

North American **Clean Energy**

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2017 SOLAR Buyers Guide

A Storage + Solar Microgrid

Providing multiple values for diverse stakeholders

Managing Blade Icing

New research and tools for anticipating icing events

Net Metering in North America

Allowing energy storage to enter a new era

Plus Show-in-Print Feature:

- 2017 Solar Power NE

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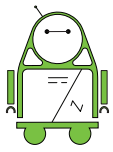


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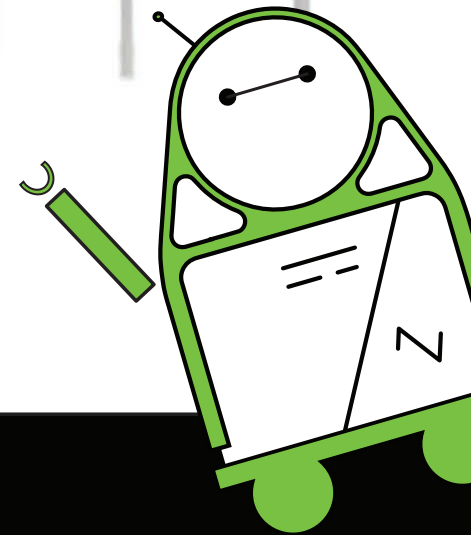
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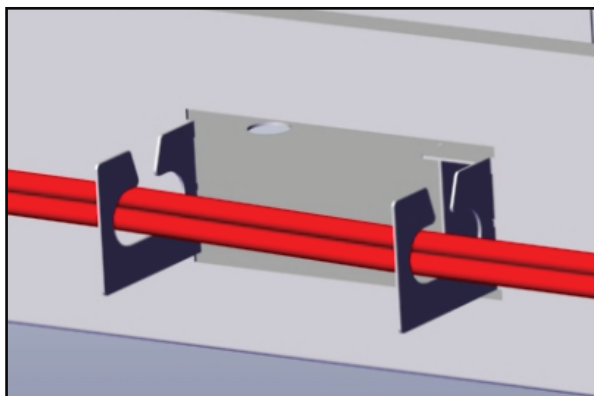
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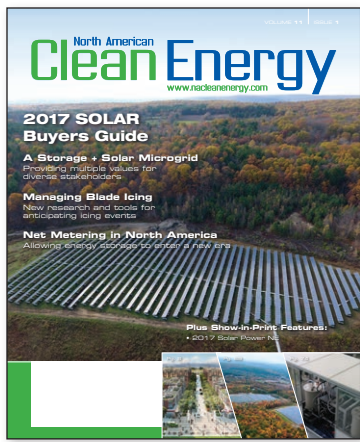
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On our cover...

Standard Solar, Inc., completed the installation of a 3.4 megawatt (MW) solar system for the Town of Stafford, Conn. The 11,780 panel virtual net-metered system featuring three arrays: two at Stafford Middle School (1.296 MW each) and an 848 kilowatt (kW) array at the Town's closed landfill, will offset all of the school's electrical usage and most of the Town's other municipal buildings.

Standard Solar, Inc.
www.standardsolar.com

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TAKE A DEEP BREATH. YOU'RE NOT COASTING ON COOKING OIL FUMES

in your parents' ancient VW van, and you don't need to send a funeral wreath to the EPA. Clean energy is here to stay. The proof is in the job numbers. According to a recent study by the Ecotech Institute, clean energy companies offered job seekers about 1.2 million openings in the first quarter of 2015. That's not a small number, and it will grow as the market for renewables continues to expand. The industries will have to wait to see how any new policies play out, and whether or not they will affect current federal subsidies. However, Maggie Koerth-Baker, senior science writer for FiveThirtyEight, assures us...

"...the health of these (wind and solar) industries isn't entirely dependent on the federal subsidies. At this point, there are subsidies and incentives at every level of government, just as there are for fossil-fuel companies. States, counties, municipalities, utility companies and even neighborhood associations all have policies that affect wind and solar, regardless of what happens at the federal level."

Statistics appear to support her optimism. Dsire, a DOE-funded organization that tracks renewable energy policies and incentives by state, lists offerings for every state in the union, from a minimum of 11 in West Virginia, to a maximum of 187 in California. Public sentiment also supports the growth and expansion of clean energy. A March 24, 2016 Gallup poll showed that 73% of United States residents prioritize alternative energy over oil and gas. Businesses have started to take notice. Brady Dennis at The Washington Post heralds the awakening of the giant corporations to the benefits of wind energy. Dennis cites...

"...the growing demand for wind energy from major corporations. High tech firms such as Google Energy, Facebook and Amazon Web Services, as well as more traditional companies such as Procter & Gamble, General Motors, Walmart and Dow Chemical, have signed contracts to purchase increasing amount of wind energy in coming years."

Solar energy shows a similar growth in adoption by major corporations. The Solar Energy Industries Association's (SEIA) 2016 Solar Means Business report, showed Walmart, Target, Walgreens, Kohl's and Costco leading in number of installations. Major companies tracked by SEIA installed 142 MW in just the first three quarters of this year, compared to 130 MW total in 2015.

Americans are voting increasingly in favor of renewable energy. They want to feel good about their choices, both financially and ethically. To you, our readers, we say, "keep up the good work." The sun will keep shining, and the wind will keep blowing, and we will keep beating the drum for a clean energy future.

Enjoy the read...

Meg and Jill



Smartwatch that never needs charging

Matrix Industries unveiled the Matrix PowerWatch, the world's first smartwatch that uses thermoelectric technology so its battery never needs recharging or replacing. Launched on Indiegogo, the device employs nano-materials, advanced thermal engineering, and low power electronics to run exclusively off body heat. It also uses this technology to measure calories burned and show power generated from the body. The rugged aircraft-grade aluminum timepiece functions as a smartwatch that wirelessly syncs with a smartphone, automatically adjusts to the current time zone, and has changeable watch faces. The device also features advanced activity, sleep, calorie, and power tracking functionality and stores up to a year's worth of data. When the watch is removed, it automatically goes into sleep mode, keeping all the data in memory; it turns on after a few seconds when it's put it back on. The Matrix PowerWatch has a high contrast display, comes with a military-grade nylon strap, and is water resistant up to 50 meters. It is the only smartwatch in the world to feature a power meter which indicates power being generated and power generated for the day.

Matrix Industries | www.matrixindustries.com



Wind energy foundation market size worth \$241.14 billion by 2024

According to a new report by Grand View Research, Inc., increasing concerns over depleting petroleum resources has resulted in influencing growing demand for renewable energy. Wind energy is gaining momentum over the past few years on account of major capacity additions owing to the declining prices. Recently there have been dramatic reductions in costs on account of increasing research and development. Growing demand for expansion of electricity generation and access is expected to be a major driver for the industry over the forecast period. Strong government initiatives and subsidies for the development of renewable energy is expected to be crucial factor for growth of the industry over the forecast period. Further key findings from the report suggest:

- Offshore wind energy foundation segment is expected to witness revenue growth at a CAGR of 14.9% from 2016 to 2024. Offshore wind turbines have large power capacities and are now being installed even in deep water.
- Onshore wind energy foundation market was valued at USD 52.01 billion. The onshore category has dominated the foundation market over the past several decades owing to reasonable cost for installation.
- North America is a major market for foundations owing to the availability of best wind resources coupled with low prices as compared to other countries.

Grand View Research | www.grandviewresearch.com



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A Solar+Storage Microgrid

Providing multiple values for diverse stakeholders

by Matthew Crosby

PEÑA STATION NEXT IN DENVER, COLORADO, IS QUICKLY BECOMING A NATIONAL model for smart and sustainable technology deployment through a unique public-private partnership. By applying cutting-edge, smart, and sustainable technology and solutions including smart mobility, smart energy, city services, smart buildings, and health and wellness, this mixed-use, transit oriented development aims to provide an unparalleled “live, work, play” experience for businesses, employees, and residents. Peña Station NEXT partners—Denver International Airport (DEN), utility Xcel Energy, the City and County of Denver, sustainability-minded real estate developer L.C. Fulenwider LLC, and anchor tenant and technology provider Panasonic—are working together to realize the vision of a smart and sustainable Colorado aerotropolis.

Smart and sustainable

Peña Station NEXT is a 400-acre transit-oriented development located southwest of DEN, adjacent to the Regional Transportation District’s 61st & Peña Station rail stop, along the University of Colorado A Line train that links downtown Denver with DEN. Fujisawa Sustainable Smart Town, a smart and sustainable development in Fujisawa, Japan, near Tokyo, was the inspiration for this global smart city showcase.

The first phase of development includes: a 700-space parking lot for DEN, the new operations hub for Panasonic Enterprise Solutions Company and Panasonic CityNOW, a hotel, an apartment complex, and the 2017 and 2019 U.S. Solar Decathlon competition site. This location is powered by a feeder that has 20% solar penetration, which will increase to 30%, when the initial phase is complete.

Smart and sustainable solutions deployed within Peña Station NEXT include: networked LED street lights, smart parking, community Wi-Fi, electric vehicle charging stations, autonomous electric shuttles to create a seamless mobility experience, smart bus shelters, and interactive digital signage. One of the first components nearing completion is a multi-purpose, solar-plus-storage microgrid.

Solar+storage microgrid pilot

This multi-use solar-plus-storage system illustrates the value of a grid, customer, and utility stack. The Peña Station NEXT microgrid project comprises five core elements:

- 1.6MWdc carport solar photovoltaic (PV) installation located over the DEN parking lot; DEN will own the carport canopy structure, while Xcel Energy will own the solar PV system and will operate it under a long-term lease agreement with DEN, and offers additional, non-energy benefits such as covered parking;
- 259kWdc rooftop solar PV array installed atop an office building;
- 1MW / 2MWh lithium ion battery system located in an outdoor-rated enclosure;
- A corporate Denver operations hub building will serve as the initial anchor load for the microgrid; a high-tech, energy-efficient office targeting LEED Gold and net-positive energy, with an intelligent building energy management system;
- Switching and control systems to operate the battery energy storage system and microgrid functionality.

The microgrid represents a “portfolio” model differing from typical microgrid designs. “Conventional” microgrids often focus on a single business case for a single entity, like a university or corporate campus. The portfolio approach extends the stack of values to the multiple stakeholders individually, and the public-private partnership as a whole. Leveraging a stack of multiple capabilities is key to making battery storage systems more cost-effective today, by bolstering their total net value, even in advance of ongoing cost declines. The microgrid is intended to serve five use cases:

- Solar grid integration, via ramp control and smoothing, will maintain distribution grid reliability and power quality on a part of the grid that already has high solar penetration;

- Grid peak demand reduction will discharge the battery to offset times of high load, such as air-conditioning demand during hot summer afternoons;
- Frequency regulation will help manage energy supply for the overall grid, and customers requiring consistent, high-quality energy (e.g., data centers), through rapid response mechanisms;
- Energy arbitrage will help offset expensive electricity demand during peak hours by charging the battery during off-peak, low-price times, and discharging during high-price hours;
- Backup power ensures resilience for the corporate facility, where a state-of-the-art network operations center demands 24/7 uptime.

Some use cases will be engaged more frequently than others, depending on grid and stakeholder needs. Overall, they will be evaluated as part of the initial two-year battery pilot program at the Peña Station NEXT microgrid, to determine the complementary value propositions for battery energy storage. Once the microgrid is live in the second quarter of 2017, the project partners will gather data to review real-world performance, and make refinements over time to ensure optimal settings for the remainder of the battery’s estimated 10-year life span.

This microgrid’s benefits accrue to different combinations of the core stakeholders, adding immediate value, as well as the potential to offer business models that could support deployment of similar microgrids and component technologies in Colorado and beyond. This project exemplifies how stakeholders of Peña Station NEXT are raising the bar for real estate development by creating a smart city allowing residents, businesses, and visitors the opportunity to live healthy, responsive, and connected lifestyles.

The utility’s renewable energy goals

The microgrid supports broader efforts to integrate an increasing amount of renewable energy onto the grid. The Colorado renewable energy standard (RES) and declines in solar and wind power costs have resulted in a recent surge of renewable energy resources in Colorado. In September 2016, the Colorado Public Utilities Commission (PUC) approved the development of one of Colorado’s largest wind farms; the 600MW Rush Creek wind facility on the Plains in eastern Colorado.

Colorado is ranked ninth in the nation for installed solar capacity, with 540MW of solar energy installed as of April 2016. Distributed rooftop solar photovoltaic (PV) systems are proliferating, especially among many Denver metropolitan region neighborhoods. In addition, investments in advanced metering infrastructure and related communication technologies will help manage the grid more efficiently, including integration of distributed resources. Other public and private parties share this interest, both to support the grid and sustain technological and market opportunities for renewables’ continued growth.

Matthew Crosby currently leads utility solutions for Panasonic’s CityNOW (smart cities) work. He previously served as a manager in the electricity practice at clean energy think tank Rocky Mountain Institute, including serving on the core team that is a strategic advisor to New York’s high-profile Reforming the Energy Vision regulatory proceeding. Crosby’s prior roles have included serving as program manager for progressive utility Austin Energy, as an energy analyst for the California Public Utilities Commission, and as research division manager for Pecan Street, which focuses on data-centric approaches to innovation in electricity and water.



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Wind Power Siting and Communities

How to avoid a Standing Rock situation

by Soledad Mills

Whether land-based or offshore, siting wind farms is a tricky process. Companies have to deal with complex permitting requirements, technical feasibility considerations, wildlife and environmental impacts, local politics, and landowner and community concerns.

As turbines have grown in size and utility-scale projects can take up several thousand acres, local communities have increasingly voiced concerns about impacts on health, their visual landscape, wildlife, and land use. Projects may also raise questions about land ownership and benefit sharing, which can lead to conflicts within communities.

As any developer knows, delays in the design and build phases of a project can have far-reaching financial, and in some cases legal, implications. In addition to meeting permitting requirements, developers are faced with the need to meet the expectations of local communities and gain a “social license” to operate. The Business and Human Rights Resource Centre (BHRRC) recently surveyed¹ 50 renewables companies on their commitments to community consultation and human rights. They found the number of human rights allegations against wind power projects is increasing, and failure to adequately consult communities is driving rising levels of resistance to renewable projects in many countries. BHRRC is planning to release an investor briefing early this year, to encourage financial institutions to conduct human rights due diligence on their renewables investments.

There are lessons to be learned from other industries regarding the importance of a social license; losses rise into millions of dollars for a project which is delayed by local opposition. Conversely, those setbacks are also instructive as to the management of this type of project risk. By identifying and engaging with stakeholders as early in the process as possible, many of these risks can be avoided or mitigated.

This approach is important for developers in both emerging and established markets. Communities are increasingly empowered through social media networks to draw attention to their concerns in any part of the world (take the unfolding developments at Standing Rock in North Dakota, for example). Furthermore, where domestic legal systems fail to respond to a

community’s complaints, they may have additional recourses through investor grievance mechanisms such as the Inter-American Development Bank and the Overseas Private Investment Corporation; or through international frameworks such as the Organisation for Economic Cooperation and Development (OECD) Guidelines for Multinational Enterprises.

There are numerous cases of wind farms running into delays, or being denied permits due to community resistance and (mis)perceptions of risks. In Massachusetts, a four-turbine project was delayed by four years due to concerns from an adjacent community about shadow-flicker. In Maryland, a 17-turbine project has been delayed indefinitely due to community concerns around water quality, wildlife impacts, and interference with emergency communications. In South Dakota, a county voted for increasing setback rules, and required a shadow flicker analysis be performed for any turbine placed in the county. In Indiana, one town is planning to ban industrial-scale wind farms altogether. In Canada, activist organizations such as Ontario Wind Resistance and Mothers Against Turbines are mobilizing communities to oppose wind development. In Mexico and Sweden, there have been cases where Indigenous Peoples have protested the impacts of wind farms on their cultural and traditional land rights. It is not impossible that a clean energy project could find itself in a Standing Rock situation.

In order to reduce the risk of failing to secure a social license to operate, it is essential to engage with communities in the project planning and design phase, before major decisions have been made. Consulting with communities does not mean every issue can be addressed, but it is an important part of building trust and demonstrating the developer is listening and responding to stakeholder concerns in a transparent process.

In establishing a community engagement strategy, there are a number of steps a project developer should consider:

1. Identify and prioritize stakeholders - don't assume that only the people in the immediate vicinity of the site will be interested in, or have an opinion about the project. Consider, for example, those stakeholders who could be affected by increased traffic in the construction phase and areas sharing the viewshed of the project, including shadow flicker.
2. Conduct a comprehensive impact assessment - consider social, human rights, cultural, and economic impacts as well as environmental impacts. Reference international standards as a benchmark, rather than focusing on minimum compliance requirements. Conduct the assessment early on, even if some data are not available. Regularly update the assessment with additional data over time. The more independent the assessment, the more credible the results. Consider engaging local universities as a resource.
3. Develop and implement engagement strategies - consider when and how different stakeholders prefer to receive information. Timing is very important, especially when key project milestones are approaching, such as a town vote. Demonstrate goodwill through strategic social investments. In some cases, a memorandum of understanding or community development agreement can be used to establish clear expectations and commitments.
4. Communicate often - discuss project benefits, but be honest about potentially adverse impacts, and get in front of detractors by addressing the plan to avoid or mitigate them.
5. Provide a mechanism for communities to raise concerns - just by having a point of contact and a clear and transparent process for receiving and responding to concerns from communities, can go a long way toward building trust and gaining a social license to operate.

As stakeholder concerns continue to draw the attention of media and civil society groups, developers of clean energy projects will find themselves under increasing scrutiny from investors, corporate power purchase agreement (PPA) partners, and non-governmental organizations to demonstrate how they are managing and mitigating social and environmental risk at their sites. As leaders in the transition to a low-carbon and sustainable energy future, renewables companies should also lead the energy sector in ensuring the transition is fair and equitable for communities.



Soledad Mills is the CEO at Equitable Origin. Equitable Origin is a nonprofit organization based in the U.S., partnering with business, government, and communities to enable sustainable development of energy and natural resources.

¹ https://www.business-humanrights.org/sites/default/files/Towards%20Responsible%20Renewable%20Energy%20Briefing%20-%20Final_1.pdf

VFD-Induced Bearing Currents Kill Motors!



Electrical bearing damage causes unplanned downtime

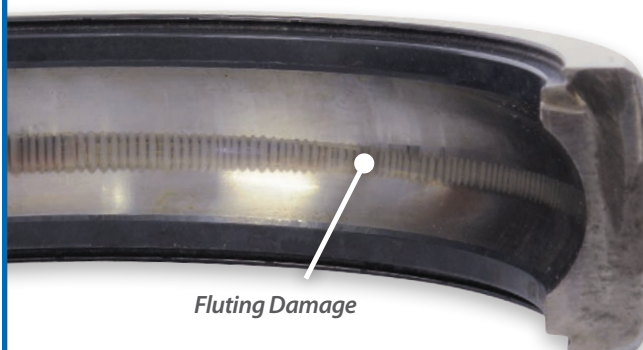
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Lowering the Levelized Cost of Energy for Wind Farm Facilities

by Bill Carlisle

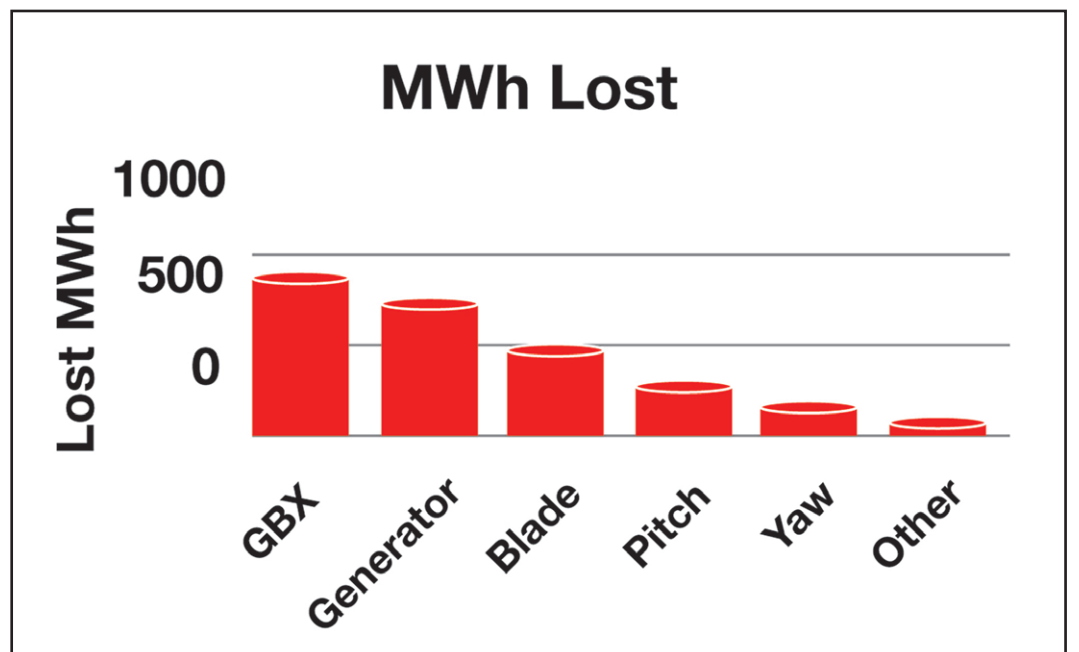


Image 1

LEVELIZED COST OF ENERGY (LCOE) CAN BE DEFINED AS THE TOTAL COST of installing and operating a wind project expressed in dollars per kilowatt-hour of electricity generated. These costs include installation, financing, taxes, operations and maintenance (O&M), salvage values, incentives, and electricity produced over the life of the wind farm.

Since 2009, the cost of wind energy has dropped 66%, mainly due to innovations in siting techniques, larger rotor diameters, and taller towers, all of which allow the capture of more electrons from the wind, as well as increases in the turbine's name-plate capacity. This is good news for the owner/operators whose new turbines have been designed with these innovations, but the United States has a significant quantity of installed base wind turbines that do not incorporate them. Therefore, the owner/operators are faced with the task of lowering O&M cost and improving turbine performance in order to optimize revenue production, and improve their Return on Investment (ROI).

The challenge for some owner/operators is the lack of internal resources to find solutions for the low-hanging fruit. Little support comes from the OEMs, since their resources are more focused on developing the next generation of turbines and solving failures on the larger components. This leaves little time for the OEMs to support some of their older technologies, and find solutions for common issues.



Image 2

One of the most important responsibilities within the operations team, is understanding the lost revenue associated with turbine downtime, and all direct and indirect costs.

Data is needed to evaluate the frequency of repairs, parts being replaced, and costs. For example, gathering mega-watt hour (MWh) lost data and plugging it into a Pareto chart can quickly become a powerful tool to identify the lost revenues associated with failing components. Image 1 illustrates the low hanging-fruit as lost MWh related to the yaw and pitch systems.

Other direct and indirect costs which need to be considered:

- Technician utilization rate – capture and comparison will flag any potential inefficiencies that need to be addressed, and highlight those sites that are performing well against those that need improvements;
- Increases in wind technician labor hours;
- Increases in turbine repairs;
- Stocking increased inventory to keep up with the replacement of failed parts;
- Increases in safety hazard due to increased number of turbine climbs;
- Possible liquidated damages due to not meeting certain production or availability targets, depending on the power purchase agreement.

Gathering and understanding the data listed above will be vital in the development of the business case used to determine alternative solutions.

Once the low-hanging fruit has been identified, it's time to select a vendor with the engineering capabilities to perform root cause analysis, and one who has partnered relations with various manufacturers to develop solutions. Look for vendors who can, not only reverse engineer, but also improve upon the original design to better suit current operating conditions under which the turbine is running.

The following two case studies exemplify how an owner/operator (the customer), working with the right vendor, found various cost savings solutions which lowered the LCOE for their respective wind farms.

Filter relocation project

The inaccessibility of an OEM gearbox filter took wind technicians 30 to 40 minutes to replace. In some cases, it was documented the technicians avoided changing the filter all together due to its obscure location. The customer realized the latter could have devastating consequences to the components, and a solution had to be found. The customer's and vendor's engineers, along with the vendor's fluid power specialists, worked closely with various manufacturers to find a solution. This coordination resulted in the design and development of a filter relocation kit (Image 2) to a more serviceable location.

This was approved as a cost savings solution, which resulted in the customer installing the retrofit design on all their turbines, with labor savings of two man-hours per turbine. They also managed to significantly lower the risk of filters not being changed out on a timely basis. Improvements were made to the filter to increase the dirt holding capacity, and lengthen times between change outs.



IPC platform

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www.advantech.com

Proportional valves failing at high rates

OEM proportional valves were failing prematurely; leading to lost revenues, increase in cost, and technicians performing unnecessary climbs. The customer engaged the services of a qualified vendor to better understand the current operating conditions in which the valves were failing, and perform a root cause analysis of the failures. It was determined the OEM valves were underdesigned to handle the operating conditions and loads under which these turbines were operating.

The vendor sought out various manufacturers who could design a more robust valve based on the loads these turbines were experiencing. The vendor, along with the customer's engineers, approved a design from a single manufacturer. The manufacturer then built a prototype based on the approved upgraded design, and an independent organization performed a bench test, which included a pressure gain test, flow test, and leak rate test. The upgraded valve was then sent to the customer for field verification, which, upon completion, showed very favorable results. The customer is now in the process of retrofitting all of its turbines with the upgraded valve.

In conclusion, there are many ways that owner/operators may take action to reduce costs and improve the overall performance of their wind farm facility. A qualified vendor can play a critical role lowering LCOE, including that low-hanging fruit.



Bill Carlisle is the manager/specialist of renewable energy for Motion Industries. Bill has 20 years of industrial sales experience with the last 10 serving Motion

Industries in the renewable energy sector. This background has built insight to customer needs and recognizing the relationship and balance that must exist between owner, operator, OEM, and various third-party industrial service providers.

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Turbine Technology Assessment

Managing risks during development and construction

by Evgenia Golysheva and Becki Meadows

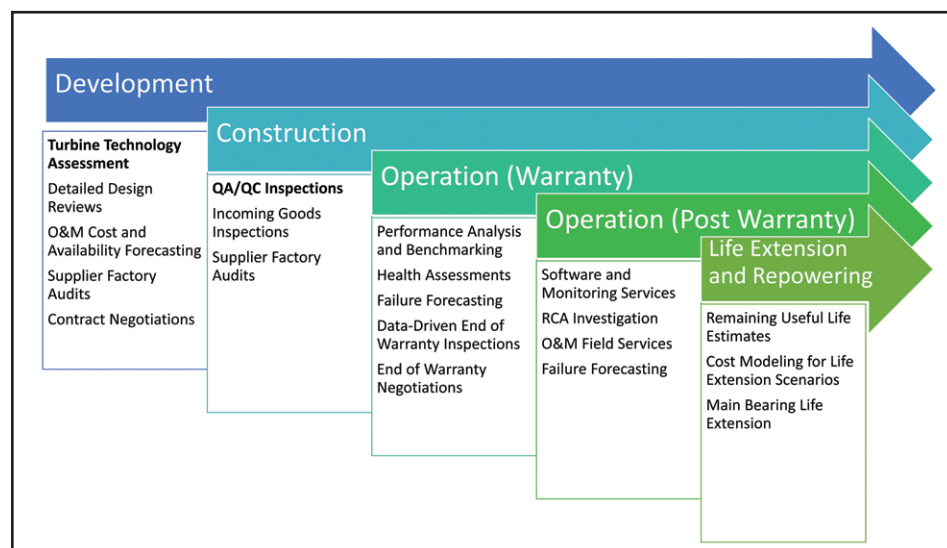


Figure 1. Comprehensive technology assessment services help reduce the uncertainty and impacts arising from newer technologies during the development and construction stages of a wind farm's life cycle.

TURBINE TECHNOLOGY AND ITS IMPACT ON LONG TERM OPERATIONS

and maintenance (O&M) cost has often been overlooked during the pre-commissioning stage of a wind farm's life cycle. In the past, certain turbine technologies have had serial issues that dramatically impacted the long term O&M cost budgets. At times, these costs have decimated operating project profits.

As the market consolidated for turbines in the 1-2.5MW class, with supply dominated by a small number of well-known OEMs with similar drivetrain designs, the uncertainty associated with forecasted O&M costs was reduced. Failure modes for the 1-2.5MW class turbines are better understood, and an established refurbishment supply chain supports the technologies.

However, turbine technology changes fast in the wind industry. Newer turbines with larger rotors are being installed at more turbulent sites. Driven by the need to reduce CAPEX, gearbox manufacturers are introducing more compact and innovative designs with higher power density. In combination with utilizing newer manufacturing techniques and materials, these designs have introduced greater uncertainties into wind farm operation and turbine performance, including:

- Increased sensitivity to manufacturing and assembly quality, due to increased complexity;
- Increased supply chain risk from bespoke designs produced by a single manufacturer;
- More complex load transmission paths which complicate the ability of traditional condition monitoring systems to expose defects;
- Higher sensitivity to operating conditions (e.g. off-axis loads due to turbulence and wind shear);
- Limited performance track record;
- Difficulty in up-tower repair due to the compact nature of the design, increasing the costs of repair and replacement of bearings; an inevitable prospect in the 20+ year asset life.

Technology choices have long-term impacts on a wind farm's profitability. A deeper understanding of turbine technology can lessen uncertainty that arises from newer technologies during the development and construction stages of the wind farm lifetime (Figure 1).

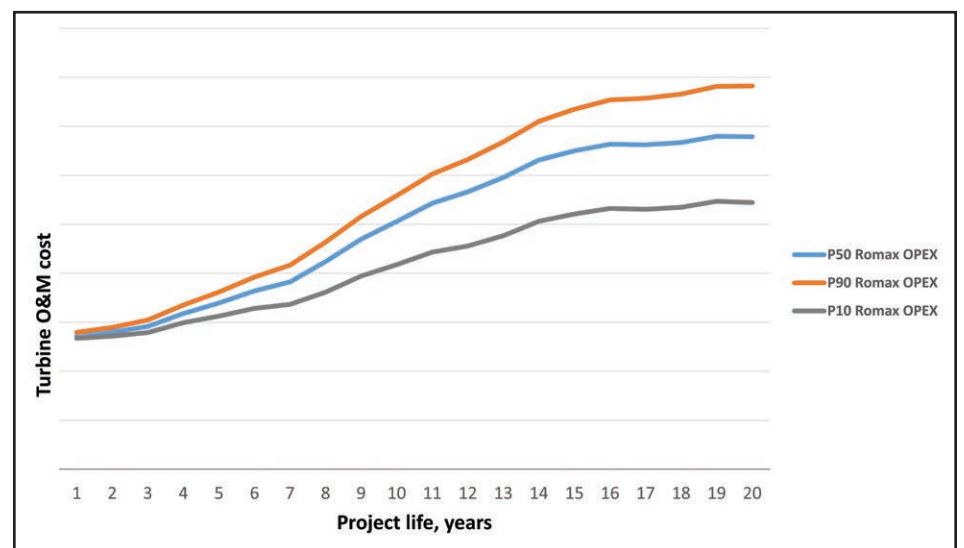


Figure 2. O&M cost forecasts include scheduled and unscheduled maintenance, with technology specific replacement and repair cost estimates.

Development stage

At the wind farm development stage, a turbine technology assessment will not only help the developer to select the best technology for their project, but will also provide project stakeholders with the necessary information to plan for long term project success, including:

- Detailed forecasts for planned and unplanned maintenance costs based on technology specific failure assumptions;
- Elements of the technology that are high risk;
- Details that should be included in the turbine supply agreement (TSA), or contract with the service provider;
- A technology specific operation strategy to maximize availability and minimize cost.

A significant portion of the OPEX budget is the cost of unscheduled maintenance. When it comes to long term OPEX forecasts, many owners assume generic failure rates. This approach often leads to large budgeting errors. More accurate estimates can be produced by using operational data for sufficient number of representative turbines. The Weibull curves generated from this data then need to be modified based on known risks for the specific sites. These site and technology specific Weibull curves are then used to generate detailed OPEX forecasts (Figure 2).

Another benefit of a technology assessment in the development stage is identifying risks associated with a specific technology. Different manufacturers, often with very different failure rates or serviceability, can supply major components for the same turbine. Developers should be aware of those differences to avoid unplanned O&M costs, and ensure the turbines are supplied with the best configuration. Depending on the technology and suppliers, certain aspects of quality assurance should be increased.

Lastly, developers/owners need a clear understanding of the operational data required to enable cost effective operation of the wind farm. It's vital to make sure the OEM provides access to this data early in the project. Neglecting this aspect exposes owners to the risk of underperformance, and leaves them in a weak negotiating position at every significant milestone of the project life (end of warranty or the service contract, serial defect resolution, and change of supplier or regulatory changes).

Construction phase

Once a turbine technology has been decided upon and manufacturing begins, the developer/owner can reduce risk to the project timeline and component

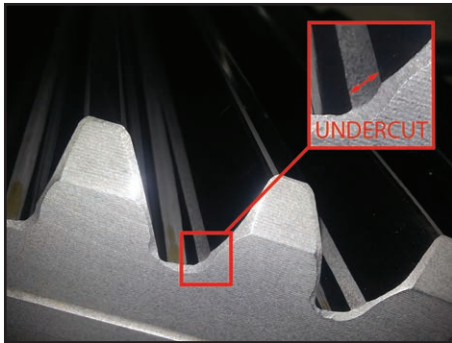


Image 3. Manufacturing error observed on the intermediate speed pinion, due to the damage discovered by third party inspectors the gearbox was categorized as non-conforming.



Image 4. Damage observed at the root of a ring gear shortly after turbine commissioning.

reliability, by performing supplier factory audits and QA/QC inspections. Verifying the component quality in the factory can ensure manufacturing errors are addressed prior to the component arriving on site. For example, during recent QA/QC inspections, a critical gearbox manufacturing error was observed and rejected by the developer/owner (Image 3). The turbine manufacturer agreed to remedy the problem prior to shipping the gearbox to site.

Once turbines have arrived on site, third party inspections should be performed to identify any damages that may have occurred during transport or pre-commissioning to critical components. These inspections are also utilized by sites as component baselines, and may be referenced against future inspections and during EOW negotiations. The damages on the ring gear of the gearbox shown in Image 4 were observed by inspectors shortly after turbine commissioning. That wear can now be monitored for further progression. Should an associated component fail, the customer will have ample evidence to support the warranty discussion.

