

North American **CleanEnergy**

2019 SOLAR BUYERS GUIDE

Pg. 33

Using Infrared Drone Technology to Test Wind Turbines

Pg. 8

When the Sky is Falling

The hazard of dropping
objects in offshore wind Pg. 12

Who's Going Green?

Maybe not who you think Pg. 80

Plus Show-in-Print Features:

- AWEA Wind Project O&M and Safety Conference 2019 Pg. 32
- Solar Power Northeast Pg. 74





RAID[®]
TORQUE SYSTEMS



ADVANCED BOLTING TECHNOLOGY

Light - Unsurpassed power-to-weight ratio

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

Fast - Decreased tightening times by up to 300%

Quiet - Operates at 75 db reducing noise level

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

WIND INDUSTRY'S
#1
TORQUE TOOL

WWW.RADTORQUE.COM

1.800.983.0044

E-RAD BLU

Panasonic

HIT[®]+
Photovoltaic Module



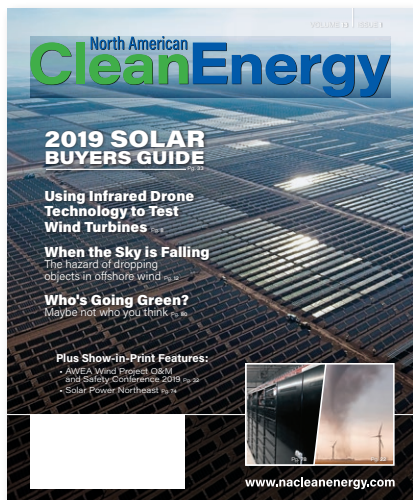
Rewriting the laws of energy efficiency

When PV efficiency gets better, home solar buyers win. Introducing the all-new HIT[®]+ premium series.

HIT[®]+ modules boost panel efficiency to over 20%, putting it among the elite few to achieve this advanced level. But HIT[®]+ goes further. With degradation rates and temperature coefficients among the world's lowest, HIT[®]+ provides what we believe are the most efficient solar panels available today. Install them and generate more electricity year after year.

Visit us at Solar Power Northeast, Booth # 211

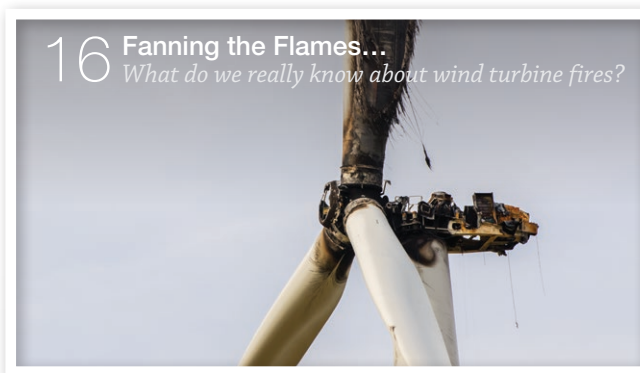
Let's take your business to
profitable new levels together.



On our cover...

Solar Frontier Americas (SFA) continues to develop its pipeline of over 1GW of utility-scale solar power generation plants. The SFA completed solar project pictured is located in Southern California.

Solar Frontier Americas
www.solar-frontier.com



29 Wind product spotlight:
Lighting



59 2019 Solar Buyers Guide
Kinetic Solar



81 Energy efficiency product
Sealevel Systems

departments

- 6 News bites
- 8 Top story
- 10 Wind power
- 29 Wind product spotlight: Lighting and Training
- 30 Wind product spotlight: Safety & Fall Protection
- 32 Show-in-print: AWEA Wind Project O&M and Safety Conference 2019
- 33 2019 Solar Buyers Guide
- 74 Show-in-print: Solar Power Northeast
- 76 Energy storage
- 80 Energy efficiency
- 82 Events calendar & advertiser's list

- | | | |
|--|--|--|
| <ul style="list-style-type: none"> 8 Using Infrared Drone Technology to Test Wind Turbines 10 Data Engineering for Wind Power Optimization
<i>The promises and challenges</i> 12 When the Sky is Falling
<i>The hazard of dropping objects in offshore wind</i> 14 Using AI to Pinpoint the New "Normal" in Wind Turbine Performance 16 Fanning the Flames
<i>What do we really know about wind turbine fires?</i> 18 What's in a Guarantee? | <ul style="list-style-type: none"> 20 A New Dawn for Vertical Axis Wind Turbines 22 Making to Latest Advancements in Weather Work for You 24 Emergency Pitch Control
<i>How ultra capacitors improve efficiency and reduce O&M costs</i> 29 Wind product spotlight: Lighting and Training 30 Wind product spotlight: Safety & Fall Protection 32 Show-in-print: AWEA Wind Project O&M and Safety Conference 2019 | <ul style="list-style-type: none"> 33 2019 Solar Buyers Guide 74 Show-in-print: Solar Power Northeast 76 Warranties and Performance Guarantees in the Stationary Energy Storage Market
<i>How are they validated?</i> 78 Utility-Scale Storage Across the Grid 80 Who's Going Green?
<i>Maybe not who you think</i> |
|--|--|--|

JANUARY•FEBRUARY 2019
Volume 13, Issue 1

PUBLISHER

Ian Stuart
istuart@nacleanenergy.com

ASSOCIATE PUBLISHER

Quinn Stuart
quinn@nacleanenergy.com

EDITORS

Jill Walters
editor@nacleanenergy.com

Meg Lugaric
meg@nacleanenergy.com

ART DIRECTOR

Chris Van Boeyen
production@nacleanenergy.com

SALES

Ian Stuart
istuart@nacleanenergy.com

Quinn Stuart
quinn@nacleanenergy.com

Don McIntosh
dmcintosh@nacleanenergy.com

CIRCULATION MANAGER

James Vail
circulation@nacleanenergy.com

ACCOUNTING

Alison Bell
abell@nacleanenergy.com

255 NEWPORT DRIVE, SUITE 336
Port Moody, B.C. V3H 5H1
Phone: (604) 461-6223

North American Clean Energy (USPS 1370) is publishing bi-monthly and distributed free by Action Media Ltd. Periodicals postage paid at Henry, IL. POSTMASTER: Send address changes to North American Clean Energy at 515 University Ave. Suite 1, Henry, IL 61537. Subscription updates can be made at circulation@nacleanenergy.com.

North American Clean Energy accepts no responsibility or liability for reported claims made by manufacturers and/or distributors of products of services; the views and opinions expressed are those of the authors and not necessarily those of North American Clean Energy. No portion of this publication may be reproduced without the permission of the publishers.

Editorial, Advertising, Production and Circulation are at 255 Newport Drive, Suite 336, Port Moody, B.C. V3H 5H1 (604) 461-6223. Subscriptions: \$48 per year outside North America. Email: circulation@nacleanenergy.com

SIGN UP FOR YOUR FREE SUBSCRIPTION

Visit our website for new subscriptions, renewals, or change of address.

NACLEANENERGY.COM

Information will remain strictly confidential.



Printed on paper with 90% recycled fiber.

Designed to **Cover**. Made of **Steel**. Engineered for **Strength**.

Optimized for Solar



500 kW

Baja Carport Solar Support Systems™



Featured: **Full Cantilever T & Semi Cantilever**

Project: **Alpert Community Center, Long Beach, CA**

- In-House Designed & Engineered
- Pre-Fabricated Steel w/Bolted Connections
- Pre-Galvanized
- No Field Welding

**Ability to be Designed for Live/Loads up to 60 psf and Wind Speeds up to 160 mph*



1772 Solar Panels | 105 Spaces | 7,075 sq ft



Nationwide Sales (800) 366-9600 | Mexico & Canada Direct [925] 229-0732 | BajaCarports.com

WHENEVER A NEW YEAR ROLLS AROUND, I FIND MYSELF

picking apart the previous year in an attempt to learn how to be happier, more successful, and more efficient. I could argue that happiness is its own form of success, but efficiency? My dishwasher is efficient, and my clothes washer and air conditioner are both efficient; that's not exactly the word I would use to describe myself - or any person, for that matter. I'm not referring to the efficiency of the human body, but of human behavior. Ever see those hoarding shows where someone has to be dug out of growing mountains of junk? One episode in particular stunned me with the revelation that the "victim" worked for other people as a personal organizer. As I basked in the guilty pleasure of realizing I'm more together than I thought I was, it occurred to me that, on some level, this person also saw herself as productive and efficient (if only for other people). Later on, I read a social media post by a friend of mine; she raises animals and grows her own food, home schools her kids, and is in fantastic shape - I felt grossly inadequate.

It's human nature to compare. When it comes to efficiency, however, we tend to look for an absolute value against which to measure the progress of our industry. Companies differ in many ways (by physical location, customer focus, and company values), but all strive to run at peak efficiency. Companies also happen to be run by humans, who are prone to the same distractions and weaknesses that prevent each of us from reaching our full potential. In light of this, it would appear that efficiency is relative. Even under ideal conditions, we can't ignore the human factor. Countless studies devote themselves to discovering the path to greater efficiency, both for people and their surroundings. Scott Kelly, as part of his PhD research at the Cambridge Centre for Climate Change Mitigation Research, found that efficiency is linked to both the building and the occupant. He cites studies demonstrating that "human behaviour is at least as important as the physical characteristics of a building in influencing energy use."¹

It's easy to understand the concept of efficiency. Putting it into practice is a lot harder. Smart technology can't replace individual responsibility: incorporating clean energy habits on an individual level is key. I wonder, how efficient can we make our world before human nature kicks in?

I remember seeing an old episode of *The Simpsons*, in which Homer is hired to motivate workers at a nuclear plant, forcing his family to relocate. Their new house is so efficient that no matter what household chore Marge attempts, the house does all the work for her. With nothing left to do, she ends up drinking wine all day. Here's hoping I'll have the same problem one day.

