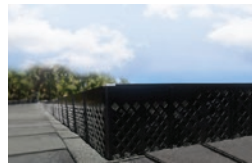
Extech Instruments | www.extech.com



Advanced pure lead carbon technology

Leoch Battery Corp introduces their new extreme performance AGM battery. Offering high energy density, fast charge acceptance, low self-discharge rate, and >2500 cycles at 50% DoD. Designed for partial-state-of-charge operating conditions, the new PLH+C Series is a solution for grid-tied and grid-zero ES systems. Approved for use in -49°F to 133°F (-45°C to +55°C) temperatures.

Leoch Battery Corp. | www.leoch.us



Protective residential solar system barrier

SolaTrim LLC announced another barrier size option will be added to their product line. In addition to the original ST-001, SolaTrim is now offering the ST-055, similar in design, but with a 5.5" width – a full inch and a quarter narrower than the standard 6.75" wide ST-001.

SolaTrim LLC | www.solatrim.com

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Smart grid integration with rule 21 certification

Fronius USA recently received UL certification for California's Rule 21 inverter requirements, which are required in California for new Net Energy Metering (NEM) applications from September 8th. New smart functions, such as voltage and frequency ride-through or soft start ramp rate, will pave the way for further solar penetration into the California grid and help to better manage the fluctuations caused by distributed energy resources (DER). These new functions have a stabilizing effect on the grid as more DER is added to it. The proper Rule 21 settings on Fronius inverters are easy to apply for installers, who simply select the "CAL" setup upon commissioning. Fronius has received certification for the Fronius Primo 3.8 - 8.2kW residential inverters, and Fronius Symo 10.0 - 24.0 480V commercial inverters. These inverters are now available with Rule 21 compliant software.

Fronius USA LLC | www.fronius-usa.com



Pneumatic module metal built to perform through 10,000 mating cycles

With robust metal contacts that can be plugged and unplugged at least 10,000 times, the new Han Pneumatic Module Metal from HARTING presents another significant cost- and space-saving opportunity to use connectors to streamline flexible production processes with high mating cycles. The Han Pneumatic Module Metal can withstand pressure up to 10 bars, covering the entire low pressure range. This compares with an upper limit of 8 bars for the existing Han Pneumatic Module with plastic contacts. With pneumatic modules, users can route compressed air feed through the same connector along with power and signal lines rather than having to set up and maintain a separate compressed air connection for drive units, control units, brakes, holding and unloading units, and much more. The Pneumatic Module Metal is available in variants with two (for hose $\varnothing = 6\text{mm}$) or three plug slots (for hoses with $\varnothing = 1.6$ to 4mm). The female contacts are available with or without a shut-off function – a spring-loaded valve that closes over an O-ring when the connector is opened, preventing compressed air from escaping. The Han Pneumatic Module Metal can be employed in a wide range of HARTING connector series that take Han-Modular inserts, including Han-Yellock and Han-Eco.

HARTING, Inc. of North America
www.harting-usa.com



Fully rugged tablet

The new Getac A140 fully rugged tablet is equipped with a 14", 1000 NITs sunlight readable display, available Intel Core i5 and i7 processors, dual hot-swappable batteries, and a suite of security features. The 14", 1000 NITs sunlight readable HD display incorporates Getac's LumiBond 2.0 touchscreen technology. The A140 supports Touch/Rain, Glove, and Pen touch modes and includes a hard-tip stylus to keep users productive in multiple scenarios and extreme conditions. Using Intel's 6th Generation Skylake Core i5 and i7 processors, combined with Intel 802.11ac Wi-Fi, Bluetooth 4.2 technology, and a hot-swappable battery design, users will experience maximum mobile performance. It comes with a range of options, including a full HD webcam for crystal-clear video conferencing, an 8MP rear camera with LED flash for crisp images and video, and 4G LTE wireless for reliable connectivity. The Getac A140 offers security features, including TPM 2.0, which monitors and protects system start-ups by ensuring the device is tamper-free before releasing control to the operating system. Multifactor authentication options, including fingerprint, RFID, or SmartCard readers, allow users to take advantage of Microsoft Windows 10 identity and access control features. The tablet is MIL-STD810G and IP65-certified to survive drops up to 4ft and survive rain, moisture, vibrations, shock, and extreme temperatures from -5.8°F to 140°F (operating temperature) and -60°F to 160°F (storage temperature). It is backed by Getac's three-year warranty which includes accidental damage and environmental exposure.

Getac | www.getac.com

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ConeDrive.com



Energy storage solution for residential applications

The Darfon H300 hybrid energy storage system is a wall-mountable pre-configured solution that consists of a H5000 hybrid inverter, distribution box, and 5kWh Lithium battery (LNMC). This is a solution for those with a limited budget, a light load to support or without much floor space. The distribution box is attached and prewired to the H5000, so there are only two products to mount. The distribution box includes quick disconnect terminals for AC, DC, and generator, AC breakers, PV disconnect, and battery connectors, making the system easy to install.

Darfon Solar | www.darfonsolar.com



Battery-less off-grid solar inverter for air conditioners

CyboEnergy, Inc. has released a family of off-grid and on/off-grid CyboInverters that can run Inverter-Air-Conditioners (IAC) without batteries. The system offers a 4-channel 1.2KW off-grid CyboInverter that directly connects to four 250W to 330W solar panels with MC-4 connectors. It can run a 9000 to 12000 Btu IAC. Another option is an off-grid CyboInverter Twin-Pack connected to eight solar panels and can run an 18000 to 24000 Btu IAC or multiple smaller IACs. Solar panels and CyboInverters can be installed on the roof with “plug-and-play” installation. The AC output wire runs down to connect to the IAC. Since the system is so simple and easy to install, the total system cost is affordable. Most off-grid inverters on the market require batteries to operate. This battery-less solar air conditioning system is unique, cost effective, and can work in high temperature and high humidity areas.

CyboEnergy | www.cyboenergy.com



Free-standing PV inverter for commercial installations

SMA America announced the Sunny Tripower CORE1, the free-standing PV inverter for commercial installations, has achieved UL listing and is available for purchase. The CORE1 was also recently awarded the prestigious Intersolar 2017 Award in photovoltaics. This solution is designed to provide up to 60% faster installation for commercial rooftop, carport, and ground-mount PV systems. The CORE1 is a fully integrated solution designed specifically to speed installation and achieve higher return-on-investment. Without the need for additional racking, components, or other equipment, installers will save a great deal of time and see reduced balance-of-system costs. The CORE1 features integrated AC and DC disconnects, direct string inputs, and six MPP channels using SMA's OptiTrac Global Peak technology. It also includes complete grid management capabilities. With 50kW of power, the CORE1 is scalable and suitable for a variety of commercial installations and system designs up to the megawatt range. Field serviceability also results in significant savings. Where most commercial inverters must go back to the manufacturer for repair in the event of a fault, the CORE1 contains components that can be replaced in the field, resulting in hours of downtime instead of days, and ultimately leading to extensive OPEX savings.

The SMA Group | www.sma-america.com

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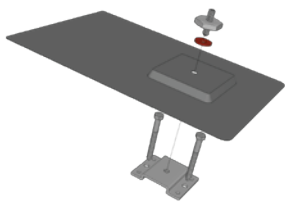
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Strong watertight flashing

Zilla Double Stud Flashing Assembly is a strong watertight flashing for composition/asphalt shingle roofs providing industry professionals two layers of waterproof protection. The design of the patented Zilla Base Plate has a laboratory tested withdrawal strength of 4289lbs using two (2) 5/16" x 3-1/2" lag screws in Douglas Fir. This flashing has passed 3rd party testing for roof flashings in accordance with AC 286 evaluation standards using the methodology of UL 441 for all regions, including coastal installations. The low profile, patented design of the Zilla Double Stud features an elevated flashing with a metal-to-metal compression zone that secures and protects the Encapsulated Gland Washer to create a complete water tight seal. With no exposed mechanical attachments, washers, or threads, the Zilla Double Stud Flashing provides maximum strength and water protection.

Zilla | www.zillarac.com



Intelligent control system for solar power plants

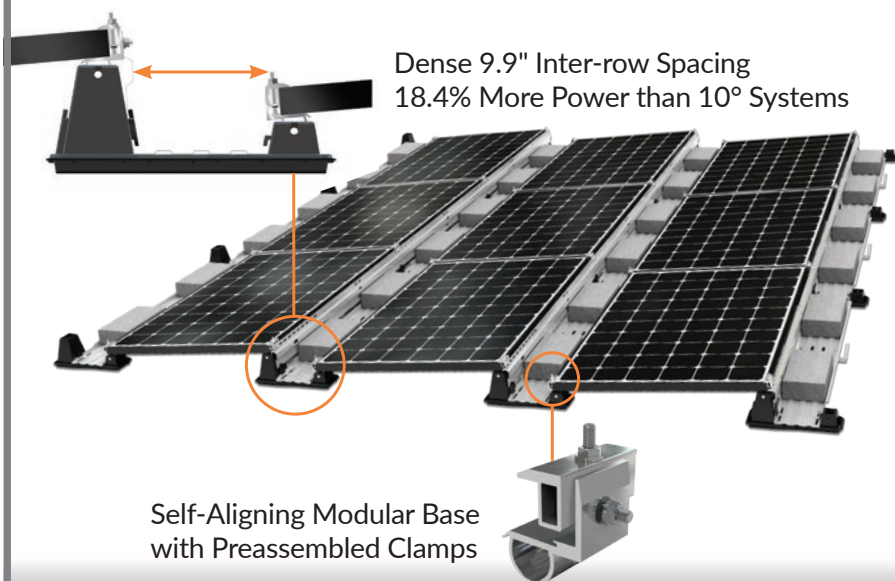
NEXTracker, a Flex company, launched TrueCapture, an intelligent, self-adjusting tracker control system for solar power plants. TrueCapture's technology continuously refines the tracking algorithm of each individual solar array in response to existing site and weather conditions. Typically delivering 2% to 6% energy gains, TrueCapture enables system owners and developers to maximize solar system performance and enhance profits for solar power facilities. TrueCapture leverages forecast-based tracking behavior algorithms for clouds, fog or haze, and row-to-row (R2R) hybrid closed-loop self-learning and course corrects the panel direction to minimize production loss due to shading and clouds. Wireless self-powered controllers on the tracker sync with the smart panels and the NEXTracker SCADA (supervisory control and data acquisition) system, connected through Flex's IoT platform, a secure, NERC-CIP compliant, industrial-strength connected intelligence platform. From the Flex IoT platform, communication is continually dispatched to control each independent row. With TrueCapture, proprietary smart panel sensors provide real-time shading information on each tracker row. The data is integrated with design parameters and processed by machine-learning software to build a virtual 3D model of the job site. An intelligent control engine combines the model with the latest meteorological forecast data to calculate and send updated and optimized tracking commands to every independent row. As a result, energy production gets a significant boost.

NEXTracker | www.nextracker.com

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Solar toolkit developed to help municipalities advance solar projects

The New York State Energy Research and Development Authority (NYSERDA) has developed a Solar PILOT Toolkit to assist the state's municipalities in understanding and negotiating payment-in-lieu-of taxes (PILOT) agreements for solar projects larger than 1MW, including community solar projects. NYSERDA developed the toolkit in response to the need for greater information on PILOT agreements as solar projects develop throughout the state. The Solar PILOT Toolkit provides a framework for local taxing jurisdictions to negotiate payment agreements with solar developers. The toolkit addresses the lack of information on property tax issues around solar development and is designed to enable municipalities to work with developers to negotiate PILOT rates that benefit the community and make the projects financially attractive to developers and their customers. The Toolkit offers guidance to counties, towns, and school districts on the structure of a PILOT agreement as an alternative solution for community solar participants and developers in municipalities that opt-out of the tax exemption. It also includes templates for a single jurisdiction or multiple jurisdictions that municipalities can tailor to meet their needs in working with developers to negotiate an agreement. The Toolkit is comprised of three elements: a model resolution to guide municipalities in exercising their legal authority to adopt a PILOT; a sample agreement that jurisdictions may use to draft an agreement with developers; and a PILOT Calculator with two options that offer guidance on methods to collect revenue.

NYSERDA | www.nyserda.gov



Renewable energy bus bar bypass breaker

Technology innovator QFactory 33's energy division, QFE002, recently announced receipt of its critical UL 67 & 489 (Underwriters Laboratories) Certifications for its B3 Bypass. The B3 Bypass, the bus bar bypass breaker, delivers exponential gains in back-feeding of energy from solar panels and other green energy sources, eases connectivity to electric vehicle charging stations and battery backup systems, and substantially reduces the installation cost of solar and other clean tech for residential and small business applications. The B3 Bypass has undergone extensive testing, and, with these certifications, is now positioned to help consumers and businesses more affordably install virtually any renewable energy source. Such UL certifications mean the B3 Bypass has met UL's stringent requirements for Standards and Safety, making the unit ready and approved for widespread commercial use.

Q Factory 33 | www.qfe002.com



Polypropylene valve body

In recent years, cost pressure in the photovoltaic industry has increased significantly. Plant engineers are looking for solutions to counteract this increasing cost pressure. The aim is to reduce the cost price of components. As a result, greater attention is being paid to the selection of lower cost materials such as polypropylene (PP) which meet the necessary resistance and purity requirements, especially during the development of new plant and processes. In the Gemü CleanStar SmartLine range, the valve body through which the process medium flows is available with flare connections (½" to 1 ¼") and metric spigots for butt-welding (DN15 to DN32) and in transparent (PP-R) and grey (PP-H) materials. Gemü also offers an extensive instrumentation line to provide a full control package solution.

Gemü Valves | www.gemu-group.com

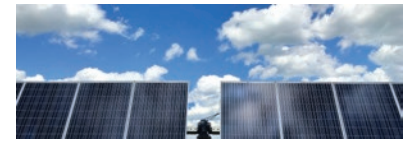


Fully ballasted roof mounting structure

The POWER Max PV Solar Mounting System is a fully ballasted roof mounting structure developed with the professional installer in mind, featuring minimum components and no loose hardware. The Power Max is designed to provide a fast assembly and short learning curve. An adjustable inter-row spacing provides maximum module density or wider spacing for maintenance. The modular design simplifies roof layouts, ordering, and final installation while stackable components reduce shipping volume and provide easy transport of materials to the roof. The new POWER Max is backed by 20+ years of industry experience, engineering support, and dedicated customer service.

Preformed Line Products

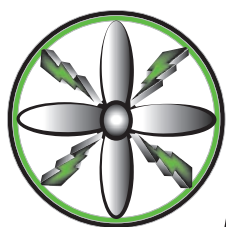
www.preformed.com



Turnkey solar tracker

Solar FlexRack's TDP 2.0 Tracker's new advanced design, BalanceTrac, increases solar power systems' energy yields and reduces installation risks and costs. Bundled with project support services for commercial and utility-scale solar installations, Solar FlexRack's next-generation solar tracker solution offers more modules per row, greater rotational range, and more granular programmable technology to mitigate inclement climatic conditions. These are just a few of the design features of the cost-competitive new TDP 2.0 Tracker that translate to higher performance, system design flexibility and cost-savings across a solar project budget. The turnkey tracker solution is efficiently designed to reduce overall project risk.

Solar FlexRack | www.solarflexrack.com



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Modules

Efficient design and a high-yield performance are key factors in any solar energy project. Regardless of the project size - whether for a residential project, commercial building, or utility-scale application - selecting the right module is extremely important. To help you find the right choice for your solar project, we've highlighted some of the top contenders in the industry.

SEE AD ON PAGE 45



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Itek Energy

Product: Itek SE 60 Cell Solar Module

Application: Residential

Maximum Power (Pmax): 305W

Maximum Power Point Voltage (Vmpp): 33.1V

Maximum Power Point Current (Imp): 9.1A

Open Circuit Voltage (Voc): 40V

Short-Circuit Current (Isc): 9.8A

Module Efficiency: 18.19%

Operating Temperature: -40°F to 194°F (-40°C to 90°C)

Max. System Voltage: 1000V

Power Tolerance: ± 2%

Cell Type: High-efficiency monocrystalline p-type cells

Glass: Low iron, tempered, patterned solar glass with ARC

Frame: (prismatic/matt) solar glass, ARC

Weight: 41lbs (18.6kg)

Dimensions: 65.94" x 3.94" x 1.57" (1675mm x 100mm x 40mm)

Max Load: 113psf

Tests/Certifications: UL 1703 / Pid 500+ hrs

Warranty: 25-year power output warranty, 12-year workmanship warranty

Key Features:

- High-power density 5 busbar with M2 PERC monocrystalline cells;
- Optional Tigo TS4 Platform for module level monitoring, RSD, optimization, and long-string;
- Certified PID Free 500 Hour Test, positive and negative bias;
- Full quality check of every module along the production line;
- Assembled in the U.S.A.

www.itekenergy.com

SEE AD ON PAGE 44



MiaSolé
A Hanergy Company

MiaSolé

Product: FLEX-02 130N

Application: Residential

Maximum Power (Pmax): 130W

Maximum Power Point Voltage (Vmpp): 32.0V

Maximum Power Point Current (Imp): 4.06A

Open Circuit Voltage (Voc): 39.1V

Short-Circuit Current (Isc): 4.57A

Module Efficiency: >16.5%

Operating Temperature: -40°F to 194°F (-40°C to 90°C)

Max. System Voltage: 1000/600

Power Tolerance: -0 / +5

Cell Type: CIGS

Glass: Flexible front barrier

Frame: Self-adhesive

Weight: 5.9lbs (2.7kg)

Dimensions: 102.3" x 14.6" (2598mm x 370mm)

Max Load: 10Pa

Tests/Certifications: UL 1703, IEC 61646, IEC 61730

Warranty: 5-year workmanship warranty, 10- and 25-year power output warranty

Key Features:

- Record efficiency levels in a CIGS flexible form factor;
- Low installed weight; < 2.9kg/m² (<0.6lb/ft²);
- No penetrations, ballast, or racking required;
- Applicable for high wind load and high seismic hazard areas;
- Bypass diodes reduce PV system shading losses.

www.miasole.com



Silfab Solar

Product: SLA-M 310

Application: Residential

Maximum Power (Pmax): 310W

Maximum Power Point Voltage (Vmpp): 33.05V

Maximum Power Point Current (Imp): 9.38A

Open Circuit Voltage (Voc): 40.25V

Short-Circuit Current (Isc): 9.93A

Module Efficiency: 19%

Operating Temperature: -40°F to 185°F (-40°C to 85°C)

Cell Type: 60 - Si mono crystalline; 3 or 4 busbar; 156.75mm x 156.75mm

Glass: 3.2mm high transmittance, tempered, antireflective coating

Frame: Anodized aluminum

Weight: 41.9lbs (619kg)

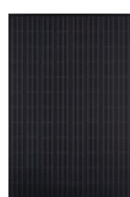
Dimensions: 64" x 39" x 1.5" (1650mm x 990mm x 38mm)

Max Load: 5400Pa

Tests/Certifications: CE, IEC, TUV, Intertek, Fraunhofer ISE, TUV Rheinland

Warranty: 12-year warranty

www.silfab.ca



Panasonic

Product: Panasonic Black HIT(R) Module

Application: Residential

Maximum Power (Pmax): 320W

Maximum Power Point Voltage (Vmpp): 58.7V

Maximum Power Point Current (Imp): 5.46A

Open Circuit Voltage (Voc): 70.5V

Short-Circuit Current (Isc): 5.89A

Module Efficiency: 19.1%

Operating Temperature: -40°F to 185°F (-40°C to 85°C)

Max. System Voltage: 600V

Power Tolerance: -0% / +10%

Cell Type: Silicon Heterojunction

Glass: 3.2mm

Frame: 35mm

Weight: 42.89lbs (19kg)

Dimensions: 62.6" x 41.5" x 1.4" (1590mm x 1053mm x 35mm)

Max Load: 2400Pa (50PSF)

Tests/Certifications: UL 1703, cUL, CEC

Warranty: 25-year workmanship and linear power output

www.business.panasonic.com/solarpanels



Mission Solar Energy

Product: MSE PERC 60

Application: Residential

Maximum Power (Pmax): 300W

Maximum Power Point Voltage (Vmpp): 32.8V

Maximum Power Point Current (Imp): 9.17A

Open Circuit Voltage (Voc): 40.8V

Short-Circuit Current (Isc): 9.61A

Module Efficiency: 18%

Operating Temperature: 111.2°F (44°C)

Max. System Voltage: 1000V

Power Tolerance: -0 / +3%

Cell Type: PERC

Glass: 3.2mm tempered, low-iron, anti-reflective coating

Frame: Anodized aluminum alloy (black)

Weight: 40.1lbs (18.2kg)

Dimensions: 65.51" x 39.33" x 1.57" (1664mm x 999mm x 40mm)

Max Load: 5600Pa

Tests/Certifications: UL 1703, IEC 61215, IEC 61730-1-2

Warranty: 25-year linear power warranty, 10-year workmanship warranty

www.missionsolar.com



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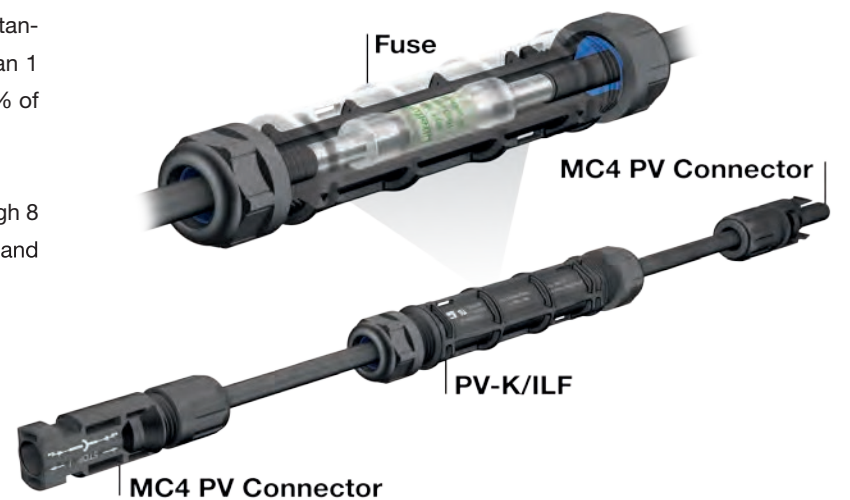
Stäubli Electrical Connectors' (formerly Multi-Contact) MC4 photovoltaic connectors are the global industry standard and can be found on more PV modules than any other connector system in the world. With more than 1 billion installed PV connector components, Stäubli Electrical Connectors provides more than 150 GW or 50% of the worldwide PV capacity.

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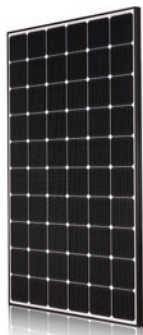


Multi-Contact

MC

STÄUBLI

SEE AD ON PAGE 29



LG

Product: NeON 2 ACe

Application: Residential

Maximum Power (Pmax): 330W

Maximum Power Point Voltage (Vmpp): 33.7V

Maximum Power Point Current (Impp): 9.8A

Open Circuit Voltage (Voc): 40.9V

Short-Circuit Current (Isc): 10.45A

Module Efficiency: 19.3%

Operating Temperature: -40°F to 194°F (-40°C to 90°C)

Max. System Voltage: 1000V

Power Tolerance: -0% / +3%

Cell Type: Monocrystalline / N-type

Glass: High transmission tempered glass

Frame: Anodized aluminum

Weight: 41.88lbs (19kg)

Dimensions: 66.38" x 40" x 1.57" (1686mm x 1016mm x 40mm)

Max Load: 6000Pa (front), 5400Pa (rear)

Tests/Certifications: AC Module: UL 1741, UL 1703 / Micro Inverter: UL 1741 / IEEE 1547, UL 62109-1, FCC Part 15 Class B, ICES-0003 Class B, CAN/CSA-C22.2 NO.107.1-01

Warranty: 12-year solar module product warranty; 25-year micro inverter warranty

Key Features:

- The LG NeON 2 ACe has a 15mm distance between the DC module and the micro inverter, mitigating any impact to performance and reliability by allowing sufficient air-flow for cooling;
- These modules produce high energy output from high-efficiency n-type cells, enabling more flexible use of available roof space;
- The LG NeON 2 ACe produces safe AC voltage, and complies with NEC 2014 and 2017 standards;
- Enphase Enlighten software makes it easy to monitor and manage from any web connected device;
- Logistics are simplified by consolidating multiple PV system components into a single product SKU, which makes it easy to order, store, and transport;
- Installation is a two step process of lifting the inverter and connecting the cable without the need to install the inverter, reducing installation labor.

www.lgsolarusa.com

SEE AD ON PAGE 42



AXITEC, LLC

Product: AXIblackpremium

Application: Residential

Maximum Power (Pmax): 290Wp

Maximum Power Point Voltage (Vmpp): 31.71V

Maximum Power Point Current (Impp): 9.16A

Open Circuit Voltage (Voc): 39.70V

Short-Circuit Current (Isc): 9.70A

Module Efficiency: 17.83%

Operating Temperature: -40°F to 185°F (-40°C to 85°C)

Max. System Voltage: 1000VDC (UL) (IEC)

Power Tolerance: -0 / +5Wp

Cell Type: Mono

Glass: 3.2mm low-reflection

Frame: 35mm black anodized aluminum

Weight: 39.68lbs (18kg) with frame

Dimensions: 64.57" x 39.06" x 1.38" (1640mm x 992mm x 35mm)

Max Load: 113psf

Tests/Certifications: UL

Warranty: 12-year product warranty, 85% of performance after 25 years

Key Features:

- High performance with aesthetics;
- Well-suited for installations where the black exterior design must match the high power output.

www.axitecsolar.us



Hanwha Q CELLS

Product: Q.PEAK BLK-G4.1

Application: Residential

Maximum Power (Pmax): 300W

Maximum Power Point Voltage (Vmpp): 32.41V

Maximum Power Point Current (Impp): 9.26A

Open Circuit Voltage (Voc): 39.76V

Short-Circuit Current (Isc): 9.77A

Module Efficiency: 18.0%

Max. System Voltage: 1000V

Power Tolerance: -0W / +5W

Cell Type: Monocrystalline Q.ANTUM

Glass: Anti-reflection

Frame: Black anodized aluminum

Weight: 41.45lbs (18.8kg)

Dimensions: 65.7" x 39.4" x 1.26" (1670mm x 1000mm x 32mm)

Max Load: 75lbs (3600Pa) x 55.6lbs (2666Pa)

Tests/Certifications: UL 1703, VDE Quality Tested, CE-Compliant, IEC 61215 - 61730, TAA Compliant

Warranty: 98% nominal power during first year

www.q-cells.com/us



Giga Solar FPC, Inc.