Evgenia Golysheva is head of consultancy for Romax InSight UK. Becki Meadows is business development manager with Romax InSight North America. Romax InSight provides software, services, and hardware for owners, operators, ISP's, investors, and insurers in the wind industry.

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Yaw and pitch drive

The new yaw and pitch drive from Bonfiglioli has the load cell integrated into the gearbox. It is possible to monitor individual performance of the yaw and pitch drive from a remote pc, detect problems sooner, and prevent failure of the gearbox and the nacelle. This keeps turbines running smoothly and producing energy, while avoiding maintenance costs and reducing or eliminating down time.

www.bonfiglioli.com



Autonomous power conversion system

Ingecon Wind Fix2var Speed, by Ingeteam, is an autonomous power conversion system that increases the Annual Energy Production (AEP), lifetime, and grid-performance of fixed-speed wind turbines by enabling them to transform to variable-speed machines to best match wind conditions. The Ingecon Wind Fix2var Speed can smooth speed changes, reduce mechanical torque steps caused by wind gusts, and minimize transients due to start-ups, emergency stops, and grid variations. What is more, the system ensures grid compliance by removing flicker effects and low frequency harmonics generated by the capacitor banks, and enabling power factor regulation.

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End-of-life support

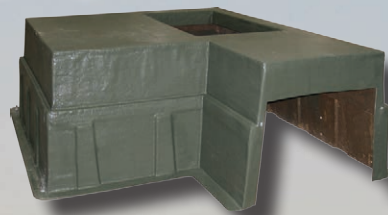
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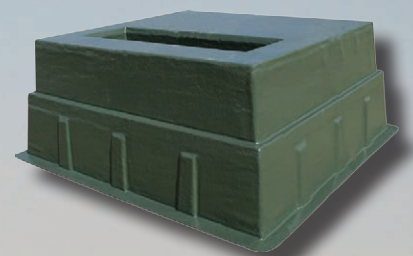
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Managing Blade Icing

New research and tools for anticipating icing events

by Juha Paldanius and Francesca Davidson

As global wind capacity increases, companies are often finding the most favorable project locations – the so-called “low hanging fruit” – have already been developed. For this reason, many developers have turned to more challenging sites in emerging markets, as well as regions with colder climates like Scandinavia, Canada, and the northern United States. These locations offer the dual advantages of low population density (with potentially fewer instances of community opposition to projects), – and some of the world’s highest quality wind resources.

Wind power in cold and icing climates is a fast-growing area of the industry. According to a “Wind Energy in Cold Climates” study by international expert group, International Energy Agency, (IEA) Wind Task 19, the cold weather market reached 127GW at the end of 2015, and is projected to grow at a rate of 12GW annually through 2020. This represents a market segment three times that of offshore wind power. It not only presents major opportunities, but considerable demand for further research, due to the special challenges these environments pose.

Challenges of Cold Climates

Cold, icy weather causes a range of known issues for the wind industry’s standard equipment. For measurement and condition monitoring, non-heated anemometers and wind vanes stop measuring when they freeze up, creating large data gaps, increased measurement campaign costs, and increased uncertainty in production estimates. Typical rime ice has been known to bring down entire met towers, and tilt-up towers can collapse under the weight of heavily iced guy-wires. Remote sensing technology, which sends out a sound or light signal and reads the backscatter to capture conditions, has increasingly been used as a replacement or supplement to

fill in data, and helps overcome these challenges in cold climates for pre-construction site assessment.

One of the biggest obstacles faced by cold climate projects is blade icing. Ice throw is a clear safety hazard and its mitigation has always been taken very seriously. What is less understood, however, is the impact of blade icing on production losses, and how to anticipate these losses prior to project construction. While estimating blade icing certainly adds to the complexity of an already complex development cycle, further research is vital, because these events cause operators to lose millions of dollars each year. Here again, remote sensing technology may provide a tool to overcome this challenge.

Defining Icing

Icing is divided into two categories: meteorological and instrumental. Both are measures of time. Meteorological icing refers to the time during which conditions are favorable to forming ice; there is liquid water, and the temperature is below 0°C. Instrumental icing refers to the time ice stays on the instruments (by definition an unheated cup anemometer) once it has started to form.

Figure 1 illustrates a typical icing event, from the start of meteorological icing to the end of instrumental icing. Note the fact that the icing time of instruments is slightly different from the icing time of a wind turbine rotor. Generally, icing can be caused by freezing rain, which is quite rare, or by cloud conditions, which is relatively common.

IEA Wind Task 19, which provides guidance on wind energy in cold climates, has instituted an ice classification system shown in Table 1. These IEA ice classes can be used to compare measures of

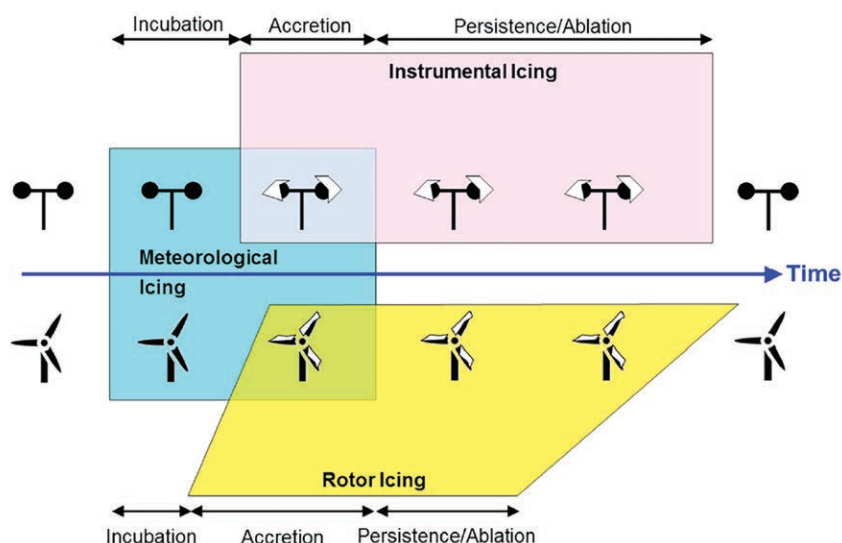


Figure 1. Source: IEA Wind Task 19 Available Technologies report of Wind Energy in Cold Climates (2016 edition): http://www.ieawind.org/task_19.html

IEA Ice Class	Duration of Meteorological Icing [% of Year]	Duration of Instrumental Icing [% of Year]	Production Loss [% of AEP]
5	>10	>20	>20
4	5-10	10-30	10-25
3	3-5	6-15	3-12
2	0.5-3	1-9	0.5-5
1	0-0.5	<1.5	0-0.5

Table 1. Source: IEA Wind Recommended Practices 13. Wind Energy Projects in Cold Climates (1. Edition 2011)



Aerial zoom camera

The DJI Zenmuse Z30 aerial zoom camera works right out of the box, offering up to a 30x optical zoom and an additional digital zoom up to 6x. It can stabilize to within 0.01 degree. Users can zoom with just a tap of the finger. With the TapZoom function, the gimbal will reorient towards the object when tapping it on the screen. With each tap, the Z30 camera will automatically adjust its focal length to give an enlarged view. For cell tower inspections, airframes equipped with the Z30 camera can operate well beyond the range of cell tower's electromagnetic fields and live stream footage to engineers anywhere in the world. The Z30 can also remain at a safe distance while inspecting a wind turbine, yet still show the condition of vital parts in detail. With "Point of Interest" tracking feature, the aircraft circles the turbine at a constant distance, keeping the object in the center of the camera frame. First responders can use the 30x zoom to quickly get an overview of a scene and collect accurate and specific information to better plan their rescue operations.

www.dji.com

instrumental and meteorological icing, and help place project sites into appropriate classes for icing severity and expected production losses.

Icing is difficult to measure directly. For wind turbine applications, a perfect icing measurement would cover the entire rotor area, not just a point measurement near the nacelle. As turbines get larger and larger, the distance between the top of the nacelle and the highest blade tip height increases. Cloud conditions can, and do, change in this distance. Given the duration of cloud-based icing, this is significant, since it is entirely possible for the blade tip to be covered in clouds while the nacelle is not. In this case, measuring at the nacelle height gives misleading results.

As turbine heights continue to increase, blade height measurements from a met mast are becoming prohibitively expensive. This is why a mobile, ground-based remote sensing solution, requiring no tower construction, is particularly attractive.

Research on remote ice sensing

Recently, the Technical Research Centre of Finland (VTT), partnered with Vaisala, Suomen Hyötytuuli, Kjeller Vindteknikk and Fraunhofer IWES, to conduct a new research project on icing. This project evaluated icing data at four sites: two in Finland, one in Norway, and one in Germany. Data was collected over periods of four to six months, from different types of measurement equipment (including remote sensing) to test whether the equipment could appropriately categorize the site's ice class according to IEA standards.

With the remote sensing equipment, the goal was to test how well the devices could identify in-cloud icing conditions using optical signals to monitor the cloud base height, and use that measurement with outside temperature measurements as a proxy for icing conditions.

The study found that the remote sensing devices with by far the highest availability, were the ceilometers installed at both sites in Finland. The ceilometer is not frequently used in the wind industry because it doesn't measure wind conditions. It does, however, provide very accurate readings of cloud height as well as cloud profiles, to better understand the composition of clouds passing over the site. Along with these capabilities, the key advantage

of the ceilometer versus other remote sensing technologies, like wind LiDAR, is that it offers 100% data availability when powered; LiDAR had only 55-80% availability in the study.

Key takeaways

As the cold weather wind market grows, further icing research is critical in learning how to ameliorate or avoid some of the special challenges these environments present. Mitigating the effects of blade icing is particularly pressing when considering production losses and risk to personnel. The industry must continue to explore alternative technologies and methods to better improve safety, and mitigate the financial impacts of icing. Although the ceilometer is relatively new to the wind industry, it is a workhorse of the aviation sector, with over 5,000 airport deployments and proven performance 24/7. With this new research and some early commercial deployments, the ceilometer appears to be a promising new solution for understanding blade icing and improving its detection.

Juha Pladanius is offering manager, and Francesca Davidson is energy communications expert at Vaisala, a global industrial and environmental measurement company with a business unit dedicated to serving the weather measurement, energy assessment, and power forecasting needs of the renewable energy.

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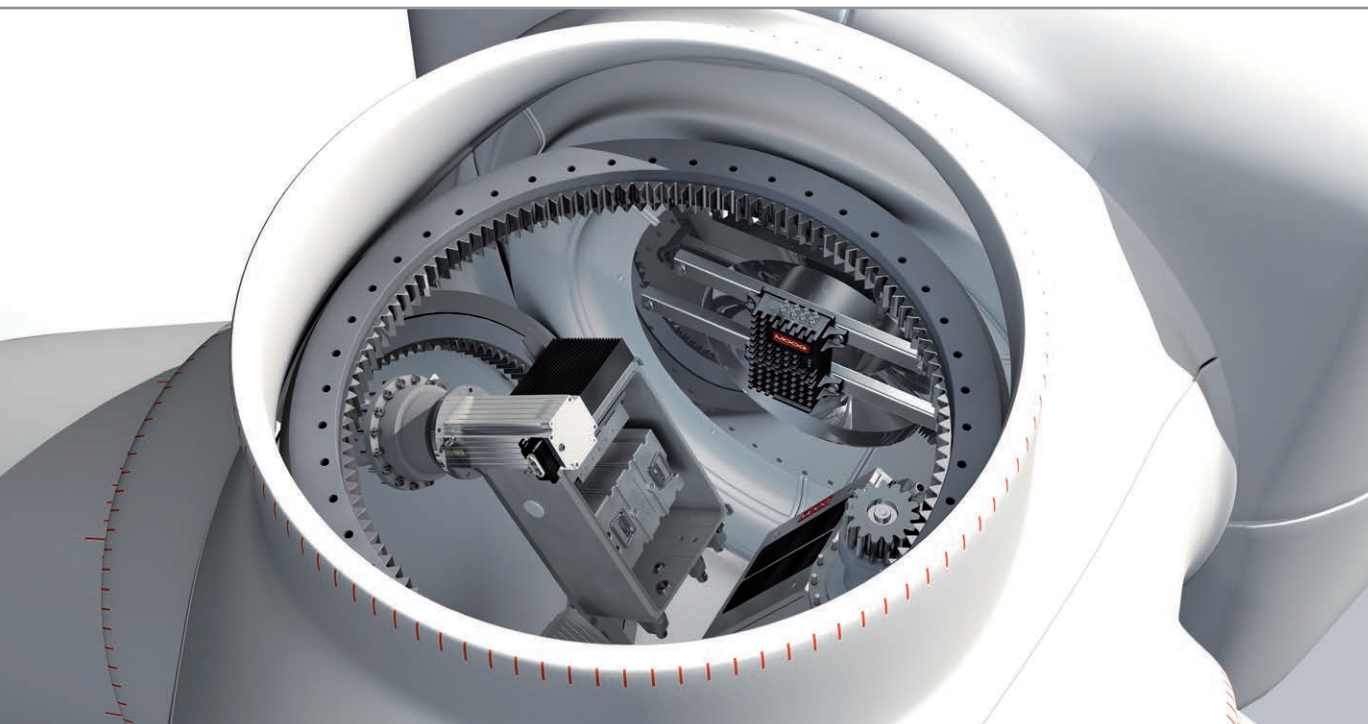


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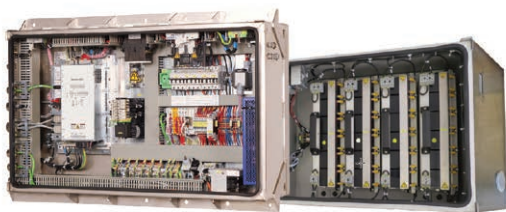
Increasing or reducing expenses

by Prasad Padman

ENGINEERS ALWAYS WANT TO LOOK INTO HOW SOMETHING WORKS, UNDERSTAND IT, and tinker with it. Human nature, however, tends to lull us into complacency when we feel we've solved a problem. When something works, we tend not to revisit the issue. But innovation often requires retracing our steps. In the case of wind turbines, this is no different.

When compared to the size of a wind turbine, a pitch control system appears small. Pitch systems keep a turbine running and ensure the safety of the turbine in the event of high winds or catastrophic events. The pitch control system monitors and adjusts the inclination angle of the rotor blades to control the rotation speed of the blades. Although these systems play an outsized role, they account for less than three percent of a wind farm's capital expenses (CapEx).

According to a 2011 ReliaWind research report, pitch system failures account for 23 percent of all downtime in wind turbines. This is more than any other component or system of the turbine. The ReliaWind report goes on to note that pitch systems tallied the highest percentage of all component failures in wind turbines, at more than 21 percent.



Current industry design



Described pitch system

Benchmarking reliability

When it comes to improving reliability in wind turbines, the pitch system is critical. One of the challenges faced by the wind industry involves identifying which improvements to component reliability bring the greatest return on investment. Most of the research done in the past focused on mechanical and electrical system level analysis, but provided very little depth in terms of failure analysis at the component level and its impact on cost of energy. Earlier this year, DNV GL, an international certification body and provider of technical assessments, quantified:

- the impact of pitch system reliability on turbine failure rate; and
- the improvement in Levelized Cost of Energy (LCoE) due to advances in pitch system reliability through innovative design.

LCoE measures the net cost to install and operate a wind turbine against expected energy output over the course of the turbine's lifetime (incentives excluded). DNV GL collected data from 69 projects, totaling 5.3GW of capacity across four million turbine days for wind turbines located in North America, Europe, and China. The turbines ranged in size from 1.5MW to 3MW.

The DNV GL benchmarking study confirms that pitch systems (whether electric or hydraulic) have a high rate of failure and significant effect on turbine reliability, downtime, operating expenses and LCoE.

Improving pitch system reliability through innovative design

As part of the study, DNV GL's research team analyzed electromechanical (EM) and electrohydraulic (EH) pitch systems from several wind turbine makers, operating in the field.

A typical pitch system used throughout the industry today consists of roughly 3,000 to 4,000 sub-components and has a system reliability of approximately 5,700 hours. Field data collected for the study is a representative sample of these designs. However, the newer pitch systems are lighter, smaller and more than three times more reliable than those more commonly used. Some of the latest designs have as few as 1,200 sub-components, which greatly reduces complexity and improves maintenance.

The benchmarking study shows that turbine reliability can be improved significantly by using smaller pitch control systems with fewer sub-components. Current industry designs incorporate components manufactured for general-purpose industrial applications, with limited customizations for wind turbines. Opportunities for improvement include optimizing the drive electronics by using pluggable PCB modules, instead of wiring off-the-shelf DIN-rail components, and using ultra-capacitors, instead of batteries, to eliminate backup power failures and periodic maintenance.

With AC synchronous motor technology (i.e., brushless, no fans for cooling), engineers are improving pitch system motor reliability and reducing periodic maintenance, compared with the AC Induction or DC motors currently used by the wind turbine OEMs. These improvements are helping the new pitch systems increase reliability over existing industry designs, by a remarkable 223 percent.

Improving the reliability of the pitch system directly affects the turbine reliability by mitigating downtime. And reducing maintenance, in turn, lowers LCoE. The DNV GL LCoE model also shows that lighter, smaller pitch systems can save up to \$1.70/MWh for a typical 3.0MW turbine.

One of the wind industry's biggest opportunities is improving reliability. Operators of wind farms and makers of wind turbines should not overlook pitch systems as a key to improving uptime, purely because the systems are such a small expense relative to the cost of the turbine.



Mr. Prasad Padman is an instrumentation and control engineer with a master's degree in finance and marketing, and has been with Moog for eight years in various roles. He is currently responsible for developing needs for next-generation motion control solutions.

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And we aren't the only ones noticing this new attitude. The wind industry's track record as the biggest, fastest and cheapest path to a more sustainable electricity sector is attracting the world's most iconic brands. Google, Microsoft, Amazon, Wal-Mart, General Motors, IKEA, Yahoo! to just name a few, all invest in wind. These and other corporate buyers accounted for more than 50% of all wind deployed in 2015.

This Brand New Attitude will be in full force at WINDPOWER 2017 in Anaheim, California.

Keys to Quality Coating Repairs

by Steve Swett

NEVER ALONE
IN THE DARK.



Let's face it, coatings on steel towers at the site aren't usually considered a maintenance issue until the corrosion begins to show up and becomes an eyesore. No one wants to see rust streaks down their towers, least of all the landowners. It's also not a good look for green energy's reputation with the public. Given enough time and neglect, these areas of corrosion could literally send a turbine toppling to the ground. Of course, that's an extreme example of what may happen if industry standards and guidelines are not followed.

Coatings failures or damages occur in a variety of ways, from manufacturing to the field. During manufacturing, the coating is applied utilizing a high-pressure spray gun that atomizes the coating, which, if not applied correctly, can build up excess coating thickness. If the dry film thickness (DFT) of the coating is excessive or outside of specification, it will lose its elasticity and fracture along the irregular surface of the welds. Water will seep in to the fracture, and corrosion will begin. Damage can occur for a multitude of reasons during transportation and erection of the towers, and often requires in-field repair. Ideally, the standards maintained by the National Association of Coatings Engineers (NACE) and the Society for Protective Coatings (SSPC) will be applied to the repair process, either before leaving the manufacturing facility, or in the field.



Lack of technician training and process is the weak link. While most people have brushed a coat of latex or possibly alkyd based paint on their houses, the application of multicomponent coatings is best left to technicians who possess the necessary training, knowledge, and

experience to complete the work to NACE/SSPC standards.

Coatings might be on hand during installation for the purpose of real time repairs, but their condition may be suspect due to lack of proper storage and use. To perform a quality repair in the field, the company performing the repair should first supply an appropriately trained or certified technician, as well as a specific work instruction outlining the necessary steps to take as reflected in the technical data sheet (TDS) of the specific coating.

Surface preparation is of the highest importance; a surface must be clean, dry, and free of any dirt, oil, and grease (or as described SSPC standards). Any existing corrosion must be removed. There are, however, certain coatings which allow for a defined amount of corrosion to be present on the substrate. If the coating does not allow for any corrosion, the next step is to remove it. There are three different levels of cleanliness (surface preparation); SSPC SP5, SP10, and SP11. SP5 is a white metal abrasive blast, completely free of any corrosion. SP10 allows for a small amount of corrosion within a specified area, and SP11 is Power Tool Cleaning to Bare Metal. Any of these will provide the level of cleanliness and surface profile that epoxy and polyurethane primers require while achieving adhesion. The next step is to remove any loose, peeling, or flaking paint. This can be achieved with either Hand Tool Cleaning or Power Tool Cleaning. SSPC basically specifies that the coating must be sound, intact, tightly adhered, and feathered back to expose the underlying coating.

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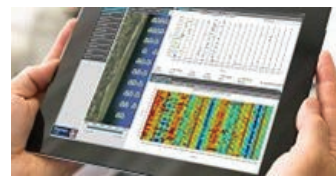
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Remote engine-driven welder

The PAT750-LI Hydraulic Crimper, by Hi-Line Utility supply The SAE-300 MP model engine-driven welder, by Lincoln Electric, features a factory-installed wireless remote control which allows the operator to activate the glow plug from anywhere between 1 and 30 seconds. Users also can remotely start or stop the engine, activate high or low idle, or adjust the Fine Current Control output. The small, weather-resistant control units fit right into operators' hands and have a 400ft (122m) range, depending on site obstructions. They also stow easily in trucks or job boxes.

www.lincolnelectric.com



Monitoring software

The Fleet Monitor 2.2 by Romax InSight provides analysis tools for SCADA data, tracking inspection and maintenance reports, trending results from lubrication analysis, and interfacing to particle counters. Features include workspaces to save analysis charts, create automated reports, and configure dashboard information. It also allows the user to create alarms and trends based on any combination of SCADA tags, identify outliers using on-the-fly trending of any health indices relative to the wind farm average, link similar alarms and email alarm notifications to single or grouped email addresses, and reduce false alarm rates.

www.romaxtech.com/fleetmonitor



Mounting fixtures and accessories

Posital offers a wide selection of accessories that simplify sensor installation and help ensure long and reliable service lives for both for sensors and the machinery they are monitoring. The products are field-tested and include: disc coupling for high-speed applications, bellow coupling for high torsion stiffness, jaw coupling for industrial automation applications, adapter flanges for different flange types, clamping rings for hollow shafts, and clamp discs for easy mounting.

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Pitch control slip ring

The Moog EPA3 slip ring is well suited for both large and small wind turbines. Its high reliability and modular design can be scaled and optimized for most requirements. It utilizes Fiber On Tip (FOT) power contacting technology. No maintenance (cleaning) is required. The slip ring can be part of a large wind turbine electric pitch control system with the option to integrate hydraulic pitch control systems, if required. It can also be used on the yaw axis of small wind turbines. Speeds range from 0 to 100 rpm with through-bore model sizes up to 54mm available.

www.moog.com



Hydraulic crimper

The PAT750-LI Hydraulic Crimper, by Hi-Line Utility supply and Burndy, features a crimp head that rotates 355° and 12-tons of force to crimp tension sleeves, taps, terminals, splices, and HYGROUND connectors. The 18V Lithium-Ion battery provides 2.5 times more charge/discharge cycles than traditional batteries and 430% more lifetime work. The Burndy PAT750-LI Hydraulic Crimper includes 2-18V Li-Ion batteries, tool retention lanyard, and die compartment for U dies in a carrying case.

www.hilineco.com

A typical three-coat system consisting of a sacrificial primer (zinc rich primer), barrier mid coat (polyamide epoxy), and UV protective top coat (polyurethane top coat) has been shown to perform the best. Application methods in these scenarios depend on the volumes to be applied and the sizes of the repairs. In some instances, applying the coatings with a brush will be best, while others may require the use of a spray gun.

During and after the cleaning and coating process, it is extremely important to document the repair. Ambient conditions, type of coating applied, batch numbers, wet and dry film readings must also be recorded, to ensure the coating is applied properly and to the correct specifications.

Repairs to wind turbine coating is serious work, and must be to executed with the highest level of quality, process, and standards so as to ensure a long lasting finish. Cutting corners on this essential maintenance will likely result in more frequent maintenance, resulting in higher costs over the life of the project.



Steve Swett is the coatings coordinator for Rope Partner, a provider of wind turbine maintenance, inspection and performance enhancement services.



Onshore low noise turbine

Siemens manufactures three onshore turbine models for optimum performance at low wind, medium wind, and noise sensitive sites. Due to a modular platform concept, all three machines share the same nacelle design. The SWT-3.3-130LN wind turbine allows operation with a 104.9 dB noise level at a wind speed of 6 m/sec. Even at an average wind speed of 6.5 m/sec, it harvests an Annual Energy Production (AEP) of around 11GWh. The SWT-3.6-130 is able to harvest an annual energy output (AEP) of up to 17GWh at 8.5 m/sec. The SWT-3.15-142 is a direct-drive wind turbine dedicated for IEC Class III. Even at wind speeds of only 6 m/sec, the machine harvests 10GWh of energy per year.

www.siemens.com/wind

A Windfall of New Sponsors Fueling Industry Growth

by Nick Knapp and Jason Steinberg

PROJECT SPONSORS IN THE WIND INDUSTRY ARE BECOMING

numerous and increasingly diverse. Over the past two years, the industry's brass has expanded beyond its handful of usual sponsors to include traditional independent power producers, utilities, and financial companies. There is also growing interest from institutional and strategic investors, as well as corporations looking to generate savings, create synergies, and achieve sustainability goals, and this movement should continue.

Operating wind asset ownership and pipeline project ownership is almost exclusively composed of prominent US power generators and experienced development subsidiaries of major European utilities, but the presence of newer pipeline owners can serve as a microcosm of the number and profile of industry sponsors.

The diverse makeup of companies which have acquired wind projects illustrates this point. Traditional utilities, private equity firms, and corporations are all investing in new wind projects.

What's driving sponsor diversification?

There are several key factors fueling the expansion of the wind industry's sponsor base. This heightened interest occurred over time due to incremental technological, economic, and political advancements.

More investors are becoming comfortable with turbine components, as well as project construction and O&M processes. The industry has achieved economies of scale by creating a vast and competitive landscape of manufacturers, suppliers, contractors, and service people. According to Bloomberg New Energy Finance (BNEF), turbine costs have declined by 30% from 2009 to 2015, and are forecasted to drop another 9% by 2025. Capacity factors have nearly doubled since 2000, and are expected to expand another 12% by 2025.

Beyond declining costs and growing capacity, recent political and legislative efforts are important industry drivers. The combination of the PTC extension with a several year run rate, the IRS's clarification of safe harbor rules, and various state and federal clean energy policies, offers much needed industry certainty. Potential sponsors can now take an extended view of the industry. For many, this provides sufficient time to formally launch renewable energy programs. Prior to the PTC extension last December, the boom-bust nature of the wind industry kept many sponsors on the sidelines. With much of the volatility in check, more sponsors are interested in committing to the industry.

These achievements have been critical to increased investment by a plethora of sponsors. However, there are other benefits less apparent and equally, if not more impactful, that are attracting new entrants.

Developers are selling projects to a larger collection of parties.

A few years ago, the majority of firms acquiring projects were a select group of US utilities and IPPs, as well as the US development arms of European utilities. Today, project M&A showcases the new sponsor universe. Novatus Energy's activity in the market is one example of a growing sponsor base. Over the last year, Novatus, who is backed by JP Morgan Asset Management, acquired several projects around the United States. Similarly, the largest US public utilities and asset managers have sought prized assets from developers. A significant portion of the US pipeline is controlled by developers without an exclusive partnership with the largest strategics.

The portfolio acquisition between SunEdison and Novatus Energy, LLC, is an example of the growing sponsor base. Over the last year, Novatus acquired several wind projects around the United States from the now bankrupt solar developer. Recent press has suggested that SunEdison will sell additional assets in Hawaii and Texas. Novatus and JP Morgan are representative of the quality of new sponsors.

Offtake agreements are becoming more diverse.

The variety of agreements are attracting new sponsors who either want exposure to differently structured revenue streams, or prefer to invest in a specific geography but can't do so under a traditional PPA arrangement. For example, hedge products have been essential to the Electric Reliability Council of Texas (ERCOT) market, and are now expanding capacity in other prominent markets such as Midcontinent Independent System Operator (MISO), Southwest Power Pool (SPP), and PJM Interconnection. Many financial firms offer hedges, which usually have shorter terms than traditional PPAs. The share of hedge products is expected to increase across different energy markets.

Other synthetic products are gaining traction. Apex Clean Energy's Cotton Plains portfolio used a 10-year Proxy Revenue Swap agreement with Allianz, the first of its kind. Capital Power's 178MW Bloom wind project in Kansas has executed a similar agreement with Allianz. There are other Proxy Revenue Swaps near execution in various power markets.

Corporate procurement continues to increase rapidly.

Companies would prefer to be directly contracted to their power sources. Many have set lofty sustainability goals. According to BNEF, in 2015, 40% of US wind and solar PPAs were signed with companies other than utilities. The American Wind Energy Association (AWEA) reported that 75% of wind PPAs inked in Q4 2015 were with corporates. Although corporate offtakers are difficult to contract with - due to shorter term contracts, lower quality credit entities compared to utilities, and basis risk and pricing ambiguity - they should continue to be major offtakers in the market.

Corporate procurement has naturally led to corporate asset ownership. With over 68 of the world's largest companies committed to producing 100% of their electricity from renewable sources under RE100 (a company-based renewables procurement campaign), businesses are expected to play a greater role as sponsors going forward.



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Capital markets are opening up.

Significant improvements are occurring in the tax equity and back leverage markets. The extension of the PTC, and investors' growing comfort with wind technology, has spurred the number of active tax equity participants to approximately 30 tax equity investors – an historic high. Many of these investors did not initially accept non-traditional sponsors, such as financial sponsors. With finite projects, the influx of investors has created a more competitive landscape. Tax equity investors are now taking on new partnerships, with greater flexibility for newer sponsors beyond large strategics.

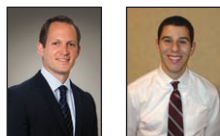
The increased role of back leverage in transactions has also attracted new sponsors. Lenders were originally sidelined for several reasons: tax equity was not comfortable with senior project level debt in the capital stack; lenders weren't comfortable being secondary to tax equity investors with the holdco structure required for back leverage; and traditional strategics financed projects on balance sheet.

Without debt, many potential financial sponsors could not meet return hurdles. As more deals were executed, tax equity investors and lenders became more comfortable with each other. This caused back leverage spreads to converge to those offered by standard project level senior debt, and project returns to increase from ~8-10% to 10-12%, ultimately making investments economical for financial sponsors. Spreads were also reduced due to an increase in the number of lenders in the market, and the market's improved understanding and appropriate risk assessment of the holdco debt structure.

Potential deterrents to the windfall

Oversaturation in ERCOT is expected to continue to stress investment. While this may slow project construction in the near term, forecasts remain strong. The further proliferation of hedges, proxy revenue swaps, and other synthetic offtake products is paramount. New transmission and scalable, cost effective storage could provide needed decongestion.

A second factor that could deter sponsor interest is the increase in development of smaller (<50MW) wind projects. Many potential sponsors will shy away from projects of this size, as their investment criteria typically call for bigger checks. This issue may be exacerbated by the lack of available tax equity and back leverage at this smaller scale.



Nick Knapp is a managing director and Jason Steinberg is an analyst at CohnReznick Capital Markets Securities, an investment bank specializing in renewable energy.

CohnReznick Capital Markets Securities

www.cohnreznickcapmarkets.com



Upgraded onshore wind platform

GE Renewable Energy added two new wind turbine models to its platform of 3MW wind turbines. The 3.6-137 and 3.8-130 models are compatible with GE's Digital Wind Farm technology. GE's 3MW turbines are configurable to meet IEC class IIIA, IIB, and IIIB wind conditions, and feature a new suite of software applications for the Digital Wind Farm, designed and developed to enhance annual energy production (AEP) and improve wind farm profitability.

www.gerenewableenergy.com



Portable magnetometer

The FerroCheck portable magnetometer from Spectro Scientific provides fast and simple measurements of ferrous wear particles in lubricants, both in the field and in the lab. It works by sensing disruption of a magnetic field that is generated due to the presence of ferrous debris, specifically iron, in the oil. Non-lab personnel can operate the FerroCheck with no solvents or sample preparation required. The lightweight unit weighs less than five pounds, is compact and battery-operated for fast, 30-second testing of small samples. The FerroCheck magnetometer can detect particles from nanometers to millimeters in size and has a sensitivity range of 0-2500 ppm with a limit of detection of less than 5 ppm. It enables users to make immediate maintenance decisions to reduce unexpected downtime and costs, and eliminate potential catastrophic machine failures.

www.spectrosci.com



Utility outerwear

The ArcLite Air by Hi-Line Utility Supply and Nasco, has a versatile design that lets the wearer layer up underneath to keep warm in the winter, while the Nomex mesh ventilation systems keeps cool and dry in the wetter months. Weighing in at just 5 ounces, the ArcLite Air uses a composite coating with CCT Technology which eliminates the PVC that causes the wearer to be hot and uncomfortable. This waterproof and windproof suit offers multi-hazard protection from flash fire and arc, and features fall protection access. The ArcLite Air meets ASTM F1891, ASTM F2733, and ANSI 107 standards.

www.hilineco.com



Torque limiter for yaw and pitch drives

This newly designed torque limiter from Bonfiglioli limits the peak torque and shuts down the gearbox if the peak torque is reached. The torque limiter is located inside an easily removable and replaceable cartridge, which is integrated into an external worm gear. This eliminates the need to replace the entire gearbox, enables faster and easier replacement of torque limiter, and reduces costs and down times.

www.bonfiglioli.com



Fall protection harness

The SKYLOTEC Ignite Series of harnesses feature high-quality padding, which is adapted to fit the human anatomy and ensures optimum weight distribution on the hips. An adjuster stops the straps from unwanted loosening. SKYLOTEC uses a color-coded system for all its harnesses. Grey contrasting elements are used in the lower part of the strap and orange contrasting elements in the upper part, so users can quickly see where the top and where the bottom of the strap is, even when they have not yet donned the harness. The main anchor points of all models are bright orange in order to label them clearly, helping to prevent accidental anchoring on the wrong loops. The four different versions of the Ignite Series models provide superior personal protection against falls.

www.skylotec.com

Safety & Fall Protection Equipment

According to the National Safety Council, falls are one of the leading causes of deaths in the workplace. Perhaps more than any other type of workers out there, those who erect and maintain wind turbines are exposed to some of the most serious, and potentially fatal, fall hazards. With many turbines reaching heights of well over 100 feet tall, wind farms are only growing upwards in many cases, and exposure to high winds can make work at high elevations even more hazardous. Here we highlight some of the latest in safety and fall protection equipment—a must for the growing industry.