Cheers to a (relatively) efficient 2019.



Meg

¹<https://www.cam.ac.uk/research/discussion/energy-efficiency-and-human-behaviour>



Chicago Bulls player calls for action in the wake of IPCC's new climate report

Following the release of the IPCC report, organizations and individuals have shared pressing messages on the individual's role in climate change. Chicago Bulls player and environment enthusiast, Lauri Markkanen, is taking a fresh approach to the matter. A collaboration between Markkanen and the Finnish renewables company Neste will have Markkanen shooting hoops with this year's world heat map. The surface of this basketball is covered with a hand-painted visualization of the world's record-high temperatures from last summer. Pictures of the blazing planet went viral in the summer, as heat waves broke records around the world. 2018 is projected to become one of the hottest years on record. With temperatures soaring, this project is an urgent call to action. The collaboration is part of Markkanen's #DontChoke campaign with Neste, which is a call to action for individuals to do their share in battling climate change. To effectively protect the climate, each action, no matter how small, is important.

Neste Corporation

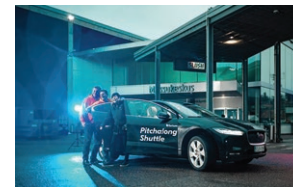
/// www.neste.com/journeytozero/laurimarkkanen



Gluttony turns into a source of power in Las Vegas

The Green Machine is an environmental initiative to increase renewable energy in Las Vegas by converting organic waste into power and water. This solution uses the current hundreds of tons of daily food waste (that is now dumped into Nevada landfills,) and instead, diverts it to an Anaerobic Digester System (ADS.) The ADS converts the organic waste into clean power and water and it even utilizes all the by-product so there is no waste. The anaerobic digester energy project will utilize the NV Green Energy Program to deliver renewable energy to consumers. This project will generate energy and reduce the need for more landfill space, as well as a host of other environmental benefits. Like other renewable energy sources, this project will begin with a higher kilowatt-hour-cost than that of the existing dirty energy. However, the Anaerobic Digester's kilowatt-hour-cost is expected to decrease quickly, because it is not subject to weather like other renewable energy sources. This extra cost would either be covered by the community, charitable donors who believe in the project, and/or the casinos that see value in helping the community become energy independent. This project will also involve building large commercial vertical farms which would offset the energy cost through food sales. This project will bring Las Vegas healthier food, reduced transportation costs, and big savings to the people in the community.

Regener8tive /// www.regener8tive.com



Perhaps the most profitable ride of your life

Fortum Pitchalong Shuttle is a new EV-taxi where sustainable and innovative startups pitch their ideas directly to Fortum's executives. A moving electric vehicle is an emission-free, private, and silent meeting space. Fortum is looking for world-changing ideas that can help tackle climate change. The most successful startups have a chance to kick-start a beneficial partnership. The majority of Fortum's energy production is CO2-free. They develop solar energy solutions and also provide plastic recycling and waste management. Now the clean energy company is looking for startups to join the change for a cleaner world. To boost the growth of potential startups, Fortum has become the major investor in Valo Ventures, an independent venture capital fund led by Scott Tierney, a former Google Capital co-founder. Valo Ventures focuses especially on finding solutions to problems related to megatrends such as urbanization, climate change, and circular economy. The new fund was launched at Slush. Fortum also partnered with Slush in order to make the event as sustainable as possible.

Fortum /// www.goitap.com



Renewable and biodegradable straws

Stora Enso and Sulapac continue to combat the global problem of plastic waste by designing a replacement for traditional plastic straws with renewable ones. The straws are based on Sulapac's biocomposite material, made of wood and natural binders, designed to be recycled via industrial composting and biodegrade in marine environments. The development of the demo straw is a joint collaboration between Stora Enso and Sulapac, a cooperation which complements Stora Enso's extensive biocomposite portfolio. Sulapac's material works in existing extrusion lines and the target is to have the straws commercially available in Q2 2019.

Stora Enso /// www.storaenso.com
Sulapac /// www.sulapac.com

Regarding the Editor's Note from November/December 2018

"I have a Nissan Leaf to serve my driving needs in retirement, which aren't much, so I'm able to recharge at home with the 120V charger (slow) that was provided with the car. But my local Walmart has a public charging station and once while there I checked it out. I was mostly mystified by it - how do I start it, do I need an online account of some sort, etc., etc. And I'm a retired electrical engineer! I'm pretty sure the plug device would have been compatible with my car, but the station's operation didn't look intuitive at all. Why couldn't it be like a self-service gas pump? Swipe your credit card, plug in and wait for the fill up. Technology should make things easier, right?"

- Mike Curran

"Rather than give readers one more reason to think twice about getting on the EV bandwagon, you should instead educate yourself about how easy it is to make the transition to an EV and how really simple most EV charging stations are to operate. They don't all work the same way, but they are no more diverse than gas pumps in terms of how you activate them. Once they are active, the steps are no more complicated than plugging the connector into your charging port... Talk to new EV owners and you'll see what I mean. Most of us charge at home and it is really not that hard once you've done it a few times. Please, there are enough challenges in getting people to see how much greater life can be with an EV. Don't provide more excuses for folks who are on the sidelines to delay getting an EV."

- Marc Fontana

"As a marketing professor who studies the diffusion of EVs, I too have noted that charging is perhaps THE key to the success of EVs appealing to mainstream drivers in the marketplace. One of the biggest issues I see is that 46 percent of America's population live in apartments and multi-housing dwellings, many of which do not allow for convenient overnight charging for EV owners. Consequently, EV owners must rely on charging infrastructure provided by Tesla, ChargePoint, EVgo, etc. I've encountered many would-be EV buyers, but because they can't get charging at home set up, they've opted not to buy."

- Edwin Stafford



One giant leap for visibility

The Kennedy Space Center's visitor complex inspires millions of visitors with technology and human achievement. Five Spotlight Solar structures have found their home at this important place. 1958 marked the first flight of photovoltaic solar cells in space, with the Vanguard 1 satellite (which remains in orbit). Space flight was one of the first practical applications of solar electricity, and the US space program has been key to advancing PV technology. Now solar has a visible presence at Kennedy, educating visitors and endorsing renewable energy. Credit goes to the Kennedy Space Center's leaders for their vision and partnership, and to Florida Power & Light's 45,000 voluntary SolarNow participants, who contributed funds to bring solar into public, interactive places.

Spotlight Solar /// www.spotlightsolar.com



UltraFLEX™

Bringing the Power to you

No other solution delivers the ultra-reliability and ultra-sustainability of the UltraFlex system and brings you the power to dramatically reduce diesel consumption, CO₂ footprint, and maintenance costs.

- Reliable and robust for the toughest off-grid locations and renewable applications
- Scalable and versatile for single and three phase operations
- Adaptable for existing or new solar arrays
- Recyclable product with a positive end-of-life value



MK Battery and Ecoult are East Penn Manufacturing Co. Subsidiaries
www.mkbattery.com | 800-372-9253



Using Infrared Drone Technology to Test Wind Turbines

by Tim Leggett "The Drone Guy"

DRONES - EQUIPPED

with high-resolution digital and infrared cameras, and connected to GPS satellites by real-time kinometric (RTK) positioning - are revolutionizing how wind farms are inspected and maintained.

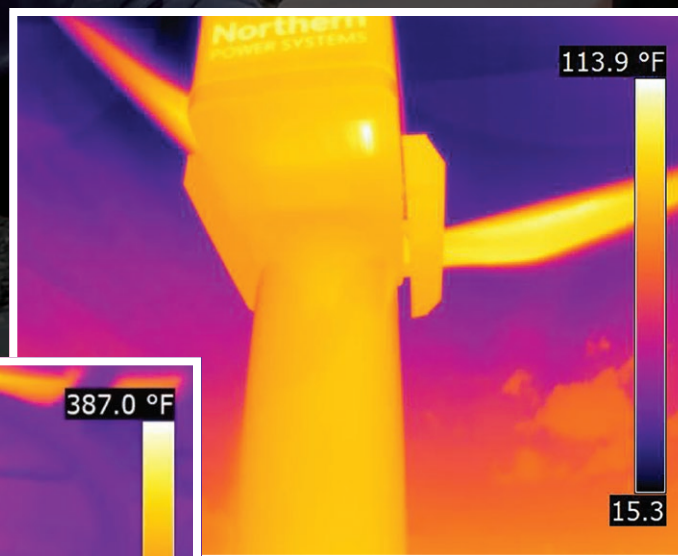
Today, a drone can inspect multiple turbines in the time it used to take to climb one. Thermographic inspections that used to require two to three technicians and several days, can now be completed with one drone and one technician in just a few hours. No longer is it necessary to subject inspectors to safety risks as they climb to extreme heights, using only harnesses and ropes.

According to the U.S. Department of Energy, 6.3 percent of the nation's electricity supply was contributed by wind energy generated by more than 80,000 turbines. All of these turbines require regular inspections, so that structural problems can be discovered before they become more extensive, and significantly impact energy performance.

Infrared/thermal testing refers to a non-destructive inspection process that uses thermography or infrared cameras. The testing can be performed in a variety of situations to detect problems before they become larger issues. As a testing technique, it is accurate, repeatable, and economical.

To perform a thermographic inspection of a wind turbine, the technician connects the drone to the RTK, a satellite navigation technology used to enhance the precision of position data, derived from satellite-based positioning systems such as GPS. RTK uses measurements of the phase of the signal's carrier wave, as well as the signal's information content; it relies on a single reference station to provide real-time corrections, providing up to centimeter-level accuracy. The technique enables the drone to fly more accurately, and stay stationary when hovering and taking images, resulting in more accurate data (and fewer run-ins with the turbine).