Product: Giga Solar Lightweight Rigid Module GS 610

Application: Residential

Maximum Power (Pmax): 295W

Maximum Power Point Voltage (Vmpp): 31.4V

Maximum Power Point Current (Impp): 9.4A

Open Circuit Voltage (Voc): 40.1V

Short-Circuit Current (Isc): 9.9A

Module Efficiency: 18.1%

Operating Temperature: 28.4°F to 116.6°F (-2°C to 47°C)

Max. System Voltage: 1000V

Power Tolerance: -0% / +3%

Cell Type: Mono c-Si

Glass: No glass

Frame: Frameless

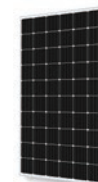
Weight: 16lbs (7.2kg)

Dimensions: 65.3" x 38.4" (1658mm x 976mm)

Max Load: 5400Pa

Warranty: 10-year manufacturing warranty; 20-year, 80% power output warranty

www.gigasolarpv.com



Suzhou Talesun Solar Technologies Co., Ltd

Product: Hipro M350+

Application: Residential

Maximum Power (Pmax): 345W - 350W

Maximum Power Point Voltage (Vmpp): 38.9V to 39.3V

Maximum Power Point Current (Impp): 8.87A to 8.92A

Open Circuit Voltage (Voc): 47.2V to 47.4V

Short-Circuit Current (Isc): 9.43A to 9.50A

Module Efficiency: 17.7% - 18%

Operating Temperature: -40°F to 185°F (-40°C to 85°C)

Max. System Voltage: 1500VDC

Power Tolerance: -0% / +3%

Cell Type: 156.75 x 156.75mm (6")

Glass: 3.2mm high transmission, tempered glass

Frame: Anodized aluminum alloy

Weight: 48.5lbs (22kg)

Dimensions: 77.17" x 39.06" x 1.57" (1960mm x 992mm x 40mm)

Max Load: 5400Pa

Tests/Certifications: DNV PVEL, TUV SUD, CEC, MSC, TUV Reinland

Warranty: PowerGuard, SOLARIF, 25-year linear power output warranty, 10-year material and workmanship warranty

www.taiesun.com



Shenzhen Sungold Solar Co., Ltd.

Product: Flexible solar panel
Application: Residential
Maximum Power (Pmax): 135W
Maximum Power Point Voltage (Vmpp): 27.38V
Maximum Power Point Current (Impp): 6.32A
Open Circuit Voltage (Voc): 23.2V
Short-Circuit Current (Isc): 5.97A
Module Efficiency: 22.6%
Operating Temperature: -40°F to 185°F (-40°C to 85°C)
Max. System Voltage: 1000V (IEC)
Power Tolerance: 0.38%
Cell Type: 4 x 10
Weight: 5.40lbs (2.45kg)
Dimensions: 4.92" x 4.92" x 0.11" (125mm x 125mm x 3mm)
Tests/Certifications: CE ROHS
Warranty: 2-year warranty
www.sungoldsolar.com



FAFCO, Inc.

Product: FAFCO CoolPV
Application: Residential
Maximum Power (Pmax): 1125W
Maximum Power Point Voltage (Vmpp): 31.3V
Maximum Power Point Current (Impp): 9.20A
Open Circuit Voltage (Voc): 39.7V

Short-Circuit Current (Isc): 9.84A
Module Efficiency: 17%
Operating Temperature: 118.4°F (48°C)
Max. System Voltage: 1000V
Power Tolerance: -0W / +5W
Cell Type: Monocrystalline
Glass: Low iron tempered with ARC

Frame: Anodized aluminum
Weight: 47.4lbs (21.5kg)
Dimensions: 65.95" x 39.4" x 1.3" (1675mm x 1001mm x 33mm)
Max Load: 170psf / 71psf
Tests/Certifications: IEC 61215, IEC 61730, UL1703, OG100
Warranty: 30-year warranty
www.fafco.com

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SolarWorld Americas Inc.

Product: Sunmodule aAC 290 black
Application: Residential
Maximum Power (Pmax): 290W
Maximum Power Point Voltage (Vmpp): 32.2V
Maximum Power Point Current (Impp): 9.12A
Open Circuit Voltage (Voc): 39.5V
Short-Circuit Current (Isc): 9.60V
Module Efficiency: 17.3%
Operating Temperature: -40°F to 149°F (-40°C to 65°C)
Max. System Voltage: 1000V
Power Tolerance: -0W / +5W
Cell Type: 5 bus bar, p-type PERC
Glass: 3.2mm structured solar glass with ARC
Frame: Black anodized aluminum
Weight: 42.5lbs (19.3kg)
Dimensions: 65.95" x 39.4" x 1.2" (1675mm x 1001mm x 33mm)
Max Load: -64 / +113psf
Tests/Certifications: UL1703, UL1741, IEC 61730, IEC 61215, IEC 62716, IEC 60068-2-68, IEC 61701
Warranty: 25-year performance warranty, 20-year product warranty
www.solarworld-usa.com

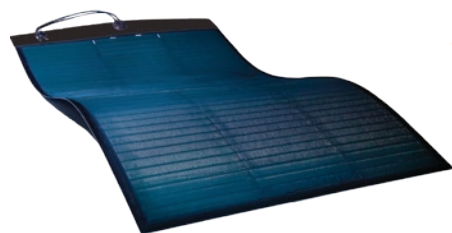
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www.ideematec.de

SEE AD ON PAGE 44



MiaSolé

Product: FLEX-03 510W

Application: Commercial

Maximum Power (Pmax): 510W

Maximum Power Point Voltage (Vmpp): 60.6V

Maximum Power Point Current (Impp): 8.42A

Open Circuit Voltage (Voc): 75.1V

Short-Circuit Current (Isc): 9.40A

Module Efficiency: 16.7%

Operating Temperature: -40°F to 194°F (-40°C to 90°C)

Max. System Voltage: 1000

Power Tolerance: -0 / +10

Cell Type: CIGS

Glass: Flexible front barrier

Weight: 14.6lbs (6.6kg)

Dimensions: 101.8" x 50.9" (2585mm x 1293mm)

Tests/Certifications: UL 1703, IEC 61646, IEC 61730, UL Class A over TPO - slope up to 1°

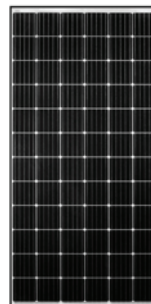
Warranty: 5-year workmanship warranty, 10- and 25-year power output warranty

Key Features:

- Record efficiency levels in a flexible form factor;
- Low installed weight; < 2.0kg/m² (<0.5lb/ft²);
- No penetrations, ballast, or racking required;
- Applicable for high wind load and high seismic hazard areas;
- Bypass diodes reduce PV system shading losses.

www.miasole.com

SEE AD ON PAGE 45



Itek Energy

Product: Itek SE 72 Cell Solar Module

Application: Commercial

Maximum Power (Pmax): 365W

Maximum Power Point Voltage (Vmpp): 39.12V

Maximum Power Point Current (Impp): 9.33A

Open Circuit Voltage (Voc): 48.08V

Short-Circuit Current (Isc): 9.69A

Module Efficiency: 18.3%

Operating Temperature: -40°F to 194°F (-40°C to 90°C)

Max. System Voltage: 1000V

Power Tolerance: ± 2%

Cell Type: High-efficiency monocrystalline p-type cells

Glass: Low iron, tempered, patterned solar glass with ARC

Frame: (prismatic/matt) solar glass, ARC

Weight: 49lbs (22.2kg)

Dimensions: 78.46" x 3.94" x 1.57" (1993mm x 100mm x 40mm)

Max Load: 113psf

Tests/Certifications: UL 1703 / Pid 500+ hrs

Warranty: 25-year power output warranty, 12-year workmanship warranty

Key Features:

- High-power density 5 busbar with M2 PERC monocrystalline cells;
- Optional Tigo TS4 Platform for module level monitoring, RSD, optimization, and long-string;
- Certified PID Free 500 Hour Test, positive and negative bias;
- Full quality check of every module along the production line;
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www.axitecsolar.us

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- AXIpremium MONO up to 350 Watt
- AXIblackpremium MONO ALL BLACK up to 290 Watt

AXITEC, LLC, 1819 Underwood BLVD, Suite 5, Delran, New Jersey 08075, Phone 856-393-7800, info@axitecsolar.com



Mitsubishi Electric US, Inc.

Product: Diamond Pro MJE PV module

Application: Commercial

Maximum Power (Pmax): 265W

Maximum Power Point Voltage (Vmpp): 30.9V

Maximum Power Point Current (Impp): 8.59A

Open Circuit Voltage (Voc): 38V

Short-Circuit Current (Isc): 9.10A

Module Efficiency: 16.1%

Operating Temperature: 114.8°F (46°C)

Max. System Voltage: 1000V

Power Tolerance: 0% / +5%

Cell Type: Monocrystalline silicon

Glass: Anti reflective coated glass

Frame: Double corrosion-resistant coated aluminum

Weight: 41.8lbs (19kg)

Dimensions: 65.2" x 39.1" x 1.81" (1657mm x 994mm x 46mm)

Max Load: 5400Pa

Tests/Certifications: IEC1215 thermal cycling test of -40°C to 85°C, UL 1703, IEC 61215 2nd edition, IEC 61730

Warranty: 25-year linear performance warranty, 10-year materials and workmanship warranty

www.mitsubishielectricsolar.com



Prism Solar

Product: Bi60-381BSTC

Application: Commercial

Maximum Power (Pmax): 300W

Maximum Power Point Voltage (Vmpp): 32.4V

Maximum Power Point Current (Impp): 9.26A

Open Circuit Voltage (Voc): 40.2V

Short-Circuit Current (Isc): 9.8A

Module Efficiency: 18%, +23% with bifacial gain

Operating Temperature: -40°F to 185°F (-40°C to 85°C)

Max. System Voltage: 1000V

Power Tolerance: -1.5% / +3%

Cell Type: N-Type Bifacial Monocrystalline

Glass: 2x 3.2mm tempered

Frame: Frameless

Weight: 63.75lbs (28.9kg)

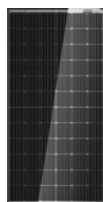
Dimensions: 66.73" x 38.74" x 0.28" (1695mm x 984mm x 7.2mm)

Max Load: 5400Pa (snow load), 2400Pa (wind load)

Tests/Certifications: UL1703, IEC61215/61730, CE, CEC on Select Models, Type=13; Burning Brand =A; Spread of Flames =A

Warranty: 10-year warranty, 30-year output warranty (front and back)

www.prismsolar.com



Trina Solar

Product: Duomax Twin

Application: Commercial

Maximum Power (Pmax): 365W

Maximum Power Point Voltage (Vmpp): 39.8V

Maximum Power Point Current (Imp): 9.17A

Open Circuit Voltage (Voc): 48.2V

Short-Circuit Current (Isc): 9.75A

Module Efficiency: 18.4% (front side)

Operating Temperature: 111°F (44°C)

Max. System Voltage: 1500V

Power Tolerance: 0 / +5W

Cell Type: Monocrystalline bifacial

Glass: 2.5mm, high transmission, AR coated, heat strengthened glass, low iron (back)

Frame: Framed and frameless options available

Weight: 62.8lbs (28.5kg)

Dimensions: 78.38" x 39.53" x 1.10" (1991mm x 1004mm x 28mm)

Max Load: 5400Pa, 2400Pa

Tests/Certifications: IEC61215, IEC61730, UL1703, IEC61701, IEC62716

Warranty: 30-year, 0.5% annual degradation power warranty

www.trinasolar.com/us



Boviet Solar USA

Product: BVM6612P-PERC 72-cell
Polycrystalline

Application: Commercial

Maximum Power (Pmax): 335W to 355W

Maximum Power Point Voltage (Vmpp):
38V to 38.8V

Maximum Power Point Current (Imp):
8.82A to 9.15A

Open Circuit Voltage (Voc): 46.3V to
47.3V

Short-Circuit Current (Isc): 9.32A to
9.66A

Module Efficiency: 17.2% to 18.3%

Operating Temperature: -40°F to 185°F
(-40°C to 85°C)

Max. System Voltage: 1000/1500VDC

Power Tolerance: 0 / +5W

Cell Type: Polycrystalline

Glass: High transparency, low iron,
tempered glass 4.0mm (0.16in)

Frame: Anodized aluminum alloy

Weight: 58.24lbs (26.42kg)

Dimensions: 77.01" x 39.06" x 1.57"
(19.56cm x 9.92cm x 39.9mm)

Max Load: 5400Pa (snow load); 2400Pa
(wind load)

Tests/Certifications: UL 1703, IEC
61215, IEC 61730, CEC listed, MCS and CE,
ISO 9001 for Quality Management Systems,
ISO 14001 for Environmental Management
Systems, ISO 18001 Occupational Health
and Safety System

Warranty: 12-year product warranty, 25-
year linear power output warranty

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LG Electronics

Product: LG NeON 72cell

Application: Commercial

Maximum Power (Pmax): 400W

Maximum Power Point Voltage (Vmpp): 40.6V

Maximum Power Point Current (Impp): 9.86A

Open Circuit Voltage (Voc): 49.3V

Short-Circuit Current (Isc): 10.47A

Module Efficiency: 19.3%

Operating Temperature: -40°F to 194°F (-40°C to 90°C)

Max. System Voltage: 1500V (UL)

Power Tolerance: 0 / ~ +3

Cell Type: Monocrystalline / N-type

Glass: High transmission tempered glass

Frame: Anodized aluminum

Weight: 47.84lbs (21.7kg)

Dimensions: 79.69" x 40.31" x 1.57" (2024mm x 1024mm x 40mm)

Max Load: 5400Pa (front), 4300Pa (rear)

Tests/Certifications: IEC 61215, IEC 61730-1/-2, UL 1703, IEC 61701 (Salt mist corrosion test), IEC 62716 (Ammonia corrosion test), ISO 9001

Warranty: 12-year product warranty

Key Features:

- LG NeON 2 has an enhanced performance warranty. The annual degradation has fallen from -0.6%/yr to -0.55%/yr. Even after 25 years, the cell guarantees 1.2p more output than the previous LG NeON 2 modules;
- The LG NeON 2 has been designed with improved temperature coefficient, thereby making it efficient even in limited space;
- LG NeON 2 has been designed with aesthetics in mind; thin wires which appear all black at a distance;
- With its newly reinforced frame design, LG has extended the warranty of the LG NeON 2 for an additional 2 years;
- The rear of the cell used in LG NeON 2 will contribute to generation, just like the front; the light beam reflected from the rear of the module is reabsorbed to generate a great amount of additional power.

www.lgsolarusa.com

SEE AD ON PAGE 42



AXITEC, LLC

Product: AXIpremium 340 Mono

Application: Commercial

Maximum Power (Pmax): 340W

Maximum Power Point Voltage (Vmpp): 38V

Maximum Power Point Current (Impp): 8.95A

Open Circuit Voltage (Voc): 46.5V

Short-Circuit Current (Isc): 9.4A

Module Efficiency: 17.52%

Operating Temperature: -40°F to 185°F (-40°C to 85°C)

Max. System Voltage: 1000V

Power Tolerance: 0 / 5W

Cell Type: Monocrystalline

Glass: 3.2mm low-reflection

Frame: 40mm silver anodized aluminium

Weight: 50.7lbs (22.99kg)

Dimensions: 77.01" x 39.06" x 1.57" (1956mm x 992mm x 39.8mm)

Max Load: 50psf

Tests/Certifications: UL

Warranty: 12-year product warranty, 85% of performance after 25 years

Key Features:

- Modules with extra long wires for ease of installation;
- Positive power tolerance for higher guaranteed yield;
- Stable module for a long life in extreme conditions;
- Micro crack and hotspot free modules;
- Availability on both East and West coasts.

www.axitecsolar.us



Solarland USA Corporation

Product: SLP150-12

Application: Commercial

Maximum Power (Pmax): 150W

Maximum Power Point Voltage (Vmpp): 18.5V

Maximum Power Point Current (Impp): 8.11A

Open Circuit Voltage (Voc): 22.2V

Short-Circuit Current (Isc): 8.68A

Module Efficiency: 14.89%

Operating Temperature: -40°F to 185°F (-40°C to 85°C)

Max. System Voltage: 600V

Power Tolerance: ± 5%

Cell Type: Polycrystalline silicon solar cell

Glass: High transparent low-iron, tempered glass

Frame: 35mm or 50mm heavy-duty anodized frame

Weight: 26.68lbs (12.1kg)

Dimensions: 59.06" x 26.57" x 1.97" (1500mm x 675mm x 50mm)

Tests/Certifications: IEC 61215, IEC 61730, UL1703 & cUL1703, ISO 9001. Certified for Hazardous Environments C1D2 - Class 1, Division 2

Warranty: 5-year limited warranty of materials and workmanship, 10-year limited warranty of 90% power output, 25-year limited warranty of 80% power output

www.solarlandusa.com

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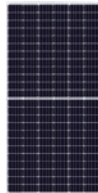
ET Solar

Product: ET-P660XXXWW_12BB
Application: Commercial
Maximum Power (Pmax): 285W
Maximum Power Point Voltage (Vmpp): 32.04V
Maximum Power Point Current (Impp): 8.90A
Open Circuit Voltage (Voc): 39.41V
Short-Circuit Current (Isc): 9.52A
Module Efficiency: 17.53%
Operating Temperature: -40°F to 185°F (-40°C to 85°C)
Max. System Voltage: 1000VDC
Power Tolerance: 0 / +5W
Cell Type: 156.75 x 156.75
Glass: 3.2mm
Frame: 35mm
Weight: 40.79lbs (18.5kg)
Dimensions: 64.57" x 39.06" x 1.38" (1640mm x 992mm x 35mm)
Max Load: 5400Pa
Tests/Certifications: STC
Warranty: 10-year product warranty, 25-year Pmax warranty
www.etsolar.com



Sonali Energees USA, LLC.

Product: SS320 Poly-Crystalline PV Solar Module
Application: Commercial
Maximum Power (Pmax): 320W
Maximum Power Point Voltage (Vmpp): 38.30V
Maximum Power Point Current (Impp): 8.36A
Open Circuit Voltage (Voc): 46.80V
Short-Circuit Current (Isc): 8.62A
Module Efficiency: 16.69%
Operating Temperature: 77°F (25°C)
Max. System Voltage: 1000V
Power Tolerance: 0 / +5W
Cell Type: Polycrystalline
Glass: 3.2 Tempered Glass (ARC)
Frame: Silver matt finished anodized frame
Weight: 50.70lbs (23kg)
Dimensions: 76.93" x 38.62" x 1.57" (1954mm x 981mm x 40mm)
Max Load: 5400Pa
Tests/Certifications: IEC 61215, 61730-1, 61730-2 & 61701, UL 1073, MNRE Approved
Warranty: 25-year linear performance warranty, 10-year product warranty
www.sonalisolar.com



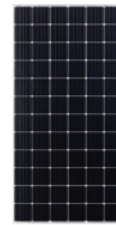
Canadian Solar, Inc.

Product: KuMax CS3U-MS
Application: Commercial
Maximum Power (Pmax): 375W
Maximum Power Point Voltage (Vmpp): 39.8V
Maximum Power Point Current (Impp): 9.43A
Open Circuit Voltage (Voc): 47.6V
Short-Circuit Current (Isc): 9.93A
Module Efficiency: 18.9%
Operating Temperature: -40°F to 185°F (-40°C to 85°C)
Max. System Voltage: 1500V
Power Tolerance: 0 / +5W
Cell Type: Monocrystalline PERC
Glass: 3.2mm tempered glass
Frame: Anodized aluminum alloy, crossbar enhanced
Weight: 49.4lbs (22.4kg)
Dimensions: 78.7" x 39.1" x 1.57" (2000mm x 992mm x 40mm)
Max Load: 5400Pa (snow load), 2400Pa (wind load)
Tests/Certifications: IEC 61215 / IEC 61730: 2005 & 2016: VDE / CE
Warranty: 25-year linear power output warranty
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BYD Company Ltd.

Product: BYD 290P6C-60
Application: Commercial
Maximum Power (Pmax): 290W
Maximum Power Point Voltage (Vmpp): 64.75V
Maximum Power Point Current (Impp): 4.48A
Open Circuit Voltage (Voc): 79.25V
Short-Circuit Current (Isc): 4.81A
Module Efficiency: 17.5%
Operating Temperature: -40°F to 185°F (-40°C to 85°C)
Max. System Voltage: 1000V
Power Tolerance: +5W
Cell Type: 12 busbar solar cell
Glass: 3.2mm tempered glass with AR coating
Frame: Anodized aluminum alloy
Weight: 41.58lbs (18.9kg)
Dimensions: 65.55" x 39.06" x 1.38" (1665mm x 992mm x 35mm)
Max Load: 2400Pa (wind load), 5400Pa (snow load)
Tests/Certifications: IEC 61215, IEC 61730, ISO9001:2008, ISO14001:2004
Warranty: 25-year linear warranty, 10-year product warranty
www.byd.com

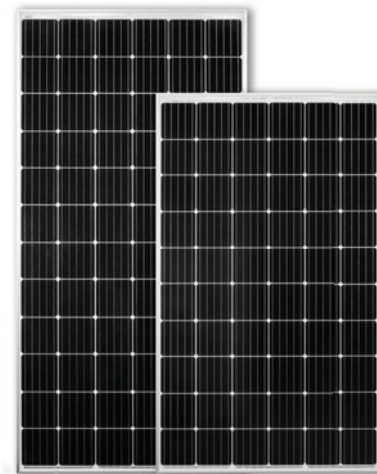


JinkoSolar (U.S.) Inc.

Product: Eagle 72, Mono PERC Module
Application: Commercial
Maximum Power (Pmax): 365W
Maximum Power Point Voltage (Vmpp): 39.7V
Maximum Power Point Current (Impp): 9.20A
Open Circuit Voltage (Voc): 48.2V
Short-Circuit Current (Isc): 9.57A
Module Efficiency: 18.82%
Operating Temperature: -40°F to 185°F (-40°C to 85°C)
Max. System Voltage: 1500VDC (UL and IEC)
Power Tolerance: 0 / +3%
Cell Type: Mono PERC
Glass: AR coated tempered glass
Frame: Anodized aluminum alloy
Weight: 58.45lbs (26.5kg)
Dimensions: 77.01" x 39.06" x 1.57" (1956mm x 992mm x 40mm)
Max Load: 5400Pa (snow), 2400Pa (wind)
Tests/Certifications: UL, IEC, CEC, TUV
Warranty: 25-year linear power warranty
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Permitting Barriers to Technology Testing and Adoption

by Christine Sutter

The DOE Wind Vision report has identified wildlife concerns, such as bat and eagle fatalities, as a barrier to the expansion of wind energy. Tools such as wildlife detection and deterrent technology are becoming essential to minimize these fatalities; more resources are focused on developing and bringing commercializing technology-based solutions to the market. Evidence of this was shown by the DOE's recent funding of detection and/or deterrent device development, as well as the technology-focused workshops and presentations at both the Wind and Wildlife Research Meeting (December 2016), and the AWEA Wind Project Siting and Environmental Compliance Conference (March 2017).