SEE AD ON PAGE 13



3M Fall Protection

Product: 3M DBI-SALA Lad-Saf X3 Detachable Cable Sleeve

Application: Ladder safety systems (Tower climbing)

Description: The 3M DBI-SALA Lad-Saf X3 Detachable Cable Sleeve for 3/8" (9.5mm) cables makes climbing ladder safety systems simple and safe. This portable connection device connects the worker's harness to the ladder cable and glides freely up and down the cable as the worker climbs.

Key Features:

- Easy to install and detach anywhere along lifeline;
- Dual independent locking system;
- Built-in energy absorber and fall indicator with swivel;
- Rugged and corrosion resistant construction;
- Compact, lightweight design.

www.3M.com/FallProtection



Corgo Industries

Product: COR-600.5 LIFT BAG

Application: Aerial lift bag

Description: The new COR-600.5 rated lift bag has a 2/3 COR-600 base, the COR-061786 rolled/Velcro closure, and an easy entry top with doubled safety closure. The 4 attaching points and full cradle lift effect ensures it will not tip. Its robust construction is rated for 600lb lifts and measures 20x20x variable height (full 33").

www.corgoind.com



Snap-on Industrial

Product: Hub Hatch Tool

Application: GE 1.5MW Wind Turbine

Description: This tool is a solution for opening a GE 1.5 Hub Hatch. It combines a flex-head, ratcheting combination wrench, with a replaceable 14mm hex bit, and an engineered, tested, and certified Drop Prevention attachment point.

www.snapon.com/industrial



Dakota Riggers & Tool Supply, Inc.

Product: Petzl Vertex Best Hard Hat

Application: At height head protection

Description: With its strong chinstrap, the Vertex Best helmet has six-point textile suspension to ensure comfort for workers at height. Its unventilated shell protects against electrical hazards and molten metal splash. The Vertex Best helmet is designed for use with optional headlamps for work in low light environments.

www.dakotariggers.com



Elk River

Product: Heavy Duty Bolt Bag

Application: Any work environment, but especially designed for work at height

Description: Elk River's new heavy duty bolt bag has several improved features to make working at heights safe and efficient. The bag features heavy duty webbing on the bottom to prevent tools and sharp objects from penetrating, and a drawstring top to prevent spillage. It is sewn and riveted for increased durability. There is an interior pocket for small items. The tool sleeves have been placed at the front to make access easier, and heavy duty tool rings were added on each side for the connection of tool lanyards.

www.elkriver.com



Power Climber Wind

Product: IBEX 1000P Climb Assist

Application: Intelligent climb assist for wind turbine technicians

Description: The IBEX 1000 climb assist system delivers personalized performance, increased safety, and better productivity. The IBEX 1000 allows user-adjustable support settings from 50 to 125lb (25 to 55kg), and provides constant load support, in both the up and down directions, regardless of climbing speed. These ride settings are stored in a load sensing EasyClimb Controller (ECC), attached between the climber and the belt, and can be changed at any time and anywhere. Motor power is controlled by signals from the ECC, which communicates climber behavior to adapt motor output for a consistent, comfortable climb. The motor responds to the climber rather than the climber responding to a constant speed and torque motor.

www.powerclimberwind.com



Hi-Line Utility Supply Co.

Product: Milwaukee M18 Fuel Lineman Magnetic Drill Kit

Application: Designed for vertical and overhead drilling 1/4" poles

Description: Using M18 Fuel technology, this compact and ergonomic drill delivers power and performance, and eliminates the risk of tripping over cords. This drill is equipped with a 3/4" Weldon to 1/2" chuck adapter, and the ability to adjust the height of the motor head, tool-free. This provides the user the ability to switch from annular cutters to twist bits, faster and easier. The new M18 Mag Drill features a magnetic base, providing a strong magnetic hold on steel material. This tool utilizes permanent magnets so that the magnetic base operates without electricity; ensuring the magnet does not deactivate if the battery is drained. Equipped with Auto-Stop Lift-off detection, power to the motor is automatically cut if excess rotational motion is detected while drilling. Kits include: (2) M18 red lithium XC 5.0 batteries, AC/DC charger, magnetic lubrication tank, 1/2" chuck adapter, chuck key, (2) retractable pilot pins, safety strap, and carrying case.

www.hilineco.com



Tractel

Product: Elastrac Wind Harness

Application: Height safety

Description: The Elastrac Wind harness features functionality and comfort using Elaspac stretch webbing and independent leg straps providing full freedom of movement in all daily work positions for wind technicians. This harness includes dorsal, sternal, side and front D-rings, a back support belt, and a suspension loop for rescue scenarios.

www.tractel.com



Motion Industries

Product: Miller AirCore Wind Energy Harness

Application: Designed specifically for wind turbine construction and maintenance

Description: The lightweight design is customized for workers building and servicing wind turbines while reducing fatigue for all-day endurance. This new line of harnesses from Honeywell keeps workers comfortable and safe while increasing productivity.

www.motionindustries.com



Petzl

Product: VOLT WIND LT

Application: Fall arrest and work positioning harness for the wind power industry

Description: The harness is easily donned due to an integrated vest which ensures the harness keeps its shape, and the FAST buckles allow the harness to be put on with both feet on the ground. It has wear protectors on the waistbelt and below the dorsal point to limit wear when moving about the inside of a wind turbine.

www.petzl.com



TEAM-1 Academy Inc.

Product: SKYLOTEC IGNITE PROTON Wind Harness

Application: Working at heights / Industrial wind safety harness

Description: The IGNITE PROTON is the evolution of Team-1 Academy's ARG 5. A safety harness with an elaborate and thought-out design with thermoformed hip padding AIRPAD and sophisticated construction provides comfort and usability.

www.team1academy.com

Training

The wind energy industry is developing more projects than ever and needs a skilled and qualified workforce to produce America's clean wind power. Workers and technicians may need specialized training to succeed and advance in their careers. Check out some of the training opportunities, professional certifications, workshops, and events offered across the country and online.



Avanti Wind Systems, Inc.

Training Program: GWO - Working at Heights

Hours: 2 days (16 hours)

Classroom/Online: Classroom or on site

Number of Participants: 4-6

Certifications: ISO 9001:2008, ISO 14001:2004, OHSAS 18001:2007 ASME A17.1.5.11, GWO (Global Wind Organisation)

Course description: Participants will learn the basics in how to plan and execute safe whereabouts in a Wind Turbine. This including knowledge and skills in national legislation, risks, hazards and the necessary ability to perform safe rescue and evacuation by practical use of emergency equipment for heights.

www.avanti-online.com



Wind Access Engineering

Training Program: Suspended Scaffolding Safety

Hours: 10 hours

Classroom/Online: Classroom or on site

Number of Participants: 10-12

Certifications: Kaeufer Blade Access Systems, Asmus Wind, Tractel, Bee Access Products

Course description: Wind Access's Suspended Scaffolding Safety course is designed to exceed OSHA's training requirements for Suspended Scaffolding under CFR 1926.451. Topics covered include hazard assessment, OSHA standards, topside rigging, wind platforms, fall arrest and self-rescue systems, and more.

www.windaccessengineering.com



TEAM-1 Academy Inc.

Training Program: GWO Working at Heights

Hours: 2 days (16 hours)

Classroom/Online: On their site, or on client's site

Number of Participants: 1-12

Certifications: GWO (Global Wind Organization), OHSAS 18001, ISO 9001, MOL Approved

Course description: This course meets and exceeds industry standards and is customized to each location. The course content is delivered in an easy to understand manner and promotes the "clip & go" systems.

www.team1academy.com

Lighting

The marking and lighting of wind turbines is primarily intended to provide high visibility and to assist pilots identify and avoid the structures. The FAA recommends wind turbines be lit with red or white lights which flash simultaneously. Listed below are some of the options available on the market today.

SEE AD ON PAGE 20



Technostrobe

Product Name: LED-RED-Standard
Effective Intensity: 2000cd
Horizontal Coverage: 360°
Vertical Beam: 3°
Expected LED Life: 10 years minimum
Input Voltage: 24Vdc or 90-250Vac
Overvoltage Protection: In both the Beacon and the Control enclosure
Frequency: 50/60hz
Power Consumption: Beacon is 9W, at 30 FPM, 16% duty cycle
Operating Temperature: -40°F to +131°F (-40°C to +55°C)

Weight: Beacon 7.05lb (3.2kg)
Dimensions (in/cm): 6.69" x 4.92" (17cm x 12.5 cm)
Cable/Connection: 16AWG, 2 conductors
Warranty: 5-year warranty
Rating/Certifications: Compliant with TC, FAA and ULc

Key Features:

- LIDS compatible;
- NVG option available;
- Simulated incandescent flash (soft-on, soft-off).

www.technostrobe.com



TWR Lighting

Product Name: L550-864-G
Effective Intensity: 2000cd
Horizontal Coverage: 360°
Vertical Beam: 3 years minimum
Expected LED Life: 15 – 20 years
Input Voltage: 120-230Vac
Operating Voltage: 120/230Vac
Overvoltage Protection: Built in overvoltage protection designed to meet Class III according to IEC61643-1, Class D
Frequency: 50-60Hz
Power Consumption: 2W (Day) / 20W (Night)

Operating Temperature: -67°F to +130°F (-55°C to +55°C)
Weight: 26lbs (11.8kg)
Dimensions (in/cm): 20.6" x 20.6" x 9.4" (52.3cm x 52.3cm x 23.9cm)
Cable/Connection: Combined power and alarm connection cable
Warranty: 5-year warranty
Rating/Certifications: United States Federal Aviation Administration AC 70/7460-1K; Obstruction Marking and Lighting
www.twrlighting.com



Hughey & Phillips

Product Name: HORIZON 2000/3000
Effective Intensity: Day White 20000cd; Night White 2000cd; Night Red 2,000cd
Horizontal Coverage: 360°
Vertical Beam: 3°
Expected LED Life: 10 years
Input Voltage: 120-240Vac 50/60Hz, +/-48Vdc
Operating Voltage: 120-240Vac 50/60Hz, +/-48Vdc
Overvoltage Protection: H&P patented design
Frequency: 50/60Hz
Power Consumption: <25 Watts
Operating Temperature: -40°F to +131°F (-40°C to +55°C)
Weight: 17lbs (7.71kg)
Dimensions (in/cm): 14" x 9.5" (35.6cm x 24.1cm)
Cable/Connection: 20ft Pigtail of #18-8C Tray Cable
Warranty: 5-year warranty
Rating/Certifications: FAA Type L-864, L-865, L-864/865
www.hugheyandphillips.com



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Solar Radiometer Calibration
Solar Water Pumping
Valve, Measurement, & Control Systems

Adhesives, Sealants, Tapes & Pastes



3M Renewable Energy Division

3M provides materials for the solar industry through differentiated energy generation and storage solutions. 3M is a supplier of advanced films, tapes, coatings, and adhesives. Their broad range of products and technologies is designed to enhance performance, improve reliability, and drive down the critical cost per watt. 3M has contributed lab tested and field proven technological solutions in solar energy since the 1970's.

www.3m.com



BUILDING TRUST

Sika Corporation

Sika supplies a full range of engineered silicones, polyurethanes, and modified silane adhesives and sealants that meet the stringent performance demands of customers in the solar energy industry. They offer solutions that have been optimized to provide for long-term performance, curing speed, and increased process throughput capabilities. Sika continually strives to exceed standards in terms of their product assembly operations and field installation services, as well as in terms of the global engineering support they provide customers.

www.sikausa.com

Aluminum Extrusion & Metal Fabrication



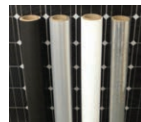
sapa:

Sapa Extrusion North America

Sapa Extrusion, a global manufacturer of aluminum profiles, works with customers to establish finished designs for custom features and improved end-use applications. Sapa's manufacturing capabilities include standard and custom extrusion, finishing (painting and anodizing), as well as full fabrication and logistic services. Sapa provides solutions to all solar market segments including: PV racking and mounting systems (open field, flat roof, and residential); solar thermal (H2O) applications; module frames and components; concentrated solar power collectors, inverter housings and components; and thermal management solutions.

www.sapagroup.com/na

Backsheets



Griff Paper & Film

Griff's PV backsheets are designed to protect solar panel electronics from the harsh environments of outdoor exposure. Griff specializes in high barrier laminates used in thin film and flexible solar panels. Custom construction sizes and colors are available. Griff offers the panel maker solutions to protect their product, and ensure safety at the installation site.

www.thegriffnetwork.com

Balance-of-Systems (BoS)



CAB Products

The CAB Solar Cable Management System, for use in large scale PV ground mount systems, is a unique and simple solution to the age-old problem of cable management. Utilizing hangers attached to messenger wire, the CAB system installs easily and is infinitely adaptable to different project configurations. Changes in elevation are easily resolved and installation is simple and fast. Their system avoids the pitfalls of trenching or cable tray including water intrusion, rodent nesting, encountering native or endangered species habitat, and rodent infestation, to name a few. The CAB Solar Cable Management System is a solution for upgrades and easing decommissioning. CAB provides assistance in the layout and on-site training, if necessary, at no extra charge.

www.cabproducts.com



Can Solar, Inc.

Can Solar, Inc. offers their solar combiner box in three models, which require no internal cabling. All connectors, DIN rails, stoppers, and cable glands are formed on the combiner body, which can be set up in just four minutes. They are NEMA 4X, UL94V-0 flameproof, TUV, TUVus, and AS/NZS certified; plus US, Europe, Taiwan, and China patented. Can Solar's combiner boxes are for outdoor and indoor residential, and commercial scale solar systems. An available option is to have the fuses and/or surge arresters pre-installed.

www.cansolarenergy.com



Joyce/Dayton Corp

Joyce motorized jack tracking units with integral trunnion mounts allow seamless integration into commercial or utility scale installations. Both tracking jack and motor/reducer are supported between the trunnion pins and the clevis end. These units, built to ISO 9001:2008 standards, reliably position up to 50 tons and are designed for long life and low maintenance. Joyce/Dayton's proprietary outdoor paint process provides superior surface protection designed for harsh outdoor environments. Customers specify the length and speed of travel. Joyce/Dayton engineers and solar designers recommend jack capacities, customization, and accessories based on system requirements.

www.joycedayton.com



Morningstar Corp.

Morningstar's PV controllers and inverters provide protection against extreme environments, corrosion, lightning surges, and harsh ambient operating temperatures (common to remote PV systems) while delivering a high operating life. Their PWM and MPPT solar charge controllers deliver extended battery capacity and life, low overall system costs, and maximum energy harvest. Their products include multi-lingual product operation/installation manuals and a variety of user and installation friendly product features.

www.morningstarcorp.com



Heyco Products

Heyco recently expanded its SunRunner 90° Cable Clip family by introducing a 2-wire version as well as a 4-wire version. The SunRunner 90° Cable Clips are designed to mount at a 90° angle to the original SunRunner. The SunRunner 90° will accommodate a single cable from .20" (5.1mm) to .30" (7.6mm); SunRunner 90-2 will accommodate (2) of these cables, and SunRunner 90-4 will accommodate (4) of these cables. The SunRunner 90° Cable Clips are designed to mount on to panels that are anywhere from .06" to .125" thick. The SunRunner 90° Series is designed for use with PV modules mounted in the landscape mode.

www.heyco.com



Shoals Technologies Group

Shoals' combiner-less BLA harness has helped streamline installation while creating between 20 and 60% material savings. The newest addition to this is the introduction of BLM which adds current and voltage monitoring along with autonomous I/V curve measurement. I/V curve measurement provides more information about the performance of a PV module or array than any other measurement method and is coupled with the fastest possible measurement tools. The entire system is plug and play and completely wireless - allowing for maximum functionality.

www.shoals.com



SolarBOS

SolarBOS, a manufacturer of electrical balance of system solutions, is now offering AC Combiners and Recoiners in addition to its wide range of DC BoS products and wire solutions. SolarBOS AC Combiners provide a safe and cost effective alternative to AC breaker panels. They support all string inverters. Key benefits include low installation cost and maintenance, reduced PPE requirements, 100% operation and reliability upon fuse replacement (as opposed to breaker degradation), and high performance at elevated ambient temperatures.

www.solarbos.com

Battery | Energy Storage



BatteryInformer

BatteryInformer specializes in Battery Monitoring for energy storage, telecom, and UPS battery backup. BatteryInformer works with VRLA batteries of all types.

www.batteryinformer.com



Canadian Energy

The Containerized Universal Battery (CUB) energy storage containers eliminate diesel and transportation costs, and provide the option for clean energy solutions such as solar arrays and wind turbines to suit the communities that need them. Designed and manufactured in Canada, the newest version of CUB is an improved solution to power and empower even the most remote and isolated communities.

www.cdnrg.com



Crown Battery Manufacturing Company

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

www.crownbattery.com



Wiley ACC Cable Clips are a high-quality wire management solution

Clipping Right Along

Long-lasting, Customizable Wire Management Clips

Wiley Cable Clips simplify wire management and create a cleaner look to solar PV arrays. Able to last a lifetime, the corrosion resistant 304 stainless steel clips are a durable solution for all environments. Coined edges prevent damage to cable insulation. The design is easy to install and no tools are required. Clips can be used in a wide variety of mounting configurations (including 90-degree) for module and rail applications. Custom designs are available upon request.

wiley



Connecting Power to Your World®



www.burndy.com

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Discover®



Discover

Discover Advanced Energy Systems (AES) Lithium-ion batteries provide productivity gains through enhanced cycling, charge time, and weight and volume improvements in renewable energy applications. Discover AES batteries are available in 24V and 48V systems with a range of energy between 2.8 and 6.65kWh, with fully integrated BMS. Renewable ready with optional plug and play compatibility with Schneider Electric battery based inverter chargers, charge controllers, and related components. Parallel up to ten batteries in one cluster with battery to battery communication.

www.discoverbattery.com



Iron Edison Battery Company

The Iron Edison Lithium Iron Battery brings new technology to energy storage projects, and is a plug-n-play replacement to other lead acid battery options. Fully compatible with common inverters and charge controllers, Iron Edison's Lithium Iron Batteries offer a safe, simple, and dependable energy storage solution for off-grid and grid tied battery backup applications. Custom battery solutions are also available for commercial projects, including telecommunications towers and UPS applications.

www.ironedison.com



Mercedes-Benz Energy

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 perfectly 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.

www.mercedes-benz-energy.com



Fullriver Battery

Fullriver's DC400-6 true deep cycle AGM batteries are built specifically for cyclic use in demanding solar applications. Their thick plate design and AGM construction combine for a robust, maintenance-free battery, delivering optimal performance in both fair weather and extreme climate conditions.

www.fullriverbattery.com



Narada Power Source Co., Ltd.

Narada specializes in manufacturing VRLA, lithium batteries, power systems focussed on telecommunication, storage energy, and mobile power fields. They also offer technologies including high-temp. batteries, lead-carbon batteries, and cycling batteries.

en.naradapower.com



GS Battery USA

GS Battery (USA) Inc. manufactures a wide variety of premium batteries for grid-tie or off-grid renewable energy applications and energy storage projects. Their line of advanced lead-carbon batteries are suitable for residential, commercial, and industrial renewable energy projects. These sealed, maintenance-free batteries deliver a cyclic performance of 5000 cycles at 70% DOD. GS Battery also manufactures lithium-ion, AGM lead-acid, and nickel-cadmium battery chemistries.

www.gsbattery.com/renewable



NEXTracker

NX Fusion Plus by NEXTracker is a complete solar + storage solution bringing together innovative technologies to deliver savings and high returns to their customers. This PV + storage offering is built on top of NEXTracker's NX Fusion turnkey product bundle, integrating battery and inverter technologies. NEXTracker's solar + storage solution will ultimately offset more load on the grid, and allow customers to use more solar and storage throughout the day, broadening the shoulders of the PV generation curve.

www.nextracker.com



Outback Power

A pre-tested, wired, and configured package complete with energy storage, OutBack Power's SystemEdge offers solar installers a simple and cost-effective installation path. It provides custom quality and craftsmanship in a pre-assembled system that can be ordered as one part number and installed in less than half the time it normally takes. SystemEdge is a UL-1741 single-brand solution from rooftop to battery. Designed around OutBack's acclaimed Radian Grid/Hybrid inverter/charger and OPTICS RE control and monitoring software with flexible settings that include Grid-Zero, Flex-Time, and Advanced Battery Charging, SystemEdge is a solution to meet any energy scenario.

www.outbackpower.com



Powin Energy

Powin Energy's BESS features their Battery Pack Operating System (bp-OS). The bp-OS provides visibility and predictability into every layer of a battery system and adds an extra level of safety to energy storage by balancing battery functions at the cell level. The BESS can be scaled to service projects that are multiple megawatts in size and a rolling chassis-mountable option with dual AC and DC connections give the BESS the ability to be transported easily between sites and interconnected quickly. The BESS is suited for microgrid or grid-connected applications.

www.powinenergy.com



Rolls Battery Engineering

Specifically designed to deliver reliable capacity in a heavy duty, dual-container design, Rolls 5000 Series 6 volt model 6 CS 27P offers customers thick plate design for extended durability and cycle life, modular cell construction, and a high Amp-Hour capacity. Used in residential and larger commercial installs, Rolls' 6 CS 27P is backed by a 10-year warranty.

www.rollsbattery.com



S&C Electric Company

Simplifying complexity, S&C's PureWave SMS-250 storage management system provides 250kW of scalable energy storage for solar power needs. Engineered with the company's 3-phase, 4-quadrant converter system, the PureWave SMS-250 delivers every use case from solar smoothing to energy arbitrage, and is a solution for storage solutions requiring less than 1MW of power. The system operates in a variety of modes, including current source mode, voltage source mode, and islanded mode.

www.sandc.com



Sharp Electronics Corporation

Sharp's SmartStorage system is an energy storage solution designed to reduce expensive peak demand charges for commercial and industrial buildings. The SmartStorage energy storage system combines Sharp's intelligent energy management system with modern hardware, operating seamlessly as a stand-alone solution or when deployed along with a solar electric system. SmartStorage energy storage systems are available with an optional 10-year Asset Management Service Agreement and demand reduction performance guarantee. If guaranteed performance is not met, Sharp will compensate for the deficit in promised peak demand reductions.

www.sharpsmartstorage.com



Shenzhen Herwin Technology Co., Ltd.

Herwin is a company with independent intellectual property rights, engaged in lithium-ion battery technology research and development, production, and sales of high-tech enterprises. Their main products include electronic vehicle power batteries, energy storage batteries, and UAV batteries. The company has been listed on the new board in China (Stock Code: 834159)

www.herwin.com



SimpliPhi Power

SimpliPhi Power storage creates energy security with a 98% efficiency charge/discharge rate, 10,000+ cycles, and 10-year warranty. Its plug-and-play AccESS systems, and PHI 2.6 and PHI 3.4kWh batteries easily scale up to hundreds of kWhs and seamlessly integrate into residential and commercial systems, both on- and off-grid. They feature a safe, non-toxic, Lithium Ferro Phosphate chemistry with proprietary architecture and power electronics. The operating temperature of the PHI batteries range from -4° to 140°, and do not require heat mitigation, nor pose a risk of thermal runaway. SimpliPhi has more than 9MW of products deployed around the world, including for the US Army and Marine Corps.

www.simpliphipower.com

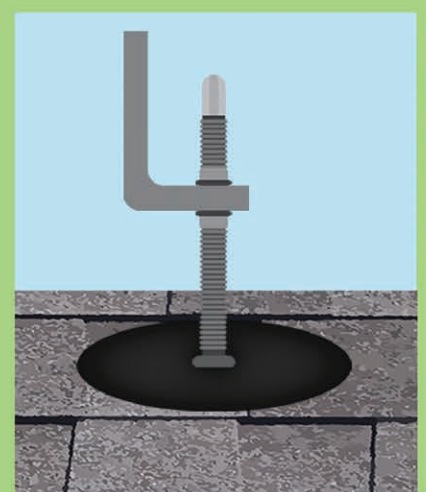


SunSystem Technology

SunSystem Technology (SST) offers a full complement of batteries and storage options and their installation for both new and existing systems. From initial commissioning to ongoing O&M and asset management support for large-scale solar energy facilities (SEF) and residential fleets, SST ensures its clients enjoy optimal system performance, minimal system downtime, and maximized system production values.

www.sstsolar.com

THE INNOVATIVE FLASHING-FREE & LEAK-PROOF QUICKBOLT FOR ASPHALT SHINGLE ROOFS



sonnen, Inc.

The sonnenBatterie eco systems help residential customers use solar + storage to meet up to 100% of their energy needs. Sonnen's intelligent energy management system provides customers with greater energy control through increased solar self-consumption, reduced peak energy usage, and reliable backup power during outages, contributing to a cleaner and more reliable energy future. Sonnen's fully integrated, intelligent battery storage systems integrate with new and existing solar systems and are scalable from 4kWh - 16kWh in a single unit.

www.sonnen-batterie.com



Sun Xtender Batteries

Sun Xtender offers a comprehensive selection of renewable energy batteries. Multiple terminal options are available to mate with existing cabling and to optimize battery bank layout. Produced in the USA under ISO 9001 + AS9100 Quality Management System, Sun Xtender batteries utilize PolyGuard protection, pure lead-calcium grids, and thick plates for long cycle life, providing increased reliability and power. VRLA - AGM: This sealed, maintenance free design means no spilling, no watering. They are shipped Hazmat Exempt, fully charged, and ready to install.

www.sunxtender.com



SHOP ONLINE
www.SolarRoofHook.com
844.671.6045



SunWize Power & Battery

SunWize Power & Battery designs and builds reliable, stand-alone industrial power solutions and electronic assemblies for integration into OEM products and off-grid field applications. With over 20 years of reliability in extreme environments and installations on all 7 continents, their solar, battery backup, and hybrid power systems are pre-engineered, assembled, and tested for easy installation and minimal maintenance. They offer a broad spectrum of remote industrial power products, including electrical components, turnkey systems, kits, inverters, batteries, modules, mounts, and enclosures.

www.sunwize.com



Trojan Battery

Trojan offers deep-cycle flooded, AGM, and gel products for a range of renewable energy hybrid systems and backup power applications. To address the issue of Partial State of Charge (PSOC), Trojan has developed Smart Carbon, a proprietary formula of carbon additives to enhance life and performance of Trojan's Industrial and Premium batteries operating in PSOC. Trojan offers Reliant AGM with C-Max Technology, a true deep-cycle AGM battery engineered for applications requiring deep-cycling power in a non-spillable design. Reliant AGM provides sustained performance and total energy output, delivering quality and reliability.

www.trojanbattery.com



Valence Technology

Valence Technology, of Austin, TX, manufactures lithium ion batteries that can be arranged in systems between 12V-1000V, from kWh to MWh. As a result of the stable, high-quality chemistry, Valence's U-Charge family of 12V, 24V, and 36V modules have a cycle life and float life which is suited for energy storage markets such as renewables and UPS. Through their design, lithium ion batteries can act as a "drop-in" replacement for lead-acid batteries, or be easily assembled into larger systems of any voltage and capacity. Valence's lithium iron magnesium phosphate batteries are fast-charging and safe.

www.valence.com



ViZn Energy Systems

ViZn Energy designs and manufactures expandable building block Zinc/Iron Flow batteries ranging from tens of kilowatts to megawatt storage. The GS200 Energy Storage System is a self-contained, modular, stationary storage system that performs both high-power and long-duration services. The zinc redox flow battery utilizes a non-toxic chemistry and has an expected lifespan of 20 years.

www.viznenergy.com

Components | Electrical Protection



Bal Seal Engineering, Inc.

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

www.balseal.com



Carling Technologies

Carling Technologies' circuit breakers can be integrated into a PV system to achieve protection against harmful overcurrent. Carling's circuit breakers utilize the hydraulic-magnetic principal, protecting not only the power system itself, but also safeguarding the structure where these systems are installed by eliminating the potential fire hazard caused by overcurrent.

www.carlingtech.com



Clark Rubber & Plastic

Clark Rubber & Plastic is a custom manufacturer of UL extruded and molded rubber and plastic components used in the solar industry. Clark Rubber & Plastic develops and manufactures custom rubber and plastic quality components such as clamp inserts, grommets, rub strips, and fastening applications.

www.clarkrandp.com



Tabuchi Electric Company of America

Tabuchi America offers their residential solar+storage solution, EIBS for 2017. This all-in-one solution consists of a 5.5kW hybrid solar inverter and 9.89kWh lithium-ion storage battery. EIBS is easy-to-install and includes a bi-directional DC/DC converter, automatic transfer switch, and a battery management system. EIBS is programmed with 4 modes for self-consumption, demand, TOU, and backup. Their remote controller makes it easy to change modes based on current energy needs. The EIBS is optimized for energy management and cost performance.

www.tabuchiamerica.com



U.S. Battery Mfg., Co.

U.S. Battery manufactures a variety of deep-cycle batteries, including for solar and renewable energy projects, which are all manufactured in the US and distributed worldwide. Products include: deep-cycle, flooded lead-acid batteries; AGM-sealed, low-maintenance batteries; and single-point watering systems. U.S. Battery's renewable energy (RE) series, deep-cycle batteries are available in two-volt and six-volt configurations.

www.usbattery.com



EMA Electromechanics, LLC

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

www.emaelectromechanics.com



EPCOS, Inc., a TDK Group Company

TDK Corporation presents EPCOS PhaseCap Energy – two new series of high power capacitors for power factor correction. These components are available with gas or resin-filled housings. They are designed for voltages of 230VAC to 690VAC and offer a reactive power of between 5 kvar and 33 kvar. The life expectancy of the B25674* series of gas-impregnated capacitors has been possible to extend by nearly 40% from 130,000 to 180,000 hours. The B25675* series of resin-filled capacitors features an even longer life expectancy of 200,000 hours. A further significantly improved feature of both series is their increased energy density in comparison with the existing types.

www.epcos.com

GIGAVAC®
ADVANCED SWITCHING SOLUTIONS



Gigavac

Designed and manufactured in the USA, GIGAVAC offers the smallest UL508 recognized contactors for high current switching at 1000Vdc. The patented series includes HX EPIC contactors rated to 350A+ and the cost effective GIGAVAC MiniTACTOR series rated up to 50A. GIGAVAC's patented sealing technologies provide complete protection beyond what is offered by traditional hermetic seals. Sealed switching technology means these contactors can safely be used in nearly any harsh environment, and at temperatures up to 85°C. They are not position sensitive and can be mounted in any axis. The HX series includes models with optional auxiliary contacts.

www.gigavac.com

Littelfuse®

Expertise Applied | Answers Delivered



Littelfuse

The Littelfuse SPXI 1500 Vdc solar fuse is designed to integrate into an in-line assembly within a wire harness. The fuse provides string protection that meets 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 to 30 amps. Littelfuse offers numerous DC circuit-protection products uniquely suited to protect the equipment and systems subject to the harsh environments of PV installations.

www.littelfuse.com/solar

THERE'S A LOT OF LIFE IN ONE BATTERY

Rolls
BATTERY ENGINEERING

The longest lasting battery for your off-grid home.

Learn more at rollsbattery.com

NABCEP Continuing Education CONFERENCE
March 21-23, 2017 Dallas, TX

Rolls
BATTERY ENGINEERING
DEEP CYCLE SERIES 4000
5-550
6 VOLTS



Luvata Appleton, LLC

Sunwire photovoltaic ribbon by Luvata is a copper-based flat ribbon used to connect silicon cells electrically and to carry out current in crystal-line silicon and thin-film photovoltaic modules. Sunwire is rolled from round wire to high precision, annealed to extra soft and plated in a hot-dip-tinning process. Sunwire offers electrical conductivity with guaranteed elongation and yield strength. These mechanical properties reduce cell breakage rates and electrical resistance in modules.

www.luvata.com/sunwire



Mersen

Mersen's HP10M and HP15M HelioProtection photovoltaic fuses are engineered specifically for the protection of PV systems. Mersen's new crimp cap termination for HP10M and HP15M fuses enables users to attach wires directly to the fuses. This eliminates the need for a fuse holder and allows an overmolded enclosure. UL Recognized.

ep.mersen.com



Phoenix Contact USA

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 effort 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.

www.phoenixcontact.com/unosolar



Rotek Incorporated

Rotek Incorporated is a manufacturer of large diameter slewing bearings and rolled ring forgings. Rotek slewing bearings are used in various applications, including in solar energy panels where tracking is critical. Offering full engineering support, Rotek manufactures large diameter, lightweight solutions with consistent repeatability for intermittent or oscillating needs, as well as for any design scenario where precision is needed with other components.

www.rottek-inc.com



Schweitzer Engineering Laboratories, Inc.

SEL designs, manufactures, and supports a complete line of products and services for the protection, monitoring, control, automation, and metering of electric power systems. Their solutions range from comprehensive generator and transmission protection to distribution automation and control systems. Their Government Services Division is dedicated to the security, safety, and reliability of electric power at facilities ranging from ships to military bases, while their Engineering Services Division provides engineering expertise and system solutions to customers worldwide. SEL University offers training that helps integrate digitally based technologies into the power system infrastructure.

www.selinc.com



SIBA Fuses

SIBA Fuses are available for protection of PV panels, sub-arrays, arrays, energy storage (ES) systems, inverters, filters, transformers, and switchgear tied to the grid. Fuses for DC side of the inverter are available in voltages 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.

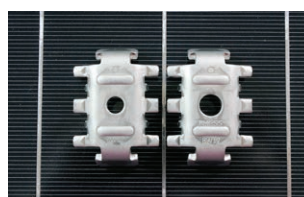
www.siba-fuses.us



STEGO, Inc.

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

www.stegousa.com



BURNDY

WILEY

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

www.burndy.com

Concentrated Solar Power (CSP)



Hyspan Precision Products, Inc.