Equipped with high-resolution digital and infrared cameras, the drone is first flown up the length of the shaft to detect any structural damage.



Then it inspects the blades for anomalies. If the technician sees any damage from birds, flying debris, severe weather events, or any manufacturing defects that may or may not have been anticipated from prolonged use of the wind turbines, a technician can fly the drone closer to capture more detailed images.

Thermal and high-resolution imagery/data help the thermographer identify, classify, and localize each anomaly in a clear and consistent manner, to understand the impact of its performance on the system. Experts analyze the data, then share it with the end user, who walks away with a



Tim Leggett is a Level 1 thermographer and a certified FAA Part 107 UAS Remote Pilot with Infrared Testing, Inc. He has a B.S. in environmental and resource economics from the University of New Hampshire. Leggett has completed over 50 drone inspections this past year.

Infrared Testing, Inc. /// www.infraredtesting.com

complete picture of the site and specific repairs that system needs.

Drones can also test for defective cells and strings of cells in solar panels; mold, moisture and physical damage to a roof membrane; and structural defects such as gaps in insulation, air leaks in windows and openings, and sealing issues in a building envelope. If left unchecked, these anomalies can result in costly repairs and energy loss.

A plant or facility manager may want to schedule an annual thermographic drone inspection of its wind farm depending on the company's location and exposure to extreme weather such as freezing, hail, lightning, storms, heavy winds, and prolonged rain. Additional inspections may be necessary after a severe weather event that may cause damage and put extreme stress on turbines. Once the blades are damaged, corrosion and oxidization can continue to build and impact energy performance, resulting in costly repairs and system downtime.

Companies also should consider planning an initial infrared inspection of wind turbines during the commissioning process, to serve as a baseline to ensure against workmanship/manufacturing errors before warranty terms expire.

Last but not least, it is important to use professionals who have been trained in the use of commercial drones and thermographic testing. A drone hobbyist or a company that installs and maintains turbines will most likely not be able to gather the most accurate data, or understand its impact on a system.


As more industrial companies become environmentally conscious and begin supplementing their electrical power with renewable energies, and as drones become more affordable and easier to use, there will be increased demand for infrared drone testing of wind turbines. Regular inspections are crucial to the effective maintenance of the turbines in order to maximize power generation, extend the life of the system, and result in a higher return on investment. Custom drones, flown by certified experts, pinpoint issues before problems escalate, saving companies energy and money.



PTN 320

#1

IN WIND GEARBOX OIL RELIABILITY & PERFORMANCE



Devoted to Protection®

FOLLOW THE LEADER AT AMSOILWIND.COM | OR BY CONTACTING US AT WINDSALESGROUP@AMSOIL.COM

Stick with a proven product and take out the guessing game.

Used by more OEM's and Owner/Operators in North America, and around the world.

With 10 years of proven results and an industry-leading warranty, make AMSOIL the first and last choice when it comes to your lubrication solutions.

NO ADDITIONAL TOP TREATS NEEDED

Data Engineering for Wind Power Optimization

The promise and challenges

by Gareth Brown

Artificial Intelligence. Deep Learning. Neural Networks. Machine Learning. Blockchain. Big data. We are surrounded by these technology buzz words and their promise of software panaceas. The unspoken assumption is to collect a lot of data, apply these new data tools, and watch value magically appear. Many industrial businesses spend millions of dollars implementing broad-based data collection, in the blind hope of a data solution.

Unfortunately, these new data tools are limited. Much like a hammer, drill, or screwdriver, only when the tool is applied by specialists will its true value be unlocked.

Without a clear vision of the value they hope to extract, many firms are unwittingly engaging in poor data engineering. This severely limits the value available to them from these new tools. Ultimately, where and when the latest data science should be used will be driven by the value proposition.

The wind industry faces at least six distinct data engineering challenges that must be addressed by any wind farm owner (or performance analyst) looking to take advantage of the latest and greatest data science techniques.

The precise inflow conditions are not known.

Uniquely among turbine power generation, wind turbine generators face an unknown input resource. For hydro or steam turbine generators (whether nuclear, molten-salt, gas, or coal) the enclosed intake enables inflow conditions to be controlled and well understood. From this, operators and analysts can generate clean performance signals to assess any turbine specific challenges.

In fact, when it comes to assessing the turbine aspect of performance, nuclear power is a lot simpler than assessing hundreds of wind turbines across a hillside. Each turbine with limited instrumentation, different, unknown, and constantly varying inflow conditions, can have diverse input resource.

Wind inflow conditions - driven by wakes, forestry, terrain, and atmospheric stability - can create performance variation higher than 30 percent within each wind speed bin below rated power: trying to detect an underperformance issue of 1 to 2 percent becomes a herculean task, especially if you don't get your data model correct (regardless of the algorithm or machine intelligence applied).

The assumptions used in wind turbine design and data collection have not kept pace with advancements in turbine engineering or software engineering.

Turbines with larger blades, farms with more turbines, and farms built in more varied global locations, challenge longstanding industry assumptions. SCADA and other software systems are often generations behind those of the analysis tools, even if the turbine has the latest manufacturer software upgrades.

This has led to problems both in terms of mechanical failures, and owner-operators' available strategies for data collection. These severely limit the effectiveness of any modern data science techniques, without significant and conscious up-front data engineering effort.

Data collection structures reflect an industry obsession with availability as the only important metric.

The wind industry's data collection structures have been built around answering the question, why has the wind turbine stopped spinning (availability)?



A better question would be, is the turbine producing enough energy (performance)? Many wind turbines suffer chronic or acute technical performance issues that do not cause shutdowns. SCADA and data collection systems are not built to capture, communicate, and manage these issues effectively.

Turbine suppliers and wind farm service providers (operators) have conflicting interests, which combine to harm wind farm owners.

The wind industry is plagued by poorly structured service agreements that do not align incentives to maximize farm output. Even the incentives for internal self-perform teams are awry; they don't create a culture and contractual environment that aligns the project team (owner, asset manager and operator) to maximize energy output over the life of the wind farm.

At the same time, not enough suppliers engage with wind farm owners to address potential performance issues in a lean, dynamic, and transparent way. Many prefer to maintain their expert position relative to their customer base.

Therefore, the only people with large amounts of cross-sectional turbine operating data (the suppliers) do not share or learn from their customers. While those at the front line (the operators) are working with smaller datasets, and poorly structured data collection systems.

The result is systemic underperformance across the wind industry.

Overly-optimistic, pre-construction energy yield estimates have left wind farm owners with limited resources to investigate and address performance issues.

Wind farms are not massively lucrative operations. On the revenue side, projects often do not achieve their pre-construction energy yield forecasts. On the cost side, as developers seek to minimize capex to get through financing, owners end up paying for it on the opex.

Current projects are financed on merchant markets with sub two cents per kwh hedges.

Any big data strategy looking to have an industrywide impact must come in with a clear and definable value proposition that can increase annual energy production quickly.

Knowledge sharing between turbine suppliers, industry consultants, and asset operators is very limited.

In the next five years, we are on target to pass one terawatt of wind energy installed globally. Who will hold the right 'big labelled data' to give future artificial intelligence tools the best chance of

bringing meaningful performance increases?

Turbine suppliers have the scale, but their closed box business model prevents them from effectively implementing an agile improvement model that would see that big data labeled effectively.

The largest operators might be active on over 20 gigawatts of assets – a mere 2 percent of the market, given the inherently local, and hence fragmented industry structure. Will they have the tools to effectively capture, label, and analyze the big data from those assets?



Gareth has over a decade of experience leading identification, development, construction, financing, and operation of renewable energy assets for a renewable energy technical consultancy. He is an entrepreneur, chartered engineer with the IMechE, and has degrees in mathematics and mechanical engineering. Currently, he serves as the CEO for the Renewable Energy Software Startup, Clir Renewables.

Clir Renewables /// clir.eco

FROM PROTECTING YOUR ASSETS TO POWERING OUR CITIES

TOGETHER IT'S POSSIBLE

Innovative lubrication that enhances performance.
Wind turbines are a vital part of the electricity network, the world's largest and most complex machine. Often operating in extreme environments, the effective lubrication of gearboxes and bearings are vital for wind turbines to deliver optimum performance. As well as offering a range of lubricants and greases, our experts are ready to share the knowledge and practices that will help ensure maximum performance, no matter what the conditions. To find out how we can help you power tomorrow, go to shell.us/power

SHELL LUBRICANTS
TOGETHER ANYTHING IS POSSIBLE

© SOPUS Products 2018. All rights reserved. CS13771-01

When the Sky is Falling

The hazard of dropping objects in offshore wind

by Mike Rice

THE U.S. OFFSHORE WIND INDUSTRY

is spreading its wings.

Established businesses, predicting higher revenues for 2019, are taking advantage of the opportunities for offshore to scale up. Offshore wind continues to be a vital and thriving industry, both globally and for the U.S. However, with this positive growth comes new safety risks, and a need for companies to take responsibility from day one.

U.S. companies engaging in offshore wind have the chance to set a benchmark for safety by rising to the challenge of preventing dropped object incidents. Avoiding serious injury to engineers, or potential loss of life, is vital. Rapid adoption of best practices, gleaned from offshore oil and gas, can help prevent costly damage to corporate reputation and finances. By learning from the decades of experience of established offshore operations, companies can set themselves apart, gaining a commercial advantage in an industry with a growing focus on improving standards.

European offshore wind experience has highlighted the scale of the threat to personnel and equipment due to dropped objects. Dropped and falling objects in offshore wind include materials carried by engineers, components lifted or carried from vessels, or smaller items fitted to the wind turbine generator (such as nuts and bolts, lights, ventilation louvres, or hatches).