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Promising technologies for reducing bat fatalities are becoming commercially available, but in order to gain acceptance from regulators, their efficacy must be demonstrated. Efficacy studies determine if the technology is effective in reducing bat fatalities, relative to existing strategies such as wind-speed only curtailment. Ideally, such studies would demonstrate efficacy across a broad suite of species, including those protected by the ESA. Unfortunately, current application of these technologies is stymied by ESA permitting challenges.

The industry now faces a Catch-22: The testing of technology designed to reduce bat fatalities results, by its very nature, in bat fatalities. Although no ESA permits are needed for testing conducted outside of the range of all ESA-protected bat species, technology used during these tests may not be applicable at sites with those species. This will likely inhibit adoption of the technology at wind farms where ESA species are at risk, and where it could generate the greatest conservation and economic benefit.

These studies are often blocked by the lack of an ESA Take permit option. Under the ESA, a permit is needed to legally take an endangered species; testing the efficacy of tools such as smart curtailment, or acoustic deterrents, risks taking such species. However, the two permit options, Recovery Permit 10(a)(1)(A) and Incidental Take Permit (10(a)(1)(B), are not well suited for this purpose.

On its face, the Recovery Permit seems ideal for “scientific research on a listed species or activities to enhance a listed species propagation or survival”. However, permits are typically awarded for research related to genetics, relocation, capture, and marking. All of these could result in harm (e.g. an individual may die from handling-induced stress), but the risk has been minimized through the development and approval of protocols. With very few exceptions,





Corded electric assembly tools

Cleco Production Tools, has launched NeoTek, a new line of corded electric assembly tools engineered to deliver one million cycles maintenance-free. The lightweight, ergonomic design along with fully programmable features such as high-output LED light rings, audible alerts, and handle vibration, create a user experience leading to decreased operator fatigue and increased productivity. The centerpiece of the system is the Cleco mPro400GC-Hybrid Controller, which features a large touchscreen with an easy-to-use software interface. Programming can be done directly from the unit or remotely from a PC using provided license-free software. Key features of the NeoTek Corded Electric Assembly Tools include: long life tool cable, controls, and planetary, and angle gears; 1million cycles maintenance-free; 21% lighter with existing cable weight reduced by 50%; configurable LED light rings with audible alarm, two-stage start switch and, vibration notification; 2.0 Cm/Cmk +/- 7%; ability to add on accessories; and quarter-turn twist-lock cable.

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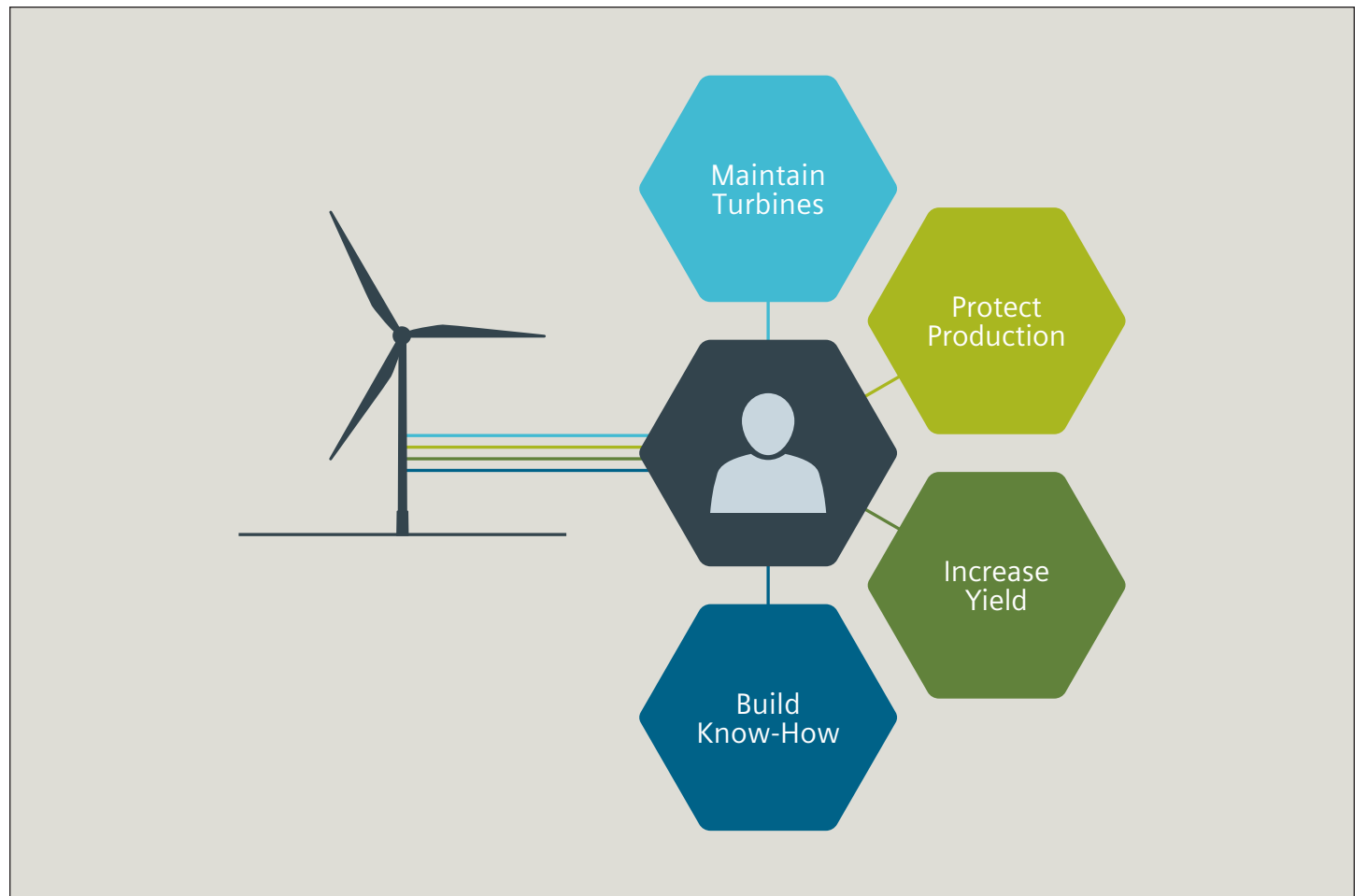
Recovery Permits are not awarded for research in which the fatalities are certain to occur (albeit at reduced level) as a result of the research.

The alternative is to secure an Incidental Take Permit (ITP). An ITP is designed for when you are “engaged in an otherwise lawful activity where a listed species may be adversely affected, and the purpose of your activity is not scientific research or enhancement of a listed species”. An ITP is typically used when an action (such as construction of an airport) will result in the Take of the species. Acquisition of an ITP is a costly and prolonged effort, which encumbers the facility with requirements well beyond the testing of the technology, and is likely to impact the wind farm’s economics. However, the biggest barrier to using an ITP is that it requires you to estimate Take before receiving the permit. Since the purpose of the study is to quantify the mortality rates, the Take level expected is unknowable a priori. This creates an unachievable requirement that effectively prevents securing an ITP, and prohibits effective testing new technologies.

Neither ESA permit is ideal, but the wind industry needs a path forward. A recent analysis (Frick et al 2017) suggests that the current level of turbine fatalities for hoary bats, a common species, are not sustainable, yet the number of wind turbines is expected to more than double by 2030 (Wind Vision 2015). This combination suggests increasing future conflict between bat conservation and wind energy development. As additional bat species receive protection under the ESA, and more areas of the US contain these federally-protected bat species, wind development will suffer. Technology tools that demonstrate efficacy in reducing bat fatalities, including ESA-protected species, are the key to “keeping common species common”, and reducing barriers to achieving renewable energy goals.

Christine Sutter is Head of Environment at Natural Power North America. She provides advice and guidance on natural resource issues to clients in the wind and solar industries throughout the US and Canada.

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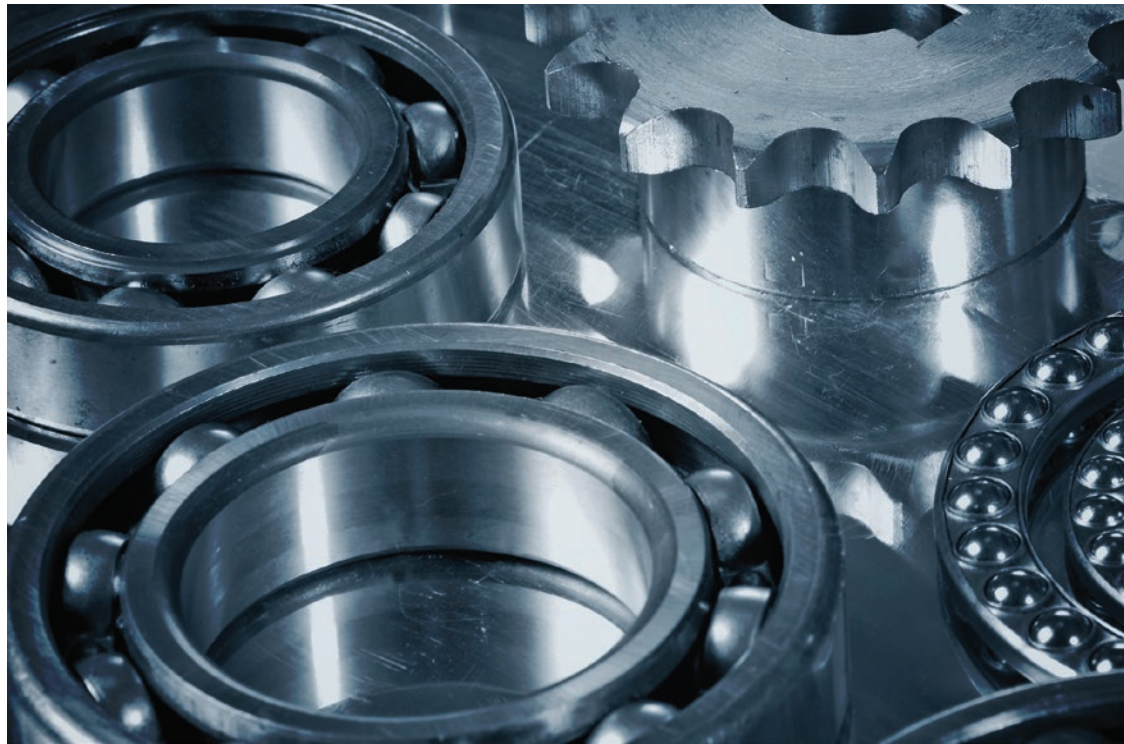


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Managing Supply Chain Costs through Digitalization & Forward Planning

by Jill Szpylman

WIND TURBINES ARE DESIGNED TO OPERATE FOR 20 years. However, wind operators experience gearbox failure rates of up to 50 percent across the lifetime of their fleet. As a result, the industry spends billions of dollars annually in supply chain costs. High transportation costs and logistical difficulties, especially in remote and offshore locations, contribute to an asset manager's need to invest in digital technologies that provide visibility into the maintenance and inventory budget needs on an annual and multiyear basis.

Unplanned failures occur because of the harsh and unpredictable weather and loading events that occur in the field. Severe operating conditions, and sliding and friction events, cause wear and roller contact fatigue that leads to bearing and gear failures. The overexertion of the performance of the parts beyond their design life cause expensive premature system failures in the field.

When a gearbox fails unexpectedly, an operator can be faced with up to \$500,000 in unplanned downtime, labor, and replacement costs. Main bearing assemblies and pitch system failures can cost between \$150,000 and \$300,000 for replacements, and blades can cost even more than that. Multiple unexpected failures in a budget year can bleed heavily into the profitability of the wind site.

Tools such as oil debris and vibration monitoring systems are often used by operators to attempt to detect failure modes that are in late stages of damage. These systems alert the operator, usually within 6 months, when a replacement part or system will be needed. However, it is almost always too late to prevent secondary system damage.

Sensor systems can also be highly unreliable, and typically only alert the wind technician when there is a late-stage failure within the system. Plus, it does not indicate where or which component(s) is failing within the system.

It's because of the unpredictable nature of field failures that prognostic software solutions have been on the minds of most asset managers in the industry. Digitalization and computational testing is the only way to move from preventative and corrective maintenance, to predictive health maintenance, which can drastically cut the cost of energy. Digitalization becomes especially important for forecasting inventory needs.

Operators can achieve significant inventory cost savings, with 18-month



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understand the life impact each offering has on the fielded turbine. A replacement part that enables life extension may cost more upfront, but has longer-term benefits by mitigating future failures at that sight, and improving the power generation from the turbine to the grid.



Jill Szpylman is Public Relations Director at Sentient Science, which delivers 18-month rolling forecasts of short and long-term prognostics, life extension action recommendations for inventory, maintenance, and servicing forecasts to the operator. Jill previously worked in government policy, and began her career as a journalist.

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forecasts into gearbox and subcomponent needs, through more accurate data of when failure initiation begins, and where in the turbine the component failure is occurring.

Digitalizing assets enables real-operating condition simulations to predict when failures occur in the field. Live monitoring integration with SCADA analytics provides more precise long-term failure predictions.

Computational testing under real-operating conditions alert the operator to subsurface failure initiation long before it propagates to the surface. When an operator knows that failure is imminent, operational changes can be made to the turbine to mitigate propagation to surface failure. For instance, physics-based derate may be recommended to reduce the stress levels on the gearbox, and mitigate progression of failure – or it may be recommended to use an additive solution to slow down the progression of wear, or cracking. These life extension actions enable the operator to push maintenance to the low wind season, and optimize labor and maintenance activities, which cuts down on the number of uptower climbs, and time spent in the turbine.

Long term forecasting also enables more economical procurement practices, such as purchasing bundled replacement components (as opposed to having large inventory stocks in warehouses around the globe). It's estimated that a 5 percent-unit cost reduction is achievable when the operator can provide the forecasting data to their gearbox or subcomponent supplier. The reduction is attributed to assured inventory in stock, better logistics planning, and budgeting.

Further savings can be made when purchasing decisions are made based on the life impact the replacement would have on the fielded asset. Historically, the supplier of the replacement gearbox dictates which replacement subcomponents to use in the gearbox. This means that operators are putting the same type of replacement part back into the machine, increasing the chances of repeat failures and outages in the future.

As technology advancements are made, digitalization of the wind turbines facilitates computationally testing out alternate supplier options, to




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Wind Turbine Interior Lighting

Welcome to the 21st century

by Daniel J. Sylawa and Graham Zimmerman



It has long been recognized that safe and efficient maintenance is an important component of effective wind turbine asset management. Interior wind turbine lighting for inspection and maintenance purposes plays an important supporting role in these efforts. However, interior lighting systems that perform poorly, or require high levels of maintenance, cannot effectively contribute to asset management efforts either in a supporting role or as asset management class.

Fluorescent lighting has been the technology most often used to illuminate wind turbine interiors. From an asset management perspective, fluorescent lighting systems present a number of operational challenges. Though long lived, fluorescent bulbs must be replaced periodically during the lifetime of a wind turbine installation. In addition, fluorescent technology performs poorly at the low temperatures often seen in wind turbine applications, requiring the use of special fixtures with heaters for effective operation. For emergency back-up purposes, typical practice has been to use fluorescent fixtures with on-board batteries, which also require periodic replacement.

The distributed nature of wind turbine lighting installations, plus the need for periodic replacements, results in tangible labor and material expense. Failure to perform the required service will result in the poor performance of interior lighting, negatively affecting safe and efficient maintenance.

New, purpose-built LED lighting fixtures have been used effectively in interior wind turbine applications. Coupled with a central UPS for emergency back-up purposes, these systems offer significant operational improvements over fluorescent technology, with the opportunity for a lifetime wind turbine installation, with little or no maintenance.

LED interior lighting: technology and application

In wind turbine applications, LED lighting offers many advantages for interior illumination. LED fixtures are typically smaller than the equivalent fluorescent fixture, allowing more efficient placement within the interior confines of a wind turbine. While both fluorescent and LED technologies offer IP67 water- and dust-tight ratings, the typical 50,000-hour life expectancy of the LED means that the fixture can be sealed for life, and does not have to be opened for bulb and battery replacement.

LED fixtures are typically more robust than glass-tube fluorescent fixtures, so they can withstand rougher handling during

the installation process. They are also more robust from an electrical standpoint, offering built-in surge suppression. From an operational temperature perspective, they offer specifications of -40 to 70 degrees Celsius, eliminating requirements for special heaters needed for low-temperature operation. LED fixtures can offer specific lighting profiles for both ladder and platform applications.

For wind tower interior lighting, LED power consumption is around 10 watts per fixture, resulting in a low lighting supply current requirement. Typical practice in the wind power industry has been to use lighting circuits at either a nominal 120 or 240 V AC, 50/60 Hz, depending on the voltage mains of the country of installation. With 10 W power consumption and a nominal 240 V AC supply, a 100-meter tall tower with a typical 20 LED fixture installation will require a supply current of less 1 A. This permits the use of cost-effective cables with wire sizes as low as 1.5 mm² (16 AWG). Fixtures are also available with a wide-range AC input that covers voltages from 90 V AC to 260 V AC, permitting global application. LED lighting fixtures requiring a nominal 24 V or other low-voltage DC supply, are also available. However, the necessity to use larger, more expensive wire size cables to reduce voltage drop can be a concern.

Sealed fixtures and low-current consumption make it practical to use a central emergency back-up UPS in LED interior lighting applications. The



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UPS is installed at the base of the wind turbine tower, and supplies AC power to lighting fixtures. When used with a 15-year long-life battery, UPS service requirements can be both convenient and infrequent. Features such as alarming, operational status, battery health monitoring, and remote operation are added benefits for asset management.

LED lighting is suitable for both new and existing interior wind turbine applications. From a lighting design perspective, EN 50308 is one of the most commonly cited criteria. This standard requires a lighting level of 10 lux for ladders, and 50 lux for platforms. For new installations, lighting manufacturers can provide light-fixture location surveys based on interior drawings of the wind turbine. For retrofit applications, where a drawing might not be available, sketches of existing turbine types can be provided for lighting survey purposes. For either installation type, results can be field-validated using light meters on a prototype basis, to determine if any adjustments are required.

To enable faster wiring times, LED fixtures are available that use insulation-displacement connectors. These allow fast wiring with the minimal use of tools. For new installations, pre-assembled cables are most common. For retrofit applications, as much as practical, the use of existing wiring is typical. Extension cables can be formed using the insulations displacement connectors found on the LED fixtures, to accommodate different light locations and wiring requirements. For mounting, LED fixtures typically have brackets that can be adjusted to meet the mounting location requirement. For certain locations with steel towers, high-strength magnetic mounting can be used. The light weight of LED fixtures is an advantage in this method.

**LED interior lighting:
An asset management
perspective**

LED interior wind turbine lighting systems have been installed globally, as the successor to fluorescent technologies. From an asset management perspective, elimination of fixture maintenance, and significantly reduced UPS maintenance, results in meaningfully lower operating expenses for interior lighting. The improved performance of these systems also allows them to play a more effective role in supporting the inspection and maintenance activities of other wind turbine systems; they offer significant benefits in wiring, installation, and operations, making them a suitable choice for new and retrofit interior wind turbine applications.

Graham Zimmerman is Business Development Specialist for Phoenix Contact USA. He recently spent over 2 years in New England as an Industrial Sales Engineer, focusing on OEM's, System Integrators and End Users in industries including Water/Waste Water, Manufacturing, Solar, Oil & Gas and Electric Utility. He has a BS in Mechanical Engineering from Penn State University.

Daniel J. Sylawa is Senior Business Development Manager – Renewable Energy for Phoenix Contact USA located in Harrisburg, PA. He has over 30 years of experience in project management and business development in the electric power, energy storage, renewable energy and industrial automation industries. He has a BS in Engineering from Drexel University in Philadelphia, PA and a Master of Engineering in Instrumentation and Process Control from Villanova University in Villanova, PA. He is a member of AWEA, IEEE, DNP Users Group and ISA.

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When Lightning Strikes

by Justin McKennon

OVER THE PAST DECADE, WE'VE ALL WATCHED THE WORLD'S energy markets shift towards cleaner, alternative sources. Technological advancements in renewable industries like wind, solar, and tidal, have enabled us to make these potential solutions a reality. As research and development continue to improve efficiency and drive down cost, these solutions will become more and more prevalent.

We still face considerable obstacles. Wind turbines, in particular, take on one of the largest hurdles; weather. Their fixed location poses unique challenges for turbine and blade manufacturers, which are expected to increase the longevity and reliability of their products without compromising effectiveness, or substantially raising costs. Lightning strikes can cause significant damage to turbines. This damage is extremely expensive to repair, and can shut a turbine down completely.

Severe storms are generally comprised of one or more cumulonimbus clouds, which can be several kilometers in height. As these clouds develop, warm air rises towards the top of the cloud. As the air rises, it becomes cooler. At the dew point, excess water vapor condenses into water droplets and forms the cloud.

When the air has risen high enough, the temperature can drop to -40 degrees Celsius, and water vapor within the cloud will freeze. As ice crystals and hailstones form, and become heavier, they fall through the cloud. When additional water droplets freeze onto the hailstone, small splinters of ice chip off, many of which are positively charged (electrically). Together, these can deposit a net negative charge. Vertical winds carry these smaller splinters upwards into the cloud, while the hailstone falls until it reaches warmer air.

This process causes pockets of electrical charge to form within the cloud, which creates strong electric fields. These electric fields allow charge from the surface of the earth to be "pulled" upwards, in an effort to become charge neutral (typically through tall objects and structures). As these charges get closer together, the electric field in the air further intensifies until it reaches levels of ~30,000V/cm.

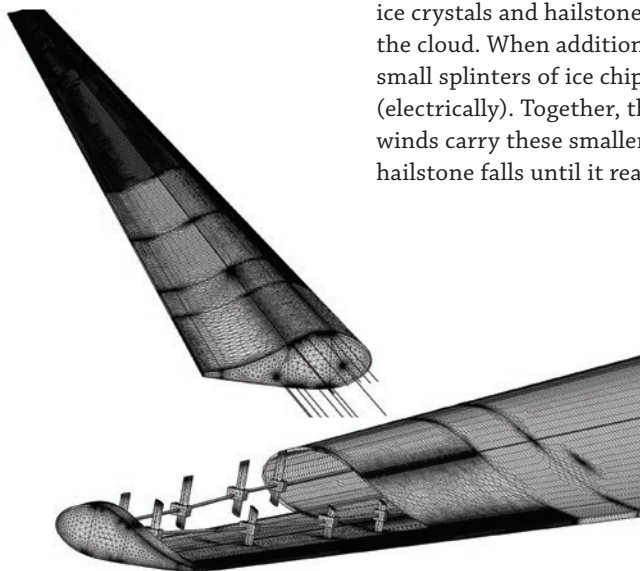
When the field intensity reaches these levels, air begins to break down, allowing charge (in the form of current) to flow through the air. Sharp objects significantly intensify

the electric field, forming corona (also called St. Elmo's Fire). Charge from the lightning cloud begins propagating towards the earth. At some point, charge from objects on the ground begins flowing upwards. When these two flows meet, a conductive channel is formed, and lightning occurs.

During a lightning strike, currents of up to (and even greater than) 200,000A travel between the cloud and the object where the lightning channel formed. Wind turbine blades have a sharp, aerodynamic profile – this not only allows them operate efficiently; it also makes them extremely susceptible to lightning strikes. Without suitable conduction paths to safely carry such high current, this transfer of energy can devastate a wind turbine blade.

Most wind turbine manufacturers strive to make blades and turbines that are more reliable, and can withstand natural phenomena such as lightning. These designs attempt to provide "preferred" current paths for the lightning current; conductive meshes over the exterior of the blades, lightning receptors (preferred lightning attachment locations), and large down conductors, help carry high currents safely to ground.

All of these precautions require highly-detailed planning that includes proper grounding of conductors, shielding of signal wires, wire routing, providing parallel current paths, etc. Despite the complexity of these designs, the benefits are significant;



the effects of lightning are not entirely negated, but damage can be significantly reduced - instead of a total blade replacement, getting the turbine up and running again becomes a maintenance and repair exercise.

The repair may be straightforward, but it's still physically demanding. Most modern wind turbine blades are several dozen meters in length. The turbine tower itself can extend 50-100 meters above the ground. Maintenance workers must climb the tower, or be carried up to the blade via a crane. The repair generally involves removing the exterior coating, prepping the damaged area for repair, repairing the laminate, and reapplying the exterior coating.

The physics of nature make lightning almost unavoidable. Therefore, manufacturers must build an effective lightning protection design into the blade.