Hyspan supports pipe motion products: 1" (25mm) to 20' (6m), vacuum to 7000 PSI (483 bar); CSP mirror collector expansion/rotation; seismic motions 1 meter +; geothermal/wellhead services; balance-of-plant: thermal growth, settlement, seismic, vibration reduction; turbine pump, compressor, safety relief valve vent connectors; abrasion service; corrosion resistant materials: Alloys: 625, C-276, AL-6XN, 2205, Zeron 100, 316L s/s; brace ball joint loops: 20% area of pipe loop; all 4 motion technologies: bellows, ball, slip, braided; factory engineering and support: local support, emergency service; EJMA Certified, ASME B31.1, B31.3, Section VIII, CE/PED, NEMA, ORMAT supplier.

www.hyspan.com

Consulting Services | Business & Environmental Consultants



DNV GL

DNV GL is currently the largest global provider of independent renewables and energy advice. They work with investors, project developers, owners, and equipment manufacturers to help manage risk throughout the entire project life cycle to ensure the performance and safety of systems from residential solar rooftops to multi-megawatt power plants. DNV GL's services include: energy assessment; independent engineering; owner's engineering; technology reviews; pre-construction engineering, environmental, and permitting; asset management; solar grid integration; solar storage applications; certification testing; and PV module and inverter testing.

www.dnvgl.com/solar



Ecology and Environment, Inc.

Ecology and Environment, Inc. (E & E) offers all the professional environmental support required to site, permit, and operate solar energy generation and transmission facilities. E & E covers all the bases—from water supply, wetland considerations, and ecological impact studies, to land use, socioeconomic analyses, and community outreach. Operating across the US, with subsidiaries and affiliates around the world, E & E provides global energy industry experience, including environmental support for more than 3,565 MW of PV capacity. Their skilled, multidisciplinary project teams help solar energy developers get the green light faster when it comes to solar projects.

www.ene.com/service/energy/solar.aspx

TRACK & YIELD

- > Higher Yield per Acre
- > Best Land-Use Enabler
- > Self-Powered Tracking and Wireless Communications
- > Low-Cost Installation & Maintenance

SF UTILITY Single Axis Tracker



Making Tracks

Soltec specializes in the manufacturing and supply of single-axis solar trackers and related services, with more than 1 GW in projects worldwide and a workforce of over 500 people. The company has manufacturing facilities and offices in Spain, Brazil, Chile and China; and offices in Denmark, India, Israel, Italy, Mexico, Peru and United States.



Soltec

Contact us:
3050 Osgood Ct, Fremont, CA
+1 510 440 9200
usa@soltec.com
soltec.com



Electrical Consultants, Inc.

Electrical Consultants Inc. (ECI) is a power delivery engineering firm which brings power delivery services through 500kV to their clients. ECI provides 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 to utilities. www.electricalconsultantsinc.com

Contractors | EPC



Blattner Energy

Blattner Energy is an EPC contractor in renewable energy construction with more than a century of large-scale project experience and over 30,000 megawatts of renewable energy installed across North America. Blattner provides EPC services for solar, energy storage, wind, and high voltage transmission and substation projects. Within the solar market, Blattner's services include: project feasibility; engineering and design capabilities; material procurement and management; pre-construction activities; full-service construction; testing and startup; operations and maintenance (O&M); and collaborative construction management. Blattner delivers a construction experience with added value throughout all phases of the project lifecycle. www.blattnerenergy.com



Fagen, Inc

Fagen, Inc. is a full service industrial contractor headquartered in Granite Falls, MN. Utilizing a database of over 25,000 direct-hire employees, Fagen, Inc. has constructed a variety of projects including solar power, wind power, biomass to power, conventional power, renewable fuels, and other industrial process facilities. Fagen, Inc. has been ranked among the Engineering News-Record (ENR) Top 400 Contractors and Top 100 Design-Build firms. www.fageninc.com



Petrochem Insulation, Inc.

Petrochem is a nationwide contractor providing insulation, scaffolding, pre-engineered metal building, metal roofing and siding, fireproofing, painting and coatings, heat tracing, and asbestos and lead abatement services. www.petrocheminc.com



SunSystem Technology

SunSystem Technology (SST) offers complete contracting services for industrial and utility-scale photovoltaic systems. In addition, from initial commissioning to ongoing O&M and asset management support for large-scale solar energy facilities (SEF) and residential fleets, SST ensures its clients enjoy optimal system performance, minimal system downtime, and maximized system production values. www.sstsolar.com



The Ryan Company

As a full service EPC commercial contractor with all in-house engineering disciplines, project references throughout the United States, and tremendous parent company bonding capacity, the Ryan Company has the background and financial strength to deliver fully functioning complex electrical projects on-time and on-budget. Their offerings encompass every step from pre-construction to complete design engineering, procurement of equipment, and construction, for large-scale solar, wind, and electrical infrastructure projects. www.ryancompany.net



Wanzek Construction

Wanzek's solar team specializes in designing and constructing complex commercial and utility-scale solar power projects with capabilities of 1MW to 100MWs. They approach projects systematically, providing innovative solutions to each project from initial development and design through construction and operations. Their team ensures an accurate feasibility process and their solar designs are developed with a focus on maximizing investment returns through performance analysis, delivery of bankable designs, high quality equipment, and maximizing project output with minimal life-cycle cost. www.wanzek.com

Economic Development



Pampa Economic Development Corporation

The Pampa EDC works to help start-up companies develop, existing companies expand, and recruit new companies to the community. They provide business counseling at no charge. The Pampa EDC Board of Directors will also consider providing low interest loans and forgivable loans. The Pampa Energy Center industrial park, is in a reinvestment zone of almost 4,000 acres. Clean energy is quickly becoming a major player in Pampa and surrounding counties. They invite clean energy related companies to consider locating in Pampa/ Gray County and experience the development of the renewable energy industry. www.pampaedc.com

Education | Research Development



Florida Gulf Coast Chapter of the U.S. Green Building Council Business of the Year Award



Everglades University

Everglades University is an accredited, private, not-for-profit university offering bachelor's and master's degree programs. They offer undergraduate degrees in Alternative and Renewable Energy Management, Environmental Policy and Management, Construction Management, Land and Energy Management, Surveying Management for Construction and Roadway, International Business, Alternative Medicine, Aviation/Aerospace, Hospitality Management, Business Administration, and Crisis & Disaster Management. In addition, they offer graduate degrees in Public Health Administration, Business Administration, Aviation Science, and Entrepreneurship. Concentrations are available. With small class sizes, innovative degree programs, and convenient scheduling to accommodate working students and adult learners, Everglades University's focus for sustainability in 2016 is on the horizon. www.evergladesuniversity.edu

Electrical Wire, Cable & Connectors



4SProducts

4SProducts manufactures medium and high voltage power cables, optical fiber cables, copper telecommunication cables, aluminum conductors and copper wires. All production and QC procedures are ISO 9001, ISO 14001, OHSAS 18001 certified and conform to relevant international standards. www.4sproducts.com



AEROSUSA INC.

AerosUSA

AerosUSA offers high UV-stabilized conduits and cable protection systems, rated to last upwards of 40 years in solar applications and outdoor environments. These conduit systems are characterized by their resistance to high-impact forces, along with their ability to protect and secure control cables. These systems are resistant to chemicals, and are free of silicone, cadmium, and halogen. They also have flame-retardant and self-extinguishing properties. AerosUSA's 1-piece integrated IP68/69K fitting system ensures a quick, safe, and reliable installation designed to save time and money, while eliminating potential failures. Accessories include straight, 90, 45, Y, and T's. www.aerosusa.com



Cameron Wire & Cable, Inc.

Cameron Wire & Cable provides PV UL 4703 1kV/2kV copper and aluminum cable, as well as UL MV cables for solar farms. Cameron will customize the overall cable design per the BOM, offering cut-to-length or bulk supply, and/or add accessories, lugs, and labels supplied in kits. Cameron Wire also offers inventory management and will warehouse planned goods at no charge, shipping the same day to satisfy tight job deadlines. www.cameronwire.com



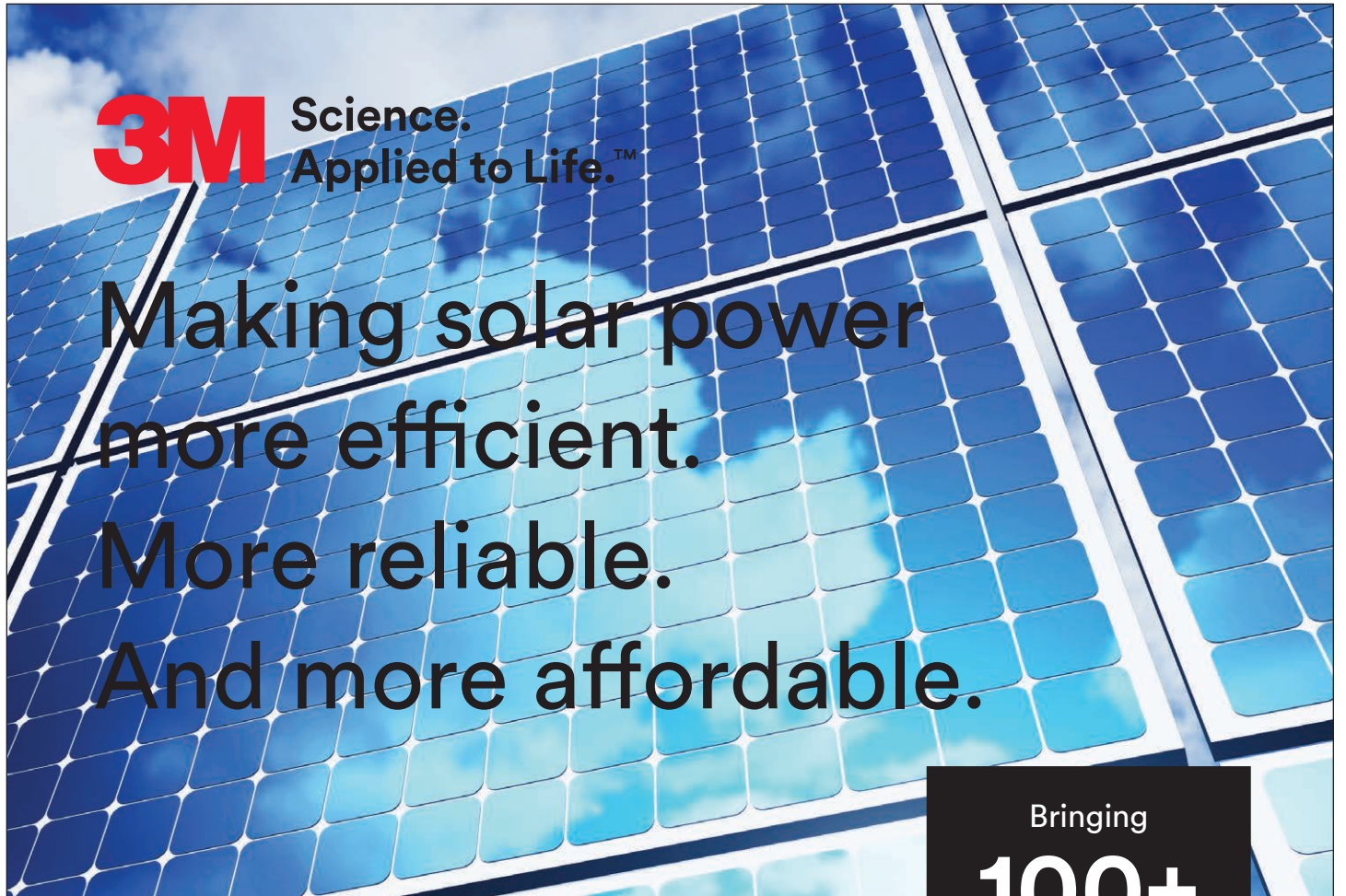
American Wire Group

American Wire Group (AWG) is a global supplier of wire and cable to the solar, wind, and utility industries. Specific to the solar power industry, AWG offers PV, power, control, transmission, and fiber optic cables. Handling large, utility-scale, as well as smaller, residential projects, AWG offers a variety of products to meet wire and cable needs, including the following: 15 kV to 35 kV TR-XLPE/EPR; ACSR/AAAC/AAC; PV AL cable; bare copper, aluminum, or copper clad steel; static/guy wire; OPGW; and related hardware. www.buyawg.com



Anderson Power Products

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



3M Science. Applied to Life.™

Making solar power more efficient. More reliable. And more affordable.

Bringing **100+** years of scientific knowledge to the solar industry

3M empowers the solar industry to realize cost-competitive and reliable energy sources. As a leader in solar innovation, 3M seeks to enhance performance, improve efficiency, and drive down the critical cost per watt.

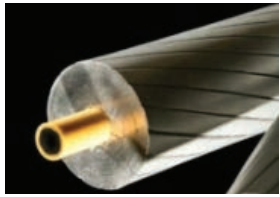
As one of the world's leading suppliers of films, tapes, coatings and adhesives, 3M has the advanced ability to supply products and provide technical support around the world. You can count on enhanced performance to enable higher power output with more uptime and less downtime.

3M has a commitment not only to quality and reliability but to your success. The strength and confidence of 3M can help maintain operations and profitability.

Learn how to drive efficiencies for your business at 3M.com/solarnace.

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CTC GLOBAL



CTC Global

CTC Global designed, developed, and commercialized the high-capacity, low-sag, energy-efficient ACCC conductor that can be used to reduce upfront capital costs on new lines and is also used to double the capacity of existing T&D lines. The ACCC conductor has been certified by SCS to reduce line losses by 27% to 31% which can increase RECS, improve project economics, and profitability. ACCC conductor is manufactured under license by more than 20 conductor manufacturers worldwide. To date more than 40,000km of ACCC is currently in service at more than 450 project sites.

www.ctcglobal.com



General Cable

General Cable

General Cable is a global wire and cable solutions provider for solar applications from the sun to the outlet. Engineered to withstand the harsh operating environments of solar applications, their full line of SunGen PV copper and aluminum wire is made in accordance with UL 4703 and CSA RPV90/RPVU90, offers superior resistance to UV sunlight, and meets the requirements for direct burial. From low-voltage DC and AC connections and EmPowr Link CL Advantage medium-voltage underground distribution, to high-voltage overhead and underground transmission lines, General Cable has the offering to comprise a complete cable solution for solar power applications.

www.generalcable.com



ILSCO

ILSCO's copper braid product offering (Type FX) is Listed to UL467 for grounding and bonding. Manufactured from pure copper braid and electro-tin plated, the seamless ferrules are clean cut and precision formed to the braid which assures a low resistance connection. ILSCO's flex braid connectors are ideal for grounding electrical cabinet doors, fence post gates, and in applications where vibration, expansion and contraction exist.

www.ilSCO.com



Kris-Tech Wire Company

Kris-Tech provides UL4703 rated PV wire from 1/0 through 18 AWG and in multiple colors. They also provide XHHW-2 and RHW-2/USE-2 wire. Lead time for production run quantities is normally within 2 weeks, and stock wire can be shipped in 1-2 business days. Custom cut lengths are available upon request. Kris-Tech can provide shipping logistics domestically or internationally. Their company works primarily through distribution channels, and is happy to connect end-users and distributors to ensure satisfaction.

www.kristechwire.com



Southwire Company, LLC

Southwire developed their photovoltaic (PV) wire for above ground solar installations with enhanced UV protection. Southwire's newly-introduced Super Sunlight Resistant (SSR) photovoltaic (PV) cable provides a solution to the aging effects of extended exposure to UV light. Extensive laboratory testing on the SSR product has proven longevity for color retention as well as superior aged tensile and elongation properties. Southwire also offers medium voltage cable, DLO cable, Tray cable, THHN, XHHW, RHH/RHW-2, RPVU90, and bare copper wire.

www.solar.southwire.com

STÄUBLI



Stäubli Electrical Connectors / Multi-Contact USA

As of January 1, 2017 Multi-Contact is now Stäubli Electrical Connectors. With over 120GW connected PV power, Stäubli Electrical Connectors can provide reliable connection solutions for bankable new energy projects. The original MC4 connectors have been installed over 1 billion times worldwide. Stäubli's portfolio ranges from miniature connectors up to high-power connectors for power transmission, test and measurement, transportation, and many other industries. The core of all Stäubli electrical connectors is the MULTILAM contact technology.

www.staubli.com/electrical



Energy Cable



Superior Essex – Energy Cable

Superior Essex is a U.S. manufacturer and supplier of energy wire and cable products serving the commercial, industrial, utility, and renewable energy markets. They provide low voltage 300V and 600V instrumentation cables, low voltage 600V control and power cables, low voltage 600V secondary URD, and medium voltage 5kV through 35kV power cables. Their MV Primary UD 35kV cables are suitable for underground collection systems designed for solar applications. They offer these cables 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.

ce.superioressex.com

Enclosures | Combiner Boxes



Fibox

Fibox is a global manufacturer of corrosion-resistant polycarbonate enclosures for the electronic and electrical industry. Fibox enclosures are designed not only to protect and insulate components and controls in the harshest of environments, but also to provide a stylish, more robust alternative to metallic and fiberglass enclosures. Fibox polycarbonate enclosures offer a stronger, yet lighter and more flexible solution, which can easily be modified to exact needs and specifications. Fibox can also customize enclosures in advance, providing customers with a ready-to-use product right out of the packaging.

<http://fiboxusa.com>



Telergon

Telergon's UL98B listed S6000R 1500Vdc load break switch is used in string combiner boxes for load-break switching of up to 400 amps. The design of the S6000DC load break switch allows for a smaller footprint in photovoltaic combiner boxes. The elimination of bridging link accessories reduces the total installation space, cost of building the unit, and saves on the amount of required labor.

www.telergon.es

wöhner®



Woehner USA, LLC

Woehner produces DIN-rail and busbar-mounted fuse holders rated for 1000Vdc PV applications. These fuseholders are targeted at North American solar combiner box manufacturers who build to the UL1741 standard. The products offer a UL4248 marking at 1000 volts DC for 10x38 fuses as large as 30 amps. They are available with or without LED-indicator lamps. The busbar mounted holder clips directly to UL-listed metric dimension busbar, eliminating the need for fabricated comb-style busbars.

www.woehner.com

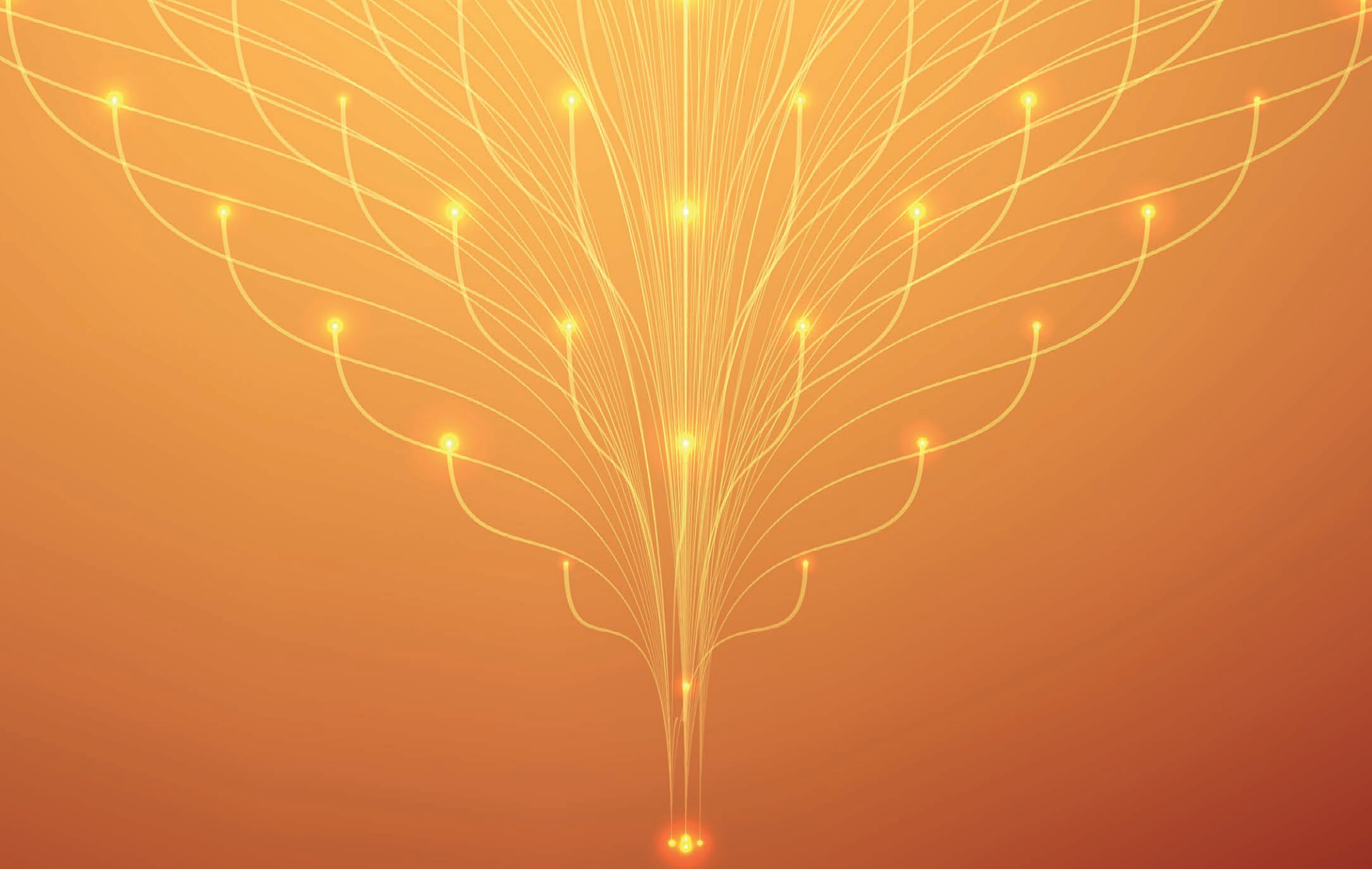
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Woehner USA, LLC

SECUR Panel is for North American solar combiner box and inverter manufacturers who build to the UL1741 standard. The product offers a UL4248-18 listing at 1500 volts DC for 10x85 and 14x85 fuses as large as 30 amps. The 10/14x85 fuse holder is suitable for use with both 1500Vdc rated UL2579 listed PV fuses or IEC60269-2 certified gPV fuses. The SECUR Panel is IP20 touch-safe and provides a safe, tool-free fuse insertion and extraction, for easy fuse installation and replacement. This fuse holder uses an advanced grade plastic material in the fuse carrier to satisfy the higher operating temperatures associated with PV fuses.

www.woehner.com



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TO SAY THAT HUAWEI IS A TECHNOLOGY COMPANY IS A BIT LIKE

saying that a Formula One car is a bit quick. For those who haven't been paying much attention lately, it's important to point out that Huawei has become one of the world's most prolific incubators of new technologies and applications. Not only do they make phones and the wireless networks that support them, they also make tablets and PCs that help you work more efficiently, watches that track your fitness, tech that makes your home smarter, and many complex electrical components you probably have never seen. More than half of the company's workforce -170,000 worldwide- is actively involved in R&D. Huawei reinvests 30% of its U.S. revenue into local innovation, and ensures a steady stream of new talent by working with more than 50 top research universities, such as Harvard, MIT, Stanford, UT Austin, and the University of California. The company was founded in 1987 as a manufacturer of phone switches, and rapidly evolved into a world leader in the field of Information and Communication Technology (ICT).

More recently, Huawei ventured into the world of solar and the broader field of advanced energy technologies. In retrospect, it seems like a natural transition. After all, sunlight absorbed by solar panels is worthless if it can't be translated into usable energy, and who better to translate than an expert in communication? More than 2000 engineers, 100 PhDs, and 800 inverter engineers teamed up to design and refine the latest technology, in line with Huawei's vision for a modular, flexible, and fully-interconnected PV system on an immense scale. Huawei's FusionSolar Smart PV Solution is a simple and intuitive way for owners and operators to rapidly deploy manage their power plants. Innovative 1000V and 1500V string inverters provide utility companies with the advanced performance, high availability, quality, and reliability that have made Huawei one of the newest leaders in PV solutions. String inverters aren't brand new, but part of the genius of Huawei's approach to nascent industries is their skill in applying years of connectivity expertise to transforming existing technology, so that it becomes more efficient and functional, and by deploying advanced systems engineering technology to make it all work at massive scale.

Central inverters have been the standard fare for utility scale PV for some time. They are the tried and true workhorses of the industry - like the mainframe of the computing world. Even the biggest fan of central inverters will admit, however, that these PV paragons have some serious drawbacks, in that they are hand assembled with far too many components that can, and do, break down and need to be replaced on a regular basis, which means O&M costs run high. Fans,

filters, and fuses are just some of the parts that keep PV plant operators up at night. When something goes wrong, personnel must visually inspect each of those parts to identify the component at fault; and, of course, when that big box stops working, all of the DC power collected by all of those modules goes nowhere.

The obvious advantage of string inverters is that they spread out the load to safeguard against power interruption; if one inverter goes down, it won't disturb the entire system. String inverters also offer greater flexibility than central inverters, since they can be easily adapted to various site and design requirements. True to form, Huawei took the best features of this concept and made them even better. Their SUN2000 inverters anchor the system, for increased energy production and ultimate cost savings. Additionally, Huawei took out the parts that tend to fail (such as the 3Fs: external fans, filters, and fuses) and created a clean design that is virtually maintenance free. Huawei's system reliability and optimized block designs add even more value for plant owners and EPCs by lowering costs. Visual inspections are recommended only a couple of times a year, reducing safety risks. The SUN2000 inverters stand up to all kinds of weather, are incredibly easy to use, and connect seamlessly using advanced communication technology with a smart system that can send a detailed alert to a phone or laptop, should anything need attention. Fewer inspections, less downtime, and real-time system intelligence work to lower O&M costs. Huawei's trademark systems approach delivers enhanced performance in utility scale plants, incorporating

automatic IV curve diagnosis, PLC communication, and cloud connectivity. Decades of expertise in technological innovations and communication have earned Huawei its reputation as a cutting-edge company that is tipping the scales of solar.

About Huawei

Huawei is a leading global information and communications technology (ICT) solution provider. Relying on its powerful R&D and comprehensive technological capabilities, Huawei unveils the cutting-edge FusionSolar Smart PV Solution by integrating the experience of digital information technology accumulated over years, Internet technology, and PV technology. Huawei optimizes and innovates the entire process from the design, construction, to the O&M of PV plants thanks to the global automatic O&M which is digital and simplified, and finally maximizes the customer benefits. According to the reports released by global consultancies IHS and GTM, the shipment of Huawei inverters is ranked No. 1 worldwide. Huawei FusionSolar Smart PV Solution has become a mainstream solution in the industry. Currently, Huawei has over 170,000 employees and serves more than 170 countries and regions, and a third of the world's population.

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www.huawei.com/solar

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QUADRON Panel for photovoltaics is a family of 1500Vdc fuse holders suitable for mounting NH1XL fuses from 50 to 250 amps and NH2XL or NH3L fuses up to 600 amps. Available in bolt-to-bolt configurations, for connecting lugged cables to M10 or M12 bolts on either side of the fuse; or bolt-to-busbar configurations, allowing current to be combined to a metric dimension busbar on the secondary of the fuse, in combiner box and inverter applications.

www.woehner.com

Energy Service Providers



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TurboDock is a low-cost, easy-to-use commercial and workplace charging station with access control. It uses Bluetooth to provide smartphone access. With easy set-up, it can provide one universal PIN, individual PINs to each driver, or it may be configured for open access, where no codes are required. TurboDock is a solution for workplaces and apartment buildings, and can be used at retail and destination locations, or anywhere easy-to-use, affordable EV charging is needed. TurboDock is managed from a smartphone app, so software upgrades and new features are easily downloaded.

www.evsolutions.com

Engineering | Operations & Maintenance (O&M)



Allied Industrial Marketing, Inc.

Allied Industrial Marketing helps to solve or prevent power quality problems. They specialize in power quality and help clients diagnose problems through engineering analysis and computer simulation, and then recommend the method to solve it. For OEMs of power quality solutions, they offer power quality components; Mangoldt Filter Reactors, Frako Capacitors, and GenMet Ventilated Enclosures. Educational power quality seminars are also available.

www.alliedindustrialmarketing.com



AquaSoli, LLC

AquaSoli provides geotechnical investigations, pile load testing (pull test, axial load testing, push testing, lateral testing), foundation design (steel piles, concrete pads), geological and geotechnical risk mitigation, forensic proof, civil engineering (mechanical design and static calculations), site dewatering plans, cut and fill design, 3D-modelling, terrestrial and airborne geomeasuring / geodetical surveying, electric yield calculations, cost estimations, feasibility studies, invest calculations, cost-benefit-analysis, and solarpark planning including electric design.

www.aquasoli.com



Black & Veatch

The ever-increasing demand for renewable energy presents new challenges for power producers. From the variable nature of the generation to the distributed nature of the assets, renewable energy projects have a unique set of factors to consider. Black & Veatch helps their clients navigate these challenges by developing dependable, sustainable, and integrated renewable energy solutions.

www.bv.com



Buffalo Turbine

Buffalo Turbine manufactures a turbine style debris blower for touch-less snow removal from solar panels. Available models include a double stacked hydraulic and a single hydraulic. Both models include standard and high speed options. With a built-in flow and pressure control system, it allows the unit to fit a wide variety of skid steer style vehicles. Also available is a PTO unit, which incorporates a direct drive gearbox in place of belts, pulleys resulting in a light and powerful turbine style blower.

www.buffaloturbine.com

Calvada Surveying, Inc.

Calvada Surveying provides efficient and speedy land surveying services, including ALTA Surveys, boundary, easements creation, acquisition exhibits, aerial mapping, underground utility locates, topographic mapping, and scanning services throughout the southwestern United States.

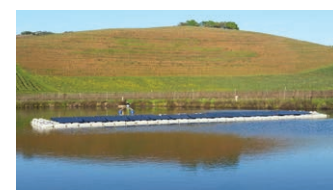
www.calvada.com



Caruso Turley Scott, Inc.

Caruso Turley Scott, Inc is a full services structural engineering consulting firm. As a nationally licensed solar engineer, CTS provides racking, canopy, and tracker development, design, and rollout, including parking structure installations and verifications, as well as single and dual axis, fixed rack systems, and rooftop verifications. Their systems are ASCE 7 for wind and seismic loads, and wind tunnel tested. Additionally, CTS offers foundations and foundation optimization, equipment pads, and ancillary structures. They can provide existing product evaluation and validation, foreign designs that are validated for the US marketplace, as well as structural design repairs.

www.ctsaz.com



Ciel & Terre

Ciel & Terre ('Sky & Earth'), develops solar power plants on inland water bodies, be they natural or manmade, such as irrigation reservoirs, water-treatment sites, dams, or quarry lakes. Ciel & Terre manufactures and provides a patented floating PV technology, named Hydrelío. Made of HDPE, a drinking-water compliant material, the floating solution is adaptable to any electrical configuration or capacity, and can withstand harsh environments such as heavy wind or waves. The French-born company distributes its solution worldwide, and offers its engineering skills including design, anchoring, installation, training, and maintenance expertise, as well as other services such as financing and project development.

www.cieletterre.us



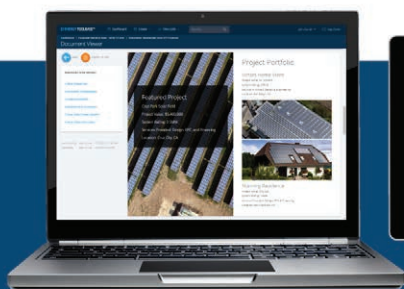
EDF Renewable Services

EDF's full range of O&M services begins prior to commissioning and goes through decommissioning. During the warranty period, they provide scheduled and unscheduled maintenance options such as balance-of-plant management, remote monitoring, and OEM oversight. They also provide total project operations and maintenance during the post warranty period. EDF's Asset Administration Services include managing projects and their commercial agreements to optimize returns over a project's lifecycle.

www.edf-renewable-services.com

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Established in 1985, Evergreen Engineering, Inc. is a multi-discipline, full-service consulting engineering firm serving the power generation, wood products, pulp & paper, chemical, and resin industries. Evergreen serves clients throughout North America and around the world. Evergreen specializes in mechanical, civil/structural, chemical, environmental, and electrical engineering. Evergreen's staff includes registered engineers, degreed engineers, designers, and draftsmen.

www.evergreenengineering.com



Heliolytics

Aerial inspections services from Heliolytics provide actionable information on system quality and performance. Aerial infrared inspections discover hidden system faults over 100% of a PV system, and can completely replace I-V tracing and manual DC inspections in an O&M scope. Heliolytics' clients are able to improve system output by an average of 1%, decrease on-site labor, and increase site safety while detecting serious systemic defects and serial component faults. The output of the inspection service is a digitized site map with the exact location and classification of all site DC faults.

www.heliolytics.com



POWER Engineers, Inc.