These objects can fall from height, with incidents occurring either on the wind turbines themselves, or on support vessels being used for turbine installation or maintenance tasks. Dropped object incidents can occur throughout the installation, maintenance, or decommissioning processes – at the foundations, nacelle or blades, in the tower, or on installation and service vessels. There is also potential for incidents during normal operations. For example, if a hidden

part of the machinery suffers severe corrosion over time, that deterioration would cause it to fall from the installation.

Dropped and falling objects, whether due to poor construction, unsuitable operational processes, a lack of adherence to existing safety guidelines, or environmental factors, pose a significant risk during the construction and operation of offshore wind farms. There are worrying signs that, despite a number of years of relatively incident-free offshore wind development and operations, the industry has not yet comprehensively addressed these major threats to the safety of its personnel.


In 2017, the Total Recordable Incident Rate (TRIR), as reported by G+ (Global Offshore Wind Health & Safety Organisation), is 3.5 times greater compared to those from IMCA (International Marine Contractors Association).

From the outset, safety has been a key priority in the oil and gas sector. The reason for this is clear: the combination of remote drilling platforms located in harsh conditions, and intense activity involving the use of much heavy machinery, creates an environment ripe for potential accidents. These conditions are by no means unique to the oil and gas sector; a harsh offshore environment, the requirement to work at height, and the use of large installation vessels are everyday challenges for offshore wind farms.

The use of robust and cost-effective secondary retention solutions like barriers and nets, as well as smaller-scale solutions such as pouches

WIND BLADE REPAIR

Hold the Power of Knowledge in Your Hands



advanced hands
on training

ABARIS

TRAINING

CLASSES FILL UP FAST
- ENROLL TODAY!

Leading the World in Advanced Composite Training Since 1983!

www.abaris.com • +1 .775. 827.6568

that tether hand-held equipment, reflects a move by oil and gas HSE managers towards self-regulation; this allows for implementation of tailored solutions for each individual project. It also avoids the need for adherence to generic regulations imposed from outside, which is particularly critical in an industry that shares a common interest with offshore wind in reducing the cost of operations, and reputational damage.

Whether caused by human error or environmental factors, it is clear that dropped and falling objects are a significant concern to the technician working on an individual installation, to the corporate team back at HQ, and to the industry as a whole. As the industry expands, businesses will be forced to take the issue of dropped object risk seriously.

As we have seen from the oil and gas experience, it is in the interest of the offshore wind industry to demonstrate that it, too, can self-regulate. Self-regulation would avoid the imposition of generic regulation and the problems that come with it - a loss of independence for the industry and for individual operators. Clearly, companies engaging in U.S. offshore wind must set a benchmark for safety, mitigating risks from day one by being proactive in self-regulation, and adopting preventative measures.

Mike Rice is Commercial Director at Dropsafe, which delivers patented mesh-security and mesh-safety solutions. DropSafe works with clients throughout the oil, gas, and wind industries to develop application-specific dropped and falling objects prevention solutions.

DropSafe /// www.dropsafe.com



Double lanyard with tie back rings

The ABSORBICA-Y TIE-BACK is a double lanyard with integrated intermediate tie-back rings and a compact energy absorber. It is designed for continuous protection on very large structures and when passing intermediate anchor points. The tie-back system allows the lanyard to be wrapped around structures with very large cross sections. The elasticized arms help to eliminate tripping hazards, and it is equipped with a captive carabiner and two MGO large-opening connectors. It is ANSI compliant.

Petzl /// www.petzl.com

Dialing up the power of your wind turbines?

Mersen has the customized solutions you will need



One of the most trusted configurations:

MERSEN'S BRONZE RING + CG677 THE PREFERRED BRUSH GRADE

Mersen has been recommending Bronze rings for decades.

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

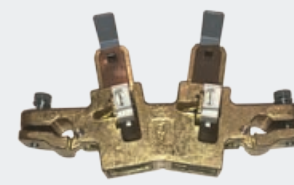
info.ptt@mersen.com



SR13-15
BRONZE SLIP RING



HCH-30X
CG677 BRUSHES



BR09-13
BRUSH-HOLDERS

WWW.MERSEN.COM

MERSEN
Expertise, our source of energy



Using AI to Pinpoint the New “Normal” in Wind Turbine Performance

by Jessica Hamm

WE EXPECT MACHINES TO BE MORE CONSISTENT THAN

we humans, but the truth is, machine behavior can vary daily. Fortunately, or unfortunately, these variations are more likely to be due to external factors like temperature and wear, rather than which side of the bed it woke up on.

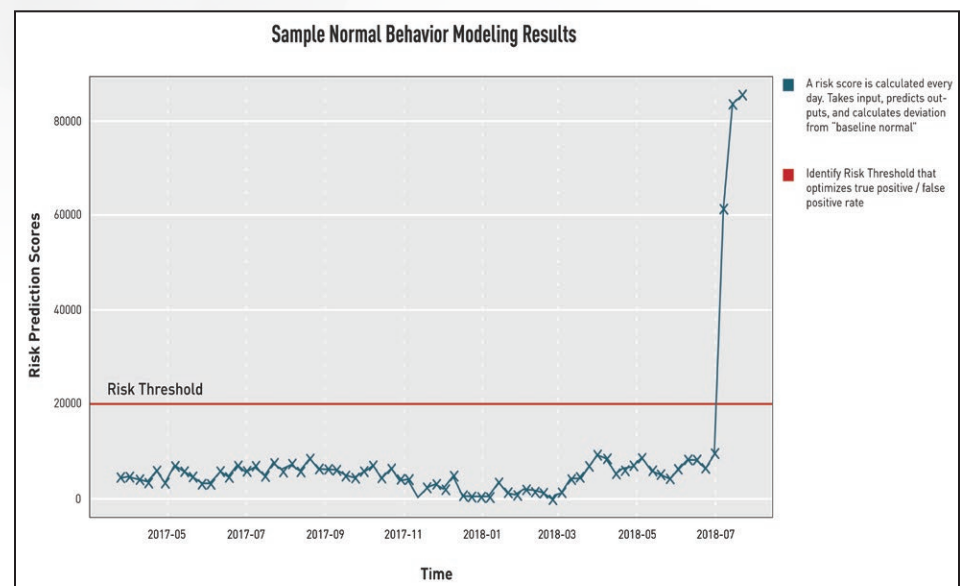
Maintenance managers have long depended upon condition-based monitoring (CBM) to alert them to this type of degradation, and the needed repairs. However, we now have a more reliable way to predict failures; by understanding deviations from normal behavior, Artificial Intelligence (AI) powered predictive maintenance has been able to detect some failures months in advance, with up to 90 percent accuracy. Imagine the difference these sorts of insights could make when scaled across operations.

The business case

Wind turbines are complicated machines that populate vast expanses of water, farmland, and mountain ranges. According to the American Wind Energy Association (AWEA), a new turbine is installed every two and a half hours, presenting both a tremendous means to generate clean, renewable energy, and a new liability in terms of maintenance and repair. Deployed turbines are at the mercy of the elements, including precipitation, lightning strikes, wind gusts, and ice, in addition to wear from normal operation. This means that every turbine operates under unique conditions and stresses, limiting the accuracy of traditional condition monitoring.

With over 58,000 turbines, and a total of 90 GW of capacity now operating across America, it's easy to see how maintenance costs are compounded by scale. A single, out-of-service 1.5MW turbine can cost an operator over \$2000 USD per day, in lost production. If needed, an unexpected crane rental pushes costs upwards of \$350K per week. Offshore repairs are even more complicated, and can cost over \$1M per week to rent a jack boat.

Fortunately, advances in AI are helping to address these problems by providing more accurate analytics to identify suboptimal performance, and quantify the risks of failure. Take, for instance, the crane rental example: With a better understanding of the failure timelines for multiple turbines in a wind farm, the operator can pinpoint the precise window of opportunity to hire a crane for several repairs at once — spreading the expense across multiple assets. With wind capacity expected to nearly triple by 2030, strategies are needed today, to drive efficiency across the industry.



Why is AI needed for predictive analytics?

Predictive maintenance involves deploying sensors to monitor critical components of a physical asset. Data is then analyzed for known and unknown clues that indicate imminent failures. Traditional approaches require technicians and subject matter experts to monitor asset health in real time, often reacting to issues rather than anticipating them. Due to the distributed nature of wind farms, limited worker expertise, and rapid industry growth, this existing methodology is unsustainable.

These aren't the only issues; predictive maintenance requires historical data and failures to create a model which can be used to predict asset health and operating states of a given asset. In traditional approaches, these models rely on pre-programmed rules, and physics-based models, all painstakingly calculated by human analysts. Not only is it a struggle to scale these models across large operations, they take a great deal of time to design and implement, and perform poorly in predicting edge cases that occur under extreme or unusual operating parameters. Most unfortunately, if a single variable of the asset is changed,

the model becomes obsolete.

Artificial intelligence can solve these challenges. AI enabled predictive maintenance platforms ingest sensor data, and automatically create models to identify when each individual asset is drifting away from its normal expected behavior. By its very nature, an AI model is continuously learning and refining itself, allowing it to analyze patterns and catch failures - especially if it has never seen them before. This flexibility also allows a cognitive model to catch edge cases that a rules-based approach cannot. Even adjustments to the asset itself are not a problem, as the dynamic nature of these models allows them to adapt to changing conditions. This new type of predictive maintenance is already being deployed across the wind industry, to protect main bearings, pitch bearings, generators, gearboxes, and more.