Most modern design approaches leverage a combination of numerical simulation and testing. Utilizing numerical simulation, electromagnetic models for wind turbine blades can be developed to analyze distributions between structural carbon, and surface protection layers. These models allow the determination of what is electromagnetically important, such as voltages or currents induced throughout the blade, including CFRP pultrusions, heater elements, surface protection layers, and down conductors. They capture critical design details such as material thicknesses, conductor routing, and receptor locations. Further evaluation exposes conductive materials and associated performance risks, such as arcing between blade elements, excessive current in structures, and induced transients into control systems.

After modeling is complete, one or several candidate protection designs is proposed, intending to conduct lightning current with lowest potential for damage or repair. In order for the model data to be considered high fidelity, it needs to be validated by replicating exactly the measurements taken during laboratory tests, and comparing them to the analytical data to determine correlation. This is typically done with high voltage strikes, high current physical damage testing, and induced transient tests.

Lightning will always affect wind turbines. It's complicated, and requires a well thought out design to reduce the severity of damage. If a good protection design is implemented, lightning damage can be reduced to a standard maintenance/repair operation, rather than a total loss.



Justin McKennon is a Senior Engineer and Manager of Simulation and Modeling at the NTS Pittsfield, MA location that specializes in lightning testing and protection services. Justin has a Bachelor's and Master's degree in Electrical Engineering from the University of Massachusetts, Dartmouth. He specializes in simulating and modeling the electromagnetic effects of lightning on wind turbine blades, electrical components, aircraft, and other structures.

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SKYLOTEC has introduced small, lightweight rescue devices with a centrifugal brake, which can be worn on the body along with Personal Protective Equipment (PPE) against falls and are ready to use in an emergency. After all, in some situations it can be essential for workers to be able to rescue themselves without any help, for example in the event of a fire in the hub of a wind turbine. The "Deus 3700" has a fire-resistant rope and can therefore be used even in extreme situations. It works up to a height of 591ft (180m) and the maximum load is 309lbs (140kg). Carrier systems for transporting injured persons round off the portfolio for this sector. Solutions such as a roll-up carrier system called the "ultraRoll stretcher" are particularly suitable for rescuing people from areas that are difficult to access. They protect the accident victim from further injury and also offer additional benefits, with a low weight and small pack size making them easy to transport. The stretcher can be quickly assembled on site in just a few steps.

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The route to successful composites machining

New CoroMill Plura routers unveiled by Sandvik Coromant offer optimized milling and slotting operations in composite materials such as CFRP (carbon fiber reinforced plastic) and GFRP (glass fiber reinforced plastic). Production engineers, machine shop managers and operators will all benefit from the patented geometries provided by the new routers, particularly those in the aerospace industry, where these materials are increasingly prevalent, as well as others in sectors such as automotive, motorsport, wind power, and marine. When milling and slotting composite materials, the new routers are used primarily in full radial engagement and at full depth of cut. In some cases, finishing passes can also be deployed. Helix angles have been carefully designed for ideal sharpness and cutting edge strength, thus ensuring longer tool life and high-quality surface, edge and slot finishes. The range comprises three cutters: the CoroMill Plura compression router, CoroMill Plura low helix router, and CoroMill Plura serrated router. All three CoroMill Plura routers can be used with or without coolant.

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www.emaelectromechanics.com



Miniature sodar

Remtech's miniature portable PA-XS Sodar measures wind speed and wind direction up to an altitude which is well above the largest wind mills. It weighs less than 44lbs (20kg) and consumes less than 10W thanks to its sophisticated signal processing software. The PA-XS acoustic wind profiler is delivered with the following turbulent software package: sigma u, sigma v, sigma w (wind speed sigmas along the 3 axis) and turbulent mechanical dissipation rate coefficient calculation. This package is suited for wind energy measurements offshore as well as on land. The equipment presents an MTBF of 100,000 hours.

Remtech SA | www.remtechinc.com



Lightweight failsafe brakes for wind turbines

Dellner Brakes' new SKP 180 weighs in at just 315kg and delivers braking force from 141kN up to 226kN through two brake housings, each containing a powerful spring applied piston. The SKP 4 x 180, weighing 630kg, combines two brake assemblies containing a total of four pistons to deliver braking force of up to 453kN. Dellner has also developed an offshore version of the brake, with corrosion protection and hard wearing paint and pistons that are specially designed to withstand harsh conditions. The new SKP's modular design means that Dellner can provide larger systems, combining several brake assemblies or customized housings with several pistons, to deliver even more braking power, tailored specifically for customers' needs. The brakes come with a range of optional extras including mounting brackets; double sealing kits; brake pads made from several different friction materials; indicators that show brake pad wear, whether the brake is ON or OFF or needing adjustment; micro and/or proximity switches, and electrical control boxes. The brakes feature cylindrical guide pins that transmit the tangential braking force from the brake lining to the brake housing and mounting stand. As a result, the brake pistons are not subject to any radial forces, which makes the brakes and the cylinder seals last much longer. As the brake lining wears, an extension of the brake piston through the adjustment nut indicates that adjustment is needed.

Dellner Brakes | www.dellner-brakes.com



Gripping glove protectors

Hi-Line Utility Supply is excited to introduce the NEW Hi-Grip Xtreme Glove Protectors. The Hi-Grip Xtreme features a full, silicone-grip palm to deliver supreme control and enhanced productivity. Improved thumb fit increases dexterity and the ergonomic round, curved fingers offer the best fit and flexibility. The black wear guard provides additional protection on the top of the hands and all leather cuffs provide extra protection. All this is stitched together with maximum strength Kevlar stitching for long-lasting quality. Available in 10", 12", and 14" lengths, in sizes 8-12.5.

Hi-Line Utility Supply | www.hilineco.com



Ignition software support with integration module

Seeq Corporation announces the availability of a Seeq connection module for Inductive Automation's Ignition SCADA system. The new Seeq integration module simplifies integration of Seeq Workbench into Ignition displays and server gateways. Ignition customers in manufacturing, mining, pulp & paper, food & beverage, and other process industries use Seeq Workbench to rapidly find insights in their data leading to better production outcomes including improved asset availability, product quality, and process efficiency. Seeq is a software application for engineers in process manufacturing organizations to rapidly wrangle, investigate, and share insights on production data. Seeq has been recognized by multiple analyst firms for its modern approach to the pressing problem of finding actionable insights in complex data sets. Ignition is an innovative SCADA platform used in more than 100 countries, and is the first universal industrial application platform with unlimited potential. Ignition empowers industrial organizations around the world and in virtually every industry, with an outstanding software platform and top-notch support. Seeq and the Ignition SCADA platform, working together, form a great combination, enabling customers to get the best of both an innovative monitoring and a data management platform, as well as rapid, interactive analytics on collected data. Customers can achieve insights to improve production results, a task that was often too time consuming.

Seeq Corporation | www.seeq.com



Tower lighting for wind turbines

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. Thanks 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. The tower lighting system is suitable for both OEM and retrofit applications.

Phoenix Contact | www.phoenixcontact.com

Nordic's Wind & Solar Products for All Seasons



Chuted Box Pads for GSU Transformers



**35kV 600Amp
Sectionalizing Cabinets**



Chuted Box Pads for Switchgear



Splice Cabinets



**Cross Bonding Pedestals with
or without arrestors**



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Quality Products for the Electric Utility Industry

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Transportation & Logistics

With all of the equipment, carriers, size, and specialized handling requirements, getting all of the right turbine components to the right project sites for construction can be a challenge in the wind industry. Safety and efficiency are important keys to ensuring projects and timelines run smoothly. Here we focus on some of the top Transportation & Logistics companies in the industry that provide the specialized services required for getting all of those wind power parts, components, and machinery where they need to be for a successful wind farm.

SEE AD ON PAGE 58



Port Corpus Christi

Services: Port Corpus Christi provides services for the movement of breakbulk and heavy lift cargo. Facilities include 6 near dock laydown yards; highway and rail accessible; a 47' deep ship channel; dockside rail; three Class-1 rail carriers, a short line railroad; available labor force; open, covered, and dockside storage; and security/safety operations.

Min/Max Loads/Tonnage: Port Corpus Christi moves more than 100 million tons of cargo per year and has developed and implemented efficient transportation and logistics solutions for the renewable energy industry including the wind energy industry.

Location/Logistics: Located on the Texas Gulf Coast, Port Corpus Christi has a straight, uncongested ship channel; limited low visibility days, and provides access via three Class-1 railroads and Interstate highways to the US, Canada, and Mexico.

Qualifications/Certifications: Port Corpus Christi opened in 1926 and has developed into a modern Port with diverse cargo handling capability and home to many industrial companies. The Port attracts



US and foreign direct investments for the construction of manufacturing facilities. The Port maintains an ISO 14001 certified Environmental Management System, and is Green Marine certified.

Key Features:

- The Port's new Nueces River Rail Yard has eight 8500ft long tracks to simultaneously accommodate 8 unit trains;
- Three Class-1 railroads directly connected to the Port's interchange yard and railroad system via short line railroad company;
- Dockside rail loading and truck transfer capability;
- Quick access to US 181 and other highways;
- Direct connector to Interstate 37 via the Joe Fulton International Trade Corridor;
- Home to a strong open wharf on the Gulf of Mexico.

portofcc.com

SEE AD ON PAGE 48



Logistec

Services: A variety of transportation solutions for the wind power industry, including: cargo handling, port logistics, stevedoring, terminal operations management, inventory management, warehousing, transloading, and trucking.

Min/Max Loads/Tonnage: Able to accommodate various tonnages and dimensions depending on the port (ranges from break bulk to heavy lift)

Location/Logistics: Some 30 ports and 40 terminals throughout Eastern Canada, the Great Lakes and St. Lawrence River, as well as the United States' East Coast and the Gulf Region.

Qualifications/Certifications: Founded in 1952, and a member of Green Marine



Key Features:

- Provider of value-added cargo handling services for industrial customers in the renewable energy sector, especially wind components;
- Utilizes the latest technologies throughout its network of strategically located facilities;
- A partner and team who manage each cargo handling operation to ensure economical and efficient solutions for each project.

www.logistec.com



C.H. Robinson Project Logistics

Services: Project logistics and transportation solutions for the wind power industry, coordinating dimensional heavy-lift shipments via air, land, and sea, including the chartering of ocean vessels, aircraft, and specialized land transport

Min/Max Loads/Tonnage: Projects are not defined strictly by volume or freight tons, but by the complexity of the cargo and any delivery obligations

Location/Logistics: Worldwide

Qualifications: A member in good standing of industry related regulatory bodies, such as The National Customs Brokers & Freight Forwarders Association of America (NCBFAA); Transport Security Administration (TSA); Canadian International Freight Forwarders Association (CIFFA); International Air Transport Association (IATA); and International Federation of Freight Forwarders Association (FIATA); etc.

www.chrprojectlogistics.com



Mattracks

Services: Rubber track conversion systems; construction, heavy duty equipment, custom applications

Min/Max Loads/Tonnage: Up to 80,000lbs GVW

Location/Logistics: Karlstad, Minnesota

Qualifications: Founded in 1994

www.mattracks.com



Logisticus Group

Services: Cargo transport, project planning and management, and technology solutions.

Min/Max Loads/Tonnage: All tonnages and dimensions.

Location/Logistics: Global capabilities.

Qualifications: Founded in 2012; AWEA and SCRA member

www.logisticusgroup.com

THE PORT OF STOCKTON YOUR PERFECT PIVOT POINT



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

The Port of Stockton: we keep things moving at a key turning point in your supply chain.



Port of Stockton
CALIFORNIA

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PORTOFSTOCKTON.COM

SEE AD ON PAGE 57



Port of Stockton
CALIFORNIA



Port of Stockton

Services: With 24/7 access to freight, the Port of Stockton is designed to quickly get cargo moving with flexible solutions for the renewable energy market. These include stevedoring, warehousing, inventory management, and transloading. Served by the UP and BNSF railways, the Port has 2.5 miles of on-dock rail with ample laydown area.

Min/Max Loads/Tonnage: The Port of Stockton has handled a wide variety of renewable energy shipments. It offers services for breakbulk and heavy lift shipments both large and small. With two mobile harbor cranes, around the clock security, and a 24/7 gate they offer unique and flexible results for critical logistical issues.

Location/Logistics: Located in the extended San Francisco Bay Area, the Port of Stockton provides instant access to less congested highways including I-5, CA-99, and CA-4, and is an hour away from I-80.

Qualifications/Certifications: The Port of Stockton has been in operation since 1933 and handles a variety of cargo for dozens of clients.

Key Features:

- Two 144 tonne Liebherr mobile harbor cranes;
- 15 multi-purpose berths available upon demand;
- Around the clock security;
- 24/7 access to freight;
- Dockside rail loading.

www.portofstockton.com



American Transport Systems

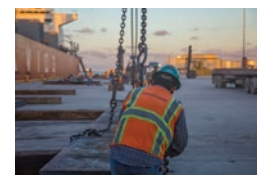
Services: Specialized, heavy-haul, motor freight, project cargo, wind turbine blades

Min/Max Loads/Tonnage: No limit

Location/Logistics: USA, Mexico, Ontario, Saskatchewan, Manitoba

Qualifications: Motor Carrier Agency, DOT, FMCSA

www.americantransport.com



Port of Brownsville

Services: The Port of Brownsville is the only deepwater port on the US/Mexico border

Min/Max Loads/Tonnage: 9.6 short tons

Location/Logistics: Brownsville, TX

www.portofbrownsville.com



Port of Vancouver USA

Services: The Port of Vancouver USA specializes in handling wind energy cargo. It provides the equipment, facilities, space, and labor needed to safely and efficiently move projects of any size through the facility.

Min/Max Loads/Tonnage: The port's two Liebherr mobile harbor cranes can operate at any breakbulk berth and have a lifting capacity of 140 metric tons each; 210 metric tons together. Terminal 2 offers a Paceco crane with a 51-metric-ton capacity and a 115-foot outreach. Stevedoring equipment includes trailers and reach-stackers to efficiently move cargo. With over 100 acres of laydown space, the rail expansion project will triple capacity and reduce congestion by 40%.

Location/Logistics: The port is 106 river miles from the Pacific Ocean on the Columbia River. The BNSF Railway, Union Pacific Railroad, Canadian National Railroad, and Canadian Pacific Railroad have direct unit train access from mainline corridors. Primary freight arterials of the U.S. Interstate Highway network run north, east, and south.

Qualifications/Certifications: Port of Vancouver USA has handled wind energy components for over 16 years. Long-term relationships with their customers have helped them develop the Port's facilities and make investments in the right equipment and training to respond to the modern challenges of moving all wind energy components.

www.portvanusa.com



Port of Wilmington, Delaware

Services: 24/7 marine terminal operations and wind project handling experience including; 2 independent stevedores; prompt and efficient State permitting and police escort services, logistics coordination, Class 1 rail, local towing company and ship agencies, onsite CBP and USDA, and FTZ

Location/Logistics: Mid-Atlantic US

Qualifications: 360 Quality; C-TPAT; AWEA Membership

www.portofwilmington.com

Min/Max Loads/Tonnage: 6 open, project "friendly" berths, heavy lift capacity to 100 MT's, 59 acres outside storage, and immediate access to interstate highway

MORE SUPPORT. MORE SOLUTIONS.

As the demand for renewable energy solutions rises, Port Corpus Christi is ready with all it takes to keep the world's energy moving.

- A 47' deep ship channel, authorized for 54'
- Dockside rail and truck transfer capability
- Three Class I rail carriers and short line railroad
- Covered, uncovered, and dockside storage
- Quick access to US 181, Interstate Highway 37 and other highways



connect with us: portofcc.com



Cranes & Heavy Lift

From rough terrains to great heights, the equipment needed to get the job done safely and efficiently at a wind power construction site must be tough and durable. Here are some of the latest cranes available today.



ALL Erection & Crane Rental

Brand: Liebherr

Model: LTM 1750-9.1

Max boom length: 171ft (52m)

Max capacity: 900 US tons

Additional features:

- The LTM 1750-9.1 offers mobility, transportability, and quick assembly - all on a chassis no longer than that of a 600-ton crane;
- The road-friendly LTM 1750-9.1 can travel at less than 155,000lbs GVW by easily removing the telescopic boom, the upper engine, and the rear outriggers;
- Once at a job site, the strong boom can be self-installed with the aid of an auxiliary rolling power pack (without the use of a boom launch trailer), and the rear outriggers also self-install so one outrigger can be done in less than 10 minutes;
- The availability of crab steering mode on the fly offers a driver the ability to seamlessly switch between standard steer and crab steer without needing to raise an axle.

www.allcrane.com



Erikson

Brand: Sikorsky

Model: S-64 Aircrane

Max boom length: 70ft (21.34m)

Max capacity: 25,000lbs

Available attachments:

- Hoist;
- Grapple;
- Rescue basket;
- Cargo pod.

Additional features:

- Global positioning satellite (GPS) and emergency locator transmitter (ELT);
- BlueSky tracker and compatible satellite phone;
- VHF FM and radio packages;
- Mode S transponder and SATCOM antenna.

www.eriksoninc.com



Mammoet USA South, Inc.

Brand: Mammoet

Model: WTA 250

Max boom length: 52.5ft (16m)

Max capacity: 250 metric tons

Additional features:

- WTA 250 only needs two transport trailers to be moved on site so mobilization and relocation is easy;
- The crane eliminates the height restrictions for turbines and renders both the assembly and replacement process fast and cost-effective;
- The cranes are attached to the tower, so there is no footprint, and no need for additional ground reinforcements;
- The tower-based design puts the crane and the operator closer to the work area, rendering assembly and maintenance both safe and easy.

www.mammoet.com



Maxim Crane Works, L.P.

Brand: Manitowoc

Model: Manitowoc 18000

Max boom length: 610ft (186m)

Max capacity: 825 US tons

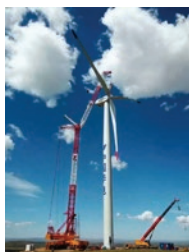
Available attachments:

- 380ft main boom;
- 55A heavy-lift boom;
- 25ft upper boom point.

Additional features:

- Maxim Crane Works' fleet of ten Manitowoc 18000's are well-suited for grassroot/maintenance on 80m to 100m wind towers;
- Maxim Crane Works is a coast-to-coast provider of comprehensive lifting services with over 50 branches across the USA.

www.maximcrane.com



Zhengzhou New Dafang Heavy Industry Science & Technology Co., Ltd

Brand: NDF

Model: QLY1560

Max boom length: 328ft (100m)

Max capacity: 100 tons

Available attachments:

- Main boom;
- Deputy boom.

Additional features:

- Independent suspension device and all-wheel drive chassis;
- Can self-travel on up to a 30% gradient road;
- Multi-mode turning;
- Main and deputy booms are multi-section telescopic truss structures.

www.zz-df.com.cn



Imperial Power Services, Inc. - a division of Imperial Crane Services, Inc.

Brand: Liebherr

Model: LTMN1500-8.1

Max boom length: 276ft (84.12m) Boom length; 300ft (91.4m) Jib length

Max capacity: 500 tons

Available attachments:

- Seven-section telescoping boom length of 276ft;
- Lattice jib extension of up to 300ft.

Additional features:

- Imperial Power Services was contracted to provide primary and auxiliary cranes in support of the main shaft replacement. The process involved removing the rotor in one piece before removing the gear box to swap out the shaft.

www.imperialcrane.com

Solar Power International (SPI) is powered by the Solar Energy Industries Association (SEIA) and Solar Electric Power Association (SEPA). SPI has been designed to serve and advance the solar energy industry by offering an annual forum to learn, explore, and bridge related products, knowledge, and opportunities. Bringing together more than 18,000 professionals in the field, this event focuses solely on creating an environment that fosters the exchange of ideas, information, and expertise for furthering solar energy developments.

www.solarpowerinternational.com

show in print

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



Solar support systems

Baja Construction, Inc., the parent company to Baja Carports, is headquartered in Martinez, CA with regional offices in Fontana, CA, Las Vegas, NV, and Holbrook, NY. Baja's in-house design engineers and project managers work directly with design/build fast-track solar project developers, EPC's, integrators, and owners. They deliver value engineered high-tensile light gauge steel solar carports and canopies.

Baja Carports | www.bajacarports.com
Booth 4155



Arc flash minimizing enclosure window

Fibox Enclosures have designed a simple way to minimize the chances of an arc flash with the Instrument Protection Window (IPW). The non-conductive polycarbonate plastic IPW creates a safe and secure environment to allow access to only certain sections within the underlying enclosure. With no need to open the entire enclosure to view electronics or perform maintenance, the IPW decreases arc flash risks and other safety hazards. The IPW is available in two sizes (12" x 10" x 3.3" and 16" x 14" x 3.3") with either an opaque or transparent cover and variety of locking options.

Fibox USA | www.fiboxusa.com
Booth 1156



Maintenance-Free AGM & GEL Batteries

With a full range of capacity options and voltage configurations to choose from, Rolls Battery maintenance-free AGM and GEL valve regulated lead acid (VRLA) batteries offer reliability and heavy-duty construction. Installed in off-grid, grid-tied, or backup float applications, these sealed battery lines require minimal ongoing maintenance and provide a versatile energy storage solution for remote or confined installations, offering superior cycle life and added peace of mind.

Rolls Battery Engineering
www.rollsbattery.com
Booth 1932



Solar structures

M Bar C Construction, Inc. has been installing carports since 1975 and since 1997 has installed over 330MW of solar structures. They provide pre-approved solutions for DSA projects, general contractors, corporate divisions, and government entities working on large scale projects. M Bar C Construction is licensed and compliant with Cal/OSHA safety programs and prevailing wage jobs. M Bar C Construction, Inc. is licensed with the California CSLB, (Contractors State License Board), #869960. Located in San Marcos, California, M Bar C Construction serves the western states including California, Arizona, Nevada, Oregon, Colorado, and Hawaii.

M Bar C Construction, Inc.
www.mbarconline.com
Booth 4828

RibBracket™ I-IV
NO MESSY SEALANTS AND NO LEAKING.

ADJUSTABLE | VERSATILE | EPDM WATER TIGHT SEAL

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

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Solar structures

Skyline Solar of AZ is a construction firm which designs, engineers, and installs custom solar structures to fit any location requirement. With over 140 MW of installations throughout the U.S. and Hawaii including over 20 MW on parking garages, Skyline Solar, a division of Skyline Steel, approaches every project with a focus on quality, safety, aesthetics, functionality, cost, and structural integrity. Skyline performs all work with their own equipment and employees, so they can offer low cost, and quality with on-time performance.

Skyline Steel, Inc.
www.skylinesolaraz.com
Booth 4663



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a division of OMCO Holdings

The OMCO *Field-Fast*™ Racking Systems

8GW

in Solar Structure
Experience!

Where *Experience* Meets *Innovation*

Buying direct from the manufacturer provides a cost advantage along with unparalleled customer support!

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602-352-2700 | www.omcoracking.com



Panel washing

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

Bitimec | www.wash-bots.com
Booth 2708



String inverter mount

Sollega, Inc., introduces their FastRack String Inverter Mount (FSIM) It can be adapted to mount most string inverters and makes the installation of an inverter, combiner box, or disconnect easy and quick. With ballast and mechanical attachment options, flexible Strut configuration, 20° tilt, and optional shade cover, the FSIM fits every roof requirement. Founded in 2009, Sollega designs, tests, and manufactures solar mounting solutions. The FastRack510 is a patented, one-piece, injection molded solar racking system designed for both commercial low-pitch roofs and ground-mount installations. It is quick to ship, stage, and install, with no assembly required.

Sollega, Inc. | www.sollega.com
Booth 1835



Environmental management

Ecology and Environment, Inc. (E & E) provides a suite of environmental services for the full life cycle of solar projects, from feasibility studies, project siting, and permitting, through pre-construction compliance, environmental monitoring, and operational auditing. E & E recognizes that renewable energy development is as much about building relationships as it is about building infrastructure. Their collaborative approach results in a level of trust with regulatory agencies and the public that provides added credibility during a project's critical early development stages. This approach helps to successfully negotiate realistic permit conditions and mitigation measures, prevents costly delays in the construction and monitoring stages, and helps clients adhere to aggressive schedules that meet critical in-service dates.

Ecology & Environment, Inc.
www.ene.com/markets/solar
Booth 4768



DC/DC power converter for photovoltaic applications

Phoenix Contact's new UNO Solar DC-to-DC power converter connects directly to a solar array. The UNO Solar converts high voltages from DC strings to 24VDC, eliminating the costs and hassle of trenching for combiner, re-combiner, and inverter control for anti-islanding applications. The UNO Solar accepts the 300 to 1000VDC input generated by the array and converts it to electrically isolated 24VDC/2.5A output voltage. For higher current applications, the UNO Solar can be wired in parallel with the use of a decoupling diode. The UNO Solar has a compact housing and high efficiency of more than 90%, so it can also be used in small control boxes. The LED monitoring simplifies startup. It is the power supply powered by the solar array, certified to UL 1741, facilitating the approval of the overall system.