From U.S. urban centers to remote African villages, POWER Engineers delivers solar PV systems that meet complex on-the-ground needs across the globe. Their experienced staff provides owner's engineering, environmental, and engineering design services for medium voltage collection systems, site civil, communications, SCADA, substations, and transmission interconnect lines. They perform upfront interconnection support and complete electrical system studies, as well as construction management, inspection services, and testing and commissioning. Their team lays the foundation to help make the most of an investment by designing reliable and cost-effective plant systems which also minimize O&M costs.

www.powereng.com



Sargent & Lundy, LLC

Helping clients evaluate and implement solar technologies is an integral part of Sargent & Lundy's leadership mandate. The firm supports developers, owners, investors, contractors, manufacturers, and research organizations with diverse projects. Experience includes: solar resource assessments; owner's engineer; due diligence and conceptual/detailed facility design; as well as grid interconnection for PV, trough, tower, and dish technology. Sargent & Lundy offers complete engineering, project services, and consulting for power generation and transmission projects.

www.sargentlundy.com

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SNC-Lavalin offers end-to-end services in the field of EPC design-build projects. Their subject matter experts have experience with designing solar facilities and as well as the accompanying T&D. They hold the ability to deliver their projects around the world and can also provide financing support. www.snclavalin.com

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SunSystem Technology

SST offers comprehensive O&M service, from initial commissioning to ongoing system monitoring, supervision, and proactive maintenance through a suite of needs-based support services. Their O&M services are designed to deliver the technical asset management actions fundamental to ensuring optimal energy production with minimal operation costs. SST understands the financial impact of their O&M services and the interdependent relationship between O&M and asset management. www.sstsolar.com

Financial Services



CSI Bonds

CSI Bonds has been in the surety bond industry for over 20 years, providing bid, performance, payment, and license bonds. They serve commercial contractors and subcontractors of all sizes. CSI concentrates in and understands the many facets of the solar and wind industries, and has relationships with a vast array of sureties, enabling CSI to provide a high level of service in a timely manner. www.csisuretybonds.com

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

twig energy, inc.

twig energy works with companies in renewable energy and energy efficiency, assisting them in raising the equity and debt instruments they require to build or acquire projects. www.twigenergy.com

Foundations



Con-Tech Systems

Con-Tech Systems supplies Geo-Support Foundation Systems to suit all ground conditions for solar and wind renewable energy sources as well as transmission lines. Their HRTB Solid Bar and Strand Systems are well suited for foundations on rock. Post-tensioning of these anchor piles to their design load, eliminates anchor and foundation movements, and provides a higher safety factor. Their single step CTS/TITAN Hollow Bar IBO Micro pile system is a solution for foundations on soils particularly when collapsing soils, such as sand and gravel, are encountered. Ground conditions and grout to ground bond values are improved during drilling and flushing of the bore hole through their grout injection process. www.contechsystems.com

Ground Screws | Anchors



American Earth Anchors

American Earth Anchors introduces 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, and was designed to fit a 2" 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 also make custom brackets for any pipe size. www.americanea.com

Handling | Manufacturing



CoorsTek

CoorsTek produces silicon carbide systems for solar wafer manufacturing, optimizing entire horizontal furnace systems. CoorsTek systems are compatible with fully automated wafer loading and transferring processes, saving both time and money. Manufactured from high-strength siliconized silicon carbide to increase dimensional stability and accuracy, these long-life components lower downtime and increase product throughput. Custom components for solar photovoltaic (PV) cell processing include: crucibles, paddles, wafer boats, liner tubes, baffles, and thermocouple sheaths. www.coorstek.com



GfE Metalle und Materialien GmbH / GfE Fremat GmbH

GfE produces and offers a wide range of planar and rotatable sputtering targets for thin film photovoltaics such as CIGS, a-Si, a-Si/ μ c-Si, CdTe, and Si wafer based cells. Standard materials include ZnO/Al₂O₃, i-ZnO, high purity Si, Mo, TiO_x, and Cr in different qualities as well as numerous other materials as per specific customer requests. GfE's rotatable bonding technology enables them to offer a variety of materials to be bonded stress-free onto stainless steel carrier tubes. www.gfe.com

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Nordic Fiberglass has been manufacturing products for the underground electrical industry since 1971. Nordic manufactures 35kV 600Amp junction cabinets for solar projects and wind farms. Nordic also manufactures box pads for pad-mount equipment, like single and three phase transformer box pads, and box pads for air and oil-filled switchgear. www.nordicfiberglass.com

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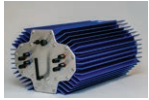
South Bay Risk Management & Insurance Services

South Bay Risk Management & Insurance

South Bay Risk Management & Insurance Services offers a comprehensive renewable energy insurance program which includes general liability, professional liability, and contractors pollution liability, protecting renewable energy contractors who frequently participate in the design of a solar or wind energy project and render opinions that could be construed as providing professional advice.

www.sbrmins.com

Inverters



Alencon Systems

Alencon's String Power Optimizers and Transmitters (SPOTs) are powerful DC-DC optimizers for utility scale PV applications. Alencon's SPOTs can be used in combination with either Alencon's central inverters, GrlPs or central inverters built by virtually any other major manufacturer. Alencon's SPOTs are a versatile solution, offering the granularity of string inverters and providing the lower cents per watt cost of a central inverter while maintaining fewer connections to the grid.

www.alenconsystems.com



COTEK The Americas

COTEK offers five unique series of pure, sine-wave inverters and inverter chargers for off-grid and backup applications. Each series delivers features to satisfy the needs of the solar power market. COTEK inverters models range from 150W-4000W, with a DC input of 12V, 24V, or 48V. The new SD series, is available in 2500W and 3500W models, with full parallel function and redundant capabilities up to 14 units. Also new is the SP series. SP models range from 700W-4000W. Both series are UL safety approved, and include advanced features unavailable on existing product lines.

www.cotek.ca



CyboEnergy

The On/Off-Grid CyboInverter has an on-grid AC output port and an off-grid AC output port. Each inverter has 4 input channels that can connect to solar, wind, or batteries and produce 1150W AC power. Each input channel has its own MPPT to eliminate partial shading issues. It can work in either on-grid or off-grid mode, and switch between the two modes automatically depending on the grid condition. The system can generate power to the grid when the grid is on and can provide backup power when the grid is down. The product is patented, UL1741 certified, NEMA 6 (IP67) rated, and made in the USA.

www.cyboenergy.com

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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.


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The Fronius SnapInverter string-inverter line offers integrated Wi-Fi and SunSpec Modbus interfaces, NEMA 4X rating, wide voltage windows, multiple MPP trackers, and easy installation in 15 minutes or less. With the identical look and feel, the Fronius SnapInverters reduce cost for training and servicing. Power classes range from 1.5 to 24.0kW. In addition, Fronius offers the Fronius Rapid Shutdown Box, which provides an NEC 2014 code (690.12) compliant solution while enhancing rooftop and firefighter safety. For online monitoring, the Fronius Solar.web portal provides a complete set of tools and goes beyond basic monitoring.
www.fronius-usa.com




Growatt USA, Inc.
Growatt USA Inc.(Growatt) unveils the latest evolution of its Growatt 4-10k MTL-UP inverter for residential rooftops. Highlights including: 3-MPPT, a wide DC voltage, fanless, light and small design, and flexible configuration allow customers to speed-up installation time, eliminate maintenance costs, and maximize the power yield.
www.growatt-america.com


Huawei Technologies Co., Ltd.
Huawei's SUN2000-33/36/40KTL (1000V) string inverter features 4 MPPTs for versatile adaption to different layouts, and 8 strings of intelligent monitoring for fast trouble-shooting. It is Power Line Communication (PLC) and String I-V diagnosis supported. Safety features include: DC AFCI compliance to UL 1699B; integrated DC disconnect for convenient maintenance; category surge arrestors for both AC and DC; ground fault protection; and residual current detection. This inverter is naturally cooled, has a protection rating of NEMA 4X, maximum efficiency of 98.9%, and CEC efficiency of 98.5%. The maximum input voltage is 1000V, maximum current per MPPT 22A. The minimum start input voltage is 250V, and output, AC active power 33000-44000W.
www.huawei.com



Huawei Technologies Co., Ltd.
The SUN2000-45KTL (1500V) string inverter features 4 MPPTs for versatile adaption to different layouts, and 8 strings of intelligent monitoring for fast trouble-shooting. It is Power Line Communication (PLC) and String I-V diagnosis supported. Safety features include: DC AFCI compliance to UL 1699B; integrated DC disconnect for convenient maintenance; category surge arrestors for both AC and DC; ground fault protection; and residual current detection. This inverter is naturally cooled, has a protection rating of NEMA 4X, maximum efficiency of 98.8%, and CEC efficiency 98.5%. The maximum input voltage is 1500V, maximum current per MPPT 22A. The minimum operating/start voltage 600V-650V. and output, AC active power 45000W.
www.huawei.com




Ideal Power, Inc.
Ideal Power offers bidirectional 30kW and 125kW grid-resilient power conversion systems (PCS) that utilize their patented Power Packet Switching Architecture (PPSA) technology to enable small, light, and cost effective PCS. The SunDial series PV string inverters provide galvanic isolation, have an integrated PV Combiner and DC disconnect, and are field upgradable for energy storage with an optional low cost plug and play bidirectional DC port kit.
www.idealpower.com




REFU, Inc.
The new generation REFU sol 24K-UL for the Americas is based on the platform of REFU sol 08-23 K inverters which deliver maximum yields with no maintenance. These flexible and efficient three-phase PV inverters are future-proof, user-friendly, and reliable. Whether accumulators are added, the PV system is integrated in smart grids, or regulations change, the new software will adapt for the future, making it easy to plan and build decentralized PV project flexibly. The simple layout can be rapidly multiplied, and partial systems connected to the grid during the construction phase provide early yields.
www.refu-sol.com

Rhombus Energy Solutions
Rhombus DC-Series, Multi-Port, Bi-Directional Universal Power Converter (UPC) is a one-size-does-more concept, and the latest addition to their Power Conversion System products. The UL Approved DC-Series provides reliability and flexibility with two power stages that can be configured in multiple ways and an integrated transformer lowers installation costs while providing grid isolation. The DC-Series includes a user interface software test suite for battery development and validation, while the compact footprint provides easy single point DC and AC installation.
www.rhombusenergy.com



Schneider Electric
The Conext CL-60 String Inverter is for commercial and utility-scale developers seeking a solution that generates the maximum power while promoting grid stability. At 60kW, with the capability of sustaining a maximum output of 63.4kW at PF=1, this is Schneider Electric's most powerful and efficient string inverter. The Conext CL-60 is durable, easy-to-install and service, and designed to maximize revenue. With a maximum efficiency of 98.9%, it reduces system losses and the Levelized Cost of Energy (LCOE).
www.solar.schneider-electric.com



Socomec, Inc.
The SUNSYS PCS2 bidirectional converters and their control systems follow a charge and discharge profile corresponding to the required functions. From 33kW to several MW, they provide a maximum efficiency of 98%. The modular rack provides flexibility and compatibility with a large number of brands and battery technologies including: lithium iron, lead, and vanadium redox. This solution offers rapid, safe maintenance, and hot module replacement.
www.socomec.us



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For over 30 years Marine Fasteners has supplied solutions with high quality Stainless Steel hardware in both English and metric. Today, Marine Fasteners leads the Solar Industry with providing quality Stainless hardware and supporting our customers with 7 distribution centers strategically positioned throughout the U.S.

Marine Fasteners serves and leads with fresh ideas thus enhancing their customers position in the market place. These ideas include using hardware options that eliminates galling, Galvanic corrosion and provides additional corrosion protection for challenging geographic environments.

www.marfas.com



SolarEdge

SolarEdge's commercial solution offers improved bottom line and PV asset management. SolarEdge technology allows for maximum power production through module-level MPPT, reduced BoS costs with longer strings, and enhanced maintenance and pinpointed troubleshooting through module-level monitoring and remote troubleshooting. Another benefit is SolarEdge's SafeDC mechanism that meets NEC 2014 690.12 rapid shutdown requirements and enables DC shutdown for installer, maintenance personnel, and firefighter safety. The SolarEdge solution consists of inverters, power optimizers, and a cloud-based monitoring platform. The technology provides improved power harvesting and module management by connecting power optimizers at the module level. The ability to connect two modules to one optimizer, combined with DC to AC conversion and grid interaction being centralized at a simplified PV inverter maintains a competitive cost structure.

www.solaredge.com

YASKAWA SOLECTRIA SOLAR



Yaskawa - Solectria Solar

Yaskawa – Solectria Solar has added the PVI 50TL and PVI 60TL to their commercial/utility-scale inverter line. They join the Yaskawa – Solectria Solar's three-phase, 1000VDC, transformerless string inverter line up, now ranging from 23-60 kW products. The PVI 50TL and PVI 60TL inverters include features such as: design flexibility, including wide MPPT range; no need for external boxes with integrated AC and DC disconnects; and allowing for multiple mounting methods. These inverters provide 99.0% efficiency and additional system cost savings for installation and long-term maintenance with their integrated data logger, remote diagnostics, and upgrades.

www.solectria.com

Legal Services



Bond, Schoeneck & King PLLC

Bond is a member of the Solar Energy Industries Association and work regularly with institutional, industrial, and municipal clients seeking to purchase or generate solar energy to obtain their objectives in New York State. They actively track the Public Service Commission proceedings involving solar development and have counseled clients in a range of key issues including: Engineering, Procurement and Construction Agreements; Project Siting Under the State Environmental Quality Review Act; Permitting Process; Power Purchase Agreements; Project Siting Under Article X of the Public Service Law; Real Estate Transactions; Tax Certiorari; and Taxation.

www.bsk.com

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McCauley Lyman, LLC

McCauley Lyman offers cost-effective advice and representation on commercial and regulatory issues including: project development and finance, particularly of renewable energy projects; environmental attribute accounting and trading; negotiating and restructuring energy sales agreements; business formation; structured transactions; sales and acquisitions; and workouts.

www.mccauleylyman.com



Troutman Sanders LLP

Troutman Sanders offers innovative solutions developed from over a century of service to the energy community. Their Project Finance attorneys represent lenders, tax equity investors, borrowers, and lessees in various solar and other renewable energy project loan and lease financings, as well as in the development, acquisition, and disposition of renewable energy projects in the US and abroad. Their team has served as counsel on over 500 utility-scale and other renewable energy projects. Troutman Sanders understands the unique issues associated with renewable energy development and finance.

www.troutmansanders.com

Lightning & Surge Protection



ERICO

One of the many grounding and bonding solutions ERICO manufactures are their MJB Grounding and Bonding Braids that provide a reliable and convenient grounding solution for applications requiring flexibility and durability, including solar trackers. The tinned copper ground braids with massivated palms come ready to install without any additional cutting, stripping, crimping, or punching and do not require the addition of tin or crimped lugs. The proprietary manufacturing process optimizes the electrical contact between each wire and helps eliminate moisture issues in the palms, preventing corrosion and lengthening the useful life of the braid.

www.erico.pentair.com



Koolbridge Solar, Inc.

Koolbridge Solar designs, develops, and sells intelligence driven, solar-ready, electrical power products which automatically select the most economical use of utility, solar, battery, wind, or generator power for homes and businesses on a circuit-by-circuit basis. Koolbridge Solar has patented and patent-pending products under development that effectively capture, manage, and distribute electrical energy throughout homes or businesses. Koolbridge's first product, the SMART LOAD CENTER, ensures no power interruption if the grid goes down while using solar power.

www.koolbridgesolar.com

Raycap



Raycap

Recap provides surge protection products specifically developed for photovoltaic power systems with operating voltage up to 1500Vdc. Raycap's Striker Surge Protective Devices (SPDs) reduce repair expenses and eliminate downtime and revenue losses resulting from lightning surges. Raycap's solutions are fully compliant to the EN50539-11, IEC 61643-1, and UL 1449 4th edition standards.

www.raycap.com



Enphase Energy

The versatile Enphase M250 Microinverter performs in both residential and commercial solar PV installations and is compatible with both 60-cell and 72-cell modules. With its all-AC approach and integrated grounding, the M250 delivers increased energy harvest and reduces design and installation complexity. The Enphase M250 Microinverter integrates seamlessly with the Enphase Engage Cable, the Enphase Envoy communications gateway, and Enphase Enlighten monitoring and analysis software.

www.enphase.com



Magnum Energy | Sensata Technologies

The storage-ready Magnum Energy MicroGT 500 Inverter from Sensata Technologies is optimized to communicate with AC-coupled Magnum battery-based inverters, allowing installation of a battery backup when it's needed. The MicroGT supports two modules per inverter, handling up to 310W modules with negligible clipping, and provides individual MPPT for each module. String up to 14 PV modules, using seven MicroGTs, with a 20A breaker, and monitor it all with the MagWeb GT, an integrated web-based dashboard.

www.sensatapower.com

Microinverters



APsystems

APsystems extends its advanced microinverter line with the new YC500i with EnergyMax power handling and integrated ground. EnergyMax allows this dual-module unit to produce 274 watts peak output per side (548W total) to match today's high-output PV modules. Trunk cable connectivity offers installers an alternative to the daisy-chain design of the flagship YC500A, for installers who favor trunk cable architecture as well as markets where regulatory bodies prefer an integrated ground. With EnergyMax technology developed by APsystems, the new YC500i maximizes the microinverter's output for top energy harvest across the whole solar array.

www.apsystems.com



Darfon America Corp.

Darfon's G320 microinverter is a solution for today's high-power solar modules. The G320 can handle both 60- and 72-cell modules up to 350W DC and outputs up to 300W AC. The G320's 3-phase configuration accommodates the electrical distribution systems of most commercial buildings and helps to reduce, if not eliminate, the need for expensive transformers. The G320 comes in four voltage/phase configurations, so it can be installed in residential, commercial, or utility applications.

www.darfonsolar.com

Modules



Axitec, LLC

Axitec's product line includes 60- and 72-cell modules to benefit any size installation. Poly- and monocrystalline modules are available with black and silver frame for implementation on residential or commercial solar applications. The AXIplus module offers an integrated optimizer solution with panel-level monitoring, maximum power point tracking (MPPT), aesthetics, and an easy installation.

www.axitecsolar.us

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Boviet Solar USA

Boviet Solar USA's polycrystalline and monocrystalline solar modules are available in 60-cell and 72-cell, 1000VDC, maximum efficiency of 17.2%, positive power tolerance of 5W, 5400 Pa snow load, and 2400 Pa wind load. They are internationally tested and certified; Type 1 fire rating per UL 1703, high salt and ammonia resistance certified, and come with a 12-year product warranty and a 25-year linear power performance warranty.

www.boviet solarusa.com



Giga Solar

Giga Solar lightweight photovoltaic modules provide the efficiency of today's high-performance monocrystalline silicon modules in power levels from 150Wp to over 500Wp, but at only 40% the weight and with no occurrence of PID. Optional, integrated mounting structures allow for rapid installations on sloped residential or flat commercial/industrial roofs. The stiff back composite minimizes deflection and simplifies handling and installation. The module has no glass top, but uses a long-lasting, high light-transmitting fluoropolymer cover film. It is also frameless, so there is no metal to corrode or conduct electricity, and no need for grounding.

www.gigasolarpv.com



Centrosolar

Centrosolar's Monocrystalline 280W, E and B Series solar photovoltaic modules, manufactured in China and America, respectively, are aesthetically designed for roof tops and commercial projects. These modules are manufactured and tested under strict quality standards, to ensure a quality product. Centrosolar guarantees a maximum performance digression of 0.7% p.a. over the course of 25 years. Their modules meet international standards, are UL certified and accredited by Intertek. Features of Centrosolar's modules include anti-reflective glass boosting power, low operational and maintenance cost, excellent loading capability of up to 5400Pa, quality management and product testing, and a 25-year performance warranty.

www.centrosolaramerica.com



Hanwha Q CELLS

The new high performance Q.PEAK-G4.1 was developed to achieve high performance under real conditions, even with low radiation intensity and on clear, hot summer days. With power classes up to 305W on a 60-cell format, it provides up to 18.3% efficiency. Additionally, it includes a competitive 12-year product and 25-year linear power output warranty of 98% first year and -0.6% until 25 years.

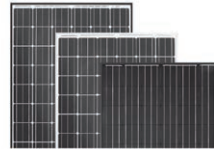
www.q-cells.us



Integrated Solar Technology

SunTegra Solar Roof Systems, designed and manufactured by Integrated Solar Technology (IST) integrate directly into the roofline of a home or building, providing a durable roof and a low-profile solar system in one. SunTegra products are designed with rugged materials, high performance crystalline technology, a ventilation system for improved efficiency, and an integrated wiring system for simple and fast installation. SunTegra products are also tested to stringent solar and roofing requirements.

www.suntegrasolar.com



Itek Energy

Itek Energy is an American manufacturer of solar PV products, with factories in Bellingham, Washington and Minneapolis, Minnesota. Itek's high-efficiency SE-series modules feature Celco technology. Built on a monocrystalline PERC 60-cell matrix, the SE-series modules produce 290-305 watts, and are certified PID-free after 500 hours of accelerated testing. Itek uses high-grade components and inspects each module at multiple points along the production line, resulting in a reliable and quality product.

www.itekenergy.com



Japan Solar

Japan Solar offers both poly/mono, 60/72 cell modules for residential, commercial, and industrial applications. They can offer a complete Japanese-made solar system plus inverter and energy storage as well as racking.

www.japansolarus.com



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Wash Panel

Wash 25 ft/min - Battery powered - Brush length up to 22 ft - Self-tracking on panels - Manual, semi-automatic, automatic



LG Solar

LG Solar is introducing their new NeON 2 modules with Cello Technology which improves power output and appearance. LG NeON 2 modules produce energy from both the front and back in order to increase efficiency. A reinforced frame design makes these modules durable in even the toughest weather conditions.

www.lgsolarusa.com



Lumos Solar, LLC

The GSX BiFi Module System was designed for overhead solar applications such as awnings, canopies, and carports. The GSX BiFi System's unique, integrated mounting system provides a weatherproof array and completely conceals all conductors and junction boxes for maximum protection and an ultra clean installation. The GSX BiFi modules are made with high efficiency, bifacial cells which produce energy from both sides of the module for maximum energy harvest and over 20% effective module efficiency.

www.lumossolar.com



MiaSole

The MiaSole FLEX module is a CIGS based flexible thin-film PV module that provides high power density for many types of roof applications. The panels are a high efficiency, flexible, thin-film product, with >16.5% cell efficiency. MiaSole FLEX modules bond to roof surfaces with a simple peel-and-stick adhesive. This adhesive approach eliminates the need for racking and reduces labor and logistics cost to provide a 20% lower BOS cost. The FLEX-02 Series module is IEC 61646 & IEC 61730, UL 1703, and Class A over TPO: Slope 2.5:12 certified.

www.miasole.com



Peimar Group

Peimar Group provides poly, mono, and high efficiency panels for both residential and commercial applications. Peimar Group's modules are made in Italy and available from 270w to 320w.

www.peimar.com



Silfab Solar, Inc.

Silfab Solar manufactures PV modules which guarantee long-term high-efficiency, reliability, and durability. Silfab's mono and multi-crystalline PV modules are produced in their manufacturing facility using quality mono- and multi-crystalline solar cells. With power ratings up to 360Wp, these high-efficiency modules maximize power to surface area performance, helping to minimize balance of system costs. All of Silfab's modules are UL and ULC certified by Intertek.

www.silfab.ca



Solaria Corporation

Solaria has developed high-efficiency solar PV modules, Solaria PowerXT series, that boost energy generation, providing high yield at a low cost. Solaria's 330W and 400W modules are optimized for the rapidly-growing residential and commercial sectors. Solaria high-efficiency modules are a solution for space-constrained applications such as residential and commercial roofs, as well as building-integrated applications requiring a high level of aesthetics. Solaria's high-output modules are built on the company's proprietary technology, patented cell cutting, and assembly processes. Through advanced ribbon-less, solder-free interconnection, cells are comprised of high density sub-strings. Inactive space between cells is eliminated. With modules exceeding 20% efficiency, Solaria PowerXT modules ensure maximum power and profitability.

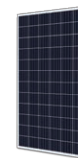
www.solaria.com



Solartec

Solartec provides polycrystalline and monocrystalline 60- and 72-cell solar modules from 10W - 350W. Certified to IEC61215, IEC61730, UL 1703, IEC61701, and IEC62804.

www.solartec.mx



Talesun Solar

Talesun Solar's TP672P (H) 72-Cell Series is certified to withstand up to 2400 Pa wind load and up to 5400 Pa snow load. It has a 330W power output with a positive power tolerance of 0-/+3% and is certified by TUV Rheinland for system voltage of 1500V. The four busbar cell improves the efficiency of the PID free modules. Warranties are 10-year for material and workmanship, and 25-year linear power output.

www.talesun.com



ZNSHINE PV-Tech Co., Ltd.

ZNSHINE PV-TECH CO., LTD. (NEEQ Code: 838463) offers project investment and operation, EPC services, and module manufacturing. The company owns a fully automatic production line with 2MW per capita output.

www.znshinesolar.com

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Separate Module Interlocking Connectors and Roof Attachments for Optimal Footing Support and Module Connection

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MageMount is a rail-less solar mounting system that is installed like a rail-based solar mounting system at lower cost and reduced installation time with familiar and fewer components for all roof types.

Magerack 510-656-6661 www.magerack.com



Apogee Instruments

Apogee Instruments' silicon-cell pyranometers measure total solar radiation to within 5%, under clear sky conditions. They are a cost-effective alternative to black-body pyranometers for performance monitoring, panel placement, and site prospecting. With rugged performance, long-term-stability, and ease of maintenance, Apogee sensors are available in different outputs including: the self-powered SP-110 with a 0-350 mV output, and amplified models with outputs of 0-2.5 VDC, 0-5 VDC, and 4-20 mA. Additional options are available to integrators, such as custom multipliers, lead lengths, and connectors.

www.apogeeinstruments.com



CAS DataLoggers

The PV-3 data logger is used by installers, homeowners, and renewable energy companies to check PV installations. It can record solar irradiation up to 1500W/m², DC voltage and DC current produced by the panel, allowing performance assessment of a solar energy installation. The Electrorecorder range uses a constant sampling technique; when the loggers start to record, they sample every channel 16 times per cycle, a cycle is 16ms at 60Hz and 20ms at 50Hz. At the end of each averaging period, 3 quantities are saved for each channel, the TRMS average, the max, and the min. www.dataloggerinc.com



Continental Control Systems

Continental Control Systems specializes in high-accuracy electric power monitoring for submetering and for measuring AC production and/or AC consumption. The company's meters and current transformers are designed to provide key electrical system measurements, including (kW), and energy (kWh), through a variety of communication protocols. These include revenue-grade BACnet, Modbus and LonWorks, and as pulse outputs. The WattNode Revenue, along with the Accu-CT, is ANSI C12.1, PBI, UL, cUL, and CE listed. www.ccontrols.com



EKO Instruments

EKO Instruments introduces the MS-80 Secondary Standard Pyranometer. The MS-80 begins a new generation of pyranometer technology while remaining cost-effective for all applications. Major performance gains have occurred in response time (<1 sec) and reduction in zero-offset A. Users will also benefit from reduced maintenance costs by not needing to recalibrate or exchange desiccant for many years. Every MS-80 comes standard with an industry exclusive ISO 17025 calibration. The affordable MS-80 provides the lowest field measurement uncertainty. www.eko-usa.com



HuksefluxUSA, Inc.

The new digital SR30 Secondary Standard pyranometer features an internal maintenance-free heated ventilation system. The circulation of heated air flow between the inner and outer domes suppresses the formation of dew and frost on the pyranometer optic. With < 2.1 Watts max power consumption, SR30 delivers a high level of performance and data availability. Critical sensor data, including irradiance, sensor serial number, and calibration data, are all available via RS485 RTU / Modbus connection. The sealed desiccant cartridge free design with internal ventilation translates into reduced sensor maintenance and cost of ownership. www.huksefluxusa.com



Itron

The Solar Gate from Itron is a communications gateway for residential solar PV installations which collects and presents different data sets to ensure proper levels of performance. With revenue grade metrology and premise load data, it acts as an intermediary between on premise solar generation, electricity demand, and electricity storage as well as the grid. The Solar Gate optimizes solar generation usage by balancing generated electricity between the home use, battery storage, and electric vehicle charging, all while maintaining customer comfort. www.itron.com



Kipp & Zonen

Kipp & Zonen have expanded their range of instruments; the new SMP6, SMP21, and SMP22 pyranometers, the SGR3 and SGR4 pyrgeometers, and the SUV5 total UV radiometer. This expanded line provides for Smart solar and sky radiation monitoring stations at all performance levels. Their Smart range has as the main benefit of a RS-485 Modbus interface, combined with an amplified analogue output. Instruments can now be connected directly to a digital data acquisition system for live radiation measurements, to monitor the status and power supply, and to keep track of the calibration history. www.kippzonen.com

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Seaward Group USA

Seaward manufactures a range of electrical safety and performance measurement equipment for solar PV applications. The new PV210 Solar PV Tester & I-V Curve Tracer is a compact and cost effective multi-function tester. It is fully compliant to IEC 62446:2016 and 61829 standards, offering a comprehensive range of tests to quickly prove the safety and performance of PV modules and strings at the touch of a button. Instantly view I-V and power curves through an Android smart-phone or tablet device using the free PVMobile app. Plus, receive irradiance and temperature measurements wirelessly via Solarlink connectivity.

www.seaward-groupusa.com/pv210



Solar Data Systems, Inc.

Solar-Log's monitoring technology integrated into GE's 1-210+ socket meter is designed to streamline residential solar PV plant monitoring, offering revenue grade metering and automatic incentive reporting in a universal, easy to install, plug and play socket meter. Advanced options include inverter direct monitoring, consumption monitoring, power management, and connection to onsite weather sensors. Solar-Log and GE Meters include a 5-year Solar-Log WEB monitoring subscription and a 5-year cellular data plan.

www.solar-log-america.com

SUNSYSTEM
technology



SunSystem Technology

SunSystem Technology (SST) offers complete performance monitoring services for industrial and utility-scale photovoltaic systems. Complex monitoring systems form a basis for providing vital data that is fundamental to managing day-to-day operations and ensuring long-term operational goals are met. Whether they are being used to monitor the performance of a single facility or roll up to an entire portfolio of facilities, SST has experience with all of today's leading monitoring systems. From installation, through configuration, to validation of the data being captured, SST provides comprehensive performance monitoring and related IT support services.

www.sstsolar.com



Trimark Associates, Inc.

Trimark delivers PV plant control, monitoring, MET, and metering for utility-scale resources. Trimark's T1-S SCADA maximizes power at the point of interconnection, even during curtailment. It accepts secure, third-party commands (AGC and ADS) then maintains precise control of real power, voltage, and VARs. Trimark's end-to-end solutions include all hardware, software, and network connections. They also engineer, test, and commission systems to fully automate PV plants, measure and analyze performance, set alarms, and display real-time information via browser and mobile interfaces.

www.trimarkassoc.com

Position Sensors

POSITAL
FRABA



POSITAL-FRABA

POSITAL is an international supplier of position sensors with applications in the solar energy industry. The company's rugged and reliable TILTIX inclinometers and IXARC rotary encoders are a solution for monitoring and controlling the position of solar power systems, including photovoltaic arrays and concentrated solar power (CSP) systems based on parabolic trough collectors or tower/heliostat arrangements. POSITAL position sensors are designed for harsh conditions and are available with environmental protection up to IP69K. With a wide variety of mechanical configurations and interface options available, POSITAL sensors are a good fit for projects of any size or budget.

www.posita.com

PV Distributors



BayWa r.e. Solar Systems, LLC

BayWa r.e. Solar Systems is a distributor dedicated to supporting local, independent installers in the solar industry. They offer a select group of products coupled with dedicated customer support. BayWa r.e.'s newly launched r.e.connect Partner Program is platform enabling small and large installers access valuable tools and increase their operational efficiency.

www.baywa-re.com

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Stellar Sun

Stellar Sun provides engineering, design, sales, and services of PV and related BoS. www.stellarsun.com

PV Installers



Ambassador Solar Energy

Ambassador Energy provides solar PV training and maintenance of solar for military bases and stations, as well as solar installations for commercial, non-profit, and residential. www.ambassadorsolar.com



Dovetail Solar and Wind

Dovetail provides solar electric (PV), solar thermal, and wind systems for new and existing commercial, utility, residential, farm, and non-profit organizations. Their systems are all built to be clean, safe, low maintenance, and durable. www.dovetailsolar.com



Hannah Solar Government Services LLC

Hannah Solar Government Services (HSGS) possesses the in-house engineering and design capabilities, experienced project team, and record of performance required to execute medium scale commercial to large scale utility solar energy projects, electrical and lighting projects, and electric vehicle (EV) charging station installation across the nation and overseas. www.hsgsolar.com



Solar Services, Inc.

Solar Services offers turnkey installation of PV, solar thermal, and solar pool heating. They provide installation of commercial, residential roof, or ground-mount arrays, and can service or upgrade all existing solar systems. Their PV module selection is based on market rate combined with Sunny Boy or Solar Edge inverters. They are also installers of AET Solar Thermal Systems and Aquatherm Industries Solar Pool Heaters. www.solarservices.com

PV Manufacturers & Equipment



ASYS Group

ASYS Group, based in Germany, is a manufacturer of machines and production lines for the electronics, life-science, and solar industries. The ASYS SOLAR brand features metallization lines and next-generation technologies for the implementation of advanced cell concepts. ASYS has delivered cell manufacturing equipment with a production capacity in excess of 25GW. Offering both scalable production solutions and high-speed technologies, ASYS provides cost-efficient metallization lines. www.asys-group.com



CertainTeed

The Apollo II roof-integrated solar system from CertainTeed is a versatile solution for power and aesthetics that installs directly on new or existing asphalt shingle roofs. Each solar shingle uses 14 high-efficiency monocrystalline silicon solar cells to provide a power rating of 60 watts. Lightweight and strong, Apollo II shingles have been tested and rated to withstand 250 pounds per square foot. The Apollo II system achieves the highest wind rating available for roofing materials and can be installed in wind zones of up to 150 miles per hour. www.certainteed.com



Despatch Industries

Despatch provides metallization firing furnaces, including the CDF and Safire. The Safire Firing Furnace with DriTech Dryer is designed with advanced features and technologies to ensure superior stability, repeatability, and cell efficiency. The Safire's twin chamber design features two independently controlled furnaces which eliminates the lane-to-lane influence found in traditional dual-lane furnaces. Microzone Technology provides the ability to precisely tailor thermal profiles around advanced materials and architectures. The Safire is available with PowerLock technology which suppresses LID on PERC cells from 3-6% down to ~1%. www.despatch.com



Ingeteam Inc.

Ingeteam's 1500Vdc PV inverter series is able to supply up to a maximum power of 1637kVA in a single unit, providing a power density of more than 5.34W/in³. This compact UL1741 compliant inverter can be easily integrated into MV solutions which contain all the equipment required for utility-scale PV plants. This inverter is available in 1000Vdc and 1500Vdc configurations with its power electronics components housed in an NEMA 4 protected compartment. www.ingeteam.com



- New and innovative sensor technology
- Extremely low maintenance
- Complete validated solar radiation data
- Easy on-site check via Wi-Fi
- Internal data logging with Web access
- Resistant to soiling
- Most affordable turn-key system
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LI-COR Biosciences

LI-COR Biosciences provides solar radiation measurement and solar resource assessment. LI-COR's LI-200 Pyranometer is a cost-effective alternative to first class thermopile-type pyranometers. The newly redesigned LI-200R features a robust case, designed to shed water efficiently. It also includes a modular, removable base and cable which allows the sensor to be removed for recalibration, without affecting existing mounting architecture. This sensor provides a solution for photovoltaic efficiency measuring systems with an extensive network of cables that would otherwise make sensor removal difficult.

www.licor.com/solar

SOLAR CLIPS



NFI-1306-V90

90° oriented clip intended to secure two USE-2 wires, up to .20" diameter, to standard module frame.

DCS-1306

Designed to secure two USE-2 wires, up to .20" diameter, to module frame.



DCS-1307

Designed to secure two PV wires, up to .30" diameter, to module frame.

NFI-1461

Designed to secure two Enphase trunk cables to module frame.



NFI-1462

90° oriented clip designed to secure two Enphase trunk cables to module frame.

NFI-1463

NEWLY designed clip to secure a single Enphase trunk cable to module frame.



DCX-2452A

Designed to secure two Enphase trunk cables on to most rail/racking systems.

For FREE product samples, please reach out to Vin Marino vin@ninefasteners.com or 800.539.3939

NINE FASTENERS INC.