AI-powered normal behavior modeling

AI-powered predictive maintenance relies on normal behavior modeling (NBM) to offer an innovative approach to anticipating secondary failures, as opposed to traditional condition monitoring. NBM uses historical sensor data and neural networks to more accurately characterize the normal operating behavior of a turbine subcomponent. An index is then developed based on the inherent risk of failure, depending on how far the observed asset behavior deviates from the derived norm.

Because behavior deviations can occur in both overt and covert ways, it is critical to understand the contributing features and indicators of failure, in order to better derive root cause and drive precise repair actions. Through a concept called explainable AI, advanced machine learning platforms are able to surface and prioritize the top contributing features that are driving the results. Explainable AI provides clear and actionable insights to the operator, helping to prioritize their next steps.

In case studies leveraging this technology, AI-powered predictive maintenance has been able to detect main bearing failures months in advance, with up to 90 percent accuracy; it has flag impending generator failures with one month's notice, at 70 percent accuracy.

Getting started with AI

How can operators obtain this technology for themselves?

To successfully implement an AI enabled predictive maintenance solution, a company needs to have a specific problem for the AI to solve - and lots of good data (of a high enough quality) for an algorithm to learn from. With wind farms, seasonality is important; having a full year of historical data improves the algorithm. An AI solution is only as good as the data it's been given. There also needs to be a

reasonable expectation of finding a pattern in the data; without that, there's nothing for the AI to analyze.

Other important considerations include clear goals, strong leadership, and selecting a legitimate AI vendor with expertise in the area. Wind operators that pay attention to these factors, and plan their AI implementations accordingly, have the potential to completely reshape their operations, and improve their operating margins for the future.

Jessica Hamm is Director of Solutions for SparkCognition. SparkCognition works with companies around the world to build human-level intelligence applied at machine scale, in order to optimize operations, and find new solutions to old problems.

SparkCognition /// www.sparkcognition.com

SKYLOTEC.COM

f

NEW PRODUCTS FROM SKYLOTEC

CLAW

NEW

IGNITE PROTON WIND

RESCUE PRO 2.0

SKYSAFE PRO FLEX

LORY PRO

CONREST

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

SKYLOTEC

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

Fanning the Flames...

What do we really know about wind turbine fires?

by Suzanne Albright

The answer is pretty clear when it comes to fires that make the headlines; impressive videos of fires burning out of control, toxic black smoke filling the sky, burning turbine blades, and other parts shooting through the sky are well documented worldwide. Perhaps the question we should be asking is, “What do we think we know?”

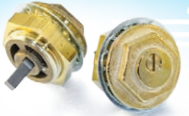
As it turns out, not too much. According to researchers at the University of Edinburgh, the numbers are grossly underreported by the wind industry. “Researchers carried out a global assessment of the world’s wind farms, which amount to an estimated 200,000 turbines. The team, from Imperial College London, the University of Edinburgh and SP Technical Research Institute of Sweden, estimate that more than 117 turbine fires take place each year.”¹

Wind industry leaders tend to dispute this information, but there is currently no international regulatory organization requiring them to report turbine accidents and failure. There are, however, various organizations committed to tracking and reporting turbine accidents. Caithness Windfarm Information Forum in Scotland is one such organization. From 2000 through September 30, 2018 (the end of the third quarter of 2018) Caithness has reported 330 turbine fires, including 19 so far in 2018². Although lower than the 117 annually claimed by researchers at Imperial College London, the number is large enough to reinforce the need for regulatory oversight. Caithness derives information from accident reports, insurance documents, and news articles.


Why is accurate reporting of great importance?

Public safety. Industrial wind projects are often built in rural communities on farms leased to wind developers by farmers, to boost their income. Setbacks from homes and other dwellings, property lines, and neighboring homes and properties are determined by local governments (these vary widely around the world). Toxic smoke from burning fiber composite blades, lubricating oils, and other turbine components are detrimental to the health of people and animals. Turbine blades are currently approaching 288 feet in length (again, composed of glass and carbon fiber composite). When older fiberglass blades burn, they release tiny airborne particles, which are easily inhaled and deposited in the lungs, irritating the capillaries.







WIND PITCH MOTOR BEARING PROTECTION



- Easy installation
- Cost effective
- Low maintenance
- Long life

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

1-800-962-4851 | helwigcarbon.com

Over time, this irritation leads to scarring that causes permanent damage. The National Institute of Occupational Safety and Health cites studies showing that these inhaled particles could damage cellular mechanisms and DNA, which could further promote the growth of cancer cells.³ Similar problems arise when disposing of these blades at the end of their lives. Research found that, "Combustion of GFRP (glass fiber reinforced polymer) is especially problematic because it can produce toxic gases, smoke, and soot that can harm the environment and humans. Carbon monoxide and formaldehyde have been reported as residue from thermal degradation of epoxy resin. Another residue is carbon dioxide, which poses concerns regarding greenhouse gas emissions."⁴

In California, exploded turbine blade pieces were reported to have flown 4,200 feet. Imagine this scenario with flaming blade debris. Further, due to turbine height, fire brigades are unable to reach the flaming gear boxes, nacelles, and enormous blades. Widespread flaming debris is also difficult to contain. Often, the only option is to stand by and watch these fires burn.

Destruction of property surrounding the turbine fire is not unusual, especially in dry, windy conditions. An example of this is the famous Australian fire of January 17, 2017; the fire resulted in the destruction of almost 3,400 hectares, or 8,401 acres. Included in the damage was a house, 300 hectares of pasture, 80 hectares of crops, 3 sheds, water tanks, and more. To demonstrate how simply a fire of this magnitude can be started, it was determined that a bird flew into the wind farm high voltage line, caught fire, dropped to the ground, and ignited the spreading fire.

It's more common for fires to start in the turbines, due to either electrical or mechanical problems. Electrical causes typically result from transformer and power converter systems that arc around cable terminations made during manufacturing. Other electrical fires result from improper operations and maintenance practices. Mechanical causes are primarily a result of hydraulic brake systems and main shaft bearings that overheat; this tends to occur in high winds, during stormy weather, when the blades spin out of control and the brakes overheat and fail. Lightning strikes are a well-documented fire hazard. Not all lightning strikes ignite turbine fires. However, it's conceivable that, as turbine bases climb higher and blades grow longer, so does their vulnerability to lightning strikes. The sparking with flammable fluids or vapor clearly poses a fire risk. With more than 80,000 turbines currently in operation⁵, turbine fires will continue to increase.

The industry has a long way to go in preventing, tracking, and reporting turbine fires. Everyone who lives in the shadows of these giant machines deserves protection to property, livestock, the wildlife, and surrounding fields and meadows. Burned out and rusting turbines not only mar the landscape, but also the reputation of a growing industry.

¹ <https://www.ed.ac.uk/news/2014/windfarms-170714>

² Caithness Windfarm Information Forum 2018

³ Jared Paventi, *Fiberglass Breathing Danger Effects*, Aug. 14, 2017.

⁴ <https://doi.org/10.1177/1048291116676098>

⁵ <https://www.awea.org/resources/press-releases/2018/doe-reports-distributed-wind-has-surpassed-1-gw>

Suzanne Albright is a Founding Member and Principal of the Great Lakes Wind Truth organization. She is also Executive Member of the group Turbines on Fire.

Turbines on Fire /// turbinesonfire.org

**Don't Be
Let Down
By An Elevator**

*Installation and
preventative maintenance
by IUEC elevator mechanics
will keep your elevators
moving SAFELY
and more efficiently!*

**27,000 Trained Craftspersons
using more than 119
Training Centers!**

Contact Carisa Barrett at cbarrett@eiwopf.org or (253) 561-4902

**We represent more than 450 elevator companies
ready to serve your Elevator Lift needs**

What's in a guarantee?

by Nicolás Rossel and Lyndsey Shuckerow



THE WIND O&M INDUSTRY, LIKE MOST SERVICE INDUSTRIES,

has a long (and sometimes checkered) history with guarantees. Wind guarantees can be notoriously difficult to understand and navigate; as the industry moves forward with increasing technological and financial sophistication, the guarantees that back the projects need to keep pace. Ultimately, each project contract is unique, and requires a granular-level understanding of its fine print. Nevertheless, with a general framework for understanding the different types of risks that underlie a project, and the guarantees that are available to mitigate those risks, owners can make informed decisions in this increasingly sophisticated environment.

The key is to understand a project or fleet's risk drivers. A breakdown of these risks helps an owner determine which they are positioned to take on themselves, and which require guarantee coverage.

Perhaps the most obvious is **Resource Risk**: will the wind blow? This can be difficult to gauge, especially given significant annual variability, and the fact that O&M providers have been reluctant to take on risks they can't adequately define. However, this is likely to change as certain service providers are able to leverage internal or external resource assessment expertise.

Even more complex is **Market and Regulatory Risk**. Market risk can include basis risk, curtailment, and anything that may impact project cash flow. Regulatory risk includes the ever-present particularities around taxes and tax credits, environmental issues, NERC regulations, and a whole host of others.

Perhaps the most relevant risk in the O&M world is **Performance Risk**, which is further broken down into **Failure** vs **Degradation Risk**. Failure risk refers to unexpected, and generally catastrophic events that can bring down a plant, or at least a significant portion of it. This includes major component and substation failures, as well as serial defects that have the same impact. Degradation can include power curve issues and blade deterioration. Performance issues are the traditional territory of O&M service providers, but, more and more, they are being asked to cover other areas of risk.

Given these underlying risk drivers, let's lay out a framework of guarantees that take on increasing levels of risk:

- **Time-based Availability Guarantee**: Based on the number of hours a site is online compared to the number of hours a site was expected to be online.
- **Performance Guarantee**: Based on the actual performance of a site compared to the resource-adjusted expected performance of a site.

- **Energy (or Yield) Guarantee**: Based on the actual performance of a site compared to the expected performance of a site, with no adjustment for actual resource.
- **Revenue Guarantee**: Based on the actual revenue from a site compared to the expected revenue.