Phoenix Contact
www.phoenixcontact.com
Booth 2619

High Precision Instruments for Solar Energy and Meteorological Research.

eko-usa.com

EKO
 Beyond Accuracy.



Standing seam metal roofing solution

EcoFasten Solar has launched their newest product, SimpleBlock-PV, a solution designed specifically for standing seam metal roofing applications. The versatile SimpleBlock-PV provides a variety of options through compatibility with any rack manufacturer's connection points (L-feet, posts), and when used in conjunction with their Mid-Clamp, SimpleBlock-PV becomes a rail-free racking system featuring integrated bonding. The system meets and exceeds all know building codes and is UL 2703 listed, with product compliance determined through rigorous testing per UL 2703: First Edition.

EcoFasten Solar
www.ecofastensolar.com
Booth 4643



Solar clips and wire management

Heyco introduces several new clips/wire management accessories for the solar market. Heyco's SunRunner 4-2 and SunRunner 4-2U are Top Rail Clips for racking manufacturers including Unirac, Ironridge, Everest, SnapNRack, Solar Mount, and other similar racking profiles. The SunRunner 4-2 and SunRunner 4-2U are designed to hold micro-inverter oval cables 250" (6.3mm) x .385"(9.8mm) such as the Enphase Q Cable. Both part numbers are included in Heyco's 20-year warranty.

Heyco Products, Inc.
www.heycosolar.com
Booth 4762

Breathing new life into tracker equipment.

Introducing the next generation SF7 single-axis tracker.



One Track
Zero Gap



LISTED

[PV SOLAR TRACKER]
E476688

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



Soltec

Contact us: [5800 Las Positas Rd, Livermore, CA 94551](https://www.soltec.com) | +1 510 440 9200 | usa@soltec.com | [soltec.com](https://www.soltec.com)



New tracker reliability research

Array Technologies will reveal the results of a recent TÜV Rheinland-backed independent report focused on solar tracker reliability. Array's latest single-axis tracker, the DuraTrack HZ v3, is reliable and offers a low cost of ownership. The DuraTrack HZ v3 is proven to be 300x less likely to experience catastrophic failure during wind events.

Array Technologies | arraytechinc.com
Booth 2919



PV wire management clip

Nine Fasteners is pleased to announce their NFI-1307-V90 PV wire management clip has recently been approved and is now being specified for site remediation on projects involving First Solar's previous iteration of solar modules. The NFI-1307-V90 clip has been selected due to its hold on the 12 gauge cable these modules utilize. This clip, as with all of Nine's offerings is manufactured entirely in the U.S. and is produced with a rolled outer edge for maximum wire safety. The NFI-1307-V90 is a 90° module mounted option, capable of holding 2 PV wires.

Nine Fasteners | www.ninefasteners.com
Booth 2074



High-breaking capacity PV fuses

SIBA FUSES are available for protection of PV panels, sub-arrays, arrays, energy storage (ES) systems, inverters, filters and transformers, and switchgear tied to the grid. Fuses for DC side of the inverter are available in the voltage range from 400VDC through to 1500VDC and current ratings from 1A through to 2500A. Fuses developed for energy storage (ES) have a high current breaking capacity and low L/R. On the AC side of the inverter SIBA is capable of meeting voltage applications up to 40.5kV with for bus protection, capacitor filters, PT transformers step-up transformers (SSK fuses specific for wind, solar, and energy storage application), and switchgear with medium/high voltage fuses.

SIBA FUSES | www.siba-fuses.us
Booth 1546



Solar carports and ground-mount systems

Powers Solar Frames manufactures and provides cost effective solutions for Solar Carports, 5 Panel Ballast Ground Mounts and posted 5-High Ground Mount systems. All products utilize the Powers patented Super Purlin, that reduces purlin usage and requirements by as much as 42%, reduces install time and saving labor costs. Installation of their Solar Carport systems eliminates the necessity of anyone being on top of the structure, all installation of purlins and panels can be done from a scissor lift. All of Powers racking and mounting components are made in the USA at their facility in Phoenix, AZ.

Powers Solar Frames
www.powersolarframes.com
Booth 2638



In-line string protection

The Littelfuse SPXI 1500Vdc solar fuse is designed to integrate into an in-line assembly within a wire harness. The fuse provides string protection that meets IEC 60269-6 and UL2579 for photovoltaic applications. The SPXI can be electrically insulated by either over-molding or using approved heat-shrink. Also available in 1000Vdc (SPFI) the products protect solar strings from 2 - 30 amps. Littelfuse offers numerous DC circuit-protection products that are suited to protect the equipment and systems subject to the harsh environments of photovoltaic installations.

Littelfuse | www.littelfuse.com/solar
Booth 4675



Time saving, yield increasing landscape rack

TerraSmart's TF2 Landscape rack increases table sizes up to 6 x 8 panels to accommodate more modules per foundation, enhancing system yield, and cutting construction costs. TF2 L reduces installation time by 35 percent through its in-field efficiencies. Its time-saving features and benefits also include an adjustable design with up to 36 percent slope capability to reduce civil work and pre-construction costs, contains only one-third the hardware found in other racks thus increasing project velocity, and is a simplified hardware stack offering speed and flexibility onsite. The TF2 L is certified to the latest UL 2703 Edition 1 standard, complies with the NEC, has passed CPP wind tunnel testing certifications, and handles snow loads up to 100 pounds per square foot.

TerraSmart | www.terrasmart.com
Booth 3775

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- ⊕ 3MW Output Power with 6 Independent 500kW Inverter Modules
- ⊕ Built-in Dry Type MV Transformer with Customizable Output Voltage
- ⊕ Switchgear and Protection Measurements on Medium Voltage
- ⊕ 50kVA Configurable Auxiliary Power
- ⊕ Optional Provisions for SCADA and Tracker Control Equipment Integration
- ⊕ Stainless Steel Enclosure with C5M Grade Paint and Mineral Insulation

PLANT DESIGN COMPATIBILITY

- ⊕ Compliance to NEC2017 Requirements for Inverter Design
- ⊕ Certified to UL1741SA and IEC62109-2
- ⊕ Options for either 1 or 6 Maximum Power Point Trackers
- ⊕ 4 to 6 Inputs per Module - 24 to 36 Total Inputs With Monitoring

INSTALLATION AND O&M MADE EASY

- ⊕ No Individual Component Integration Required in the Field
- ⊕ Compact Footprint - 20' x 6.5'
- ⊕ Factory Tested Full Power Conversion Station
- ⊕ Innovative Filterless Air-Cooling with Cyclone Drives
- ⊕ 120lbs Plug & Play Power Conversion Section to Increase Up-time
- ⊕ Individual Disconnection for all Modules on DC and AC Side
- ⊕ Large Area for Better Cable Management

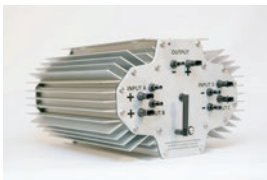


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A UTILITY SCALE POWER CONVERSION STATION



DC-coupled solar + storage and PV retrofit solution

Alencon Systems LLC debuts its latest generation DC-DC optimizer, the SPOT X2. The SPOT X2 is light and easy to install, while at the same time offering more power and higher efficiency than ever before. Additionally, the SPOT X2 features improved on-board firmware to increase energy yield. Headlining the software improvements in the SPOT X2 is a maximum power point tracking (MPPT) algorithm which assures optimal PV power harvesting under fast changing weather conditions. Alencon's SPOT X2 has been specifically targeted at two, in demand PV applications: PV retrofits and DC-coupled Solar + Storage. The SPOT provides a solution for enabling collocated, DC-coupled Solar+ Storage applications. At the heart of the SPOT's ability to facilitate large scale DC-coupled Solar + Storage installations is its galvanic isolation.

Alencon Systems, LLC
www.alenconsystems.com
Booth 1115



High performance digital secondary class pyranometer

SR30 is the latest high-performance digital Secondary Standard pyranometer from Hukseflux, for communication over RS-485 (Modbus RTU). The pyranometer features an 'internal' low power maintenance-free ventilation system with dome heating, < 2.3W max power drain with ventilation and heating active. SR30 requires no filter maintenance as the internal ventilation system is sealed. Noteworthy performance benefits include low thermal offset-A bias (< 2 W/m²) with ventilation and heating active, accurate data availability, increased measurement accuracy, and low cost of ownership. The pyranometer is equipped standard with an onboard digital tilt sensor, making SR30 fully compliant with the latest IEC 61724-1:2017 PV performance monitoring standard. SR30 requires no routine desiccant maintenance and is backed by a 5-year warranty.

Hukseflux USA | www.hukseflux.com
Booth 1008



Maintenance-free AGM batteries

Crown Battery's maintenance-free AGM batteries are designed from the ground up for renewable energy. Built using robotic assembly, the industry's heaviest plates, and more active materials, they deliver enhanced performance and lifespan. Crown1 batteries are optimized for energy storage in off-grid applications and for uninterrupted power supply for grid-connected users, offering a wide array of configuration options, improved temperature management, and more. To ensure quality, Crown1 batteries are manufactured at the company's Fremont, Ohio headquarters. The plant includes environmentally-friendly, roof-mounted solar and wind arrays, and every battery incorporates recycled lead and plastic to help protect the environment. Proprietary cast-on-strap systems allow for 100X the precision of manual welding -- for improved battery life, reliability, and performance. Heat-sealing equipment, automated testing, and vision systems streamline production and ensure maximum precision, uniformity, and power.

Crown Battery | www.crownbattery.com
Booth 4821



PV system protective fuses with crimp cap termination

Protect off-grid or grid-tied PV systems from unexpected ground faults and line faults using Mersen's HeliProtection fuse line. Mersen's HP10M, HP15M, and HP15G photovoltaic (PV) fuse series were engineered and designed specifically for the protection of photovoltaic systems. Their enhanced fuse construction makes them a solution for continuous temperature and current cycling withstand adding to system longevity. The 1000VDC-rated HP10M, and the 1500VDC rated HP15G and HP15M were designed for low minimum breaking capacity capabilities of 1.35 times the fuse rated current value, allowing for safe circuit interruption under typical low fault current conditions produced by PV arrays. In addition to the standard ferrule terminal, a unique wire crimp terminal (CC option) permits solderless wire-to-fuse connection for overmold encapsulation of fuse and wiring, specifically designed for in-line fuse applications. UL Listed.

Mersen | ep.mersen.com
Booth 2609



COMPREHENSIVE
PORTFOLIO OF
1500VDC PV
COMPONENTS



1500VDC HELIOPROTECTION® FUSES FROM MERSEN

Mersen's HeliProtection photovoltaic fuses are engineered specifically for the protection of PV systems. Their enhanced fuse construction makes them ideal for continuous temperature and current cycling withstand adding to system longevity.



Residential energy storage system

A complement to home solar, Mercedes-Benz Energy Storage Home uses the same lithium-ion technology developed for use in Mercedes-Benz electric and hybrid vehicles. Up to eight energy modules, each with a capacity of 2.5kWh, can be combined to create a custom sized system. The benefits of Mercedes-Benz Energy Storage Home include protection against fluctuating energy costs, utilization of self-produced clean energy, energy independence, and a reliable energy supply.

Mercedes-Benz Energy
www.mercedes-benz-energy.com
Booth 1309

DISCOVER the Benefits of The HUCK Solar System™



For faster...forever...installations

The Huck Solar System™ sets a new standard for installation speeds, up to 20X faster than nuts and bolts. This system also includes self-grounding fasteners that eliminate multi-piece assemblies – saving even more time and money.

Delivering 5 - 10X the fatigue strength of conventional fasteners, Huck structural blind rivets and lockbolts are designed to withstand the harshest vibratory conditions, including 100+ MPH winds.

For more information on how the innovative Huck Solar System can improve PV installation, visit us at AFSRHuck.net/solar



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The Huck Solar System™ – fasteners, power systems, ergonomic tooling



800.388.4825
AFSRHuck.net/solar



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Effective and harmless solar panel cleaning

Solar Panel Wash cleans solar panels to increase output performance. It is approved by panel manufacturers because it does not harm the panel's films or aluminum rails. It uses less water to clean because it carries dirt and sand off of the panels by its sudsing, hydrophobic action. FST foam duct sealant protects inverters, combiners, transformers, and switchgear by keeping water and gases out.

American Polywater Corporation | www.polywater.com
Booth 1873



Energy wire and cable

LS Cable & System U.S.A., Inc. is a U.S. manufacturer and supplier of energy wire and cable products serving the commercial, industrial, utility, and renewable energy markets. Low voltage 300V and 600V instrumentation cables for control systems, audio, intercoms, energy management, and alarm controls, low voltage 600V control and power cables for industrial or utility substation circuits, low voltage 600V secondary URD for utility underground power distribution and medium voltage 5kV through 35kV power cables for primary power. All cables are designed, produced and tested in their U.S. manufacturing facilities. Their MV Primary UD 35kV cables are suitable for underground collection systems designed for solar applications. These cables are offered with conductor strand filled, gauge sizes up to 1250kcmil Aluminum, TR-XLPE or EPR insulation, multiple concentric neutral configurations, and LLDPE jacket, meeting the applicable ASTM, ICEA and AEIC standards, and they are RUS accepted.

LS Cable & System U.S.A., Inc.
www.ls.spsx.com
Booth 648



Unlinked single axis horizontal tracker

Ideematec's safeTrack Horizon 3rd generation SAT solution features wind tolerance up to 180 mph, snow tolerance up to 80 psf, and slope tolerance up to 36% (with significantly reduced grading), with high pile efficiency, and low O&M cost. The unlinked tracker design of the safeTrack HZ3, paired with the option of variable length and number of tracker tables per North-South tracker row allows for high design flexibility (GCR). Individual backtracking of each tracker row further helps maximize the system output. The safeTrack HZ3 allows for a "2 modules in portrait" configuration and is easy and fast to install, with no special tools or installation skills required. Due to pre-assembled parts, and a low number of foundations and motors, installation time and costs are reduced. The use of maintenance-free components, in combination with Ideematec's unlinked safeTrack HZ3 design leads to low O&M costs.

Ideematec Inc. | www.ideematec.com
Booth 4941

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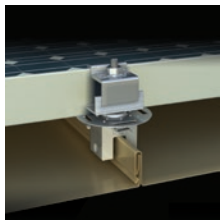
WWW.WARMFLOOR.COM 877-STEP-TEC



Advanced home energy monitoring system

Smappee has entered the U.S. solar market with the launch of its flagship product, Smappee Plus. This energy monitoring system empowers consumers to better manage their electricity use and costs by providing detailed, real-time measurements of their energy production and consumption. Smappee Plus integrates Smappee's patented NILM (Non Intrusive Load Monitoring) technology with submetering clamps to measure real-time energy use from household electronics and appliances, providing consumers with insight into their personal energy use. Suited for homes with solar and other renewable technologies, Smappee Plus acts as an energy traffic controller by directing the energy flow within a user's home to maximize both energy efficiency and clean energy payback. As an increasing number of homes become "smart" featuring multiple energy installations such as solar, heat pumps, and batteries, Smappee Plus has been designed for the modern smart home, and is ready for peer-to-peer energy trading on smart grids using blockchain technology.

Smappee | www.smappee.com
Booth 6522



Solar module mounting solution

The S-5! PV Kit is one of the first solar module mounting solutions to be listed to the new UL subject 2703, a standard that covers both bonding and mounting, and has gained an ETL listing to UL 1703. This non-penetrating, DirectAttach PV mounting solution for standing seam metal roofs fits the majority of solar panels on the market and can withstand the harshest weather conditions while maintaining electrical conductivity. S-5!'s new EdgeGrab is specifically designed to be used in conjunction with the patented S-5-PV Kit for solar array end conditions. The S-5! PV Kit reduces cost by eliminating the need for inter-module copper wires and lug bonding, and ultimately saves time and materials by providing the entire attachment system.

S-5! | www.s-5.com

Booth 1857



Component distributor

Mudge Fasteners works with solar contractors, racking manufacturers, and solar distributors to provide standard stainless steel screws, bolts, nuts, and washers, as well as solar mounting hardware like EJOT, Elco, 3M, S-5!, Solar Connections. Mudge also offers products for cable and wire management, labeling and identification, sealants, adhesives, fall protection, tools, bits, and a full panel maintenance program.

Mudge Fasteners

www.mudgefasteners.com

Booth 4729



Standardized rooftop mounting hardware

The Total Roof Platform (TRP) system standardizes rooftop mounting hardware. The TRP uses the same design, two rails fully supporting the modules, same ClicLoc clamps, same rail, and same Bond-Aid Splice for all systems, so there is no guesswork. By creating smart Roof Connection Kits to fit each all types of roof surfaces including shingle, metal, and flat roofs, Advanced Racking has simplified the ordering, installation, and management of roof top PV racking hardware. Fast installation time plus low overhead cost helps generate more sales and provides security for long life racking systems.

Advanced Racking, Inc. | www.advancedracking.com

Booth 1162

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MAXIMIZE PV PRODUCTION & UTILIZATION DC COUPLED POWER SYSTEM

The DPS-250 is Dynapower's new cost-effective solution for coupling energy storage with solar with a DC-to-DC converter to maximize production and revenues for existing and new utility-scale PV installations. The DPS-250 has the highest round trip efficiencies and lowest cost of integration with existing PV installations of available energy storage solutions. Additionally, the DPS-250 opens new use cases for revenue generation including — **clipping recapture, curtailment and outage recapture, low voltage harvesting, capacity firming, energy time shifting and ramp rate control** — for both existing and new utility-scale PV installations.

To learn more about the value of the DPS-250 solution please visit

www.dynapowerenergy.com/dps-250-dc-to-dc-converter/

to download our white paper and data sheet,

or email rpratt@dynapower.com.

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COST-EFFECTIVE, EASILY SCALABLE

FULLY INTEGRATED ENERGY STORAGE SYSTEM

Dynapower and Samsung SDI — the respective leaders in energy storage inverters and batteries deployed worldwide — are proud to offer the BTM-250, a 250kW/550kWh fully integrated energy storage system. The modular, easy-to-install energy storage system provides the utmost in reliability and efficiency alongside an industry leading low cost to install.

The BTM-250 is available in 2, 4, and 6 hour configurations. Units can be paralleled to scale to meet the needs of any behind-the-meter installation. The BTM-250 features Dynapower's proprietary **Dynamic Transfer™** allowing the system to seamlessly transition from grid-tied to islanded mode while maintaining all critical loads.

To download the BTM-250 data sheet please visit

www.dynapowerenergy.com/sdi_dpc_offering/

or email rpratt@dynapower.com.



INVERTER: UL 1741 SA

50. BURLINGTON, VT/UNION CITY, CA

dynapower.com



Versatile ground mount system

The Advanced Modular ground mount system is a solution for large commercial and utility scale solar projects. Innovative features like integrated bonding, cable management trays, and UL Certified components reduce electrical costs. Engineered cross bracing, high strength steel, and physical testing on every site makes the Advanced Modular ground mount system a very rigid system. AP Alternatives' shallow helical foundations allow massive versatility with soil issues, including: soft soils, low friction soils, high water tables, shallow bedrock, deep frost lines, and rolling topography all at basically no cost increase.

AP Alternatives | www.apalternatives.com
Booth 4361



100% leakproof mounting solution

SolarRoofHook is showing their new Low Profile QuickBOLT for Asphalt Shingle Roofs. Like the original QuickBOLT, the Low Profile QuickBOLT uses a stainless steel backed EPDM washer to ensure a 100% leakproof seal. This Microflashing compresses and concaves to chemically bond with the Asphalt Shingle Roofing. The Low Profile QuickBOLT simplifies the installation process by removing the height adjustable nature of the original QuickBOLT. By eliminating the adjustable component, the Low Profile QuickBOLT shortens installation of the original QuickBOLT to less than one-minute. This not only makes the installer's job easier, but it allows them to save time and money up on the roof. The Low Profile QuickBOLT also allows installers to create a level array with no adjustments.

SolarRoofHook | www.solarroofhook.com
Booth 1414



Mounting solutions for composition/asphalt shingle roofs

Quick Mount PV engineered its patented Elevated Water Seal Technology into a waterproof, integrated L-foot and flashing for cost-effective, fast, single-bolt installation. The L-Mount Series comes in single- and double-slot options for maximum versatility and works with all leading racks. L-Mounts are designed for simple lag-bolt installation onto existing composition/asphalt shingle roofs. The L-Mount features a 9x12-inch aluminum flashing with alignment notches and rounded corners to easily slide under shingles and speed installation. The L-foot rotates 360 degrees for optimal adjustability and positioning of rail. No shingle cutting required. The L-Mount comes with a 25-year limited product warranty and is available in mill or black finish.

Quick Mount PV | quickmountpv.com
Booth 3339



Rail-less mounting system

POWER DISK is a unique roof attachment that can go anywhere on residential rooftops. It does not need to be secured to rafters and allows solar modules to be installed in four simple steps. POWER DISK is flexible and adaptable; it allows installers to set modules in portrait or landscape format and can be attached directly to rafters, if desired. Fitting most framed 60- and 72-cell modules, POWER DISK is pre-assembled and quick-to-install with built-in electrical grounding clips integrated in the mount and optional flashing. POWER DISK is UL2703 code compliant. PLP's website also features a new POWER DISK design tool which provides optimal residential roof layouts with the unique deck mount attachment and offers built-in code compliant engineering, and a simple user interface.

Preformed Line Products
www.preformed.com
Booth 1015



Electrical and integrated solutions

WEG Transformers USA, formerly CG Power Systems, provides electrical products and integrated solutions for T&D, industrial, and renewable markets with offices and plants located in five continents. Their products, solutions, and services include: distribution, substation and power transformers, multi-winding (3, 4, or 6) step-up transformers for wind and solar applications, generator step-up transformers, voltage regulators, complete mobile substations (new and refurbishment), and full turn-key field repairs and commissioning services. They have been serving the N.A. renewable market for more than 20 years from their local manufacturing plants and service center in Washington, Missouri with installed base of more than 12,000 wind and solar step-up transformers (24GW).

WEG Transformers USA | www.weg.net
Booth 4185

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Residential panels with enhanced performance

LG Electronics USA has introduced the LG NeON R 60-cell solar panel for residential installation with back contact. The newly released technology, with all electrodes on the rear side, creates a panel with polished aesthetics, improved temperature coefficient, and heightened visual appeal. LG NeON R has improved temperature performance characteristics, which significantly enhance output for maximum efficiency. NeON panels are rated at 365W per panel, and the N-type cells used in the NeON use almost no boron, so Light Induced Degradation is significantly reduced, maximizing performance, and maintaining maximum potential power output for the life of the module. The NeON R is designed with high-end design appeal in mind, in addition to high-performance. Eliminating the busbars on the front of the module not only creates a seamless visual, it also maximizes light absorption.

LG Electronics USA | www.lg.com
Booth 3026



Meteorological measurement solutions

Lufft's all-in-one Weather Sensors (WS) provide easy installation, integration, and will maintain into any DAS/SCADA/PLC/Datalogger system. Lufft's robust, no moving parts, pre-calibrated WS meet the needs for temperature, humidity, pressure and wind readings, and also include sensors with embedded Second Class and Secondary Standard Solar Radiation Sensors, reducing maintenance, inventory, and replacement costs. The Lufft portfolio includes products like the WS800; with a maintenance-free precipitation (rain/snow) gauge, along with lighting detection to extend safety to the production team and provide the information needed on insurance claims. Lufft's WS product family fill critical meteorological measurement requirements for any renewable energy installation.

Lufft | www.lufft.com

Booth 818



Electrical and electronic connectors

As a provider of electrical and electronic connectors using MULTILAM advanced contact technology, Stäubli offers a wide range of connection systems and accessories for photovoltaics, plug connectors, junction boxes, and cables.

Stäubli Electrical Connectors | www.staubli.com/electrical
Booth 3238



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Travelers Global Renewable Energy has more than 25 years of experience providing specialized insurance products and service solutions to our customers. Our underwriting teams and in-house risk control and claim professionals have a deep understanding of renewable energy exposures. They can help you minimize risks ranging from equipment breakdown to employee safety, and address complex issues unique to renewable energy claims. So whether you're a solar or wind farm developer, the manufacturer that makes the parts, or the company that maintains the facility, we can help protect your operations – wherever they are – for the long term.

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Maintenance-free, deep cycle AGM battery

Fullriver DC Series Deep-Cycle AGM batteries are specifically built for cyclic use in demanding solar applications. The thick plate design and AGM construction combine for a robust battery delivering optimal performance in both fair weather and extreme climate conditions, all in a spill-proof, non-hazardous, and maintenance-free package.

Fullriver Battery
www.fullriverbattery.com
Booth 1638



Canopy and carport solutions

RBI Solar takes a site-specific design approach to every canopy or carport project. They offer solar mounting canopy structures for areas such as walkways, detention basins, recreational parks/ball parks, as well as new or existing carport parking lot structures. Each solar canopy project is customized to a client's needs, creating a functional and cost-effective solar installation through complete responsibility for the design, engineering, manufacturing, and installation of efficient PV racking solutions, including DSA options.