233A South Street | Hopkinton, MA 01748 | 800.539.3939

www.ninefasteners.com



Matenaer Energy Products

Matenaer Energy Products provides in-house stamping, machining, fabricating, and coating capabilities which allows them to provide their customers with a one stop solution. Their lasers, multiple robotic welding cells, and stamping presses up to 1000 tons produce high quality components. Matenaer's production is easily scaled from low volume prototype work to high volume production. With years of experience working in the alternative energy field they understand and are able to ramp up to production volumes quickly when a project hits.

www.matenaer.com



MORNSUN

MORNSUN introduces the new 200-1500VDC DC/DC converter PV series to address the needs of a 1500VDC PV power system. This series provides standard output voltages of 24V, 12V, and 5V to power monitoring and control circuits in the system, and features multiple protection functions that improve system safety when a breakdown occurs. Features include: ultra-wide input voltage: 200-1500VDC; operating temperature: -40°C to +85°C; isolation: 4000VAC; suitable for high-altitude applications (up to 5000 meters); multiple protections; high efficiency, low ripple, and noise; CE/UL/CSA/EN62109 approval; PCB, chassis mounting, and Din-Rail mounting.

www.mornsun-power.com



Mühlbauer

Mühlbauer provides a reel-to-reel production equipment solution for the full range of all back-end processes. Their automation technology enables the conversion of thin film materials or organic solar materials, like CIGS, a-Si, organic photovoltaic, and others to flexible solar panels or any other flexible solar product.

www.muehlbauer.de



OAI

OAI designs and manufactures Class AAA Solar Simulators and I-V testers to be used in production or research and development for the testing of solar cells. Beam sizes include 52x52mm, 100x100mm, 156x156mm, 208x208mm, and 300x300mm. Solar Simulators can be upgradeable to DSSC, CPV, Multi-Junction, and Organic Solar Cells.

www.oainet.com



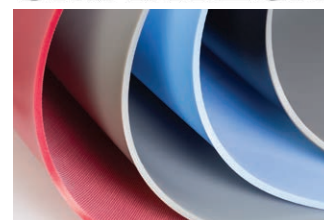
PowerFilm Solar

PowerFilm designs and manufactures amorphous silicon thin film solar panels. These panels are durable and portable. All products are manufactured in house and their engineers can help design customized solar solutions. They offer standard solar panels that fold up, roll up, and can help their customers stay powered wherever they go.

www.powerfilmsolar.com



SMARTECH



Smartech International

Smartech supplies North American PV module manufacturers with Steinbach Laminator Diaphragms and PTFE Sheets. Steinbach materials are consistent and durable. Steinbach's patented EVA-resistant Lamibrans Diaphragm provides extensive cycle-life and low per-cycle cost. Steinbach's solid silicone diaphragms come in range of durometers, in seamless widths of 3 meters or more. PTFE release sheet and transport belt materials are available in a wide variety of thicknesses and surface treatments, including anti-static coatings.

www.smartechonline.com



SoloPower Systems

SoloPower Systems SP1 and SP3 Series modules are suited for installation where roof integrity, weight, and wind load factors are of paramount importance. SoloPanel SP3 is their second-generation, large-format flexible module engineered for commercial and industrial building applications. The SP3 module is configured for multiple adhesive applications, enabling rapid installation, and low-cost system integration with a wide variety of roof substrates such as EPDM, TPO, and Built-up-roofing / Modified bitumen. Designed and manufactured in USA, SoloPower modules are built to meet or exceed UL 1703, IEC 61646, and IEC 61730 standards.

www.solopower.com

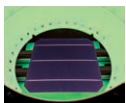


Vacuum Research Corporation

Vacuum Research offers high vacuum valves, vacuum gauges, and rotary vane vacuum pumps, as well as rectangular gate valves to transfer photovoltaic wafers through the process chambers during solar cell fabrication.

www.vacuumresearch.com

PV Module Inspection



ISRA VISION / GP SOLAR

As a global specialist for optical inspection, ISRA VISION / GP SOLAR offers automatic process and quality control systems for the photovoltaic industry. Their solutions for photovoltaic applications, from wafers, cells, and modules to thin film, solar glass, and solar thermal, along with their worldwide service, offer customers high performance and reliability in manufacturing.

www.gpsolar.com

PV Washing System



American Polywater Corporation

Solar Panel Wash cleans solar panels to help 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 with its sudsing, hydrophobic action.

www.polywater.com



Bitimec PV WASH, Inc.

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

www.wash-bots.com

Racking & Mounting Systems



Advanced Racking Solutions (ARS)

Advanced Racking and hb Solar Canada's new carport system design provides flexibility and installation advantages resulting in improved material and deployment costs. The company's Total Roof Platform (TRP) standardizes rooftop mounting hardware. It simplifies the ordering, installation, and management of PV racking hardware. By creating and validating a mounting system approach to fit all types of roof tops; shingle, metal, and flat, the left over rails, clamps, splices, etc. can easily be recycled into the next project. Reduce upfront cost, inventory, and installation times.

www.advancedracking.com



AllEarth Solar

The AllEarth Solar tracker is a complete grid-tied, dual-axis solar electric system that uses GPS and wireless technology to follow the sun throughout the day for optimal energy production. The tracker's 360° range allows it to produce up to 45% more electricity than fixed systems, resulting in more guaranteed savings from a solar installation. Made in America, the tracker comes with an industry-leading 10 year warranty, a 120-mph wind rating, and superior snow shedding. Its simple, durable design and complete system pallet simplifies costly procurement and installation time.

www.alleearthrenewables.com

COTEK SD Series Pure Sine Wave Inverters



SD 3500

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- Advanced protection features
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COTEK is a global leader in the manufacture of off-grid, battery-based pure sine wave inverters. This product-line enhances the reputation that COTEK has established since 1986 for innovative technology and total quality assurance. With a 2 year warranty and excellent customer support, the SD series will soon become the industry standard.



CR-10 Remote



COTEK The Americas - now serving Latin America!
For complete product specifications visit: www.cotek.ca



Allied Tube & Conduit

Allied Tube & Conduit provides in-line galvanized steel tube to assist with solar racking and tracking. Their Gatorshield is strong and has a reduced weight, with advanced corrosion protection and formability. Gatorshield also complies with UL2703. To ensure precision, they offer prototype and fabrication services. Allied is able to provide small and large O.D. sizes with heavy gauge, meet and exceed tube strength requirements, tool up for new profiles to meet customer specific needs, swage tube to help build a solar array, and various types of tube fabrication.

www.atc-mechanical.com



Brilliant Rack

Brilliant Rack is a fixed-tilt ground mounted racking solution designed to simplify and accelerate installation while ensuring long-term performance. Brilliant Rack enables Xpress Mount technology that allows for quick installation of up to 14 panels at once. The system has been designed to reduce labor time and costs with fewer components, preassembled tilt beams, and built-in wire management. The system is optimized for projects of all sizes from residential to utility-scale.

www.brilliantrack.com



Anar Solar, LLC

Anar Solar's patented approach provides an efficient, economical, and eco-friendly solution. Their racking system can be assembled quickly and easily, and can be fine-tuned to optimize production. Their surface ballast system needs no field trenching or site grading, so the need for costly heavy machinery is eliminated, and impact on a site's ecosystem is minimized. Their non-invasive, racking and ballast system can be used on previously-unusable sloped surfaces, such as capped landfills, to increase the site's total power generation.

www.anarsolar.com



DPW Solar Mounting Systems | Preformed Line Products

DPW Solar mounting systems and enclosures are engineered and manufactured by Preformed Line Products (PLP), a global supplier of Energy and Communication infrastructure solutions. Since 1993, DPW Solar has provided racking systems for utility, commercial, residential, and industrial applications. DPW Solar product solutions combine high strength and ease of installation, and include the Power Peak Ground Mounts, Power Rail Roof Mounts, POWER XPRESS Ballasted Roof Mounts, Top-of-Pole (TPM), Side-of-Pole (SPM), and new POWER DISK Rail-Less mounts.

www.dpwsolar.com



AP Alternatives LLC

AP Alternatives racking solutions utilize proprietary shallow helical anchors which allow them to complete large utility projects. They are able to provide value to project sites with soft soils, shallow bedrock, high water tables, rolling topographies, and other challenging site characteristics. APA has two core utility racking solutions; Advanced Modular (four high in landscape), optimized for heavy snow and wind areas with a prepanelization option for high wage environments; and Ready Rack (two high in portrait), that can easily be optimized for any site. Both solutions allow for rapid install, reduction of onsite labor, and max material utilization.

www.apalternatives.com



EcoFasten Solar

The GreenFasten system utilizes EcoFasten Solar's patented, watertight compression technology. With a single attachment point, GreenFasten delivers a fast, easy, and cost-efficient install while maintaining the integrity of the roof. Compatibility with a wide variety of EcoFasten compression brackets makes GreenFasten a versatile, reliable solar roof mount. Backed by IAPMO. Made in the USA.

www.ecofastensolar.com



Ecolibrium Solar



Ecolibrium Solar

EcoX is a simple, rail-free racking product, optimized for residential installations. EcoX is designed with small components and condensed packaging, which improves transportation and logistics costs, and makes EcoX simple and easy to handle on the jobsite. By optimizing attachment placement, EcoX systems use up to 30% fewer penetrations. The EcoX system is fully certified to the UL2703 standard, including Grounding and Bonding, Class A Fire testing for both Type I and II modules, and Mechanical Load testing. This validation provides seamless permitting, and the module-specific UL2703 certification eliminates rough inspections. Universal clamps support standard framed modules, and flexible component positioning helps designers maximize modules on the roof. EcoX is designed with the installer in mind, and Ecolibrium Solar's field trainers offer on-site field support to help ensure a smooth transition.

www.ecolibriumsolar.com



1500VDC HELIOPROTECTION® FUSES FROM MERSEN

Mersen's Helioprotection 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.

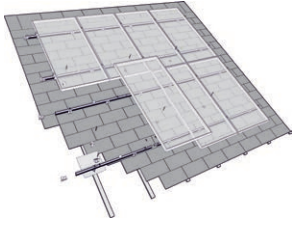
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ESDEC

INNOVATIVE MOUNTING SYSTEMS

CLICKFIT FLATFIX



Esdec BV

European racking specialists Esdec, brings their latest evolution in rail systems to the residential sector. Esdec listened to the American installer and homeowner and designed ClickFit Supra to deliver speed of installation combined with incorporated wire management and a unique shingle flashing plate. Esdec has over 1GW of racking systems installed globally, and their products all carry a 20-year warranty.

www.esdec.com



Everest Solar Systems

Everest Solar Systems' D Dome Railless System for flat roofs is a double-sided, low ballast system designed to be installed in an East/West orientation to minimize shading between modules. This system installs fast and easy, using Everest's factory pre-built assemblies. They adapted D Dome Railless to the workflows of a construction site with quick and easy handling. They have added a new online tool for certified users, which allows contractors the ability to design their own D Dome System, create a ballast plan, generate a report, and print their own BOM.

www.everest-solarsystems.com



Fabrack Solar, Inc.

Fabrack solar mounting systems are made from corrosion-resistant aluminum and stainless steel hardware for a durable maintenance-free product. Fabrack's racking systems are fully engineered and manufactured in Ontario using local aluminum, and are engineered for maximum snow load and wind shear in Ontario. The racking systems carry a 25-year warranty against defects in material and workmanship. Fabrack's four-season variable racking is easily adjustable for the optimal seasonal angle increasing ROI by 15% over fixed installations. As an added bonus, the panel's winter position keeps panels free of ice and snow, maintaining production all winter long.

www.fabracksolar.com

GAMECHANGE SOLAR

REPOWERING THE PLANET



GameChange Solar

GameChange Solar's Genius Tracker is a single axis tracker with a power density of 99.3%. With Black & Veatch technical assessment, CPP wind tunnel tested and rated 150mph, ETL / UL 2703 tested, this reliable linear actuator drive system has a 40-year operating life and is IP 66 rated for operation in harsh environmental conditions. Every drive actuator has its own battery backup and wirelessly linked controllers, eliminating all trenching and Tru3D-Gimbal bearings account for pile installation being out of plumb, out of azimuth, and out of vertical and east-west alignment. The self-powered rows eliminate the central drive and allow for uninterrupted grass cutting and panel washing.

www.gamechangesolar.com

GAMECHANGE SOLAR

REPOWERING THE PLANET



GameChange Solar

Pour-in-Place Ballasted Ground System features: self leveling technology with adjustable feet and slots allowing fast install and more than 7" vertical adjustability to navigate sloping ground prior to concrete pouring; up to 4ft. high ground clearance to allow for snow and vegetation; 5° to 35° tilt with multiple inter-row spacing options; full layout and engineering analysis for every project; integrated grounding and wire management; no gravel beds or other expensive ground preparations required for leveling as needed for precast.

www.gamechangesolar.com

GAMECHANGE SOLAR

REPOWERING THE PLANET



GameChange Solar

Max-Span Post System is a value-driven system which supports all double-sided glass thin film and other modules. Its galvanized Z purlins have integrated trays for easy wire management, and it's rugged beam and brace rapidly attach to pile with just six bolts. The Max-Span Post System provides 5° to 35° tilt with multiple inter-row spacing options, and with up to 4 ft. ground clearance, it eliminates snow and vegetation shading issues. GameChange Solar offers stamped layout and engineering analysis for every project. The system's earth screws and helicals are StickyPile G235 galvanized steel (HDG available), HDG, purlins, beams, and braces are G90 galvanized steel, and integrated grounding with star washers or teathed module clamps is included and approved under ETL /UL 2703.

www.gamechangesolar.com

GAMECHANGE SOLAR

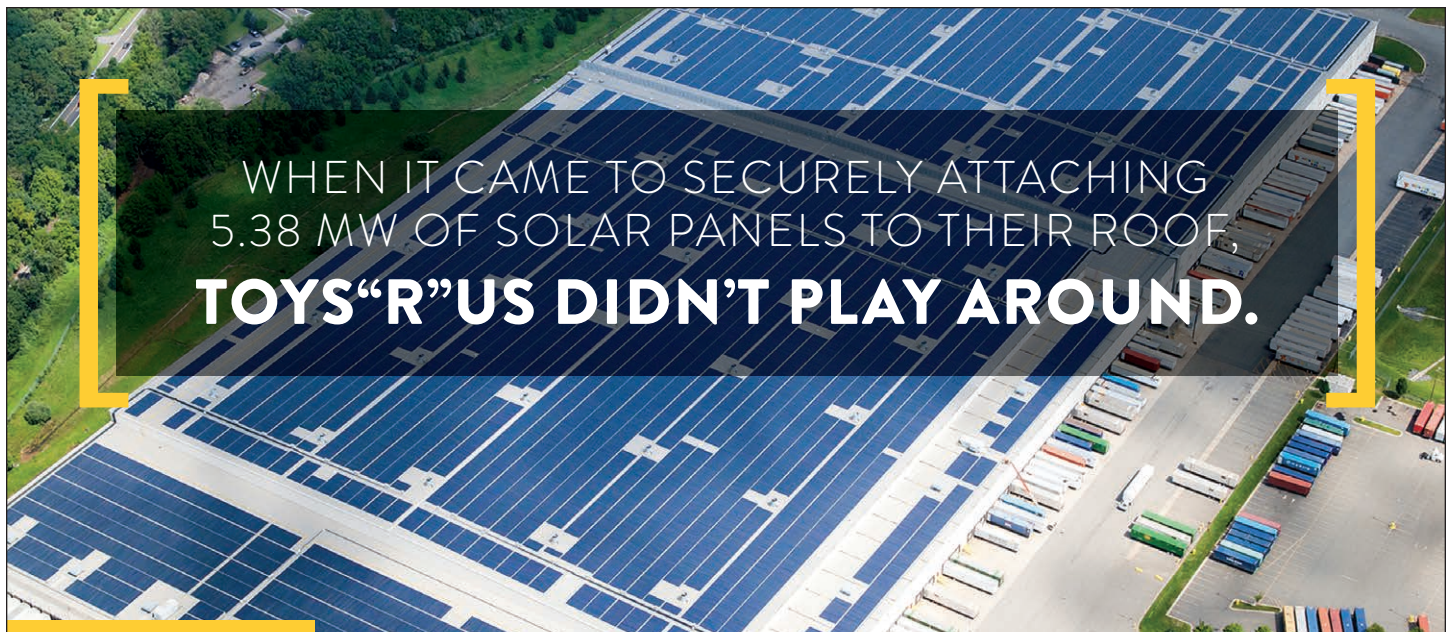
REPOWERING THE PLANET



GameChange Solar

GameChange Solar's Grid-Lite Roof System is a cost effective, low weight ballasted roof system with an interlocking grid design combined with next-gen wind deflector which reduces ballast to minimal amount. This system can handle the most severe seismic conditions and offers 5° and 10° tilts. Providing a fast install with minimal and durable G90 and stainless steel components, the integrated wire management trays enable string wiring throughout entire array prior to panelizing.

www.gamechangesolar.com



WHEN IT CAME TO SECURELY ATTACHING
5.38 MW OF SOLAR PANELS TO THEIR ROOF,
TOYS "R" US DIDN'T PLAY AROUND.



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Learn more at www.S-5.com or call 888-825-3432.





Kinetic

The watertight flashing kit made by Kinetic includes a baseplate that flush-mounts to the roof, a 9" x 12" black flashing that maximizes coverage of the penetration points, as well as stainless steel hardware. The baseplate is secured to the roof with up to two lag bolts and has a separate blind stud on top for L-Bracket attachment, eliminating the through-hole that may cause water leakage and lead to dry-rot. The unique raised channel provides an ideal place for sealant application on the underside, while also diverting water off the top of the flashing. The black textured, powder-coated flashing blends well with all asphalt roofs, and easily slides under shingles during installation.

www.kineticsolar.com



Magerack Corporation

MageMount is a rail-less solar mounting system that is installed like a rail-based mounting system with separate roof attachments and interlocking module connectors. It provides complete solar mounting solutions with roof attachments for all roof types at lower cost and reduced installation time with familiar and fewer components. Magerack Solar Mounting System is rail-based solar mounting solution including all components from rail and clamps to roof attachments. Both systems are UL 2703 certified and Class A fire rating with all components having built-in bonding capabilities. Magerack's patented L-foot with flashing is cost-effective and easy to install.

www.magerack.com



OBO Bettermann of North America, Inc.

OBO Bettermann has a wide variety of cable tray systems designed for the solar industry. These systems can mount independently, or to many popular racking systems. Their sales and product development team are available to assist with specific installation needs and have the experience in selecting and routing the right cable tray system for the job. They offer cable ladders, wire mesh trays, trough trays, and more, in a variety of finishes including aluminum, and hot dipped galvanized.

www.obous.com



Kinetic Solar Racking and Mounting

Kinetic Solar Racking and Mounting's Aerocompact S (south oriented), is the solution for mounting framed modules on flat roofs. It's the fastest and least expensive mounting system on the market, with excellent installation features. With Aerocompact S, an assembly time of 10 minutes per kilowatt can be achieved. With the Aerocompact+ (east-west oriented), an assembly time of five minutes per kilowatt can be achieved. These systems are wind-tunnel tested, conform to UL 2703, and are delivered fully pre-assembled, with protective matting and a barrier to prevent diffusion of the plastic softener. An analysis of the flat-roof design is also included for accurate ballasting.

www.kineticsolar.com



MT Solar

MT Solar's entire Top Of Pole Mount, from the frame to the solar modules, can be installed on the ground. Once assembled, it can be lifted to the top with the chain hoist. With a simple hand crank tilt mechanism, a home-owner can easily adjust the tilt from 5° to 90° while standing on the ground. Single pole mounts can hold up to twenty 60-cell modules or fifteen 72-cell modules. Multi-pole mounts can support any configuration of 4 or 5 modules high in landscape. Mounts are made with standard parts, which allows distributors to stock them in their warehouses, or installers to change the design halfway through the order. Lead time on standard mounts is always less 10 days.

www.mtsolar.us



OMG Roofing Products

PowerGrip Plus, from OMG Roofing Products, is watertight, easy-to-install, and provides a secure connection directly to the roof deck or structural members, thereby taking the wind load off of the membrane or roof cover and onto the structural deck. Once heat welded in place, properly installed PowerGrip Plus units help eliminate rack movement that can damage commercial roofing systems. With 2,000 lbs. of tensile strength and 1,075 lbs. of shear strength, PowerGrip Plus is designed for use with ballasted solar racks on roofs covered with thermoplastic (TPO and PVC) roofing membranes.

www.omgroofing.com



Opsun Systems, Inc.

Opsun Systems provides bifacial PV racking design, engineering, and manufacturing. They offer custom design services, providing an optimized structure, adapted to wind, snow, roof or soil type, module type, in any location, with any requirement. With no rail, deflector, or any component behind the PV modules, it is possible to achieve up to 30% more energy with this racking solution for bifacial PV modules.

www.opsun.com

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- Fab Shops – Health Care Writ Large!
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- Stand Out from the Rest – Certifications
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- Voluntary Air Sampling Program
- Invest Right – Building Investment Trust

ORION SOLAR RACKING

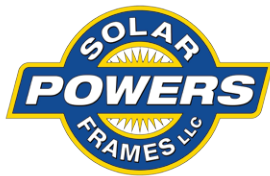
We Make Solar Installation Simple™



Orion Solar Racking

The Venus Flashing Kit is used to attach the Venus Residential Roof Mount System to standard composition shingle roof structures. The kit is fast and easy to install and creates a sleek look for the solar system to roof connection. A solution for residential rooftops, this rail system is suitable for composition shingle, flat, Spanish tile, and metal roofs. The Venus System has been installed on pitched roofs and flat commercial roofs. Orion Solar Racking also offer standoffs and adjustable tilt attachments.

www.orionracking.com



Powers Solar Frames

Powers Solar Frames is a manufacturer of Solar Carport systems, 5-High posted, and Ballast Ground Mount systems that consist of up to 5 modules high in landscape mode, all utilizing their patented Super Solar Purlin and Gator Clamp for securing modules to their Super Purlin. Each of these systems are efficient to install saving time, labor costs, and material costs. The design of Powers Solar Frames Solar Carport systems allows for a reduction of up to 42% less purlin usage, providing ease of installation. The Gator Clamp is certified to meet all relevant bonding requirements of UL Subject 2703.

www.powersolarframes.com



RBI Solar, Inc.

To reduce the expense of utility-scale and commercial ground mount solar projects, RBI Solar developed a solution with a broad selection of components such as a top chord engineered to bear loads while requiring less steel. Never sacrificing strength where it is needed, this solar mounting solution also reduces production costs through a more streamlined process. The RBI Solar next generation ground mount solution is manufactured at all of the company's five locations.

www.rbisolar.com

ROOFCLAMP.COM



Roof Clamp

Roof Clamp's two models replace dozens of other clamps. Made of 6061-T6 aluminum with all stainless steel hardware, the 3-point attachment system guarantees strength for parallel and perpendicular loading. Their clamps feature anti-seizing, coarse thread set screws which allow for unlimited re-torquing and re-attachment. Over 95% of today's standing seam profiles are compatible with the universal for Roof Clamp system.

www.roofclamp.com



Pegasus Solar

Pegasus Solar designs, manufactures, and sells the LightSpeed Mount, a rail-free residential solar mounting systems for composite and tile roofs. Their latest innovation is the LightSpeed Tile Replace system which reduces installation times by eliminating the need to cut roof tiles, and the replaced roof tiles can be used as spares to replace cracked tiles. The top flashing is shaped to seamlessly replace standard Flat, S, or W tiles, and also maintains the waterproof integrity of the roof. Tile Replace Flashing kits are supplied with a post and EPDM boot in packages of six Single Mounting assemblies, or four Double Mounting assemblies. The LightSpeed Mounting assemblies for composite roofs are also available in complete kits which include the flashings, mounting assemblies, and bolts. The system can be used for mounting an L foot for rails, or for attaching conduit and junction boxes to the roof. Each system is designed to be easy to handle, waterproof and aesthetically appealing.

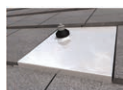
www.pegasussolar.com



PV Racking

The PV Racking clamp-free mounting system is easy to install, saves panel installation time, is secure, and aesthetically pleasing for ground and roof installations. Simply slide the modules into place and begin wiring. PV Racking's slide-in-place gravity-held system holds the panel along the entire module frame length, which makes the system very secure. Since there are no large gaps between the panels to accommodate clamps, this system creates an attractive, sleek, and smooth appearance.

www.pvracking.com



Quick Mount PV

Quick Mount's Tile Replacement Mount provides a fast and easy way to install solar on tile roofs while protecting against water intrusion. The Tile Replacement Mount eliminates messy and time-consuming tile grinding and cutting to significantly reduce installation time and labor costs. It also creates replacement tiles on the job. The Tile Replacement Mount works with Flat, S and W shaped tiles, and all standard rail-based racking systems, is flashed at both the deck and tile levels for code compliance, and features Quick Mount's patented QBlock Elevated Water Seal Technology.

www.quickmountpv.com



Solar for every roof.

EcoFoot3®

Introducing the all-new EcoFoot3 Ballasted Racking system. Structural load sharing for a lower system weight. Integrated conduit and cable tray supports. Simple installation process. EcoFoot3 supports solar for every roof.



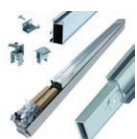
www.ecolibriumsolar.com
740-249-1877



Roof Tech, Inc.

Roof Tech's compact and versatile rail-less PV mounting system with integrated flashing, RT-[E] Mount is fastened to rafters or anywhere else on roof decking (7/16" OSB minimum). Once panels are clamped, the array is electrically bonded. RT-[E] Mount comes complete with watertight and durable RT Butyl flashing. Power electronics mounting is available for the E Mount Air, as are P.E. stamped certification letters, UL 2703, ICC ESR-3575, and ASTM 2140 certifications.

www.roof-tech.us



S:FLEX, Inc.

S:FLEX Inc.'s 12-Kit is a solution for installers desiring a quick, easy, pitch roof racking solution. The 12-Kit comes complete with all the rails, components, and UL Certified splices to mount any manufacture's framed PV modules, up to 12 in portrait, or is adaptable to landscape. The Kit includes UL Certified bonding slices, which mechanically and electrically bond the short rails to make a very compact kit, minimizing storage space and shipping costs. The 12-Kit carries a 10-year warranty, is all aluminum, and is fully recyclable.

www.sflex.com



Schletter

A rugged, all steel structure, the FS Uno is a pile-driven system designed to meet the demands of large ground mount installations where cost savings is a driving force. Wind tunnel tested to 140 mph, the FS Uno is code compliant to IBC 2006, 2009, or 2012 code compliant (ASCE 7-05, ASCE 7-10) depending on installations requirements. Made of 100% galvanized steel, this robust system is EL Classified to UL Subject 2703, Ed. 1 tested with leading module manufacturers. For a complete package, Schletter offers a thorough structural design based on a geotechnical investigation for local terrain conditions for rammed piled installation.

www.schletter.us



Silverback Solar (div of RoofScreen Mfg.)

The R-Series Racking System is Silverback's most economical option. The versatile design allows many different configurations, heights, and spacing. This racking series can be elevated over small obstructions and is a solution for moderate to low slope commercial roofs. Adjustable round posts make it easy to level and set tilt angles, and the simple design makes it very fast to install.

www.roofscreen.com



SnapNrack

SnapNrack's new Array Skirt enhances the aesthetics of the Series 100 racking system by providing a clean finished look to the front of the array. The Universal End Clamps attach to the inside of the modules allowing the rails to be trimmed flush with the array and capped off with end caps. Snap-in hardware is used throughout the system for attaching rails to mounts, modules to rails, and wire management accessories to rails making the process intuitive and easy to train for installers. The integrated wire channel of their rails conceal unsightly wires resulting in fewer service calls over the life of the system, overall labor savings, and a sleek finish.

www.snapnrack.com



Solar Clam-P

The new Snap-Skirt from Solar Clam-P provides an attractive array cap that snaps into the Solar Clam-P A-Beam and BEAST. Comes in Black Anodize standard, but custom color options, as well as customer lettering are available. No tool is required, and can be installed on any type of panel frame or any standard rail system. Can also be used as a barrier against pests.

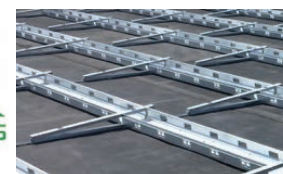
www.solarclam-p.com



Solar Connections International

The Solar Connection Kit is a UL tested, solar panel mounting system that can attach to any solar panel frame. Each solar kit utilizes the cable management disc allowing for cables to be top loaded and secured. The Solar Connection Kit is compatible with the Standing Seam Base Clamp which attaches to any standing seam profile. Their WaveLock technology provides strength with optional 1, 2, or 3 points of attachment. Offering ease of installation, the Silver Bullet set screws include a rounded bullet tip to maximize strength and won't damage the paint or pierce the seam.

www.solarconnections.com



Solar Mounting Solutions, Inc.

Solar Mounting Solutions is a US manufacturer of racking systems for all types of projects from residential to large commercial and utility-scale projects. Its Ballasted Low Profile System is designed to fully cover and protect the concrete ballast which can otherwise deteriorate when exposed to the elements. The system arrives pre-assembled requiring significantly less time and effort to install. It incorporates the THRU-ITT integrated wire management system allowing wiring to remain organized and protected. Solar Mounting Solutions' experienced design and support team also offers code-compliant designs for any locality.

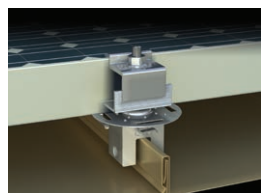
www.mountforsolar.com



SolarRoofHook

SolarRoofHook's patented QuickBOLT is a flashing-free, leak-proof mount designed for Asphalt Shingle Roofs. Comprised of only five parts, the QuickBOLT can be easily carried on to a roof and installed in under a minute. Simply drill, seal, and mount. There is no bulky flashing needed. All product spec sheets, test results, installation videos, and written installation instructions can be found on the SolarRoofHook company website.

www.solarroofhook.com



S-5!

The S-5! PV Kit is a UL subject 2703 listed solar module mounting solution, 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 harsh 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.

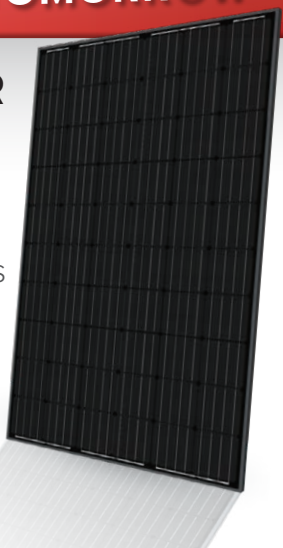
www.s5.com

Japan Solar

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Japan Solar US, Inc. 650-571-5904

info@japansolarus.com | www.japansolarus.com



Sollega

Sollega specializes in commercial ballasted/hybrid flat roof racking. The FastRack (FR510) is injection molded, utilizing glass-reinforced nylon, and engineered to outlast the useful life of the array in extreme weather conditions (25-year warranty). The one-piece hybrid mounting system arrives ready to install. Quick to ship, stage, and install, the U.S. manufactured FR510 includes integrated features such as: wire management, grounding, optimizer/micro-inverter mounts, and all top down one size tool attachment which means less extra hardware and cost. FR510 supports all framed modules at 5° or 10° tilt angles. Inter-row spacing is 10" and 13". FR510 has a Class A Fire rating (Type I & II). Sollega provides full PE Engineering and design services. www.sollega.com



Structural Solar LLC

Structural Solar provides specialty design-build structures for solar canopies, solar pavilions, and solar carport installations. Their services include foundation and structural design, fabrication, coating, caisson installation, and steel erecting with racking installed. www.structuralsolarllc.com



SunLink Corporation

SunLink delivers full-scope product+service+software solutions for utility-scale and commercial roof and ground-mount solar projects of every size and complexity. With distributed and centralized tracker, fixed-tilt, and roof-mount products, SunLink's full range of proven mounting products is able to meet the requirements of virtually any project site worldwide. The PowerCare field services team is also available to provide expert installation, geotechnical, and O&M services for all SunLink products. Further, SunLink's VERTEX project intelligence, monitoring, and control platform provides predictive and proactive O&M management, and improves system performance and overall project returns. www.sunlink.com



SunModo Corp.

The EZ Sunbeam system is an elevated all-aluminum system, so modules can be placed above roof obstructions. By spanning over obstacles, it takes advantage of the roof space to maximize system size, offering an increased return on investment (ROI). Robust and versatile, the EZ SunBeam system offers advanced engineering, designed for multiple configurations, and is adjustable for any tile. The EZ Sunbeam system is lightweight for structural loads, yet strong for high coastal winds, and made of all-aluminum to resist coastal salt-air corrosion. The SunBeam system can also be integrated with steel supports for ground-mounted solutions. www.sunmodo.com



TerraGen Solar

TerraGen Solar is a solar PV mounting system solutions provider with a focus on upfront engineering, ease of construction, and high quality manufacturing. TerraGen offers a variety of mounting systems including, but not limited to, flush mount racking systems, tilted pitched roof systems (south facing modules on an east/west pitched roof), and flat roof ballasted systems. In addition to their standard product offerings, they provide solutions for engineering and construction challenges relating to solar PV systems. www.terragensolar.ca



TerraSmart

TerraSmart, headquartered in Estero, Florida, provides solar ground mount racking, design, engineering, manufacturing, and installation services. TerraSmart also provides the patented ground screw which supports over 3GW of installed capacity worldwide. The fixed-tilt racking (with wire-management) is fully integrated with the ground screw foundation and has generous tolerances built in to accommodate difficult site conditions. Additionally, TerraSmart's rack mitigates grading, cutting, fill, and permitting fees during the site preparation process. www.terrasmart.com



TRA Snow & Sun

TRA Snow and Sun provides customized solar mounting systems for all roof types and awning applications, portrait and landscape arrays. Their systems are designed for corrugated roofs, east/west elevated mounts, flush and ballasted mounts, and utilize easily installed mounting for all tile profiles. All clients receive free engineered layouts within 2 working days for each project's specific requirements. www.trasnowandsun.com



Unirac, Inc.