Another way to view the framework is to visualize which risks an Owner is still exposed to under each type of guarantee, as shown in Figure 1. With a time-based guarantee, an Owner is still exposed to most performance risk, all resource risk, and all market risk. On the other end of the spectrum, with a revenue guarantee, the guarantee provider holds almost all of the risk.

As guarantees become more sophisticated, the service provider will need to be supported by additional subject matter experts. Service providers specialize in performance; resource risk is typically well understood by a resource assessment group; and market and regulatory risk is handled by asset managers or a finance team.

Now that you've established your risk appetite - and are ready to sign a guarantee - what else do you need to know? Unfortunately, guarantee structures and terms and conditions have not been standardized across the industry. Here are a few helpful hints to think about as you review your guarantee.

Guarantee Target and Calculation: The target (generally expressed as a percentage) is what your guarantee provider is obligated to hit (or pay damages). Guarantees are typically in the mid to high 90s for utility-scale plants, but can be lower, depending on how

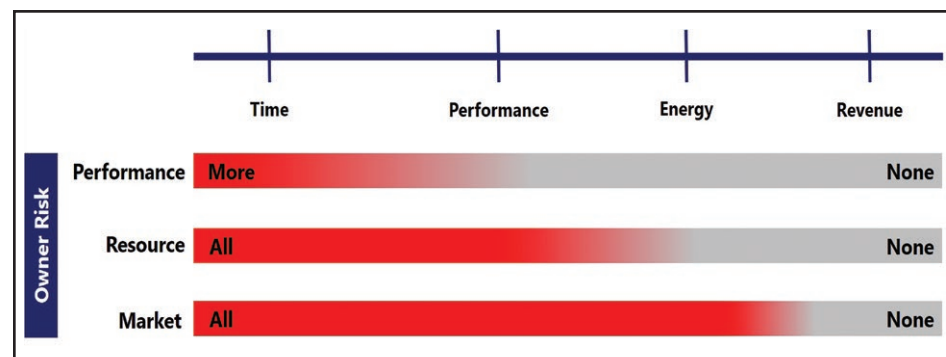


Figure 1: Visualization of Owner Risk Exposure under Varying Guarantee Types










External Curtailment	20,026.1 MWh 4/3/2018 100 WTGs affected	
Forced Outage	4,308.9 MWh Last active 4/3/2018 98 WTGs affected	
BoP/Grid Shutdown	2,663.8 MWh 3/31/2018 75 WTGs affected	
Standby/Low Winds	776.8 MWh Last active 4/3/2018 100 WTGs affected	
Underperformance - Icing	679.6 MWh 4/2/2018 96 WTGs affected	
Scheduled Maintenance	456.0 MWh Last active 4/3/2018 64 WTGs affected	
Unclassified	317.9 MWh Last active 3/29/2018 88 WTGs affected	
Underperformance - Unclassified	215.8 MWh Last active 4/3/2018 100 WTGs affected	
Underperformance - Deregated	93.9 MWh Last active 4/3/2018 79 WTGs affected	

Figure 2: Tracking Performance and Exclusions (Wind)

averse your guarantee provider is to taking on additional risk. The calculation compares actuals to expected (uptime hours, production, revenue), with adjustments for any exclusions.

Exclusions: Understanding what events are excluded is key to understanding how much risk is being passed on to the guarantee provider. Some categories of exclusions are straightforward, such as Force Majeure or curtailment; others are more questionable, such as scheduled maintenance, major component replacements, or degradation. It's a good idea to spell out, as clearly as possible, who will be responsible for lost performance for each scenario.

In addition to defining exclusions, the guarantee provider should also explain how they will track excluded events. If this is not defined upfront, the guarantee could become an administrative burden. An example of tracking performance and exclusions is provided in Figure 2.

Liquidated Damages/Bonuses: Liquidated damages are the typical method to enforce a guarantee, where the guarantee provider is responsible to make the Owner whole for losses. Owners might also want to incentivize the guarantee provider to increase performance with bonus payments. Helpful hint: be wary of step calculations (e.g. 0-1 percent above target is equal to a 5 percent bonus, 1-2 percent above target is equal to a 10 percent bonus). These can disincentivize the operator from maximizing performance, with the operator thinking "I hit my first bonus level, and it's a lot of effort to hit the next level". A better bet is linear calculations, where each additional unit of production is equally incentivized.

As the industry continues to advance, so too will the guarantees that backstop performance. Guarantees are essential to ensuring the financing of a project, protecting cash flow, and providing assurance that your plant is being operated with the Owner's best interests in mind. However, beyond the guaranteed performance levels, it is important to understand the risks that are being mitigated, and to structure the guarantee so as to avoid administrative burden, and provide true and transparent coverage.



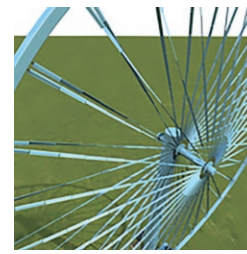
Nicolás Rossel is Head of Business Development – Asset Optimization, Mexico for EDF Renewables, he joined the Chilean office in 2016, and is currently based out of Mexico City, Mexico. Prior to joining EDF, Rossel worked as a senior consultant at Sunspot Services Chile. He has lived in the US, Canada, Chile, and Mexico. He has a BA in English from the University of British Columbia in Canada, and an MBA from UAI in Chile.



Lyndsey Shuckerow is Strategic Growth Analyst – Asset Optimization for EDF Renewables. Prior to joining EDF, Shuckerow worked in economic consulting for the energy industry. She has a BS in Mechanical Engineering from Cornell University.

EDF Renewables

/// www.edf-re.com





Wind turbine designed for extreme weather

BarberWind Turbines' 800kW wind turbine has been specially designed to serve the distributed generation market and is especially interesting to Caribbean island nations because it has a built-in lifting system and can be hinged down in the approach of severe weather or a hurricane. An advantage of the lifting system is the BWT doesn't need a heavy-use crane to erect it. It is assembled on the ground and then raised into place utilizing its own apparatus. Plus, it ships in standard containers so it doesn't require special transport or permits.


BarberWind Turbines LLC


/// www.barberwind.com

Nordic Chuted Box Pads for Pad-Mount Transformers

- **Nordic Fiberglass was first to design and manufacture "chuted" box pads for pad-mounted transformers installed in a slurry mix solution next to the tower pedestal.**
- **Chuted box pads provide a reliable and simple solution to protect underground cables from the tower to the transformer.**
- **Installed eyebolts on the box pad allow the attachment of lifting straps to hold the box pad up to the desired height.**





NORDIC FIBERGLASS, INC.

Quality Products for the Electric Utility Industry

P.O. Box 27 Warren, MN 56762 Tel: 218-745-5095 Fax: 218-745-4990 www.nordicfiberglass.com

A New Dawn for Vertical Axis Wind Turbines

by Douglas Hirsh and John Selby

Large, horizontal axis wind turbines are becoming a ubiquitous aspect of the landscape – both onshore, as well as offshore. Designs and efficiencies continue to improve, and costs keep coming down. As the wind market matures, more and more players drive market efficiencies, which helps to lower the price per kilowatt-hour. By 2027, total worldwide wind power capacity is expected to double over 2018 levels.¹

As efficient as they are, horizontal axis wind turbines have their limitations:

- they need substantial bases and the right kind of substrate
- they require significant capital investment
- they are not well suited to areas with gusty omnidirectional winds
- they face opposition to being installed in areas where they may harm wildlife (such as birds and bats)
- they aren't able to address the market between 10 kW micro installations, and the typical 2.5 MW entry point for large units.

This leaves a significant market void that hasn't been adequately addressed until recently. Vertical axis wind turbines aren't a new technology; they've been in use around the world for decades. Historically, vertical axis wind turbines have traded efficiency for low cost, ease of service, and scalability – used primarily for mundane tasks like pumping water, or local power generation for micro or small grid needs on farms. Even these applications have been displaced by a new generation of efficient, and affordable, micro scale horizontal axis wind turbines.

You may wonder, what has saved vertical axis units from the history books?

The answer is engineering.

A very old concept has been given new life, thanks to recent advances in design enabled by computational fluid dynamics, metallurgy, the generator set, bearings, lubricants, power storage, and a



complete rethink of the structure. Where efficiencies used to be in the 7 percent range, new generation vertical axis wind turbines are seeing efficiencies of greater than 60 percent. That's comparable to - or even better than- the best new horizontal axis units.

Unlike horizontal axis based wind farms that have a very rigid cost and placement structure, vertical axis units offer a refreshing degree of freedom.

Vertical axis wind turbines can be placed wherever there is wind. This includes the rooftops of buildings in



EINPART
Your One Stop Shop

Key Features

Approved FAA AC 150/5345-43G
Aircraft Detection Lightning Systems interface (ADLS)
Dip switch to set flash rate and test mode
Integrated brightness sensor
Overvoltage protection Class III, IEC61643-11
Maintenance free corrosion resistant material for all surfaces
UV and ozone resistant optical sealed units
Plug and play 110/230 60Hz power supply
GPS synchronized flashing
Infra-red LED's (NVG compatible)
Wireless Mesh radio network (Lidar functionality)
Dimming visibility

Weight: 9lb (4.40Kg)
5 year Warranty



Einpart LLC, Supplier of FAA Lights, Tools, Spare Parts & PPE for the Wind Industry
einpart@einpart.com - www.einpart.com



value. Power per acre is still greater than 1.5 MW. There are many places around the world that are hesitant to embrace wind power for fear of having infrastructure destroyed during hurricanes and typhoons. Vertical axis units are robust and heavy, and have been tested in winds to 130 mph. Vertical axis units can effectively power micro grids and buildings. They work well on manned and unmanned offshore oil and gas platforms.