RBI Solar | www.rbisolar.com
Booth 2709



Integrated hybrid storage solution for residential and small commercial

Darfon's H200 hybrid energy storage system integrates Lithium batteries (LFP), a hybrid inverter, and BMS into a rack enclosure. Just roll it in, install the batteries, connect the wires, and then drive away. The H200 is a DC coupled system designed to provide PV supported backup and arbitrage, and is available with 10, 15, or 20kWh battery options. Critical loads are supported up to 5kW continuously and 7.5kW for 1 second. The integrated hybrid inverter handles up to 6.5kW PV with two MPPTs, and back-feeds to the grid up to 5kW.

Darfon Solar | www.darfonsolar.com
Booth 2126



Durable AGM series batteries

U.S. Battery Manufacturing's line of AGM Series batteries provides sealed low maintenance and deep-cycle performance for RE applications. U.S. Battery's AGM products are tough, durable, and provide peak performance in harsh conditions. Utilizing advanced paste and plate technology, U.S. Battery's AGM products produce long life-cycles and low self-discharge rates. Built with high-quality case and cover materials, as well as rigidly mounted plates, all of the AGM Series products are designed to withstand shock and vibrations, and feature low hydrogen gas emissions allowing them to be used safely in tight compartments.

U.S. Battery | www.usbattery.com
Booth 1915



Solar ground-mount earth anchors

American Earth Anchors introduce's the PE46-Hex8 to their line of Penetrator earth anchors. The hex8 has been field-tested to 9,000lbs. of downward pressure and up to 14,000lbs. of pullout strength. It was designed to fit a 2"v schedule 40 pipe, making it an option for solar panel ground mount racking. The hex8 can save time and money by replacing concrete footings providing the advantage of no digging, no forms, no pouring, no waiting, and easy leveling by screwing up or down. American Earth Anchors can make custom brackets for any pipe size for any earth anchoring needs.


American Earth Anchors | www.americanea.com
Booth 725



Simple and efficient wire management

Solar Raceway's Wire Management System is focused on addressing balance of system solutions with simplicity, efficiency, and durability. The system is comprised of 3 main interlocking components: base, cable tray, and top cover, in 100% brush anodized aluminum and available in three sizes; 1.5", 2.5", 3.5" diameters. No wire pulling equipment is required with this system, S/R is used from solar modules to home runs and even inside of buildings. Designed as an open tray method of installing wires; once wires are placed in the cable tray, and the system is adequately checked, installers just snap on the top cover and installation is complete. X5 anodized colors and 340 architectural colors available upon request. UL Listed.

Solar Raceway | www.solarraceway.com
Booth 2128



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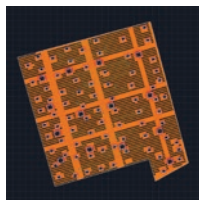
SOLARPOWER INTERNATIONAL



High power production tracker

Genius Tracker's pre-assembled drive system and easily assembled components combine to offer fast install and overall value for low O&M costs. It has completed Black & Veatch technical assessment, CPP wind tunnel testing, is rated 150mph, and ETL / UL 2703 tested. Genius Tracker provides 99.5% panel density on rows. This rugged tracker is designed for a 30-year field life in harsh environmental climates: -30°C to 65°C rated actuators, IP67 submersible rated motor end, and IP66 rated front end. Every drive actuator has its own battery backup and wirelessly linked controllers, eliminating all trenching. Tru3D-Gimbal bearings account for pile installation being out of plumb, out of azimuth, and out of vertical and east-west alignment. Self-powered rows eliminates central drive, allowing for uninterrupted grass cutting and panel washing.

GameChange Solar
www.gamechangesolar.com
Booth 4621



Residential and commercial design/sales platform

Aurora streamlines and automates the solar design process, empowering solar installers to focus on satisfying their customers. Aurora is showcasing their new commercial design suite, with new design and financial analysis tools tailored specifically to C&I projects.

Aurora Solar Inc. | www.aurorasolar.com
Booth 1381

The Center of Your Solar System



This is where your investment in Solar & Wind Power Equipment pays off.



Crown Battery's proven array of Renewable Energy Deep Cycle Batteries. Unlike some deep cycle battery manufacturers who lump a few of their industrial products into a group and call it their RE line, Crown Battery evaluated the marketplace needs and re-engineered an entire line of 2-, 6- and 12-volt batteries to fit contemporary solar and wind power systems.

- ▶ The most complete, dedicated array of RE batteries with unmatched application flexibility and ease of handling
- ▶ Battery capacity ratings that range from 120 to 3690 ampere-hours (100 Hour Rate) and unmatched application flexibility
- ▶ Recognition of Crown Renewable Power Batteries as best-available and most-reliable by serious RE system owners

You've researched the renewable energy equipment you've bought. Now it's easy to select the storage batteries you need. Crown Batteries. Once you compare all the other renewable energy batteries in the world today, you'll find there's really no comparison. It's truly the best batteries for your solar system.

Contact us for more information: 419.334.7181
www.crownbattery.com
sales@crownbattery.com



Cellular and WiFi monitoring

The eGauge Pro has the ability to measure DC and AC power simultaneously. Other new features include 30 current transformer inputs, 0-277Vac and +/-60Vdc measurement ports, LCD interface, and two USB inputs. These improvements were designed to increase usability without an increase in the total system cost. The eGauge Pro has embedded Ethernet and Power Line Communication, and is USB WiFi and cellular enabled for Internet connectivity. The meter holds a UL stamp of approval for safety and adheres to ANSI C12.20 for high-accuracy revenue grade measurements.

eGauge Systems, LLC | www.egauge.net
Booth 2612





Insulated wire management products

BURNDY, a manufacturer and provider of wire management solutions to the Solar PV industry, announces the addition of the new WILEY insulated wire management products to their WILEY line of products. WILEY insulated products are a durable, long lasting, and reliable solution for protecting wires and cables. The vinyl coating acts as a shield against vibration and cable insulation damage. WILEY insulated p-clips are easy to install with an oval fastening hole to accommodate any subsequent adjustments. WILEY insulated straps are a reusable alternative to a cable tie solution. WILEY insulated straps are suitable for general wire fastening applications, such as holding hydraulic hoses, wire harnesses, cables, and everyday solar wire management.

BURNDY | www.we-llc.com

Booth 1969



Touchless, hydraulic snow removal

Buffalo Turbine has been manufacturing turbine style blowers since 1945, which are made using high-precision machined components, resulting in long-lasting dependable products. These turbine units are being used worldwide in a variety of applications. The diverse product line provides its customers with the ability to choose a product that best suits their application and various budgets. The newest of all the applications is touchless snow removal with its stacked hydraulic unit that quick attaches to most skid steers.

Buffalo Turbine | www.buffaloturbine.com

Booth 435

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- Flat roof pitch roof and ground mount

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ISO-17025 accredited pyranometer calibration services

ISO-CAL North America LLC is a full service ISO-17025 accredited calibration laboratory, specialized in the field of solar radiometer (sensor) calibration. Based in sunny Phoenix AZ, services include both indoor and outdoor WRR traceable pyranometer and pyr heliometer calibration in accordance with the ASTM, or ISO, calibration standard of choice. Their secondary transfer indoor ASTM G207-11 calibration process replicates the OEM calibration method of the leading pyranometer manufacturers, assuring continuity in sensitivity scale from one calibration interval to the next. In addition to instrument sensitivity, every ISO-CAL North America calibration certificate states the expanded calibration uncertainty ($k = 2$) of the reported instrument sensitivity value. Calibration turnaround is 1 - 2 weeks typical, depending on instrument type and calibration method. Expedited calibration services are available on request. Additional ISO-CAL North America accreditations include ANSI Z540.1 and ANSI Z540.3.

ISO-CAL North America, LLC

www.isocalnorthamerica.com

Booth 1010

SIBA Fuses: *Your trusted source for all your circuit protection requirements, from solar power to wind power, and energy storage. We are the world leaders in these applications and the most trusted name for your circuit protection needs. Stop by our booth at SPI to view our products and speak with our engineers about how we can help with your next project!*

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www.siba-fuses.us

SIBA



Complete power conversion station

The HEM Series Power Station is the latest addition to the Power Electronics solar inverter family. The HEM platform combines the advantages of both string and central inverter topologies, and provides a complete power conversion station including internally connected inverters, MV transformer, MV switchgear, and auxiliary power in a single cabinet which fits in a 20ft container. The HEM is UL1741 SA certified and designed to meet NEC 2017 inverter requirements. The 3 MW HEM platform is built with 6 x 500kW power modules based on V1500 design. The power conversion section is designed to be field replaced with minimal effort, improving uptime and providing redundancy. The HEM ventilation system is a forced-air, filterless system based on patented cyclone drives developed by Power Electronics. A dry-type MV transformer and external switchgear provides configuration flexibility to match project requirements, while 50kVA aux-power and multiple MPPTs provides compatibility with various PV field architectures.

Power Electronics
www.power-electronics.com
Booth 3539



Immersive training solution

Interplay's immersive training program delivers 3D solar training via a virtual reality (VR) headset, tablet, or laptop focused on helping employees become better at their job. Interplay believes in creating a system of learning to help a company's employees build their careers and ensure the company delivers the best possible work for their customers. Interplay's online software platform features 3D simulations, gasification, and a smart system of learning delivered to engage and educate. The courses range from Mechanical and Electrical Install to System Commissioning, and O&M.

Interplay Learning
www.interplaylearning.com
Booth 1268



Balance on tracker solution

Shoals' Balance on Tracker is a full PV utility-scale solution, which includes all necessary electrical and mechanical components to move panels and transport electricity to the inverter. The SAH tracker, all electrical harnesses, the BLA, and wireless string monitoring have been designed and optimized at the system level.

Shoals Technologies Group | www.shoals.com
Booth 3426



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HynesIndustries.com
800.321.9257
3805 Henricks Rd.
Youngstown, Ohio 44515



Reliable and cost effective solar systems

Arctech Solar offers two new products to customers, fixed tilt ground mount and single-axis trackers. The company's new fixed tilt ground mount is designed to reduce balance of system costs by minimizing the part count, increasing land adaptability, and decreasing installation time, thereby reducing cost to the customer. The new single-axis tracker accommodates larger 1500V systems and incorporates Arctech Solar's reliable signature redundancy design to ensure uptime and reduce O&M.

Arctech Solar | www.arctechsolar.com
Booth 4145



High yield single axis utility tracker

SF7 horizontal single-axis solar PV tracker is the seventh-generation product of Soltec's 12-year history as a solar PV tracking specialist. With zero array-gaps on the tracker, SF7 enables up to 5% greater yield per acre, and it does that with 54% fewer piles-per-MW, 15% less parts count, and 58% fewer screw type connections. Other SF7 standard advantage features include short tracker site-filling options, unique steep-slope tolerance of 17% NS, efficient self-powering, and cable management solutions for combining, fusing, and protecting PV source circuits more economically. Soltec is prepared for large-scale tracking challenges with a mature standard product, a 2.5GW annual manufacturing capacity, and global stocking synchronized with regional operations and customer project schedule.

Soltec | www.soltec.com
Booth 3640



Hybrid lead-acid battery

MK Battery's Deka Solar line includes sealed lead acid GEL and AGM batteries and select flooded products. The new UltraBattery is a hybrid device – a chemical combination of a lead-acid battery and an ultracapacitor, achieving higher-rate, partial-state-of-charge operation with extended longevity and high efficiency. Its unique chemistry not only increases power handling but vastly reduces hard sulfation, facilitating excellent longevity, and allowing it run for long durations between refresh charges. The UltraBattery is a solution for low voltage home and commercial use, as well as high-voltage grid applications. It's extremely efficient; up to 90–95% of every unit of energy stored is available for re-use when used in partial-state-of-charge. Like all batteries in the lead-acid family, UltraBattery is fully sustainable with its closed loop recycling.

MK Battery - Deka Solar
www.mkbattery.com
Booth 1921



250kW DC-to-DC converter

Dynapower is pleased to introduce the DPS-250kW DC-to-DC converter purpose built to be a cost-effective approach to coupling energy storage with existing or new utility-scale solar installations. By coupling energy storage on the DC PV bus, costs associated with adding energy storage are greatly reduced. The DPS-250 requires no additional AC Switchgear, no changes to the MV Transformer, and less trenching than other energy storage system options. Additionally, no changes to Interconnection Agreements, PPAs, or interconnection studies are required; further reducing costs and time associated for adding energy storage to utility scale solar installations. The MPS-250 DC-coupled solution provides high efficiency while unlocking several production/revenue streams for the system owner. The DPS-250 allows for clipping recapture, curtailment and outage recapture, low voltage harvesting, capacity firming, energy time shifting, and ramp rate control.

Dynapower | www.dynapower.com
Booth 1440



Residential, commercial, and industrial energy storage solutions

The SLR Series of advanced lead-carbon batteries from GS Battery are an energy storage solution for residential, commercial, and industrial distributed energy projects. These sealed, maintenance-free batteries are available in a variety of form factors, voltages, and AH ratings. The SLR line utilizes advanced nanoscale carbon structures in the design of the negative grid. This enhancement allows the battery to perform well at partial state of charge (PSoC), achieve fast charge and discharge rates, and have cyclic performance of 5000 cycles at 70% DOD. GS Battery also manufactures lithium-ion, AGM lead-acid, and nickel-cadmium battery chemistries for the energy storage market.

GS Battery (U.S.A.) Inc.
www.gsbattery.com/renewable
Booth 1221



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(pictures shown with SCI PV KIT)

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Energport Energy Storage Systems are designed to generate customer savings by reducing electric bill demand charges and/or by shifting customer usage of utility-provided power from expensive daytime periods to significantly less expensive night-time periods. Configurations are also available to provide uninterruptable power supply capabilities. Energport provides systems designed for plug-and-play residential, multi-kW commercial, and multi-MW industrial applications. Energport Energy Storage Systems can also be closely integrated with solar PV generating systems.

Energport Energy Storage Systems

www.energport.com

Booth 735



All-in-one solar monitoring system

RaZON+ is a system which measures direct, diffuse, and global solar irradiance, all at a high level of accuracy. This new turn-key system for solar radiation monitoring consists of a sun tracking device equipped with GPS and new Smart sensors, and it has built-in data logging. RaZON+ is both innovative and user-friendly. The design of the pyrliometer minimizes the effects of soiling, which results in higher accuracy of the measurements.

Kipp & Zonen | www.kippzonen.com

Booth 815



Sales and project management software

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 any solar company from the field or in the office.

JobNimbus | www.jobnimbus.com/spi

Booth 1368



H5001 Hybrid Inverter

Simplified Installation

- » Single location for all breakers, disconnects, connections & switches
- » Convenient knockouts for conduit access
- » Quick connects for PV, grid-tie, load & generator

Multiple Modes of Operation

- » Off-grid, backup, residential, TOU arbitrage
- » Remote generator startup

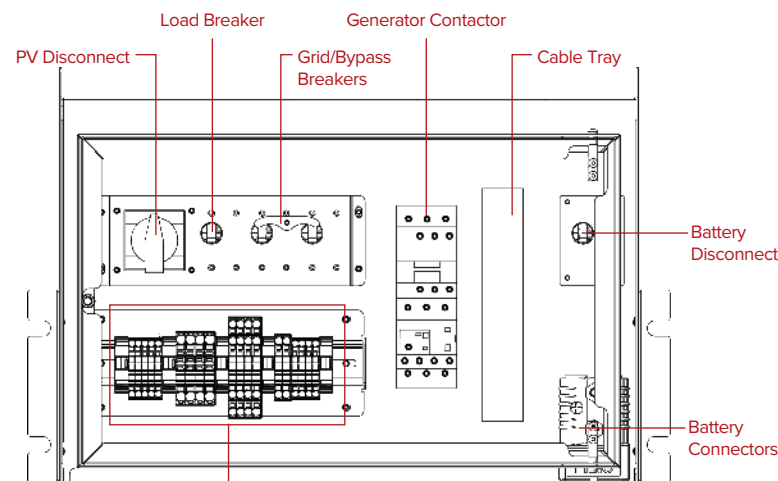
DC Coupled

- » Storage-ready string inverter
- » Higher efficiency



Grid	PV	Critical Load
5kW	6.5kW with 2 MPPT	5kW cont., up to 7.5kW

Integrated Storage Solutions



Quick Disconnect Terminals [PV, Grid, Load, Generator]

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- 📘 Like us at facebook.com/DarfonSolar
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Maintenance-free battery system

Leoch Battery Corp's 48V 1000Ah provides 48KWh of energy in a completely sealed, maintenance-free battery system. This system is a safe and reliable solution for home and small business use. They've combined tubular plate structure with GEL technology to offer a long-life design capable of delivering 3500 cycles at 50% DoD. Easy to install and performs well in wide temperature range.

Leoch Battery Corp. | www.leoch.us
Booth 534



Simple and cost-effective OEM racking with turn-key field installation

The OMCO Field Fast Rack comes straight from the manufacturer, and is designed with features which reduce installation costs, streamline supply chain, and ensure proper construction. As the OEM and one source to partner with, they have integrated pre-assembly of components in the factory, few parts to manage in the field, and the nationwide manufacturing footprint (Arizona, Ohio, Indiana, and Alabama) tooled and ready to optimize freight and logistics costs, and shrink lead time. OMCO's team also provides turnkey installation for any size project.

OMCO | www.omcoracking.com
Booth 1145



Reliable and robust fasteners

Huck fasteners have been engineered to provide quick installation speed and vibration resistance, making them a joining system solution for a wide range of solar applications. These fasteners are engineered to be installed in 1 to 2 seconds and battery powered tooling adds even more flexibility and speed to installations. In addition, self-grounding Huck fasteners are now being used to replace conventional multi-part, grounding assemblies. Huck fasteners also have the strength to support the connection of the solar panels to their frames, providing a level vibration resistance that allows them to withstand winds exceeding 100 mph. Finally, these fasteners are designed to be tamper proof, providing an additional measure of security for valuable PV panels.

Arconic | www.afsrhuck.net/solar
Booth 4739

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www.sollega.com

SOLAR POWER INTERNATIONAL
Booth #1835



Plug and play energy storage system

Developed in partnership with solar and energy storage installers to optimize equipment and streamline cost calculations, SimpliPhi Power's complete plug-and-play energy storage system, the AccBESS, is a fully integrated solution that easily incorporates power storage into new and existing solar installations, both on and off grid. It combines the company's battery technology with a Schneider Electric inverter charge controller, associated power electronics, and system management in one box. Pre-programmed software settings and system performance monitoring complete the solution. Also, by eliminating any ventilation or active cooling requirements, the AccBESS can be safely installed both outside and inside. Since being introduced in the fall of 2016, the AccBESS has been installed in a variety of residential, commercial, and "glamping" projects throughout California, Hawaii, and the U.S. east coast. The AccBESS is operational at the Stone Edge Farm Microgrid project and at a residential installation in San Diego by CleanSpark.

SimpliPhi Power
www.simpliphipower.com
Booth 1829



Modular, plug and play, battery energy storage system

TrinaBESS, Trina Battery Energy Storage Systems, is the energy storage division of Trina group and the sister company of Trina Solar, a provider of PV total solutions. TrinaBESS develops, manufactures, and delivers battery energy storage systems (BESS) for utilities, solar companies, project developers, installers, and distributors for residential, commercial, and utility markets. TrinaMega is a modular plug-and-play containerized BESS solution, entirely custom-made, in order to answer specific battery usage and functions from utilities and large energy users. TrinaMega provides up to 2.9MWh per containerized BESS. Each TrinaMega is scalable, and includes the complete BESS system, UPS, SCADA unit, thermal management, fire suppressant, power supply, and auxiliary systems. TrinaMega is designed, manufactured, and tested in full compliance with the latest edition of IEC, EN, and UL standards, and provides an optimized safety, control, and monitoring system.

TrinaBESS | www.trinaenergystorage.com
Booth 3048



Easy-to-assemble steel mounting system

Schletter's new G-Max solar mounting system ships with 30% pre-assembled components resulting in efficient installation, fewer touch points in the field, less hardware to lose, reduction in install time, and reduces the bottom line. With a 20-year warranty and UL 2703 certified, G-Max is suited for utility-scale and large commercial ground mount installations. Schletter engineering has optimized components for strength, safety, and ease-of-installation. G-Max allows modules to be installed either from top-down or bottom-up creating a safer installation with reduced ladder or scaffolding requirements. As much as 20% reduction of piles creates an overall reduction in manufacturing times, improved shipping costs, simplified site deployment, and faster installation time. G-Max's combined purlin design eliminates fourth purlin in portrait resulting in a 25% reduction in material. G-Max also includes visual quality assurance measures designed into the system including part identification numbers and embedment depth call-out.

Schletter, Inc. | www.schletter.us
Booth 2057



All-in-one hybrid inverter and EMS

Knowing the active demand of energy storage and management systems for residential applications, E-Store Home is an all-in-one product designed to store sunlight and harvest affordable energy. With its built-in hybrid inverter and improved EMS, E-Store Home makes residential generated solar energy available day and night. E-Store Home features modulated batteries to allow flexible installation and diversified combination. Furthermore, equipped with 24-hour smart cloud monitoring, it is easy to track the system in real time anywhere with web and mobile apps. E-Store Home is compact and matches modern home aesthetics.

ET Solar, Inc. | www.etsolar.us
Booth 4245



Solar warning labels

PV Labels has created two new items to help installers comply with code and finish off the install with a professional look. The new 05-218 and 05-219 labels have been designed to communicate the multiple messages required on DC and AC junction boxes. Based on the need to satisfy ANSI standards, these unique labels fulfill multiple code requirements while still fitting on these smaller components that have such limited space for labeling.

PV Labels | www.pvlabels.com
Booth 535

Visit us at
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Mandalay Bay Convention Center, Las Vegas
Sept. 11-13 Booth 1932

2017 MARKS THE TEN YEAR ANNIVERSARY OF THE ISLE OF EIGG ELECTRIFICATION PROJECT



THERE'S A LOT OF LIFE IN ONE BATTERY.

The Isle of Eigg is the most populated of several small Isles located off the West Coast of Scotland. In late 2007 a unique hybrid renewable energy system was installed, combining hydro, solar & wind sources and battery storage. For the past 10 years, ninety six Rolls 4 KS 25P batteries have provided over a half a MegaWatt of reliable storage capacity and continue to operate superbly. Offering residents, businesses and community facilities with reliable electricity and reduced dependency on fossil fuels, this large scale off-grid system now provides reliable power for the 100+ residents of Eigg, generating virtually 100% of their electricity using renewables.



Installation by:



YOUR RELIABLE OFF-GRID SOLUTION.
PREMIUM DEEP CYCLE FLOODED AND MAINTENANCE-FREE AGM & GEL

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Strong, universal commercial mounting anchor

OMG Roofing Products has introduced PowerGrip Universal for mounting solar racking systems on all commercial roofs. PowerGrip Universal is designed to reduce or eliminate ballast in solar racking systems, so there's less weight, material handling, and labor on the roof. PowerGrip Universal is designed with performance in mind, offering 3300 lbf. of tensile strength, 2500 lbf. of shear strength, and 2000 lbf. of compressive strength. Made of heavy-duty cast aluminum, PowerGrip Universal is easy to install, saving time and labor. The system transfers the load to the structural roof deck, and does not require any membrane welding.

OMG Roofing Products | www.outofthestoneage.com
Booth 629



Deep-cycle AGM and flooded solar batteries

The Trojan Battery Solar product line features both true deep-cycle AGM and flooded batteries which are specifically designed for solar and other renewable energy applications. Trojan Solar AGM features a non-spillable, maintenance-free design which enables installers to customize the use and position of the batteries in various applications. Trojan's Flooded Solar batteries leverage their 90 years of deep-cycle flooded technology expertise and are engineered to provide high cycling. Trojan's Solar AGM is certified for non-hazardous shipping per U.S. DOT/IATA regulations and tested to an eight-year design life under the IEC 61427 standard for solar batteries. Both the Solar AGM and Solar Flooded lines are manufactured in the U.S. and are optimized for frequent cycling in harsh environments.

Trojan Battery Company
www.trojanbattery.com
Booth 1415



High density racking system

Ecolibrium Solar's new EcoFoot5D High Density 5-Degree Racking System delivers 18.4% more power than 10-degree systems by combining a small 7"x16.7" roof-friendly modular base and dense 9.9" inter-row spacing. The result is a tightly packed array which enables installers to maximize power density on flat roofs. EcoFoot5D is built on the EcoFoot Modular Platform with more than 200MW installed. Bases fall into alignment as modules are placed. Preassembled parts eliminate the need for PV panel preparation. The combined effect is an organized workflow and fast, non-stop installation. For pitched roofs, the new EcoX Tile Hook enables easy attachment of EcoX Rail-less Racking to tile roofs. Installers benefit from fast assembly, 30% fewer penetrations, and reduced logistics. Two height options attach to curved and flat tiles. Shingle, metal, or deck mounting available.