Unirac's SUNFRAME MICRORAIL (SFM) racking system includes a structural front Trimrail for fast array alignment and improved aesthetics. Minimize total labor with pre-assembled parts, integrated bonding hardware, and one tool installation. Compact packaging lowers logistics costs from the warehouse to the roof. Patented mounting components provide post-install height adjustment and allow for removal of individual panels for maintenance. www.unirac.com



Zilla Corporation

Zilla's patented Double Stud XL Flashing Assembly attaches directly to sheathing while also providing the option for structural members if necessary. Without having to locate structure, the Zilla Double Stud XL eliminates the need for installation prep work, standardizes design and installation processes, achieves greater speed and flexibility in the field, and makes it possible to complete more projects in less time at less cost. Zilla Double Stud XL is compatible with Zilla flush mount systems or any solar mounting system to help drive better bottom line results. www.zillarac.com

DPW PREFORMED LINE PRODUCTS

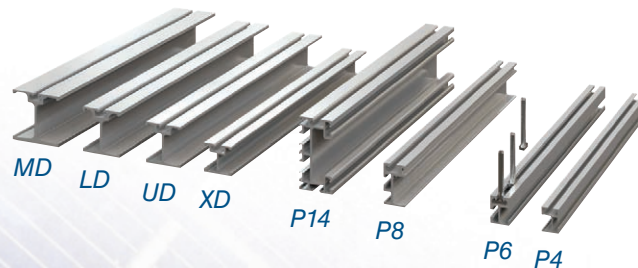


Residential Installations

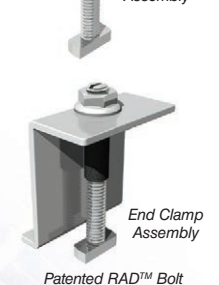


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Pre-Assembled Module Clamps Patent Pending



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Whitham Group Executive Search is a Bay Area search firm specializing in Renewable Energy, Energy Storage, Battery, Construction, Utilities, Engineering, and Environmental Services. Whitham Group is a messenger of corporate career opportunities, and are also salespeople, entrepreneurs, serial networkers, and brand ambassadors, assisting their client's current leadership team by making crucial candidate screening decisions. They recruit nationwide and maintain a vast network of corporate candidates.
www.whithamgroup.com

Residential or Small Office Solar | PV



Baker Electric Solar

San Diego-based Baker Electric Solar designs, installs, and maintains photovoltaic solar power systems for commercial facilities, utility-scale projects, and homes across Southern California. They help realize long-term energy independence for those looking to break free from their high electric bills. The Baker family of businesses has installed over 1GW of combined solar power through all of its residential, commercial, and utility-scale solar projects.
www.bakerelectricsolar.com



Sullivan Solar Power

Sullivan Solar Power services San Diego, Orange County, and Riverside County in both the residential and commercial space. Their installers utilize Kyocera, SunPower, or Panasonic panels. Sullivan Solar Power provides the homeowner with the option to buy or lease with various financing packages.
www.sullivansolarpower.com



Sun City Solar Energy

Sun City Solar Energy designs, sells, and installs solar electric systems including off-grid, grid-tie, and grid-tie with battery backup.
www.suncityenergy.com



SunRun of Virginia, Inc.

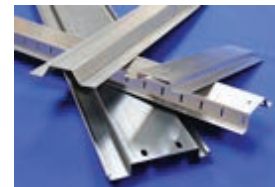
A SunRun portable, stand-alone solar plus storage energy generator system combines a main unit for energy storage and output with a renewable source for energy generation. The included solar panels are the most commonly used generation source, but the unit may also be recharged by wind or water turbine, the grid, a gas generator, or additional solar. It is the inverter, or lack thereof, that defines the model SUN110, SUN220, SUN240, SUNPWR. Applications include business continuity, powering off-grid sites, pumping water, and disaster relief.
www.sunrun.com

Roll Forming



Hynes Industries, Inc.

Hynes Industries fabricates roll formed solar racking components. Z-Purlin, C-Channel, C-Post, and custom roll formed alternatives can be used in ground piling applications in place of I-Beams or T-Beams. The material-efficient shapes offer structural strength, high bending in load bearing, and soil friction for reliable anchoring. Profiles can be nested for easy storage and transportation. All shapes are available in a wide range of standard or custom sizes. Roll formed profiles are light and strong, reduce part costs, and eliminate secondary operations through in-line programmable punching of holes, slots, and other features. Specialty corrosion resistant materials available, including hot and cold rolled, hot dipped galvanized, HSLA, pre-painted, vinyl clad, and stainless steel.
www.hynesindustries.com



Johnson Bros Metal Forming Co.

Johnson Bros Metal Forming is a manufacturer of panel frames and other solar energy components, such as the supports and structural components for panels, as well as reflector troughs for solar concentrators. They offer a wide variety of custom shapes for various different solar panel frames and structures.
www.johnsonrollforming.com



Samson Roll Formed Products Co.

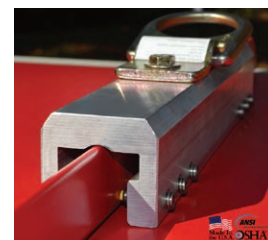
Samson Roll Formed Products offers custom profile design and have developed tooling for more than 2,000 roll formed shapes; many of which are tool-free options, from simple angles and channels, to more exotic profiles requiring multi-stage operations. Samson's capabilities include: notching, stamping, bending, assembly, packaging, and more. For the solar industry, Samson has designed brackets and channels specifically to support photovoltaic arrays, and parabolic shaped channels, the main component of Compound Parabolic Collectors, which are used for solar water heating and cooling projects.
www.samsonrollform.com



voestalpine Roll Forming Corporation

RFC is part of the voestalpine Metal Forming Division highlighting roll forming capabilities in 13 countries worldwide including South America and China. Within the United States, voestalpine RFC has over 35 roll lines with capabilities designed to handle a variety of metal types for both open profiles and in-line welded custom tubes. voestalpine RFC has advanced roll forming technologies and techniques and tackles unique shapes with challenging features and tolerances. They have been manufacturing their products in facilities located in Kentucky, Pennsylvania, and Indiana for 70 years.
www.voestalpine.com/RFC

Safety



Standing Seam Roof Anchor

The Standing Seam Roof Anchor allows homeowners, building owners, and contractors work safely on standing seam roofs without penetrating the panels. This patented, non-penetrating anchor is engineered to provide fall protection on standing seam roofs. It consists of a solid 6061-T6 aluminum body with 12 stainless steel set screws. The standard assembly also includes a 5,000 lbs certified d-ring for single man attachment. It arrives ready to use as a single seam, single user anchor.
www.fallpd.com

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SMI designs and delivers standard and custom complete solutions for MOCVD/PECVD/CVD/ALD systems or components for manufacturing and R&D thin films of Carbides Chalcogenides GeS/CuS:Ag GeSbTe CNTs Diamond Graphene II-VI's III-V's Nanodots/wires Nitrides Oxides Si/Ge Polymers, etc. Sales are supported by an inhouse applications lab featuring tools and analytic equipment. Feature applications are power devices, PVs, batteries, memories, optoelectronics, spintronics, etc. SMI's applications laboratory is used to research new materials, processes, and device structures under contract or in collaborative efforts. SMI also provides government contract teaming and development services; helping to propose and win government contracts.

www.smicvd.com

Site Assessment & Forecasting

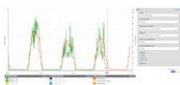


First Base Solutions

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

VuMAP is easy-to-use with nothing to install.

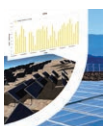
www.firstbasesolutions.com



Global Weather Corporation

Global Weather Corporation's SolarWX service proves forecasts of Global Horizontal Irradiance (GHI) and, when system characteristics are available, estimated power output, for any solar installation at any location in the world. SolarWX's accurate estimates of GHI enable applications such as solar energy generation, home and industrial energy use, and agriculture. Typical users include utilities, energy traders, smart home applications, photovoltaic monitoring systems, and agricultural information services. Forecasts can be displayed in their simple, intuitive, web-based display. Alternatively, forecast data feed can be integrated into any customer's system.

www.globalweathercorp.com



Meteodyn

Meteodyn develops wind and solar energy software and software platforms. They also provide solar energy tools and consulting services, solar resource and production assessment, PV plant design, and solar production forecasting.

www.meteodyn.com/en



Renewable NRG Systems

Renewable NRG Systems' (RNRG's) SRA System is a complete solar measurement station for utility-scale PV projects. Site-specific solar resource assessment campaigns provide accurate context to correlate long-term, satellite-derived irradiance data. This approach provides a low resource-related uncertainty which drives financial terms and, ultimately, project ROI. RNRG's latest generation SRA System includes a soiling measurement option for improved characterization of energy losses due to soiling effects. Together with their Technical Services Partner Network, RNRG provides a turnkey approach to solar measurement for accurate and repeatable measurements in any location.

www.renewablenrgsystems.com

Software Supplier



Aurora Solar

Aurora is a software platform that enables solar PV installers to create accurate engineering designs and professional sales proposals with just an address and an electric bill. Aurora uses satellite imaging and LIDAR to help build complete 3D models of sites remotely, eliminating the need for truck rolls. The shading analysis is NREL validated, and their bankable shading reports are accepted by all major rebate authorities. The Optimizer is an automatic PV system designer that reduces design time by 95%. Aurora's performance simulations are calculated down to the cell-string level, and financial analyses with customizable cash, leases, or PPA models can be included in sales proposals. Free and unlimited one-on-one help and training sessions is available through their personalized customer support center

www.aurorasolar.com



Energy Toolbase

Energy Toolbase is a software platform for modeling and proposing the economics of solar and energy storage projects. Their SaaS product is used by distributed energy organizations to accurately, objectively, and transparently analyze their projects.

www.energytoolbase.com



JobNimbus

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

www.jobnimbus.com

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PVComplete

PVSketch is a seamless design solution for solar developers. A user-friendly interface allows professionals easy access to a precision layout tool with little or no training. PVSketch helps visualize solar energy solutions and creates accurate energy modeling. PVSketch is part of the PVComplete platform. PVComplete allows solar developers, installers, and engineers to work together on a single, versatile platform combining efficiency and accuracy. Sales professionals can begin a project quickly online with PVSketch and then transfer the project to PVCAD, their AutoCAD plugin, for a detailed engineering plan set. Together, PVSketch and PVCAD enable seamless solar design from concept to construction.

www.pvcomplete.com



Valentin Software

PV*SOL premium is a professional software for the design, simulation, and yield calculation of solar electric systems. The 3D visualization provides a precise shading analysis for both roof and ground-mounted plants. Buildings and objects are created quickly and easily by importing floor plans and maps directly into the 3D visualization. Detailed profitability calculations can be carried out on systems with and without battery storage. A trial version is available on the Valentin Software website, as well as video tutorials and introductory online webinars.

www.valentin-software.com

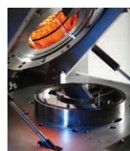


Velocify

Velocify, a sales acceleration platform, helps sales teams and solar companies sell more by bringing speed and control to the entire sales process. Velocify helps solar sales professionals prospect with precision, quickly respond to new leads, and follow a proven sales workflow to find and convert more leads.

www.velocify.com

Solar Coatings



Annealsys

Annealsys manufactures Rapid Thermal Processing and Chemical Vapor Deposition equipment for R&D and production. RTP systems are available from 2 to 8-inch. Cold wall chamber, high temperature, and high vacuum capability are the main features. Special configurations for selenization and sulfuration processes are available. DLI-CVD / DLI-ALD systems dedicated to oxides and metals deposition are available from 2-inch up to 200mm. Annealsys provides worldwide sales and service.

www.annealsys.com

Solar Fasteners



HellermannTyton

HellermannTyton's Low Profile Metal Edge Clip is a solution for more confined areas where space is an issue. Designed for effortless insertion, the Low Profile Metal Edge Clip fits the width and depth of frames typically used in light weight solar modules, but has a high extraction force that tolerates extreme environments as well. This provides assurance that the cables are secure on a panel. HellermannTyton's Low Profile Metal Edge Clip can easily be removed with a flathead screwdriver and is also simple to install.

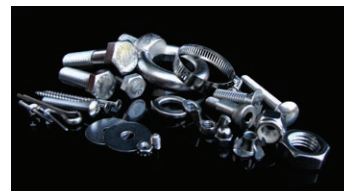
www.hellermanntyton.us



Leco Solar

Leco Solar provides a variety of quality wire management solutions to the solar industry. With cable ties at the core of Leco Solar, their company has increased its offerings through the years to include Edge Clips, PV Wire Clips, Stainless Steel Solar Ties, Fir Tree Mounts, Adhesive Mounting Bases, Labels, and Placards. Leco Solar can meet customer requirements with a wide range of products and offer solutions and alternatives when needed.

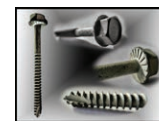
www.lecosolar.com



Marine Fasteners

Marine Fasteners is a distributor of corrosion resistant, stainless steel hardware in both imperial and metric. Their hardware eliminates galvanic corrosion, enhances corrosion protection, and alleviates galling challenges.

www.marfas.com



Mudge Fasteners

The DURA-CON Power Lag showed no corrosion in tests to 1500 salt spray hours when used with aluminum components. The integrated washer head increases bearing surface, the serrated flange resists loosening due to vibration, and type 17 tip allows easy starts and quick drives.

www.solarfastenerexpert.com



Nine Fasteners, Inc.

Nine Fasteners announces the release of a brand new clip in early 2017. The new clip, NFI-1307-V90, will be a 90 degree version of their most popular current clip, the DCS-1307. The NFI-1307-V90 is a module mounted clip with a perpendicular orientation designed to secure 1 or 2 standard PV cables or a single oversized PV cable.

www.ninefasteners.com

Solar Integration



BirkSun

The Boost 2 is a powerful and easy-to-use BirkSun ever. It's waterproof design contains a built-in internal battery with digital power management and an LED indicator display. BirkSun is useful at the beach, music festivals, and during international travel. Dimensions: 18.5"(H) x 13"(W) x 8.5"(D) / 2.4 pounds. Volume: 26 Liters

www.birksun.com



California Sunlight Corporation

California Sunlight Corporation offers high efficiency, cost-effective, portable solar energy systems. Products include: solar-powered BBQs, solar balloon cooker, active daylighting, solar table lamp, solar flashlight, solar charger, solar lighting, and micro-CPV systems.

www.california-sunlight.com

Kinetic
SOLAR RACKING AND MOUNTING

- Commercial and residential solutions
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Solar Support Structures & Carport Systems



Baja Carports

Baja Carports specializes in the turnkey development of high-tensile, light gauge steel structures that serve as a mainframe for solar energy projects, generating both electricity and revenue while providing shade and protection. With their in-house engineering and construction teams, Baja designs, engineers, supplies, and installs any structural project, including carports, ground-mounts, and RV and boat storage facilities. Baja Carports' Solar Support Systems are designed to support solar panels with a proprietary attachment integrated into projects nationwide ranging from school campuses, train stations, sports complexes, shopping malls, hospitals, and office buildings.

www.bajacarports.com



Falcon Steel America

Falcon Steel provides custom metal fabrication products, produced from recycled material. They provide solutions for residential, commercial, or utility-scale solar projects. Whether it be support structures, solar pedestals, or land access gates, Falcon Steel's engineering department provides custom tailored solar solutions. Falcon Steel has been designing and fabricating steel structures and custom products for over 52 years.

www.falconsteel.com



M Bar C Construction, Inc.

M Bar C Construction Inc. provides reliable solutions for general contractors, corporate divisions, and government entities working on small or large scale projects. Using heavy and light gauge structural steel, they can incorporate solar efficiency into parking lot canopies, fixed and tracker ground-mount, and parking structure canopies. M Bar C installs approximately 40MW of solar canopies each year. Their solutions are designed to be cost efficient for the long term needs of the customer. M Bar C is licensed and compliant with Cal/OSHA safety programs and prevailing wage jobs. CSLB# 869960.

www.mbarconline.com



Orion Carport Systems & Construction, Inc.

Orion Carport Systems offer cost-effective solar canopy designs for a wide variety of parking environments, including elementary schools and universities (DSA Approved). From design to engineering, supply and install, Orion provides fast and easy module installation for commercial application needs.

www.orioncarports.com



The Mount Makers, Co., Ltd.

The Mount Makers provide aluminum extrusions with a surface treatment of Anodic oxidation thickness of 12¼m, providing corrosion resistance even in bad environments. The top of column can adjust 0°~45° from north to south, and the clamp can fix to modules with thicknesses ranging from 30mm to 50mm.

www.themountmakers.com

Solar Thermal Manufacturing & Equipment



Beijing Sunda Solar Energy Technology Co., Ltd.

With German technology and standards, SUNDA's metal absorber evacuated tube solar collector series includes: SEIDO1 series heat pipe vacuum tube and collector; SEIDO2 series direct flow vacuum tube and collector; SEIDO3 storage type vacuum tube and solar shower; SEIDO8 horizontal heat pipe vacuum tube and collector; and SEIDO6 receiver tube and parabolic trough concentrating collector. These products have applications in domestic hot water, industry process, pools and spas, space heating, solar air-conditioning, sea water desalination, and CSP. SUNDA's products are internationally certified, as well as Solar Keymark and SRCC.

www.sundasolar.com



Butler Sun Solutions, Inc.

Butler Sun Solutions' new SRCC OG-300 certified PV Wand heats any standard tank using DC power from PV panels (up to 1500 Watts). For closed loop solar thermal systems, the Solar Wand heat exchanger converts any tank to a solar water heater, and is also SRCC OG-300 certified. Both systems are off-grid, and either system also can heat spas. Butler Sun Solutions also offers their PV Hot Plate, DC-powered for clean and convenient cooking anywhere.

www.butlersunsolutions.com



Molded Fiber Glass Companies

Molded Fiber Glass Companies provides custom FRP molding from facilities located in California, Texas, Ohio, South Dakota, and Alabama.

www.moldedfiberglass.com



SEA Groups, Ltd.

SEA Groups offers heat pipe with vacuum tube solar collectors, hot water heating, and swimming pool heating in all environments, in all four seasons. They hold a U.S. patent for retrofitting existing gas/electrical water heaters into solar water heaters with cost effective proprietary technologies.

www.sea-groups.com

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Lower your production costs by choosing quality **Steinbach** materials.



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704 362 1922





Solcan

The Solcan 2101 solar thermal collector is manufactured in Canada and is available with a 4' x 7' and 4' x 8' collector frame. The standard header is 3/4" with pre-installed union connections. Other header sizes and connection methods are available upon request. Solcan solar collectors are backed with a 10-year limited warranty and have a life expectancy of over 20 years.

www.solcan.ca



Viessmann Manufacturing Company

Viessmann is a manufacturer of renewable energy and fossil fuel heating systems. A complete line of Viessmann solar thermal systems for residential or commercial applications includes: flat plate solar collectors featuring ThermProtect technology; vacuum tube solar collectors; pre-fabricated pumping and heat transfer stations; solar control units and communication accessories; DHW storage tanks with internal heat exchanger coils; mounting systems; and system accessories. Constructed from high quality materials, all Viessmann solar thermal system components are carefully design-matched to ensure performance and reliability throughout the system lifespan. Viessmann solar collectors and residential system packages are SRCC and CSA certified.

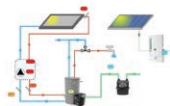
www.viessmann-us.com

SOLOPOWER SYSTEMS

Flexible, Ultra-thin, Light Weight PV Modules
MADE IN THE USA

6308 N MARINE DRIVE PORTLAND, OR 97203 solopower.com

Solar Thermal Monitoring



Solar Wave Energy, Inc.

Solar Wave Energy provides monitoring for solar thermal systems, allowing owners, installers, and service people to verify operations and remotely adjust system controls. Solar Wave Energy's monitoring platform allows simultaneous viewing for both solar thermal and P.V.

www.solarwave.com

Solar Thermal Systems



ALGAentis

ALGAentis provides solar air conditioning (chiller), and combined solar thermal heat systems, delivered via split, ductless blowers (DC motors), and chilled from an exterior condenser powered by 900W PV panels with no inverter required. The system is made in the USA, UL tested, and certified by ENERGY STAR, AHRI, UL 1995, C&USA 22.2, ETL, and California Energy Commission [CEC certified solar air conditioner]. The system converts from DC to AC at night or can go 100% off-grid with an available battery pack.

www.greencleanenergies.com



ECHO Systeme

ECHO Systeme provides commercial and institutional solar thermal systems as well as flat plate collectors, evacuated tubes and solar concentrators. They offer DHW, heating and process application as well as design, drawings, and pricing and certification and approval.

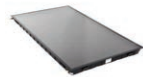
www.echosysteme.com



RESOL GmbH

The RESOL product range includes a range of solar thermal and heating controllers as well as a variety of accessories for the efficient use of energy.

www.resol.com



ROTH Industries, Inc.

Solar heating systems from Roth are complete, high-performance, reliable systems which produce clean energy and reduce utility costs.

www.roth-usa.com



SolarSun Air Conditioning and Thermal Heat Pumps

SolarSun provides DC powered solar air conditioning and thermal heat pump heating, as well as supplying potable hot water needs, from a 900 watt roof top DC solar power system. Certified by ENERGY STAR, AHRI, UL 1995, C&USA 22.2, ETL, and California Energy Commission, their AC/DC12 compressor runs on DC power converted from solar panels, without needing an inverter, controller, or batteries. The solar DC power directly replaces an equivalent amount of AC power from the power company and can cut daytime energy costs for air conditioning or heating by up to 80-90%. During the day, the AC/DC12 can get most of its power from solar resulting in an efficiency above SEER 35 when using two >= 230W solar panels.

www.greencleanenergies.com/solarpower



Stiebel Eltron

Tempra Plus tankless electric water heaters feature Stiebel Eltron's Advanced Flow Control to automatically adjust flow rate, if needed, in order to keep the output temperature constant, and supply continuous hot water to open draw-off points. If the water flow rate is greater than what the heater can provide given the outlet temperature setting, the Advanced Flow Control automatically adjusts the flow rate just enough to maintain that set point temperature. Tempra Plus units are a backup solution for solar thermal systems. There is a 3-year warranty on all Stiebel Eltron tankless, on-demand, electric water heaters.

www.stiebel-eltron-usa.com



Sun Bandit by Next Generation Energy

Sun Bandit by Next Generation Energy is an ICC-SRCC certified, ENERGY STAR rated, and UL listed on-site solar PV water heating and energy storage solution. It requires no net meter connection and provides simple off-grid operation empowering home builders, solar professionals, and consumers to reap the benefits of solar energy regardless of the incentive landscape, and without utility approval or long-term contracts.

www.sunbandit.us



The LeverEdge

Solar Hydronics Corporation, a whole owned subsidiary of The LeverEdge, offers advanced solar pool heating systems. Their collectors are manufactured to high quality control standards and are produced in a modern facility. The LeverEdge also offers their customers training and support.

www.theleveredge.com



TIGI Solar

TIGI developed a new type of solar thermal collector, efficiently generating heat even in cold climates and for high temperatures, required for commercial and industrial users. TIGI's patented technology of transparent insulation minimizes energy losses and maintains high performance in these scenarios. Collector-level overheating prevention and sealed case design ensures long life of products with low need for maintenance. Certified in Europe and the USA with initial sales in industrial and commercial users and successful in US government pilot projects.

www.tigisolar.com

Temperature Profiling

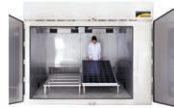


Apogee Instruments

Errors in air temperature measurement up to 10°C (18°F) are common in naturally aspirated, multi-plate sensor shields in low wind, high solar load conditions. These errors are well outside the 1°C (1.8°F) recommended standard for PV monitoring. Apogee Instruments' TS-100 high-efficiency, fan-aspirated radiation shield solves this by providing constant internal aspiration using an IP55 rated 80 mA fan, which can operate as low as 28 mA using pulse width modulation. Built from rugged UV stable plastic, the unique Coand inlet and internal Venturi contour shape optimize air-flow over the temperature sensor, consistently yielding accuracies of 0.1°C (0.18°F) when used with the recommended thermistor.

www.apogeeinstruments.com

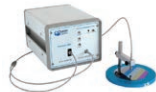
Testing & Certification | Testing Chambers



Atlas Material Testing Technology, LLC

With over 30 years of testing and measurement experience supporting the solar industry, Atlas provides weathering instruments, solar simulation chambers, testing services, and consulting solutions for the Photovoltaics, Concentrated Solar Power, Solar Thermal, and Building Integrated Photovoltaic markets. To address the unique needs of the photovoltaic industry, Atlas has developed a comprehensive durability testing program specifically for photovoltaic modules - Atlas 25+, a proprietary, multi-dimensional durability testing program designed to subject photovoltaic modules to the environmental degradation stresses which can be expected over long-term service.

www.atlas-mts.com



Ocean Optics

Ocean Optics miniature fiber optic spectrometers and thin film metrology instruments are beneficial for evaluating materials used in the testing and production of photovoltaic panels. As developers of PV materials seek improvement in solar cell efficiency and finished panel quality, the need is great for flexible systems to evaluate glass coatings, dopants, and other materials. Optical sensing systems such as UV-Vis and NIR spectrometers and thin film measurement systems are easily configured for research lab and process line applications. Applications include characterization of solar cell materials, spectroradiometric measurement of solar simulators, and quality control in panel production.

www.oceanoptics.com



Q-Lab Corporation

Q-Lab Corporation is a global provider of material durability testing products. They design and manufacture standard test substrates, as well as weathering, light stability, and corrosion testers. In addition, contract test services, which include accelerated laboratory testing, are available at various Q-Lab locations. Outdoor exposure testing for weathering, light-fastness, and corrosion are also available in the US.

www.q-lab.com



UL

UL helps to enable safety and accelerate innovation across the PV value chain – including PV plants. They perform testing and certification of materials, components, products, and systems, as well as on-site field evaluations. Additional service opportunities are available to help developers remove risk from the construction of solar PV systems and build confidence for stakeholders by performing energy yield assessments, design reviews and construction inspection for compliance to codes.

www.ul.com/solar

Theft Protection



Bryce Fastener, Inc.

Bryce Fastener provides tamper-resistant and custom keyed ground-mount security screws, nuts, and self-drill fasteners.

www.brycefastener.com



Cone Drive



Cone Drive's engineering team designs and creates precision motion control solutions for a wide range of Concentrating Solar and Concentrating Photovoltaic Power Generation systems around the world. Our products feature high torsional stiffness for structural integrity, static backholding torque up to 158,300 Nm, non-locking or self-locking worm gear ratios, robust corrosion protection, extremely low backlash options, and maintenance-free operation over the system's lifetime. Working as an extension of your engineering team, Cone Drive's team of design, manufacturing, and quality engineers will deliver the ideal solution to meet all of your cost and performance specifications.

Visit our new website!

ConeDrive.com



Tools



Rennsteig Tools, Inc.

Rennsteig has been manufacturing tools designed for durability and efficiency. Their tools are designed for high performance, ease of use, and long life. Rennsteig's crimp system tools are specifically engineered for the wires and contacts for a wide variety of industries. So installs go quickly with no material wastage, and gives standards-compliant connections. Rennsteig offers tools for all major manufacturers and all their tools are designed and crafted in Germany. They can meet any customer specifications and requirements.

www.rennsteig.us

Tracking Systems



Array Technologies, Inc.

All the features of the DuraTrack HZ v3 are designed to work together and result in the best LCOE. The streamlined design helps save on installation costs, O&M costs are reduced due to zero scheduled maintenance, and production is increased with 99.996% uptime, 6% more density, and failure-free wind mitigation.

<http://arraytechinc.com>



Exosun, Inc.

Exosun's single-axis tracker, Exotrack HZ, was engineered to deliver high energy output while minimizing CAPEX and OPEX for ground-mounted solar plants. Exotrack HZ's straightforward design is reflected in its installation rate of 200 man-hours per MW. No machines are needed to assemble the structure's few and lightweight parts on site. With its short rows, Exotrack HZ smoothly follows flowing topography without land grading. The system's linked-row architecture and grease-free, balanced structure make it a reliable tracker. With very few key components, failure risks and O&M actions are reduced to a minimum for 25 years. Exotrack HZ can be delivered with a smart module cleaning device.

www.exosun.net



Grupo Clavijo ETL

Grupo Clavijo ETL designs, calculates, and manufactures solar trackers and fixed tilt according to customer's specifications and local or federal standards. Grupo Clavijo has a high-volume manufacturing facility in Spain with qualified and experienced staff and several global production centers. With high precision CNC machinery, their integrated quality management system is certified to ISO 9001:2008, and their environmental management system to ISO 14001.

www.grupoclavijo.net



Ideematec

Ideematec's patented single row tracking System HORIZON offers high power density (100kW per single row), 200 foundations per MW, and flexibility for undulated terrain (up to 36%). Its individual backtracking can be optimized for undulated terrain to maximize the power output and the tracking system can be equipped with a snow drop off function. The horizon is a solution for utility scale installations in flat areas, and also fits uniquely shaped and hilly terrain without grading.

www.ideematec.com



NEXTracker

NEXTracker's single-axis tracker technology, NX Horizon, brings self-contained motor power to each row of solar panels, using less steel, rotating a full 120 degrees. Smartly designed and efficient, NX Horizon has been installed on close to 6GW of solar projects globally.

www.nextracker.com



Renewable Future Energy Resources, Inc.

Renewable Future Energy Resources provides products designed to last including: solar panels, hybrid inverters, lithium-ion batteries for storage, and trackers for 10-50 panels.

www.solarpowermrg.com



Solar FlexRack

Solar FlexRack's TDP Turnkey Trackers are a next generation, single-axis tracker solution, complete with comprehensive services and support. This tracker contains an updated tracking technology bundled with a full suite of project services and support for commercial and utility-scale solar customers. As a low total cost solution, this tracker includes full design, installation, commissioning, and support services bundled in one contract. Solar FlexRack's TDP Solar Tracker solution is supported by an in-house team of engineers and geologists.

www.solarflexrack.com



Soltec America, LLC

Soltec's SF Utility single-axis solar tracker is a Land-Use Enabler providing built-in tolerances for irregular land, including its unique steep-slope tolerance of 17% grade North-South. Moreover, SF Utility is a Yield Enabler providing configurations to achieve the highest yield per acre. That, combined with related Land-Use features extends yield potential to where others cannot build without special costs. SF Utility provides low-cost installation with low piles-per-MW; meaning lower pile-driving and grading expenses, and lower environmental impact. This results in overall less costly site preparation and installation activities.

www.soltec.com

Utility Scale Solar | PV



GP JOULE USA, Inc.

GP JOULE is a global renewable energy company offering developing, designing, engineering, building, operating, and financing for commercial and utility scale ground mounted PV installations. Across North America, and in Canada, GP JOULE, provides turnkey EPC Services including major equipment supply and financing. The company offers its proprietary PHLEGON Single Axis Tracker supply, installation, and O&M, as well as project development support services.

www.gp-joule.com



SMA America

SMA's newest Sunny Central inverter offers a 1500V solution for more reliable, safe, and efficient PV power plant design. The Sunny Central 2500-EV-US inverter helps achieve cost-savings by reducing the size of the DC cabling and lowering the quantity of combiner boxes and medium-voltage equipment required. Additionally, each inverter pad needs fewer system components because of the integrated DC fuse servicing switches and convenience power. This utility-scale solution offers design flexibility and can be used with a variety of modules. Certified to the new UL 62109 standard, the Sunny Central 2500-EV-US represents a level of safety, functionality, and reliability.

www.sma-america.com



Solar Frontier Americas Development

Solar Frontier Americas Development, a subsidiary of Solar Frontier, develops and sells utility-scale photovoltaic plants in the United States and Latin America. Headquartered in San Francisco, California, Solar Frontier Americas Development has offices in San Jose, California and Reno, Nevada. The solar project development team partners with leading solar system component suppliers, EPCs, and other developers to deliver high-yield solar electric power plants that help meet the clean energy needs of today.

www.solar-frontier.com

Soltage

RENEWABLE ENERGY PROVIDER



Soltage

Soltage offers solutions in the development, financing, and operation of utility-scale solar power generation stations providing electricity under long-term contracts to commercial, industrial, educational, utility, and municipal customers across the United States. Soltage has developed 35 solar energy projects with more than 85MW total distributed generating capacity under management across eight states. The company has deployed over \$250 million into solar projects since 2006, and its projects have produced 207,487MWh of lifetime solar production to date. Soltage is backed by a group of investors including leading independent power producer Tenaska and infrastructure equity investors Basalt Infrastructure Partners, and is headquartered in Jersey City, New Jersey. www.soltage.com

TMEiC



TMEiC

TMEiC's Solar Ware Samurai Series of photovoltaic inverters offers the first 1500V inverter fully certified to UL1741. The Samurai is available in three power classes, 2500kW – 2700kVA (1500V), 2300kW – 2500kVA (1500V), and 1833kW – 2000kVA (1000V). TMEiC's Solar Ware Main Site Control provides overall coordination and control of utility-scale PV plants, providing access to complete information about an entire plant's power production. www.tmeic.com



UGE International, Ltd.

UGE provides solutions to its clients in all stages of the solar PV project lifecycle including: consulting and project management, engineering and design, turn-key construction, and development. UGE has developed numerous solar rooftop and ground-mount projects across the United States, Canada, Panama, and the Philippines. www.ugei.com

Other Associations



IMPACT

IMPACT is a labor management partnership designed to provide a forum for union ironworkers and their signatory contractors to address mutual concerns and encourage reasonable, balanced solutions. 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. www.impact-net.org

ISO-CAL™

north america



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.

Equipped to calibrate any pyranometer or pyr heliometer model type, ISO-CAL offers both indoor and outdoor Primary or Secondary reference calibration services in accordance with all ISO and ASTM calibration standards.

Supported sensor types:

- ✓ Pyranometers
- ✓ Pyr heliometers
- ✓ Pyrgeometers
- ✓ UV Sensors
- ✓ Net Radiometers
- ✓ PAR Sensors
- ✓ LUX Sensors
- ✓ Spectroradiometers



480-336-8133

info@isocalnorthamerica.com
www.isocalnorthamerica.com

SR30 | Digital Secondary Standard Pyranometer

Join the evolution...



ev·o·lu·tion
/ ,evə'looSH(ə)n/

noun

The gradual development of something, especially from a simple to a more complex form.

When it comes to superior performance, even Darwin would agree the latest SR30 pyranometer from Hukseflux is the natural selection.

SR30 pyranometer employs an internal, low power, maintenance-free ventilation system with heating, rendering larger higher power/ high-maintenance external ventilators obsolete. The SR30 is locally supported in the U.S. and backed by a 5-year warranty.