Through innovative engineering, vertical axis wind turbines have come into their own, and provide a viable and cost-effective solution to the 10kW - 2.5MW market. With new and highly efficient scalable designs, and the ability to be placed in unconventional locations, vertical axis turbines can extract power where nothing else is suitable. Windy but environmentally sensitive locations - near migratory bird routes or bat roosts - can now be safely addressed. Areas where discreteness is desirable can now be serviced, while still maintaining the visual appeal. Reliable, scalable, and long lived, vertical axis wind turbines have earned their place in the burgeoning renewable energy and wind power marketplace.

Douglas Hirsh is Operations Manager and Vice President of Sales and Marketing for PROSTO Wind Power. Doug has spent a career working with leading edge electronics and control systems. Since 2014, Doug has focused his efforts on the burgeoning renewables market, with a focus on wind power and power grid monitoring

John Selby has been a manufacturers representative for the last 25 years. Since 2016, John has worked for PROSTO Wind Power John's focus has been instrumentation, desalination, waste to energy and wind power.

PROSTO Wind Power /// www.prostowind.com

¹<https://www.greentechmedia.com/articles/read/wind-forecast-doubling-capacity-by-2027-will-be-a-breeze#gs.yqXafmQ>

big cities, or areas with height restrictions due to municipal ordinances or nearby airports. Vertical turbines are silent. Bats and birds see them, and avoid them. Vertical turbines can grow with need (as opposed to need attracting use). And new, innovative power storage techniques, such as graphene based ultra-capacitors or compressed air, can store energy until it's needed.

Vertical axis wind turbines are omni-directional. This means that, regardless of the direction the wind is coming from, a vertical axis system will capture that wind and turn it into energy. Large, horizontal axis units can pivot at the head, but responding quickly and repeatedly is tricky for these designs.

A common criticism faced by vertical axis wind turbines is that, regardless of how efficient the design may be, they will never be able to produce the same power as a taller, traditional unit of equal capacity. At a given height, wind power is related to the friction coefficient associated with the terrain characteristics around the location being measured. Flat prairie or bodies of water have very low friction coefficients (around 0.1). Under such circumstances, power generated will be similar. For high friction coefficient areas (around 0.4) in big cities, for example, its advantageous to be above the turbulent wind.

If a horizontal axis design is inherently better at capturing the greater wind power contained in the more laminar airflow at altitude, why have this discussion? Because vertical axis units do a very effective job of filling the void that micro, or large-scale horizontal axis units can't address.

The cut in speed for new vertical axis design units is lower, and optimal power can be generated at much lower wind speeds. ROI is in the range of 7 - 8 years; with a design life of greater than 60 years, vertical axis units offer tremendous



Quick EV charger with modular technology

NarrativeWave, an Internet of Things software company, has announced the release of Analytic Starter Kits. These kits answer the needs of operators who are looking for cost-effective digital solutions that can impact their business operations from Day 1. NarrativeWave's Tower Performance Analytic identifies every tower in the fleet that is underperforming and analyzes the most probable causes. This saves significant diagnosis time, results in higher energy output, and lets operators fix the problem themselves quickly or inform the OEM to address the problem. The Analytic Starter Kits are a seamless part of NarrativeWave's software solutions. As a result, engineers can configure, change, and build any other type of analytics inside NarrativeWave for maximizing productivity and assessing performance.

NarrativeWave

/// www.narrativewave.com



Get a quote today. Call 281-906-9572 or visit WindComServices.com/request-for-proposal



DON'T LET THE WINTER WEATHER
PREVENT A NECESSARY BLADE REPAIR

Sub-Zero blade repairs get your blades back into service.

- ✓ Temporary repairs can get the turbine running in one or two days
- ✓ Turbines can remain in service through the windy season
- ✓ Quick mobilization and implementation



CHRONOS
WindCom™ RapidShot Inspections

It's time to start planning for summer repair services.

- ✓ Inspections performed while turbines are in operation
- ✓ Reports provided by blade and damage level
- ✓ Find damages before they get worse

Making the Latest Advancements in Weather Work for You

by Marty McKewon

AS A BUDDING JUNIOR METEOROLOGIST

in the mid-1970s, I used to wonder how cool it would be if I could pull up a radar at home and see what the storm was doing. Instead, every night I had to settle for watching my favorite television meteorologist use his magic marker to draw fronts on the weather map, and listening to the constant recorded weather loop on my NOAA weather radio.

How far the weather industry has come! Today, anyone can pull up one of hundreds of weather apps on their phone to view an instant radar, or search for boundless weather information and models, watching the weather be sliced, diced, and analyzed 24/7. You can easily experience weather information overload - something I never thought I'd be saying.

Technological advancements in the industry are truly a significant boon to the renewable energy professional - especially during a time when volatile and extreme weather has become the norm, and will be for the foreseeable future. More targeted and useful weather information is available for decision making purposes.

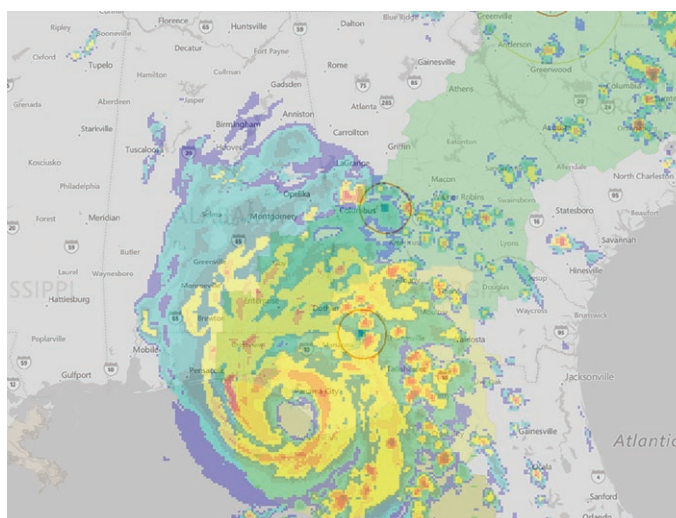
Advanced weather modeling

The general public was first introduced to weather models by their weatherman, during the local on-air forecasts. Compared to those early days, the current data dump can seem overwhelming (especially when you try to make sense of the spaghetti plot of 15 different hurricane tracks, each depicting a different solution). That said, the new NOAA High Resolution Rapid Refresh (HRRR) model can provide accurate near-term forecasts for many weather variables. A major tool for renewable wind energy professionals is the prediction of the lightning threat. Updated every hour, and extending to 18 hours into the future, this forecast depicts the coverage and intensity of lightning events. Armed with this information, wind farm site managers can more accurately prepare the day's maintenance plan. For example, an expected afternoon of high lightning activity may warrant a reschedule of the planned gear box job.

Additionally, smarter planning through review of lightning predictions can result in safer work conditions for your employees. Commercial solution providers are introducing intelligent displays of these forecasts, making it easier and faster for renewable energy professionals to leverage this information, and make smarter decisions. Additional value from the HRRR model forecasts include radar reflectivity and hub height wind forecasts; these variables are produced every hour.

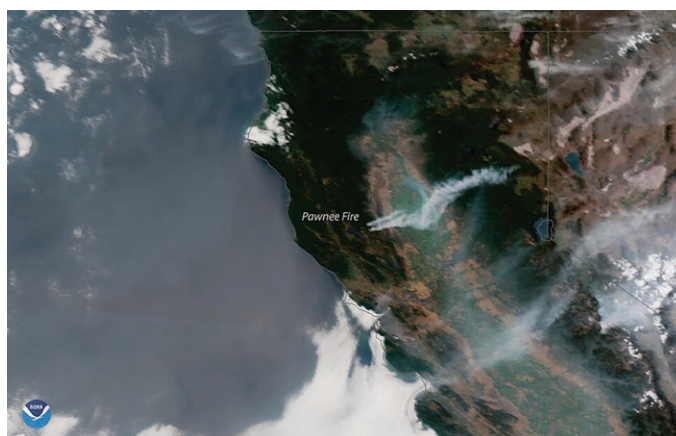
Dual Polarization Radar

You know the radar gun that state trooper used to pull you over for speeding? The same technology is used in all National Weather Service Doppler radars. The original NEXRAD Doppler radar produced horizontal pulses to detect precipitation and other weather phenomena. The upgrade - Dual Polarization radar - produces horizontal and vertical pulses, which gives meteorologists a better handle on the size and shape of the target the radar is seeing.



HRRR forecast of Hurricane Michael Landfall

Today's radar can more easily determine between rain, snow, and ice. Ice and snow are major concerns to the industry because both can have a significant impact on wind production; ice and wet snow can accumulate on turbine blades, creating extra load and cutting generation. Heavy loads can cause turbines to shut down, leading to complete production loss. Dual Polarization radars can even detect very light precipitation like freezing drizzle and freezing mist which, when present over a prolonged period, can also impact turbine performance.



GOES 16 image shows wildfires burning in Northern California

New GOES Satellite Imagery

The GOES 16 Satellite (launched in 2016) and GOES 17 (launched in 2017), are two of the newer technological advancements in the weather industry. These satellites can collect three times more data, at four times improved resolution, and cover the planet five times faster than their predecessors. Both satellites will allow meteorologists to deliver more accurate forecasts and analysis, and allow turbine owners to better access hazards impacting their operation.

Consider some of the benefits:

- Better detection of low clouds = increased awareness of production loss to solar operators
- Better detection of smoke from wildfires = impacts to work crews/ potential unsafe working conditions
- Improved tropical tracking and forecasting = clearer picture of potential impact on wind farm facilities

In recent years, Hurricanes like Harvey have impacted the wind industry. Nowcasting tools like the GOES satellites give a much clearer picture of the intensity of the storm, and whether it's trending weaker or stronger. Why? Because these satellites update as frequently as every 5 minutes - hurricane hunters can only fly into the storm a limited number of times per day, to collect information.