Ecolibrium Solar
www.ecolibriumsolar.com
Booth 6501

TRACKING THE SUN. FROM DAWN TO DUSK.



Scorpius plant in Karnataka, India

“Scorpius Trackers is amongst the TOP TEN Global Tracker Technology Companies for 2016 - *Greentech Media*”

■ **ONLY** Tracker Supplier from India to complete Independent Engineers Bankability Review



■ Completed Boundary Layer Wind Tunnel Testing of Structures

UNIQUE TECHNOLOGY FEATURES



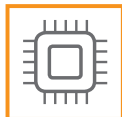
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No lubrication required



WiFi enabled communication



Electronics for -10°C to +60°C



Stowing at wind speeds



No power required

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 Pune - 411016, Maharashtra, India.
 T: +91 20 2565 9413
 E: info@scorpiustrackers.com

ScorpiusTrackers 
www.scorpiustrackers.com



Smart module with integrated monitoring

Boviet Solar USA's 280-295W 60-cell Smart Module (BVM6610M) is a monocrystalline solar module designed to harvest 25% more energy from a solar system. This is a high-quality, reliable solar module with SolarEdge-powered smart monitoring built in. The module has a simple system design for ease of installation and features more installation safeguards, such as module-level voltage shutdown for both installer and firefighter safety. The 60-cell Smart Module delivers between 280W and 295W of power with efficiency rating between 17.2% and 18.1%. The unit also comes with Boviet's 12-year product warranty and 25-year linear power output warranty.

Boviet Solar | www.bovietsolarusa.com
Booth 2963



Efficient wire management system

RayTray is a home run wire management system. Created by an NY-based EPC, initially, for their own use. It has since been adopted by many other EPC's and on commercial solar installations in over 23 states. Listed to conform to UL Standard 870, this system is for use on ballasted flat roofs or standing seam. It can fit up to thirty 10 gauge wires. It is an efficient, labor, and cost saving alternative to PVC pipe or conduit. Quick to install, easy access for O&M. No grounding, no roof attachment needed. Made in USA in a factory powered by solar.

RayTray Solar Wire Management
www.raytraysolar.com
Booth 1009



Reliable, intelligent 1500Vdc string inverter

The Huawei SUN2000-45KTL-US-D0 is a 1500Vdc string inverter. Huawei's 8 DC inputs inverter provides intelligent monitoring and power line communication technology. With real-time operation monitoring, it offers adaptive edge 4MPPT for fast tracking. The maximum efficiency reaches 99% and CEC efficiency of 98.5%. The DC is AFCI compliant to UL 1699B, and the DC disconnect is integrated, offering safety and convenience for maintenance and ground fault protection with Category C surge arresters for both DC and AC. Its multi-level topology can significantly reduce self-power consumption, and directly increase energy yield by 1-2%. This reliable inverter has no need for external fans due to its natural cooling technology and rates an outdoor application of NEMA 4X.

Huawei FusionSolar North America
solar.huawei.com

Booth 3921



Solar project developer

Innovative Solar Systems (ISS) develops utility-scale solar farm projects in the US with a yearly pipeline of approximately 200 projects (20MW-200MW in size) totaling over 10GW's per year. ISS currently has projects in over 35 US states. ISS sells its projects to investors at either early stage, shovel ready, NTP, or COD. ISS has the ability to provide REC's and purchase power agreements (PPA's) to both credit worthy utility companies and corporate off-takers.

Innovative Solar Systems (ISS)
www.innovativesolarsystemslc.com

Booth 849

Power delivery engineering services

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.

Electrical Consultants, Inc. (ECI) | www.electricalconsultantsinc.com

Booth 726

The Battery Matters



The Difference Between Deka Solar and Other Batteries Is Like Night & Day

When it comes to solar power systems, don't settle for just any battery and be left in the dark. For energy storage and power when you need it, always choose Deka Solar, the long-life, reliable battery for on and off-grid power needs in even the harshest conditions.



Deka Solar Gel, AGM or flooded batteries are the proven choice for all your renewable energy applications.

- Competitive Warranty • Quality systems certified to ISO9001
- U.L. recognized components • Available through MK Battery distribution centers across North America, Europe and the Asia Pacific region.

Deka Solar Saves The Day

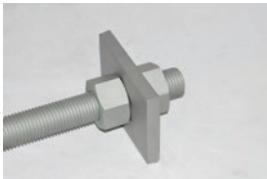


Find your new Deka Solar battery

mkbattery.com © MK Battery 2016



MK Battery – An East Penn Manufacturing Co. Subsidiary MADE IN USA with U.S. and Imported Materials



Solar components

With over 40 years of manufacturing experience, Matenaer Energy Products partners with renewable energy OEMs and EPCs to provide the metal stamping, fabrication, CNC machining, and specialty coating products and services. From fabricated welded assemblies to foundation hardware and support structures, they specialize in creating solutions and high quality production. Their offerings include: stamping, welded assemblies, machined components, specialty hardware, geomet and dacromet coating, piles and beams, light assembly and kitting, logistics management, customized Kanban programs, and more.

Matenaer Energy Products
www.matenaerenergyproducts.com
Booth 822



High performance power supplies

New ABB CP-C.1 high-performance power supplies offer efficiency up to 94%, which leads to less energy consumption and therefore increased cost and space savings, as well as overheating protection. CP-C.1 power supplies tolerate harsh conditions, including extreme temperatures and offer a 50% integrated power reserve and switching at high peak currents to keep the application running. They also are equipped with active power factor correct and include a broad AC and DC input range, as well as worldwide approvals. The new CP-C.1 power supplies are available in 24VDC with 5A/120W, 10A/240W and 20A/480W.

ABB | www.abb.com
Booth 4121



100-1500VDC input DC/DC converter

MORNSUN PV Series power modules (CE approval) offer a wide input voltage range of 100-1500VDC and a temperature range of -40F to 158°F (-40°C to 70°C), which enables the control systems to get power directly from the solar panels, and ensures reliable operation. The modules feature an isolation voltage of 4000VAC, multiple protections such as output over-voltage protection, short circuit protection, and anti-reverse connection protection which ensures the stability of the circuit. This PV series is available in multiple packages including: PCB mount, DIN-Rail mount, and Chassis mount.


Mornsun America, LLC
www.mornsunamerica.com
Booth 2177-5



Labor management and training

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. The Iron Workers & IMPACT provide training to their growing 130,000 ironworker members at 157 training centers across North America. Thousands of hours of training are provided every year, and certifications are constantly checked and updated to ensure that their labor force is ready and able to deliver immediate manpower.

IMPACT | www.impact-net.org
Booth 703




ENERGY STORAGE SYSTEMS

C&I 30kW/60kWh systems in stock

MSRP: \$32,000

FEATURES:

- SGIP qualified supplier
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- Reduce electricity bill by demand charge reduction / time of use management / emergency backup
- Modular scalable design
- Safest Lithium battery available
- Cloud based
- \$0 down leasing available
- 10 Year warranty
- CE/UL compliant



Email: yvette@energport.com | Toll-Free: (844)990-0055 | www.energport.com



Instruments for weather stations

Apogee Instruments partners with companies like SMA, AlsoEnergy, Solectria, and others to provide instruments for weather stations, including their silicon-cell pyranometer, aspirated shield for ambient air temperature measurements, and new low-cost thermopile pyranometer. Apogee is committed to providing quality instruments, in a timely manner, with a four-year warranty. They also provide calibration services for secondary, first class, and second class pyranometers. These calibrations are done to meet the ISO 9847 type IIc calibration procedure.

Apogee Instruments
www.apogeeinstruments.com
Booth 935



Watertight flashing

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

Kinetic Solar Racking and Mounting
www.kineticsolar.com
Booth 1169



True turnkey EPC solutions

GP JOULE is a global renewable energy company which develops, engineers, constructs, operates, and finances commercial and utility scale PV ground mount installations. It provides a full range of products and services focused on delivering a low installed cost for PV solutions. GP JOULE has developed complete in-house and local execution with a team of civil, mechanical, and electrical experts. GP JOULE offers solutions in regions with high wind and snow loads, on sites with space constraints or challenging topographies. Complementing its turnkey EPC offering, GP JOULE's PHLEGON Single Axis Tracker is engineered and tested to specifically meet the challenging environmental and geotechnical conditions in the northern locations. It is a reliable and safe tracking solution with an increased yield of 15% to 25%.


GP JOULE PV USA Inc.
www.gp-joule.com
Booth 1409



Sealant free asphalt shingle flashing solution

With simple and easy installation, the EJOT flashing is designed to be used on three tab asphalt shingle roofs. With triple layer sealing, it provides watertight seals on top of the flashing, top of the shingle, and bottom of the shingle. The kit includes a flashing and an EJOT Solar Fastener JA3-SB-8.0 x 80/70 E22 for wood substructures. The fastener has a 5/16" lag screw on the bottom and can be used with L-feet or other Hanger Bolt Clamps to support the rails. For the installation preparation in the shingle and wood substructure use the EJOT Click&Drill Hole Saw.

EJOT Fastening Systems L.P. | www.ejot-usa.com
Booth 948



Calibrating to a higher standard





Solar Radiometer Calibration Services

ISO-CAL provides fast, reliable, ISO/IEC 17025 and ANSI/NCSL Z540 accredited solar radiometer calibration services: WRR, WISG and/or NIST traceable.

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noun
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www.sunbandit.us
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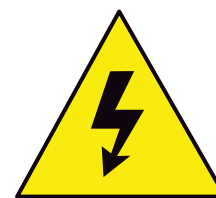
Sinexcel's PWS2-30K-NA commercial and industrial inverter provides a transformer-less design and compact size, offering easy installation and integration in indoor or outdoor storage systems. Its wide DC voltage range is compatible with most batteries, and the MESA compatible protocol has a full list of registers which offers high flexibility of control.

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Ingeteam | www.ingeteam.com
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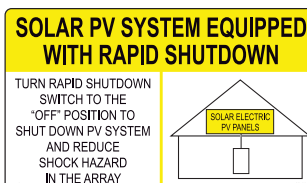
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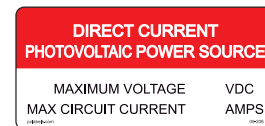
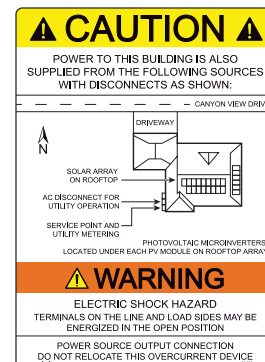
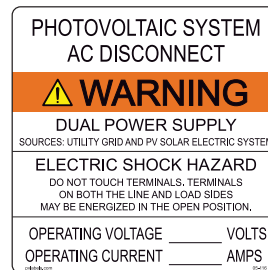
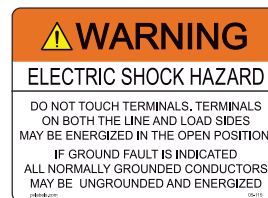
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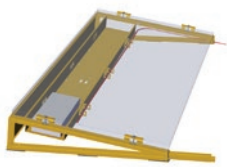


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Solar Mounting Solutions LLC | www.solarmountingsolutionsllc.com
Booth 902



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Booth 504

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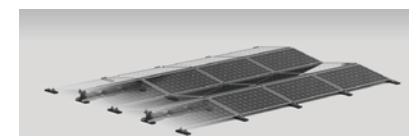
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Powin Energy | www.powinenergy.com
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Delta Group | www.deltaww.com
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The Itek Smart Module is available in both 60- and 72-cell, and integrates the craftsmanship of Itek's SE module with Tigo's TS4 platform, offering flexibility and value. The Itek Smart Module offers functionality such as monitoring, rapid shutdown, optimization, and long strings. The J-box covers are designed for a simple plug and play, so it is easy to convert or upgrade the system to accommodate changing site conditions. Selective deployment means the system can be designed to yield maximum energy harvest at minimal cost, and remote monitoring reduces truck-rolls by providing reliable data in real time.

Itek Energy | www.itekenergy.com
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Electro Plastics is the manufacturer of STEP Warmfloor, a low-voltage heater based on self-regulating PTC Nano Polycarbon technology. Because the heater is self-regulating and acts as a floor sensor, it cannot overheat; as the material warms up, it consumes less electricity. The system is very energy efficient, operates on extra-low voltage, AC or DC, and can be connected directly to renewable energy, like solar or wind. Maintaining an even low temperature is more efficient than an on/off system and requires less solar panels, which makes this a solution for Net Zero Energy buildings. The installation is simple, and the thin and flat heaters can go under most flooring. Used for primary heating and floor warming; it is also available for snowmelt and roof deicing. All products are manufactured in USA with sustainable, non-hazardous and recyclable materials.

Electro Plastics, Inc.
www.warmfloor.com
Booth 6523



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TMEIC Corporation in Roanoke, Va. introduces the next generation of SOLAR WARE SAMURAI Inverters, approved for outdoor installation. The new inverter is the latest addition to TMEIC's portfolio of PV utility-scale solar inverters for industrial markets, offering 3.2MW at 1500V. Built on decades of engineering experience with power electronics, SOLAR WARE SAMURAI inverters offer advanced grid management in an efficient, compact footprint. Unique features include: Proprietary 3 level inverter topology; Maximized and optimized efficiency; Wide MPPT range (875Vdc - 1300Vdc) allowing for best-in-class DC/AC ratios; Flexible DC-input configuration to meet complex array configuration; Designed for extreme environments, including desert heat and salt prevention; Designed to meet utility scale grid interconnection requirements.

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Solar Connections International
www.metalmaster.com
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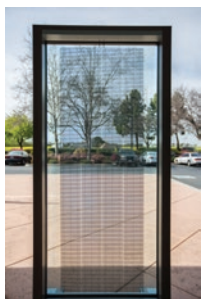


PV inverter-integrated electric vehicle charger

SolarEdge Technologies, Inc. has unveiled their inverter-integrated electric vehicle (EV) charger. By supplementing grid power with PV power, SolarEdge's Level 2 EV charger offers charging up to six times faster than a standard Level 1 charger with its innovative solar boost mode. SolarEdge's HD-Wave inverter, once integrated with an EV charger, will not only provide the existing management and monitoring of solar production, but will also enable EV charging from a single inverter and dashboard. The combined solution will offer considerable cost savings on both hardware and labor by eliminating the need for an additional conduit, wiring, and breaker installation. The solution will also eliminate the need for an additional dedicated circuit breaker, which saves space and a potential main distribution panel upgrade. Based on patent-pending technology, the EV charger is embedded into SolarEdge's HD-Wave inverter and leverages its solar boost mode. This mode utilizes both grid and PV to charge at 9.6kW (40 Amp) Level 2 charging, which is up to six times faster than standard Level 1 charging. If PV is not available, the inverter-integrated EV charger will use grid power to charge at 7.6kW (32 Amp) Level 2 charging, which is up to five times faster than standard Level 1 charging. With a 12-year warranty, the inverter-integrated EV charger offers potential future operating modes, such as demand-response and charging at off-peak hours to optimize Time-of-Use (TOU) rates.

SolarEdge Technologies | www.solaredge.us

Booth 3741



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Deployment of Solaria Corporation's PowerVision-150S enables structures to generate electricity cleanly and reliably. Solaria's solar cell process technology has allowed the company to develop an aesthetic vision glass which can be used in locations not typically associated with solar panels; including skylights, patios, and window openings, providing an electricity generating, see-through surface. Building owners and occupants accrue many benefits, as solar-outfitted windows mitigate the sunlight's effect on a building. When combined with high-efficiency solar PV modules, they offer a seamless strategy to unlock the full power potential of buildings with technologies boosting energy generation, providing high yield at a low cost. Extensively tested and demonstrated at Lawrence Berkeley National Laboratory's FLEXLAB, Solaria PowerVision has proven to deliver a combination of high performance and high power density with optimized thermal performance, effective daylighting, and glare control.

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Booth 2413

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Microgrids

Bringing power to remote regions of the world

by Romina Arcamone Garcia

Establishment of clean energy microgrids worldwide is boosting the power supply to remote villages that are either not connected to the main electric grid, or only have access to diesel-powered electricity for a few hours a day. A battery-based microgrid system ensures that these areas have access to reliable energy 24/7, which allows remote communities to operate lighting, communications, radios, TV, and other electrical appliances. Access to electricity also enhances productivity of local businesses, and fosters the development of new commercial activities.

Microgrids - Giving Opportunities to the Poor

The majority of Haiti has little to no access to grid power; the town of Les Anglais was no exception. Thanks to a grant from the "USAID Powering Agriculture: An Energy Grand Challenge for Development," a hybrid microgrid with battery backup was installed for the Les Anglais community.

This microgrid is the first of its kind in Haiti. It includes 93KW solar PV, a 410kWh deep-cycle lead acid battery bank, and a 30KW backup diesel generator. Smart meters were developed to serve residential and commercial customers, including agricultural processing facilities. After three years of feasibility studies with a small group of customers, This microgrid provides reliable electrical power to the community, which consists of 450 households and businesses, as well as the downtown area of Les Anglais.

Deep-cycle batteries are key components in photovoltaic microgrid applications that require reliable energy storage. They also reduce a project's operating costs, by eliminating or reducing the need for diesel fuel consumption, fuel transportation, and maintenance required by diesel generators. The 93kW solar PV solution is supported by a 480-volt battery bank container solution, featuring 152 deep-cycle gel batteries with 38 batteries per string.

Colombia Micro Grids Bring Power to Remote Villages

The Municipality of Acandi is located in western Colombia, an area that is mainly jungle. It stretches along the Caribbean Sea, bordering Panama. This remote area is not tied to an electrical grid, and residents had access to electricity for just a few hours a day via diesel generators.

The Colombia Ministry of Mines and Energy issued a mandate to expand the availability of electricity to these remote areas by building five solar hybrid microgrids, with a total solar capacity of 191 KWp. This project is the first of its kind in the Choco region, and provides 431 households access to clean, affordable, and reliable energy for the next 20 years.



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One of the greatest incentives for the installation of the five microgrids was to reduce the use of diesel fuel. Not only were the generators noisy and emitted pollutants, but the area can only be accessed by boat, so transportation costs are prohibitively high. In addition, when a generator broke down, the community would have to go without electricity until someone could fix it, which, in these remote locations, could take a very long time.

Today, however, the solar microgrids provide electricity for most of day. Residents don't have to plan their day around the time when electricity would have been available via the diesel generators. Children can now study at night, parents can cook in the evening without the having to use candles, and businesses can stay open after the sun goes down.

With batteries being one of the most expensive components of a microgrid, the economics of the projects required the installation of industrial, high quality, deep-cycle batteries engineered to achieve a 20-year lifespan, as well as having the lowest price per kWh per cycle. The deep-cycle batteries selected also featured a carbon formula to address the inconsistent charging the batteries would regularly experience. This carbon additive enhanced overall battery life, improved charge acceptance, and provided a faster recharge of the batteries.

Reliable access to electricity contributes to expansion and improvement of the community's commercial activities. It also helps attract more tourists to the area. These factors improve the overall quality of life, and allow the residents to have access to improved communications, education, and jobs for many years to come.

Romina Arcamone Garcia is Market Manager of the Latin American division of the Trojan Battery Company, a manufacturer of deep-cycle batteries with more than 90 years of experience.

Trojan Battery Company | www.trojanbattery.com



Off-grid energy scalability without installation

Swiss startup, Power-Blox, offers the new Power-Blox 200 Series, a completely modular and scalable off-grid energy solution requiring no professional installation, maintenance, or configuration. Each Power-Blox 200 cube provides 200W of alternating current and can provide enough power for lighting, one refrigerator, a television, and mobile phone or laptop charging. The cubes can be powered by any external source, including an optional solar panel, a wind turbine, biomass, or a diesel generator, due to incorporated and pre-configured inverters. To increase the amount of power storage in the system, simply add additional Power-Blox without any additional maintenance or configuration. Proprietary electronics and pre-configured inverters enable a truly scalable 'plug and power' architecture for use in almost every off-grid application. The technology is self-configuring and self-learning. In case of failure or grid breakdown, the units automatically disconnect and run as autonomous off-grid power supplies. When two or more Power-Blox are combined, a proprietary technology called Swarm Power causes the individual modules to use machine learning technology to optimize performance and balance power distribution across the entire system. Within a Swarm Power system, the power generation, storage, and distribution are done with a fully decentralized architecture to manage fluctuating current. The energy in the Swarm is stored in nodes and every component of the grid learns how to adapt to the current state of the grid by observing the grid parameters and adapting its behavior with the use of artificial intelligence.

Power-Blox | www.power-blox.com



Ensuring maximum grid stability

Sunny Central Storage is the central component of SMA's solution for integration of utility-scale battery storage systems. These systems enable the integration of large amounts of intermittent renewable energy into the utility grid while ensuring maximum grid stability. Sunny Central Storage is compatible with different types of battery technologies, including all leading manufacturers. It is designed to compensate for fluctuations in solar energy generation, and offers comprehensive grid management services such as automatic frequency control. The battery inverter is optimized for continuous operation at nominal load and temperatures of -25° C to +50° C and is also available as a turnkey solution with a medium-voltage block from SMA. SMA can create customized storage solutions to meet the challenges of individual projects, with advanced technology and a full power class lineup for 1,000V and 1,500V applications.

SMA | www.sma.com



Integrated behind-the-meter energy storage system

Dynapower introduces the BTM-250; a 250kW energy storage system optimized for behind-the-meter energy storage applications where reliability and footprint matter, including demand response/demand charge reduction and backup power. The BTM-250 is a fully integrated energy storage solution coupling Dynapower's smart inverter with Samsung E2 batteries.

Dynapower | www.dynapower.com



Multi-string bi-directional modular storage inverter

Sinexcel's PWS1-500KTL inverter provides a transformer-less and modular design, offering flexibility and cost-savings in shipping, installation, and maintenance. Up to 8 strings with independent DC connections allows different types of batteries to work together at the same time, and can save battery system cost. Transformer-less design offers flexibility to work in different AC systems and with high efficiency.

Sinexcel, Inc. | www.sinexcel.us

Inverter Repowering

Dramatically improving existing PV plant performance and economics

by Neil Shea



With solar becoming the lowest cost source of new energy at less than \$30 per megawatt hour (MWh) and zero escalation, gigawatts (GWs) of Utility-Scale Solar Photovoltaic (PV) systems have been deployed, creating a revolution in the energy business.

Unfortunately, many early projects used immature inverters, which have become extremely unreliable. These inverters cause significant downtime, missed production, lower revenue and returns, significant Operations and Maintenance (O&M) work, and increased consumption of fossil fuel. To make matters worse, some manufacturers of these machines have gone bankrupt or exited the PV market, making spares and repair knowledge scarce. This situation has caused some utility owners to lament, “What good was it being an early adopter of PV?”

Beginning in 2010, gigawatts of Utility-Scale projects have been commissioned each year. Initially, these systems were built with the 600Vdc products from the industry-leading inverter suppliers of the time. The typical design had two to four 500-kilowatt (KW) inverters on a pad with a shared medium voltage (MV) transformer. Unfortunately, after nearly a decade in the field, these machines have become unreliable, with one utility company observing that they “can’t keep up” with inverter repairs (despite dedicating four O&M technicians to service 150 megawatts). Another owner noted their 100MW+ plant experiences weekly inverter failures, with equipment down for weeks, due to the OEM’s lack of responsiveness, even for products under warranty. This reality is incredibly expensive for the industry in terms of lost production and major unanticipated costs for O&M teams and spare parts.

Fortunately, there is a solution. Like all components in the PV value-chain, inverter technology has improved in efficiency, power density, reliability, and price. Modern central and string inverters enable rapid and low-cost repowering, with payback terms of 3-5 years before the ITC, through increased production/revenue and lower O&M costs.

Today’s inverters come in 1000Vdc and 1500Vdc versions, run at 98.9 percent maximum efficiency (versus 97 percent for installed hardware) and have dramatically improved reliability (up to a 55 year MTBF) with quick spare installation. What’s more, the increased power density of the new models allows for small footprints, meaning existing pads and MV infrastructure can be retained. It’s beneficial to repower - the price point for these inverters is 80 percent less than the 2010 vintage machines.