- Superior measurement accuracy
- Highest data availability
- Low cost of ownership
- Most value added features standard
- Performance validated (test data included)
- Compliant with latest ASTM & IEC standards



New

Low-power internal ventilation with heating via digital control over RS485 / Modbus (patent pending)

Internal ventilation port
Easy-view bubble level

HuksefluxUSA™

631-251-6963

info@HuksefluxUSA.com | www.Hukseflux.com

Civil Engineering

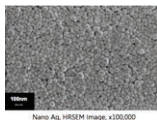


Taney Engineering

Taney Engineering meets all pre-construction project requirements from Zoning and Entitlements to Final Maps. Services include Feasibility Studies, Grading Plans, Street Plan and Profiles, Hydrology Studies, Aerial Mapping, Ground Support Services, A.L.T.A. Surveys, Boundary and Topographical Surveys, Construction Staking, and Hydrologic Modeling. Taney Engineering also provides Channel and Storm Drain Design, Flood Control Masterplanning, Technical Drainage Studies, Sedimentation and Erosion Modeling, Stormwater Detention/Retention, Basin FEMA Flood Plain Delineation, Hydraulic Design of Bridges and Culverts, Record of Survey, Right-of-Way Acquisitions, GPS Surveys, Aerial Control Surveys, Geodetic Survey, Legal Descriptions, Lot Line Adjustments, and Parcel Mapping.

www.taneycorp.com

Conductive Inks



PV Nano Cell, Ltd.

Sicrys conductive ink, I55DMG4-045, is a photo-voltaic metallization conductive ink, based on nano silver particles uniformly dispersed in Diethylene glycol mono methyl ether (DGME). The ink is designed for use in the printing of solar cells and provides efficiency and improved inkjet printing of fine grid lines. It is compatible with numerous print heads, and is suitable for various emitters, able to be co-fired with back side aluminum conductors and used as a seed layer for plating. I55DMG4-045 can be stored at room temperature for ease of use.

www.pvnanocell.com

Displacement Blowers & Vacuum Pumps



Tuthill Vacuum & Blower Systems

Tuthill provides high performance M-D pneumatics, reliable positive displacement blowers, and vacuum boosters, as well as Kinney mechanical vacuum pumps, and engineered systems ready to install and run.

www.tuthillvacuumblower.com

Equipment Manufacturer



GRT Utilicorp, Inc.

GRT Utilicorp manufactures post driving and pressure digging machines. They also provide sales of new and used machines, truck and track mounted machines (for highway median or solar panel post driving), repair and replacement parts, pneumatic rock drills, augers, and driving equipment for smaller jobs.

www.grtutilicorp.com

High Voltage Electrical Equipment



Southern States, LLC

Southern States, LLC designs and manufactures high-voltage switching devices. The CapSwitcher capacitor switcher and RLSwitcher reactor switcher are the latest products from Southern States. They join an offering of medium and high voltage switching products utilized in collector substations and as part of the utility interconnect and transmission system.

www.southernstatesllc.com

Metal Supplier

Samuel, Son & Co., Ltd.

Samuel, Son & Co. is a metals and industrial products manufacturer, processor, and distributor. They supply and process domestic metal products to the solar energy industry, including aluminum sheets and extrusions, stainless/carbon sheets/plates, and rollformed sections. Samuel stocks large inventories of metal products, enabling them to provide JIT, customized kitting of parts and stock, as well as hold programs. Samuel provides comprehensive processing services and produces exacting tolerances to meet customer specifications.

www.samuel.com

Microblasting Equipment



Comco, Inc.

The unique properties of high-energy abrasive particles make microblasting a solution for CIGS solar cell applications. It cuts without heat or vibration and can selectively remove layers without damaging underlying layers or surfaces.

www.comcoinc.com

Microgrid Control Systems



Sustainable Power Systems, Inc.

Sustainable Power Systems Universal Microgrid Controller (UMC) is a standardized industrial control system designed to reduce the cost and complexity of microgrid deployment. It is engineered to meet the needs of a wide spectrum of microgrid configurations, grid-tied or off-grid, eliminating the need for solar project developers to do controls integration and custom programming. The UMC optimally coordinates renewables, storage, controllable loads, backup generation, and the grid inertia, if any. In Simulation Mode, the UMC monitors and controls a virtual version of a proposed microgrid, allowing customers to experience the microgrid controller in action, before making a purchase decision.

www.sustainablepowersystems.com

Printing/Metallization Equipment & Services



ASM Alternative Energy

Alternative Energy provides fuel cell and solar cell solutions. The full range of ASM Alternative Energy technologies includes their Eclipse XP cell metallization platform, efficiency-enabling screens and stencils, SolarBlade half cell technology, and Solar WIS wafer inspection systems.

www.asm-ae.com

Radiant Heating



Electro Plastics, Inc./STEP Warmfloor

Electro Plastics, Inc. is the manufacturer of STEP Warmfloor, an electric heating system based on self-regulating nanotechnology. As the material warms up, it uses less energy and cannot overheat. Installation is simple, and the thin, flat heaters can go under any flooring. The system is energy efficient, can be operated by line or low voltage, AC or DC, and can be connected directly to solar panels. Used for primary heating in new construction and remodeling for all buildings, it is also available for snow melting and roof deicing. All products are manufactured in USA with sustainable, non-hazardous, and recyclable materials.

www.warmfloor.com

Satellite Internet Provider



Skycasters

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

www.skycasters.com

Solar Lighting



SolarOne Solutions, Inc.

SolarOne provides solar powered lighting for commercial and municipal applications including roadway, pedestrian/bikeway, and parking lot illumination.

www.solarone.net

Solar Radiometer Calibration



ISO-CAL North America, LLC

ISO-CAL North America is an ISO/IEC 17025:2005 accredited calibration laboratory specialized in the calibration of solar radiometers: including UV, visible light, solar, and far infrared sensors. Services include indoor and outdoor WRR, WISG, or NIST traceable primary and secondary reference calibration, depending on calibration method and sensor model type.

www.isocalnorthamerica.com

Solar Water Pumping



Franklin Electric

The new Photon SolarPAK system efficiently draws groundwater to the surface for a variety of uses. The Photon solar drive features a smaller modular design providing flexibility and simple maintenance for the installer, and a robust IP66, NEMA 4 enclosure which protects against wildlife, insects, dust, and weather. The system is available in a variety of flow rates from 2.5 gpm to 90 gpm and power ratings of 0.75 and 1.5 hp. Franklin Electric can also connect solar installers with their network of water systems professionals to partner with.

www.franklinwater.com

Valves, Measurement & Control Systems



Gemu Valves, Inc.

Gemu supplies valves, measurement, and control products to plant designers (production equipment for solar wafers and cells) and end customers (manufacturers of solar cells) in the solar industry.

www.gemu.com

RBI SOLAR

COMPLETE RACKING SOLUTIONS

"LET US TALK ABOUT YOUR NEXT SOLAR PROJECT"

- ✓ Cost-effective
- ✓ Custom Design
- ✓ Robust & Durable
- ✓ Optional Installation

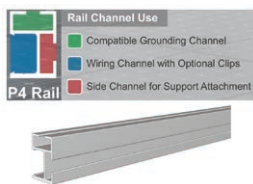
DESIGN ENGINEERING MANUFACTURING INSTALLATION

RBI Solar Inc. | 513.242.2051 | info@rbisolar.com | www.rbisolar.com

Solar Power Northeast, formerly known as PV America, attracts well over 1,000 northeast PV leaders, manufacturers, and service providers looking to grow their business in the Northeast US. Solar Power Northeast is powered by the Solar Energy Industries Association (SEIA) and Solar Electric Power Association (SEPA). Solar Power Northeast was designed to serve and advance the PV solar market, by bringing together PV industry leaders, professionals, manufacturers, and service providers to explore business solutions, new technologies, policy initiatives, and other market factors.

show in print

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



Top clamping PV mounting system

The P4 has been added to the lineup of the Power Rail family. The PV module mounting system is engineered to reduce installation costs and provide maximum strength for parallel-to- roof, tilt up, or open structure mounting applications. The Power Rail P4 is ideal for saving costs on shorter span applications. Power Rail mounting systems are designed with the professional PV solar installer in mind. The top-clamping rails utilize a single tool with a revolutionary RAD fastener for fast bolt placement. The shape of the RAD provides an anti-rotation feature, locking the bolt in the proper orientation when installed. The high strength rigid rails also include an integral wiring channel for securing cables and providing a professional finish. The system includes a wide selection of mounting options designed for secure and water tight attachments to any roof style.

DPW Solar / Preformed Line Products
www.dpwsolar.com



Fixed-tilt ground-mount

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

TerraSmart | www.terrasmart.com



Solar and energy storage inverters

Eaton Power Xpert 2,000-kilowatt (kW) and 2,200kW solar inverters and 2,500kW energy storage inverters provide high power ratings for grid-tied, utility-scale projects. The Eaton solar inverter technology yields lower levelized cost of energy (LCOE) and 98.5% efficiency by the California Energy Commission (CEC). Eaton's Power Xpert solar inverters also enable a skid-less inverter station design to reduce equipment requirements and installation costs. Eaton Power Xpert energy storage inverters are designed to increase electrical resiliency in large-scale applications and work with a wide-range of battery chemistries to store and transmit power when needed. The inverter design also helps provide precise power ramp rate control and frequency regulation to enhance the reliability of electrical power transmission and distribution.

Eaton | www.eaton.com/solar



Versatile mounting clamp

The Standing Seam Power Clamp is a mounting clamp that can attach to virtually any standing seam profile and provides strength using Solar Connections' WaveLock Technology with optional 2, 3, and 5 points of attachment. The top of the Standing Seam Power Clamp can be custom drilled and tapped to fit any bolt configuration. Offering ease of installation, the Silver Bullet set screws include a rounded bullet tip to maximize strength and won't damage the paint finish or pierce the seam. Additionally, the Standing Seam Power Clamp is available in standard mill finish aluminum material, making it an easy-to-stock item. The Standing Seam Power Clamp can be powder coated or Kynar coated to match the color of the roof system.

Solar Connections
www.solarconnections.com



Financial services

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

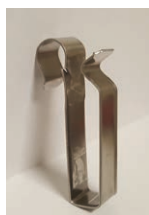
Rodman CPAs | www.rodmancpa.com



Pole-mounted tracking system

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

AllEarthRenewables
www.allearthrenewables.com



Rail-mounted stainless steel clip

Nine Fasteners, Inc. is currently in development of a new wire management offering for the solar industry. This clip will be rail mounted with the capability of holding up to four standard diameter PV wires, or, two of Enphase's new IQ Q cables plus a single standard diameter PV wire. It will be produced using a 300 series stainless steel and will incorporate a rolled outer edge as is standard on all of Nine's clips. Once complete, the clip will be presented to Underwriters Laboratories for testing and certification to receive UL's Certified Component designation. *Please note, picture attached is a prototype and final design may differ slightly.

Nine Fasteners, Inc.
www.ninefasteners.com



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Managing Project Risk in Emerging Markets

by Aaron Daniels

Due to a variety of economic drivers, lack of deal flow, and declining returns, many renewable energy investors are being compelled to transition from mature markets like North America and Europe, to emerging market investments. This trend is well illustrated by Ernst & Young's 2016 Renewable Energy Country Attractiveness Index, in which half of the markets listed represent emerging markets.¹

What are emerging markets?

Emerging markets evolve economically, and successful investments favor early (though not necessarily first) movers. There is a window between economic growth and incentives to sufficiently overcome market risk; as the market grows, investor competition naturally reduces project returns. The eventual entry of utilities further accelerates this decline in investor returns. As emerging markets mature through growth, returns typically decline faster than risk. Late movers into emerging markets may find deal flow, but returns at this point are typically less than the risk exposure.

For example, many Latin American renewable energy investment opportunities are too mature to yield sufficient investor returns. Southeast Asia, on the other hand, currently fits squarely in the window of an attractive risk/return ratio. Instead of relying on precedent, investors seeking emerging market opportunities often mistakenly turn to mature markets, because they either don't understand their true nature, or don't have the capacity to identify and manage emerging market risks.

Emerging market risks

Early mover investors looking to leverage that "sweet spot" in the risk-to-returns ratio face unique challenges due to their experience in more typical, mature market investments. In other words, these investors will not have a precedent to reference. The diversity of cultures, business practices and languages in these new markets, as well as shortfalls in the existing legal frameworks, can create a sense that risks are unidentifiable.

However, the rapid growth in emerging markets indicates these risks can and are being managed successfully by well-prepared investors. Successful investors in this market segment implement a robust, integrated risk management approach, leveraging advisors with emerging market experience and a comprehensive risk management strategy.

The risk management team

Investors prefer to see risks transferred, either to the contractor or project insurers. This requires a lawyer and insurance broker. However, the one person commonly overlooked is the project manager. The project manager uses his or her experience of building and operating renewable energy projects to bridge the gap between the technical and commercial aspects of the project. They identify project risk, plans, and integrate risk strategies between project plan, contracting, and insurance, as well as manage the risk during project execution. Without a project manager experienced in emerging markets, legal and insurance risk strategies are developed in "silos", presenting gaps that ultimately manifest themselves as cost and schedule overruns in construction, and revenue losses in operations.

- **Project Manager** – The root cause of typical technical problems on emerging market projects is the gap in understanding between experienced foreign advisors and local technical professionals. From a European perspective, renewable energy (specifically wind) is a 35-year-old industry, and technical advisors from mature markets tend to interact in emerging markets from that perspective. Local engineers can reinforce this perspective, as most local engineers are very bright and capable. They just don't have the years of experience to know where the typical pitfalls in renewable energy projects lie. In other words, local engineers don't know what they don't know. Meanwhile, foreign engineers don't ask what would be considered the "dumb" questions – basic things that

are unique to renewable energy projects: design, logistics, construction methodology, and off-taker interfaces. A knowledgeable project manager with experience of building renewable energy power plants in emerging markets is critical to evaluating project risks, expecting the unexpected, and developing a robust risk plan.

- **Project Attorney** – Too often we see a contract "template" being used. An approach that assumes the next project will be identical to the last is dangerous, as, while there are similarities, each project has a unique risk profile. In emerging markets, general assumptions on risk mitigation cannot be taken for granted, and it is important to remember that the market may be developing legally as well as economically. Bonds may be difficult or impossible to call on if they are with a bank that doesn't have strict compliance regulations. Permitting will likely be unclear in a developing country, since emerging market regulatory authorities will have little previous experience. It's critical to have an attorney with experience contracting as well as contentious litigation experience, while focused in emerging markets. Understanding what went wrong in previous, similar projects helps ensure those lessons learned are brought to the next project.
- **Insurance Broker** – Insurance is often an afterthought, parked during contract negotiations, and settled directly by project insurers and a lender's insurance advisor, to meet the lender's minimum insurance requirements. However, the gap between contract caps, warranties, and exclusions, and the extent of insurance coverage is a very common cause of investor losses. Again, the risk profile of each project is unique. Insurance coverage and interfaces with contracting should be contemplated prior to start of contracting, to ensure this gap is resolved. Given the risks involved in emerging markets, additional insurance coverage could be a wise investment. For a relatively minor increase in premiums, LEG3 coverage warranties defects in design, material, and workmanship. Requiring contractor professional indemnity coverage is a contractor cost. Coupled together, investors are protected against direct and consequential losses associated with latent defects, which could be catastrophic to investors should these "hidden" quality issues emerge.

In conclusion, the growth of renewable energy projects in emerging markets continues apace. Successful investors that leverage the high risk/return period of market evolution are those who move early and employ advanced risk management methodology. The key to risk management in emerging markets is a risk team with emerging market experience: a project manager, attorney, and insurance broker who work seamlessly to identify, plan and manage project risk comprehensively.



Aaron Daniels is managing director at Modern Energy Management PTE, Ltd. With experience in the construction of over 2400MW and the development of over 1000MW of wind energy projects globally, his specialties include de-risking projects and improving project financial returns.

Modern Energy Management (MEM) | www.modernenergy.co.th

¹[http://www.ey.com/Publication/vwLUAssets/EY-RECAI-48-October-2016/\\$FILE/EY-RECAI-48-October-2016.pdf](http://www.ey.com/Publication/vwLUAssets/EY-RECAI-48-October-2016/$FILE/EY-RECAI-48-October-2016.pdf)

Net Metering in North America

Allowing energy storage to enter a new era

by Sandro Costa

The process whereby energy produced at one point in time is captured for use at a later time is known as energy storage. Energy storage technology converts energy from forms that are difficult to store, into more convenient or economical storable forms. Grid energy storage consists of a collection of methods used to store electrical energy on a large scale within an electrical power grid. Electrical energy is stored during times when production exceeds consumption, especially from intermittent power such as wind, tidal power, and solar. The stored energy is then distributed via the grid when production is less than consumption.



Why energy storage is important

1. Energy storage can balance the load by allowing future consumption so existing generating capacity is used more efficiently.
2. Power usages can be bridged to avoid a break in service during the seconds-to-minutes required to switch from one power generation source to another.
3. Storage works to control voltage and frequency, which helps avoid damaging sensitive equipment.

Although the concept of energy storage has been discussed for years, it has not always been technically or economically feasible. The falling costs of technology, innovative new business models, and government policies and regulatory reforms, are driving a dynamic and fast growing market for energy storage. Energy storage markets around the world are expected to continue growing substantially in North America, from \$40 billion in 2016, to \$50 billion by 2020, according to Lux Research. This represents a 25 percent increase annually over the next four years.

New technologies such as lithium-ion batteries, flow batteries, flywheels, and sodium-sulfur battery systems, offer improved operational flexibility, better charge/discharge cycle life, and, in some cases, longer duration or fast response capabilities. Lithium-ion batteries in particular, with more power and extended lives, are

becoming the dominant energy storage device.

Several jurisdictions in North America have modified energy regulations impacting energy storage. The California Public Utilities Commission (CPUC) approved a target requiring the state's three largest utilities to procure 1.3 gigawatts of energy storage by 2020. Two years ago, California changed its regulations to exempt small energy storage systems from interconnection fees and review. Over a dozen Mid-Atlantic States are enjoying reduced costs and improved service thanks to various energy storage systems. The U.S. Department of Energy, through its Grid-Scale Rampable Intermittent Dispatchable Storage (GRIDS) program, funds projects which develop innovative new energy storage technologies.

In Canada, the Ontario government recently proposed changes to its net metering regulations, to allow energy storage. Net metering is a billing arrangement by which companies and individuals who generate renewable energy on site for their own use, receive bill credits for any surplus electricity they output to the electricity grid. If the power supplier provides power that is greater than what is used from the grid over the billing period, the power supplier receives a credit that can help lower future energy bills. At the end of the billing period, the customer only pays for their net consumption. Net metering originated as a way to encourage consumers to invest in renewable energy sources such as solar or wind power.

Net metering regimes which allow energy storage, enable consumers who generate some or all of their own electricity, to use that electricity anytime instead of only when it is generated. This is particularly important for wind and solar power, which are non-dispatchable (cannot be distributed at the request of the grid owner or power plant). Net metering with storage allows consumers to defer their usage. For instance, solar power generated during the day could be used at night, or wind power generated one day could be used later in the month. Power usage can also be delayed to non-peak hours or even different months.

In Ontario, solar energy companies with solar storage products are applauding the proposed change in net metering regulations that allows storage. Dramatic declines in the price of solar photovoltaic (PV) energy systems have made it a very cost-competitive source of electricity. The addition of energy storage to a solar PV installation increases the usefulness and flexibility of solar, and allows the storage of excess solar electricity for use at night and on darker days.

Energy storage is an attractive option for those struggling with increasing energy bills, either from rising energy prices, or time-of-use programs like demand charges or dynamic pricing, that erode profits. Storage can also be a viable option for businesses that rely heavily on steady, high quality power, such as the semiconductor industry. Given the pressures of rising energy costs and the demand for more high quality power, as well as recent technological developments and energy regulatory changes, energy storage appears to be on the verge of a major breakthrough.

Sandro Costa is the vice president, energy efficiency sales at ONEnergy Inc., an energy management firm serving commercial, industrial, multi-residential, and residential clients. ONEnergy serves customers in both Canada and the United States, with offices in Toronto, Vancouver, and Stamford, CT.

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Flow batteries

A disruptive force in energy storage with the industrialization of a new chemistry

by François Huber



CAN RENEWABLE ENERGY REPLACE FOSSIL FUEL OR NUCLEAR POWER PLANTS?

Even if it doesn't happen overnight, the future of energy will not be limited to just our good old power plants. And it's not because we've suddenly decided to tackle global warming. Many studies illustrate what's happening all over the world: renewable energy is successfully competing with fossil fuels and nuclear energy, irrespective of public incentives.

This is why stationary energy storage has drawn so much interest in the last few years. If wind can be stored at night or solar energy during the day, to be redistributed when it is needed, it will allow an incremental rise in production, removing the last roadblock to a fully green energy mix.

This also explains why flow batteries have recently attracted hundreds of millions of dollars in investment worldwide. Storing renewable energy, or related grid management services, require a power range of dozens of kW to several MW, several hours of charge or discharge, and industrial features such as reliability, easy maintenance and durability. Why are flow batteries so good at doing this?

A conventional battery is a box containing electrodes, and liquids called electrolytes. In the process of charging and discharging the battery, the electrode typically dissolves in the electrolyte and is regenerated in the second part of the cycle. The amount of power a battery can store is proportional to the amount of electrolyte in the battery.

Flow batteries are different in two respects. First, the electrolytes are located in tanks outside the battery, and pumped into it for charging and discharging. Flow batteries store outside the box. And second (for genuine flow batteries as opposed to hybrid systems), there is no electrochemical reaction between the electrodes and the electrolytes. Only the molecules in the electrolytes are oxidized and reduced during the cycles; the electrodes serve as electron-carriers.

Two major consequences result. One is that the amount of energy stored in the battery is proportional to the quantity of electrolytes in the tanks, not the size of the battery. For example, in order to store the energy produced by a solar farm, doubling the capacity with conventional batteries (such as lead-acid or lithium-ion) will require double the batteries. Flow batteries only require pouring more electrolytes in the tanks. The other consequence is an increase in battery life. The dissolving and regeneration of the electrodes in ordinary batteries usually leads to a degradation of the performance, and ultimately the demise of the device. The liquid phase reaction in flow batteries is more reversible.

Flow batteries have been developed for several decades, but are still produced in small numbers. What is limiting their expansion?

The energy storage market can take some of the blame. Until recently, it was possible to manage renewable energy without storage, or with short-duration batteries. Flow batteries are unsuitable for other applications such as electronics or electric vehicles because of their low energy density.

The history and evolution of flow batteries has also affected production. The first molecules used in the electrolytes were metals and halogens dissolved in very acidic electrolytes. Today, the dominant chemistry is vanadium (zinc-bromide is another). The resulting electrolytes are extremely corrosive, which can impact reliability, maintenance, safety, and the environment. Vanadium systems use the same electrolyte on both sides, while zinc-bromine systems are

more energy-dense hybrids. Both of these smart chemistries, however, are handicapped by the difficulties of chemical engineering, i.e. their implementation in industrial systems.

Various chemistries (with solvents other than water) have been studied in order to prevent these problems and increase performance, but they have not yet reached high Technology Readiness Levels (TRLs).

The technical limitations of the flow batteries have, so far, not completely convinced end-users.

The recent advent of organic flow batteries, on the other hand, can be the game-changer the market needs. Based on organic molecules in aqueous alkaline solutions, this second generation of flow batteries holds the keys to several groundbreaking advances:

- The electrolytes are non-corrosive, eliminating leakages and the need for part replacement;
- The molecules are biodegradable, and potentially reusable or recyclable; solving toxicity, environmental, or life-cycle issues;
- The electrolytes can use off-the-shelf molecules synthesized for other purposes, and at low, non-volatile costs.

Moreover, this new chemistry can apply to entire families of molecules, not just a single element like vanadium or bromide. Future breakthroughs are possible with new molecules, new production processes, or new formulations of the electrolytes.

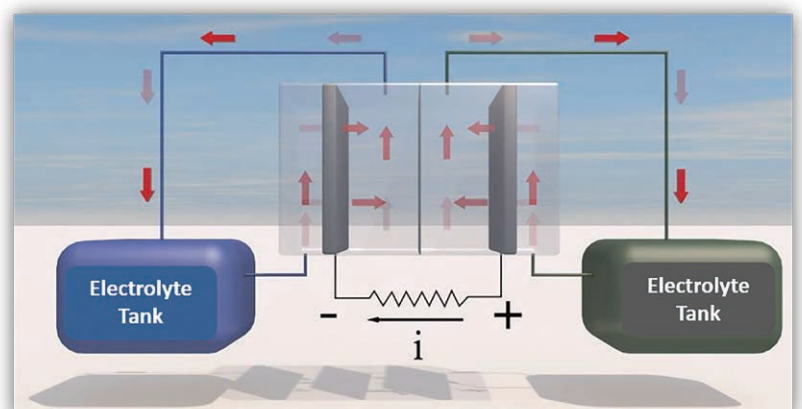
Industrial scale-up could be surprisingly fast. The process is a combination of well-known technologies, so building a gigafactory is not necessary, and risks are limited. Compared to a lithium-ion battery, flow battery cells are constantly cooled by the flow of water-based electrolytes and cannot burn, and the Battery Management System (BMS) is quite simple.

As the need for long-duration systems increases, either for grid services in advanced economies or off-grid applications such as rural electrification, these new flow batteries may be the key to helping us keep the promises of green energy.



François Huber is chief executive officer and co-founder of Kemwatt Energy. With over 20 years of experience in renewable energy, electrical equipment, and industrial systems, he established Kemwatt in 2014. Based in Rennes (France), Kemwatt designs and develops organic Redox Flow Batteries using only organic electrolytes. With over €2 million from initial seed funds along with numerous awards, Kemwatt aims to bring their technology worldwide to support all smart and micro grids.

Kemwatt Energy | www.kemwatt.com



When the Energy Storage Market Hits a Tipping Point

by John Gurski and Adam Gerza

IT'S INEVITABLE THAT ENERGY STORAGE WILL BE A HUGE MARKET

opportunity in the future. Knowing the numerous benefits storage can deliver, it's easy to envision how batteries will ultimately transform the grid as we know it today. But the market has not yet come to fruition, and it's fair to say most predictions have been overly optimistic as to when it will really take off. Arguably, a few things must happen for the storage market to scale up, and how to know when we've truly hit the tipping-point.

The energy storage market today

Today's energy storage market is still in its youth: the customer-side-of-the-meter segment is in the early innovator stage. To date, just a tiny, insignificant number of customers have made the decision to install storage. The economics of customer-sited storage generally do not make sense, so, for the vast majority of customers, the payback period and rate of return don't justify the investment.

There is, however, a small subset of customer-sited storage projects that are financially viable. The one "pure-play" value stream opportunity (i.e. does not rely on any revenue from grid services) that can make economic sense is peak-demand shaving. For some commercial and industrial (C&I) customers, demand charges can comprise up to 50 percent of their total electric bill. This offers a real business case for meaningful dollar savings, as storage systems can be configured to reduce a customer's peak power demand. But this application is only viable when a very specific set of circumstances is present: a C&I customer with a spikey, short-cycle load profile, on a rate schedule with high demand charges.

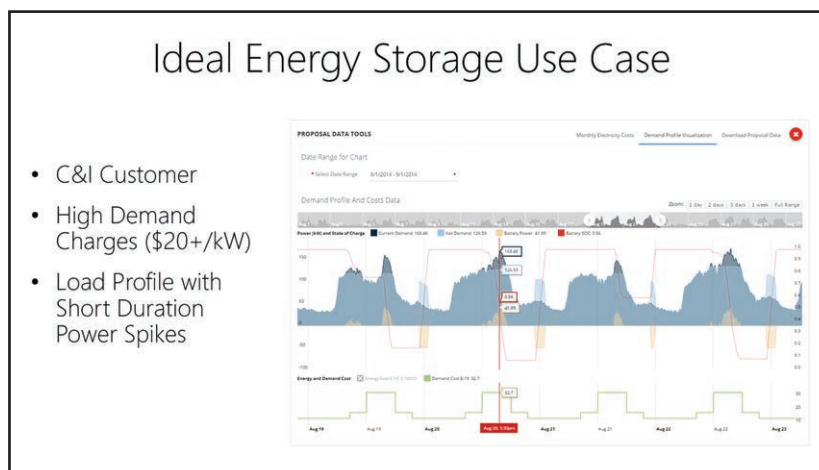


Figure 1

Limited opportunities have constricted the market. Only a handful of companies are currently developing and installing customer-sited storage projects. A full-time energy storage developer requires a high-level of sophistication and determination. Getting a project to the finish line means overcoming numerous hurdles, such as explaining the technology and policy risks involved. Sales cycles are long, and the sales process is not easily repeatable. Many energy storage system manufacturers/vendors also have to perform the downstream integration function. Well-established vendors are doing project development in-house. A few C&I solar developers have launched energy storage divisions within their companies, but they are the minority.

How the market will scale-up

Demand for customer-sited energy storage will be driven by economics. Customers will buy when it makes financial sense. A few key factors will facilitate the business case. On the cost side, battery prices are expected to decline as manufacturing capacity expands and becomes more efficient. Install costs will also decrease as integrators develop more efficient and repeatable processes. The value side of the equation is improving as well; changes to utility rate design and net metering frameworks are allowing storage projects to realize more dollar savings. Factors like higher demand charges, time-of-use schedules with wide price differentials, and NEM 2.0 frameworks that create strong incentive to not export energy, are all opportunities for storage. Enticements like the self-generation incentive program (SGIP) renewal in California, and other state and federal programs, will assist projects in penciling out financially.

As the business case for customer-sited storage improves, projects in more regional markets, and for different customer classes (e.g. C&I, residential, agricultural), will become practical. As installations incrementally ramp up, battery technology will become more widely understood. Increasingly, bankable projects and third party financing companies are entering the space. All of these factors will help shorten the sales cycle, and allow the downstream market to develop more repeatable processes for developing, financing, and installing projects. This is a virtuous cycle.

When will the market scale-up?

When the economics of energy storage become truly viable, many new entrants will enter the downstream market segment. This will be the true signal that the market has officially hit a tipping point. Similar to the rooftop solar market, the downstream channel will evolve into more of a long tail distribution curve, where there are a handful of large national players, many large regionals, and lots of small mom-and-pops. When those small mom-and-pop solar installers can consistently sell storage projects, the market will have arrived. Indeed, solar installers are particularly well positioned to be the downstream channel of the future; they have an existing installed customer base to upsell to, have learned a lot of lessons on customer acquisition, often times have a brand name in their local market, and prudent integrators have a strong understanding of the policy, rate design, and NEM dynamics within their local utility territory.

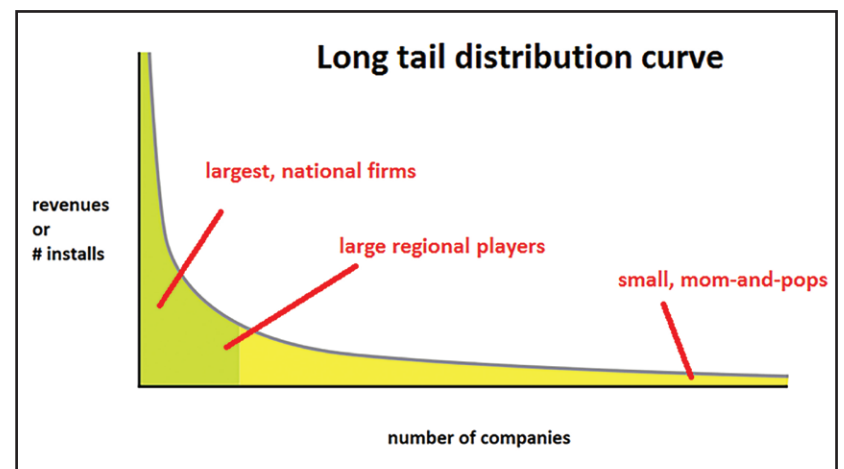


Figure 2

John Gurski is the founder and CEO of Energy Toolbase. Adam Gerza is the COO.

Energy Toolbase | www.energytoolbase.com



Methanol fuel cell

Sirius Integrator offers a new fully integrated Horizon Mini 100 (100w) Reformed Methanol fuel cell battery-charging generator. The Mini 100 keeps mission and data critical application devices running unattended for long periods of time in remote locations, and in the harshest outdoor weather. This off-grid, grid, and solar backup power system provides up to 2400w (2.4kwhs) per day to 12v or 24v battery systems. Packages include the Horizon Mini 100, 100w fuel cell system, an empty 10 liter or 25 liter fuel cartridge, a fuel sensor, cabling, a laptop adaptor, a normal or very cold outdoor enclosure, and a 2-year or 2000-hour warranty. Optional add-ons include a multi-fuel cartridge setup for extended run-times or a standard drum connection, GPRS comms module and remote management website, and a DC to DC converter to charge 24v battery systems. The very cold enclosure includes a motorized vent and heater, controller and temperature sensor, 1.5" of installed insulation, and thermal warming of incoming air.

Sirius Integrator | www.horizon-fuelcell.com



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EnerSys | www.enersys.com



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- 07-11 **LIGHTFAIR International 2017**
Pennsylvania Convention Center – Pennsylvania, PA; www.lightfair.com
- 22-24 **2017 Midwest Solar Expo and Smart Energy Symposium**
Renaissance Minneapolis Hotel, The Depot – Minneapolis, MN; www.midwestsolarexpo.com
- 22-25 **AWEA Windpower 2017 Conference & Exhibition**
Anaheim Convention Center – Anaheim, CA; www.awea.org

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- 11-13 **Intersolar North America**
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Multi-Contact's connection solutions are now being developed and offered under the name of Stäubli Electrical Connectors. Stäubli is an international technology Group for leading mechatronic solutions.

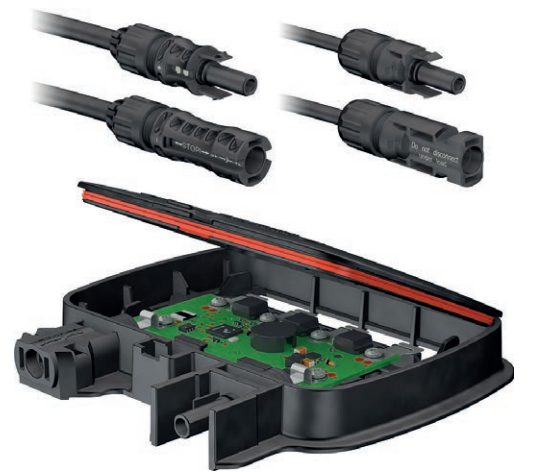
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