While each system is different, and requires a specific evaluation of single-lines combined with aerial IR inspection, some best practices apply when planning an inverter repowering. The first objective is to **change as little as possible**. This starts in the DC field, where the goal is to retain modules, cabling, and combiner boxes. Another critical item to retain is the MV transformer, an expensive component with

a great deal of life left at the 10-year mark. Preserving these original components will minimize labor, downtime, and permitting costs. Next, for 600V systems, string voltage needs to increase for the new 1000V inverters’ MPPT. One way to achieve this is through DC-DC Optimizers. These components combine existing strings, present a higher MPPT voltage to the inverter, and can increase the DC energy available for conversion up to 3 percent by improving the original field’s string mismatch. Furthermore, the higher combined strings’ voltage turns inverters on earlier in the day, and off later at night. While systems are modeled to lose 0.5 percent of production annually due to module degradation, in the real world, strings degrade at different rates. Optimizers increase high degradation strings’ voltage that lowers overall degradation 0.25 percent per year, or 6 percent over 20 years.

Earlier systems utilized 500KW central inverters on a skid, with 35 SF footprints weighing 3,670 pounds. These can be replaced with five 100KW string inverters with 1’ x 2.33’ footprints, and weighing 165 pounds per inverter. The small footprint creates an opportunity to retain much of the skid, DC & AC cabling, and MV infrastructure. With monitoring and on-site spares, it also enables a 2-hour replacement. Alternatively, two 500KW inverters can be replaced with a central 1,000KVA inverter that has a footprint equal to one 500KW inverter.

Repowering larger inverters requires careful analysis around reusing the transformer, and minimizing skid rework and crane time. 1MW 600V inverters can use a DC/DC optimizer with all the optimizer benefits described above, and can be directly replaced with a modern 1000V, 1,000KVA Inverter. 1000V systems can be replaced directly with a 1000V 1,165kVA system, or use DC-DC optimizers to step string voltage up to 1500V to leverage 1,800kVA inverters, with approximately 20 percent better CAPEX.

The cost to implement a repowering, while project dependent, includes evaluation and engineering, new inverters, cabling labor, and may require new



Sinexcel



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500kW

Scenarios

Grid-interactive PV + Storage	Grid-forming Storage only
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Contacts:

Sinexcel Inc.	Tel : +1 443 742 9198	SPE Booth 737
	E-Mail : henry@sinexcel.us	Web : http://sinexcel.us/

combiner boxes (and some lost production during installation). If minimal system changes can be achieved, this cost can be in the mid-single cent/W range.

After repowering, owners enjoy dramatic economic benefits. The improved inverter efficiency increases production almost 2 percent. A field demonstrating 97 percent availability can be updated to more than 99.5 percent availability with Performance Guarantees. New inverters have optimized cooling systems, increasing high temperature production during valuable peak demand. If optimizers are deployed, the DC available for conversion can be as much as 3 percent higher. Altogether, repowering results in up to 7 percent more production and revenue. Additionally, O&M costs are significantly reduced. A large project experiencing weekly failures requiring truck rolls may spend \$1,000 to \$8,000 per roll (depending on repair duration and cost of parts) on top of the cost of dedicated technicians. Eliminating such costs can mean six-figure savings each year. The cumulative repowering benefit drives a 3-5 year payback (before taking the 30 percent ITC) for projects with PPA rates of \$0.07-0.11/kWh. Some firms in the renewable financing sector can mitigate repowering costs by writing short-term loans, which are cash-flow positive for the 5 years, until the loan is paid back.

A remarkable revolution has occurred in the last decade, making PV the lowest cost source of energy. The pioneers who first adopted solar power have assets that can benefit from new and improved technology. Using state-of-the-art inverter and optimizer technology, these owners can enjoy increased production and revenue, with the low operating expense they were promised.



Neil Shea spent 25 years in the semiconductor and technology business at companies like Intel, VLSI Technology and multiple start-ups in a variety of Business Development, Marketing and General Management roles. In 2007, Neil joined the solar business helping launch a PPA start-up, worked to build SOLON's North American module manufacturing, Development and EPC businesses before driving Gehrlicher Solar / M+W's EPC and Development efforts. Currently, Neil is at Ingeteam helping build its PV Inverter, Storage & repowering business.

Ingeteam Inc. | www.ingeteam.com



New solar AGM line of true deep-cycle batteries

Trojan Battery Co., LLC, has launched its new line of maintenance-free, true deep-cycle absorbent glass mat (AGM) batteries specifically designed for solar and other renewable energy applications. The new Trojan Solar AGM line is manufactured in the U.S. Offering a three-year warranty for stationary applications, and tested to an eight-year design life under IEC 61427 standard for solar batteries, this initial release includes a wide range of Trojan Solar AGM models. With its non-spillable design, the new Trojan Solar AGM batteries enable installers to customize the use and position of the batteries in customer applications, and are certified for non-hazardous shipping per U.S. DOT/IATA regulations.

Trojan Battery Company

www.trojanbattery.com



Versatile megawatt-scale energy storage solutions

Northern Power Systems Corp now offers a full suite of megawatt-scale energy storage solutions incorporating various battery types and capabilities, depending on the application and end-user need. In addition to providing multiple battery options, NorthernPower can integrate its own power conversion and control hardware to deliver the optimum energy storage system. Northern Power's energy storage systems incorporate batteries from UniEnergy Technologies, Eos Energy Storage, and Samsung SDI together with the company's FlexPhase power conversion platform, controls, battery management hardware, and ancillary systems. The company is currently working on multiple projects using the different battery technologies and anticipates adding to this list of solutions.

Northern Power Systems

www.northernpower.com



Scalable outdoor power conditioning and energy storage system

Delta Group has released its scalable outdoor Power Conditioning System (PCS) and new scalable Energy Storage System (ESS) allowing up to 500kW and eight hour energy storage capability. The company's portfolio of renewable energy power conversion and energy storage technologies are intended for commercial, industrial, and utility scale applications. The flexible Delta ESS Cabinet incorporates and allows dual sourced lithium-ion battery modules for supply chain risk abatement, a Battery Management System (BMS), and an integrated thermal management HVAC system for outdoor rated applications. The scalable ESS supports two, four, and eight hour energy storage when coupled with Delta's scalable 125kW – 500kW power conditioning system. The ESS paralleled cabinets have a scalable capacity up to 1.32MWh. The ESS enclosure is IP55 rated for dust and water protection. The ESS Cabinet satisfies a multitude of field capacity requirements and allows deployments in demanding environments. Through high energy density and an extended lifecycle, the ESS Cabinet supports commercial buildings and behind the meter applications to optimize energy usage and lower operational costs through demand charge management (peak shaving, time-of-use optimization via load shifting, power backup, renewables self-consumption optimization, and ancillary power services).

Delta Group | www.deltaww.com



Li-ion battery pack for any electric forklift

Romeo Power introduces THUNDER PACK- C, a lithium-ion (Li-ion) battery pack designed to be adapted for any electric forklift make or model. Like its predecessor, the THUNDER PACK - J 2.0, THUNDER PACK - C is safe, non-toxic, and energy efficient with a significantly long cycle life. Romeo Power THUNDER PACKs are warranty-backed to last 4,000 cycles – approximately 12 years – deliver quick recharge, require no maintenance, and produce zero emissions and zero odors. All Romeo Power battery packs are engineered to exceed government safety requirements and include an advanced battery management system based on control-oriented, physico-chemical models. Combined with the company's innovations in thermal engineering, manufacturing processes, and the materials chosen to connect components, Romeo Power battery packs have small space requirements and offer enhanced state-of-charge (SOC) and state-of-health (SOH) monitoring.

Romeo Power | www.romeopower.com



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www.canwea.ca

show in print

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



Community friendly obstruction lights

Technostrobe has been manufacturing obstruction lights for tall towers since 2001. Their LED lighting systems can be combined with LIDS Technology to insure the intensity of the lights on a wind farm are adapted to the surrounding visibility, thereby helping the site become more community friendly. Their customer base extends across North-America and involves projects representing more than 4000MW of installed power.

Technostrobe | www.technostrobe.com



Ensuring and proving bolting accuracy

RAD Torque Systems’ innovative Smart Sockets can help ensure a torquing procedure is working properly. It provides essential proof that the work was done and it was done well. The RAD Smart Sockets store important logs while torquing, which can be accessed later by an Android device or PC. The integrated transducer measures torque directly on the head of the bolt, which eliminates many variables in the application during use.

RAD Torque Systems
www.radtorque.com



Grounding cable for wind farms

Grounding cables improve both capital and O&M costs up to 40 percent. Copperweld cables replace theft-prone copper cables for grounding. Proper grounding saves turbines, transformers, and electronic circuits from severe damage during lightning or fault conditions. Copperweld’s metallurgical bond process provides owners, developers, and contractors with cost-efficient grounding cables from tower base to collector system through substations.

Copperweld | www.copperweld.com



Wind power plant and service solutions

Wind turbine manufacturer and service provider, Vestas, has over 85GW installed in 75 countries, including over 3000MW installed and 3000MW under service in Canada. Vestas works in close partnership with customers to offer effective solutions to harness the clean, low cost power of wind energy. Their core business is the development, manufacturing, construction, sale, and maintenance of wind power plants, with competencies covering every aspect of the value chain from site studies to service and maintenance.

Vestas | www.vestas.com



Renewable energy wire and cable solutions

General Cable provides wire and cable for the generation, transmission, and distribution of electricity from wind energy globally. From the nacelle and tower of the wind turbine, to the step-up transformer and the collection system, and from the substation to the power grid, they provide a broad range of traditional and next-generation renewable energy products for the terrestrial and offshore wind markets. A complete cable solution—from optical fiber and grounding wires for SCADA systems, low-voltage DC and AC connections, and medium-voltage distribution, to high-voltage overhead, underground, and submarine transmission lines, is engineered to withstand the demands of entire wind power system.

General Cable | www.generalcable.com



Grounding solution with corrosion protection

SAE Inc., a grounding solutions manufacturer, announces the launch of a new conductive liquid backfill: ConduFlow. This product can replace traditional grounding backfills, as well as transform how companies approach and implement grounding systems. ConduFlow is a dust free, conductive carbonaceous pourable backfill material that is installed as a liquid and cures as a solid. ConduFlow eliminates health and safety concerns associated with current powdered backfill materials and provides corrosion and theft protection. It can be poured on exposed rock surfaces to protect conductors where trenching is not possible. With an expected in-service time that is up to 20x the industry standard, electrode corrosion is virtually eliminated.

SAE, Inc. | www.saeinc.com



Project development and O&M

EDF EN Canada develops and builds wind and renewable energy projects which harness the earth’s renewable resources, helping to drive the green energy economy and industry. With over 1,600MW throughout Canada, they have experience in all areas of project development, including: site selection; procurement; financing; permitting; project planning and construction; long-term management; operations and maintenance (O&M); as well as project de-commissioning and repowering. Their O&M affiliate, EDF Renewable Services, ensures ongoing profitability for project owners and investors by providing a full range of expertise and O&M services. With 10GW of energy under contract, EDF Renewable Services is a provider of third-party operation and maintenance services in North America.

EDF EN Canada
www.edf-en.ca | www.edf-rs.com



High efficiency onshore wind turbines

The Nordex Group has installed more than 21GW of wind energy capacity in over 25 countries. The product portfolio of the group is focused on multi-megawatt onshore turbines with rated power from 2.4 to 3.9MW for nearly all geographical regions: from grid-constrained, land constrained, unrestricted projects to sound restricted, and very complex terrains. Anti-icing system, cold climate versions, a dense service network, preventive maintenance, and end-to-end modernization are also part of the company's offer.

The Nordex Group
www.nordex-online.com



Condition monitoring systems

Bachmann Monitoring offers comprehensive condition monitoring system (CMS) solutions consisting of stand-alone to fully integrated options, installation offered worldwide, remote monitoring services delivering greater than 99% detection rate, and a multitude of training options. Bachmann provides custom designed CMS solutions with guaranteed high availability and backwards compatibility maintained with every new product rollout, to ensure their customers' wind turbines will be equipped with the latest in predictive maintenance technology throughout their lifetime.

Bachmann Monitoring
www.bachmann.info



Combined breaker & grounding switch

EMA Electromechanics' VDH/GSMI combined 34.5kV outdoor vacuum circuit breaker and high-speed, mechanically interlocked grounding switch is specifically designed for wind power projects. This patented system for switching and grounding of wind collection circuits replaces traditional use of oil insulated grounding transformers combined with conventional circuit breakers in every feeder of a wind power substation, making green energy greener.

EMA Electromechanics, LLC | www.emaelectromechanics.com



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Money Motivates

Cost reduction is still the top driver of energy efficiency adoption

by Mitchell Rosenberg

Despite three decades of heavy marketing of energy efficiency by utility programs, service and product vendors, and government, large and mid-sized commercial facilities can still do more to reduce business costs and emissions. These facilities account for roughly ten percent of non-transportation energy use in the United States.

Recent engineering and economic studies consistently find that the typical large and mid-sized commercial facility could cut their energy consumption by twenty to thirty percent, through capital and operating improvements that satisfy most firms' internal investment criteria. However, in many areas of the country, participation in energy efficiency programs by commercial facilities has begun to decline, threatening the achievement of state environmental goals.

Study Motivation and Objectives

For program delivery and analytic services in the energy efficiency industry, it's important that both providers and their customers understand the energy efficiency-related actions and attitudes of commercial facilities decision makers. A recent, annual survey sought to explore the following questions:

- What are large and mid-sized customers doing to manage energy use and costs?
- In what specific ways do these activities support broader business goals and values?
- What distinguishes firms that actively pursue energy efficiency, from those that do not?
- What broad areas of opportunity to increase energy efficiency remain?
- How do customers respond to energy efficiency service offerings and public programs?

Study Methods

In 2015, the survey focused on managers in a nationwide sample of five hundred commercial facilities, with more than one hundred employees. The sample was designed to be representative of the national population of such facilities, in terms of building type (principal use) and number of employees. The sample was administered online to a panel maintained by Survey Sampling International. Surveys were completed in December 2015 and December 2016.

The Findings

Results of the 2015 and 2016 were similar. Using the 2015 study, results can be grouped into the following major themes:

1. Most large and mid-size commercial facilities pursue energy efficiency through capital investments and O&M. However, significant opportunities remain in inactive market segments, and for improved energy-related O&M in all segments.

Energy Management Policies and Practices

- 65% of facilities set energy savings goals.
- 50% of facilities engage executives in reviewing progress against savings goals.
- 51% of facilities employ energy managers
- 73% of facilities track energy use on an ongoing basis

While the prevalence of basic energy management practices is encouraging, the findings indicate that roughly a third of large and mid-sized facilities have not adopted these practices. These facilities and their owners represent a prime target of opportunity for greater energy savings.

Energy-Related O&M

Managers were asked whether or not they regularly undertook six common energy-related O&M practices, including preventive maintenance of HVAC equipment, and testing of controls to verify settings and control sequences. Only thirty five percent of respondents reported implementing three or more of these practices. Another thirty five percent reported implementing one or none.

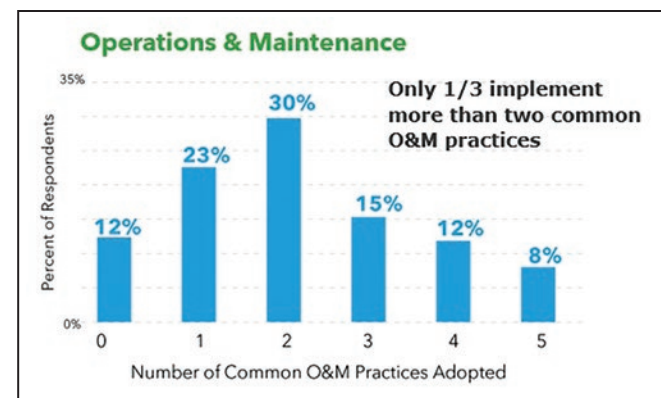


Figure 1: Adoption of O&M Practices

Capital Improvements

Forty-six percent of facilities undertook capital improvements valued higher than \$50,000 over the two years prior to the survey. Energy efficiency was the major driver and component for these improvements.

- 58% of facilities with major capital improvements identified reducing energy costs as a key project objective; 30% identified reducing energy costs as the most important objective for all capital improvements.
- 89% of all major capital improvements included at least one energy efficiency measure; 67% included at least two measures; 35% included at least three measures.

2. While adoption of energy efficiency practices and capital measures are related to conventional segmentation variables (such as facility size and use), corporate policy and leadership support have a far stronger statistical association with those activities.

- After controlling statistically for the effects of facility size, composite indices of adoption of capital measures, O&M practices, and energy management, activities were significantly higher for firms that set energy savings goals and received executive support for energy efficiency activities, than for those that didn't.

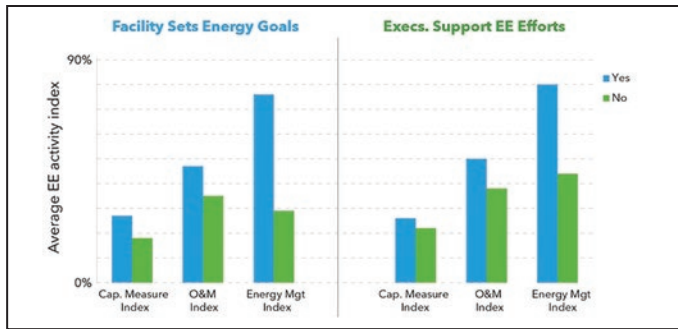


Figure 2: Effect of Goal Setting and Executive Leadership on Energy Efficiency Activities

3. The majority of facility managers view energy efficiency as proven cost control and investment strategy.

Most sample managers believe that energy management and efficiency investments advance core business values, including customer and staff retention and improved profitability.

- 53% strongly agree that energy efficiency is “very important to the financial success of my organization.”
- 84% of facilities that installed energy efficiency measures reported that they led to at least one of the following business benefits:
 - o Reduction in energy costs – 55%
 - o Reduction in O&M costs – 47%
 - o Reduction in occupant complaints – 45%
 - o Increase in worker productivity – 45%

4. Customers in states with strong utility programs showed higher levels of adoption of a selected range of energy efficiency.

Rates of adoption of various measures and practices were compared between facilities in states among the top 13 for energy efficiency programs and policies (as rated by the American Council for an Energy Efficient Economy). Facilities in strong program areas had significantly higher levels of adoption (at the time) of advanced energy efficiency products such as LED lighting and high efficiency HVAC, as well as for energy-related O&M in general. However, equipment vendors have a higher influence on energy equipment purchases than utility or government programs.

Implications for Energy Efficiency Programs and Policies

The findings suggest two effective strategies to reach inactive customers.

- Using workshops, case studies, and other publicity, recruit local business leaders in strategic, local economic sectors, to serve as ambassadors for the energy efficiency business case. They will be best at convincing peers and competitors to establish goals, and direct management attention to energy efficiency practices, both of which are strongly related to the adoption of capital and operating measures.
- Tap into local vendors to sell energy efficiency. This “trade ally” strategy is commonplace, but the current market calls for excellent execution.



Mitchell Rosenberg is a Director in the Sustainable Energy Use Services business unit of DNV GL. He has over 30 years of experience in market research and the design, delivery, and evaluation of energy efficiency programs. Rosenberg headed the Commercial Facility Pulse Survey to characterize the attitudes of commercial facility managers toward energy efficiency and to use these insights to identify strategies to increase program participation in that segment.

DNV GL | www.dnvgl.com



Industrial-grade pre-assembled cooling tower

SPX Cooling Technologies, Inc., announces the new Marley NC Everest Cooling Tower, a pre-assembled, crossflow evaporative cooling system offering a viable alternative to field-erected towers. The NC Everest provides a high cooling capacity in a pre-assembled cooling tower and reduces pump energy up to 20%. The design and field assembly process reduces on-site labor and work duration for a safe work environment. NC Everest provides more site placement options and typically uses up to 10% less plan area than field-erected towers. Built with industrial-strength materials and engineered to withstand the rigors of power and heavy industrial applications, the NC Everest features a heavy gauge steel structure, Marley Geareducer, and robust mechanical components. The integral cold water basins eliminate costly concrete basin construction. Seven-foot doors provide access to the tower’s interior service decks and mechanical components, making routine inspections and maintenance safe and easy. Featuring the new, patent-pending MarKey Drift Eliminator, the NC Everest Cooling Tower achieves low measurable drift, down to 0.0005% of circulating water flow, so less water escapes the tower. The NC Everest is Factory Mutual approved for use without a fire protection system to allow more affordable operation insurance.

SPX Cooling Technologies, Inc. | www.spxcooling.com



On-demand ventilation management systems

Ventacity Systems offers sentient ventilation management solutions with 24/7 intelligent on-demand operation for dedicated outdoor air systems (DOAS). Ventacity’s Smart Building Gateway (SBG) technology provides secure, round-the-clock remote performance monitoring and fault alerts, via an automatically configured mobile internet connection. It monitors conditions including indoor/outdoor temperature, relative humidity, and occupancy status. Additionally, the SBG connects with sensors to automatically detect and reduce unhealthy levels of CO₂ or volatile organic compounds (VOCs), to maintain a healthy indoor environment. All of Ventacity’s systems are easily installed, and engineered to Passive House Institute U.S. (PHIUS) standards for a long life of high performance.

Ventacity Systems | www.ventacity.com

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St. Paul, MN; www.energyfair.org
- 10-13 **SPI 2017**
Mandalay Bay Convention Center – Las Vegas, NV; www.solarpowerinternational.com
- 19-21 **tcbiomass 2017**
Radisson Blu Aqua – Chicago, IL; www.gastechology.org/tcbiomass
- 20-21 **AWEA Fall 2017 Committee Working Meeting**
Renaissance Minneapolis Hotel, The Depot – Minneapolis, MN; www.awea.org
- 27-29 **AWEA Wind Resource & Project Energy Conference 2017**
Snowbird, UT; www.awea.org

OCTOBER

- 02-04 **Solar Connect**
Hyatt Regency La Jolla – San Diego, CA; www.infocastinc.com/event/solar-connect
- 03-05 **The 33rd CanWEA Annual Conference & Exhibition**
Palais des Congrès de Montréal – Montreal, QC; www.windenergyevent.ca
- 11-13 **2017 Electrical Energy Storage Applications and Technologies (EESAT)**
Westin Hotel – San Diego, CA; www.energystorage.org
- 12 **ACORE Finance West**
The Bently Reserve – San Francisco, CA; www.acore.org
- 19-20 **Solar Power Midwest**
Sheraton Grand Chicago – Chicago, IL; www.events.solar/midwest
- 22-24 **Renewable Energy Markets 2017**
New York Hilton Midtown – New York, NY; www.renewableenergymarkets.com
- 24-25 **2017 AWEA Offshore WINDPOWER Conference & Exhibition**
The Roosevelt Hotel New York – New York, NY; www.awea.org
- 25-26 **AWEA Wind Energy Finance & Investment Conference**
The Roosevelt Hotel New York – New York, NY; www.awea.org/finance

NOVEMBER

- 06-08 **Microgrid 2017 Conference & Exhibition**
Boston Park Plaza – Boston, MA; www.energystorage.org
- 07-09 **AWEA Wind Energy Fall Symposium**
Albuquerque, NM; www.awea.org
- 14-15 **Energy Storage STUDIO**
The Westin – Cleveland, OH; <http://studio.energystorage-events.org>
- 29-30 **Solar Business Festival 2017**
Hilton Downtown Hotel – Austin, TX; www.sbf-texas.com

DECEMBER

- 04-05 **Solar Canada**
Metro Toronto Convention Centre – Toronto, ON; www.solarcanadaconference.ca
- 11-12 **Solar Power New York**
New York Marriott at the Brooklyn Bridge – New York, NY; www.events.solar/newyork

JANUARY 2018

- 25 **Southeast Wind Conference**
Loews Atlanta Hotel – Atlanta, GA; www.awea.org

FEBRUARY 2018

- 05-06 **Solar Power Northeast**
Westin Boston Waterfront Hotel – Boston, MA; www.events.solar/northeast/
- 27-28 **AWEA Wind Project O&M and Safety Conference 2018**
San Diego, CA; www.awea.org

MARCH 2018

- 07-08 **SEIA's Inaugural Codes & Standards Symposium**
Santa Barbara, CA; www.seia.org/codes
- 19-22 **NABCEP 2018 CE Conference**
Conference & Event Center Niagara Falls – Niagara Falls, NY; www.nabcep.org
- 20-21 **AWEA Wind Project Siting & Environmental Compliance Conference 2018**
Memphis, TN; www.awea.org

Page	Company	Website
17	3M (solar)	3m.com/solarnace
84	American Earth Anchors	americaneearthanchors.com
86	American Polywater	www.polywater.com/solarpanelwash.html
64	AP Alternatives LLC	apalternatives.com
67	Arconic	afshuck.net/solar
31	Arctech Solar	www.arctechsolar.com
42	Axitec, LLC	www.axitecsolar.us
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86	Continental Control Systems	www.ctlsys.com
73	Crown Battery	www.crownbattery.com
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69	Dynapower	dynapower.com
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37	Green Energy Experts	greennrgexperts.com
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83	HuksefluxUSA Inc	www.hukseflux.com
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84	Matenaer	matenaerenergyproducts.com
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