How can you make all this work for you?

Most of you reading this article are not meteorologists; you need to check what the experts say. Similarly, renewable energy professionals need to rely on their commercial providers to deliver the latest technology in clear, easy to digest formats in order to make fast, accurate decisions that benefit the bottom line. In today's volatile climate, it's vital to leverage all the tools you can to mitigate the impact of weather on your business.



Marty McKewon is Chief Meteorologist at Indji Systems, a provider of weather monitoring and alerting solutions to the Renewable Energy Industry. Marty has 30 years of weather industry experience, including roles as a Meteorologist, Product Manager, and Sales Professional.

Indji Systems /// www.indji.com

WIND +

POWERING THE FUTURE. TOGETHER.



2018 has been a historic year as wind power surpassed **90,000 MW** installed and the AWEA WINDPOWER Conference grew **10%** making it the **largest show in 5 years**. The wind industry's powerful growth is poised to continue in 2019, with more than **37,700 MW** of wind capacity under construction or in advanced development.

In May 2019, that future begins in Houston, the energy capital of world, where leaders from the wind industry and across energy sectors will gather at AWEA WINDPOWER 2019. In Houston, we will take the next steps forward to powering that future, together!

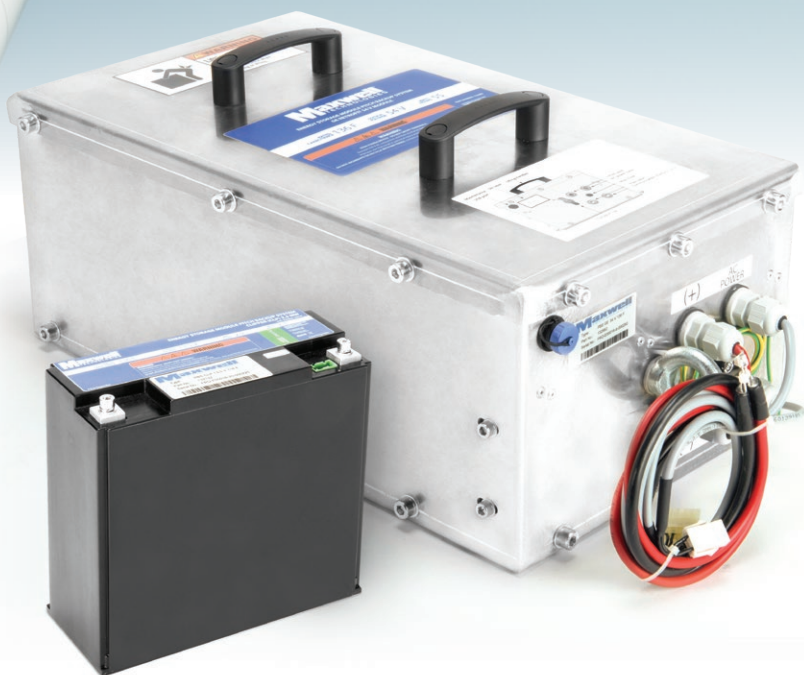
REGISTER NOW!
www.windpowerexpo.org



Emergency Pitch Control

How ultracapacitors improve efficiency and reduce O&M costs

by Joshua Hitt



Wind farm operators make every effort to maximize turbine production, but they often face maintenance issues that disrupt operations. Battery-based emergency pitch control systems can be a leading contributor to turbine downtime and maintenance cost.

A turbine's pitch control system shifts the angle of the blades to protect the turbine from damage during a grid power loss event, or excessive wind speeds. Site managers often spend additional budget dollars performing unscheduled maintenance to address the issues associated with batteries, including degraded performance in cold and hot weather conditions, battery voltage faults, and additional turbine climbs to replace failed battery components.

Retrofitting existing pitch systems with ultracapacitors, however, will translate into higher reliability, longer life, less maintenance, and overall improved turbine operation.

Ultracapacitors, also called supercapacitors, are high-power energy storage devices that store charge electrostatically (as opposed to the electrochemical process in lead-acid batteries). As a result, ultracapacitor technology provides higher reliability; systems do not require scheduled maintenance for 10 years or more, pitch battery maintenance is eliminated, and wind farm operating efficiency improves.

For remote turbines exposed to extreme heat or cold environments, the electrostatic energy storage method of ultracapacitors make them an excellent choice. Cold temperatures slow the rate of batteries' chemical reactions, resulting in high internal resistance, and inefficient charge acceptance. Generally speaking, a battery that provides 100 percent capacity at 80°F (27°C), will typically deliver only 50 percent capacity at 0°F (-18°C).

Consider that each charge/discharge cycle also lowers battery capacity, due to poor charge acceptance. As a result, continual operation at frigid temperatures can render the battery ineffective in executing an emergency pitch. Even with environmental conditioning (heaters and fans), battery-based systems still experience extreme ambient temperature



Weather Monitoring Designed for Wind Farms

Better Solution...Better Protection...Better ROI

www.indjiwatch.com/renewablead

conditions, and degraded battery performance. Batteries perform best when applied for long-term energy storage requirements in more mild environments.

In addition to vulnerability in extreme temperatures, batteries are often the source of pitch faults reported by the SCADA (supervisory control and data acquisition) system. Battery voltage faults are one type of fault specific to the turbine's emergency pitch backup system. This fault may appear during a battery load test, during battery charger failure, or when cold weather affects battery system performance and the battery fails to charge.

If a fault cannot be resolved remotely, wind technicians must climb the turbine to perform diagnostic inspections. Climbs up-tower present safety risks to the technician, and are costly in terms of maintenance hours, complexity of the process, and lost energy revenue due to downtime.

To overcome the challenges with lead-acid batteries, wind farm operators are retrofitting wind turbines with ultracapacitors as a much more reliable energy storage alternative. Existing batteries are replaced with ultracapacitor storage modules, considerably simplifying the backup system. Ultracapacitors perform the same function as the original battery system, with the following advantages:

Ultracapacitors withstand the pitch system's load with minor voltage drop, compared to battery systems. Once the ultracapacitors are installed and fully charged, subsequent recharges are completed in a few minutes. Often, site personnel must wait for batteries to recharge for approximately 20 to 30 minutes before the pitch process can complete. The fast-responding power and charging capability of the ultracapacitors recovers valuable time. In addition, ultracapacitors provide quick, high power, even after long stretches of non-use. This is a performance advantage compared to batteries, which often have failures after stretches of idle time.

Ultracapacitors are available as form-fit-functional replacements for battery pitch systems, and do not require modifications to the turbine hardware. Current ultracapacitor-based retrofit systems include an integrated charger and communication interface, so that initiation of ultracapacitor system check, voltage, and temperature are reported to the turbine SCADA system. Ultracapacitor retrofits do not require extensive technician training for installation.

The ultracapacitor-based system significantly reduces system failure rates, repair time, and both unscheduled and scheduled O&M costs. Ultracapacitor-based energy storage reduces the high number of hours spent maintaining and troubleshooting battery-based systems; this reduces the cost of additional turbine climbs performed to address battery system issues. Technician hours are saved, and turbine availability and operational efficiency are increased. Further, consumable lead-acid battery and charger replacement parts are no longer needed, nor are the complicated battery storage and disposal processes.

In order to remain competitive with other power generation sources, wind farms must harness the most efficient technologies. While batteries are the traditional energy storage technology for pitch control systems, they present challenges with cycle life, reliability, and flexibility in extreme temperature conditions. Replacing end-of-life or failed battery parts is a time-consuming and costly process that can be avoided with ultracapacitor energy storage systems. Wind farms that have retrofitted existing turbines with ultracapacitor energy storage experience streamlined operations, more turbine uptime, and greater overall efficiency.

Joshua Hitt is senior product line manager at Maxwell Technologies, a manufacturer of ultracapacitor energy storage solutions for pitch control, with over 67,000 wind turbine installations worldwide.

Maxwell Technologies /// www.maxwell.com



Energy management software

The technology group Wärtsilä announced the release of GEMS 6 (Greensmith Energy Management System, version 6), the latest generation of its software platform serving grid-scale deployments globally. GEMS 6 offers a set of capabilities used to integrate a broad array of generation assets including solar, wind, hydro, storage, and thermal. GEMS 6 is component-neutral to provide maximum flexible and has integrated 16 different batteries to date, each according to the application needs of each project. GEMS 6 can be used independent of energy storage. Using software-based intelligence and machine learning to enhance grid systems and networks, GEMS 6 offers a wide library of algorithms and applications. With GEMS, renewable energy sources and engine systems can now be equally modeled and simulated in a virtual environment using real-time data, which allows GEMS to be lab-tested, rather than on-site, and offers significant cost efficiencies in testing time, outages, and time-to-market. GEMS also integrates weather and load forecast data to optimize an entire grid system. GEMS can operate autonomously and automatically, based on either a rule-based engine or machine-learning, to act and function according to different or specific conditions sensed within integrated systems such as solar and/or the grid itself. GEMS is capable of processing more than 100,000 points of data per second in default mode and uses data analytics to improve the way in which it optimizes energy storage and the overall grid system into which it is integrated.

Wärtsilä Energy Solutions /// www.wartsila.com/energy



Industrial wireless family

Antaira Technologies announces the expansion of its industrial networking infrastructure family with the introduction of the ARS/X/Y-7234-AC series. Antaira Technologies' ARS-7234-AC-T is designed for industrial and enterprise indoor wireless access applications and also allows the user to position the wireless antenna in a better signal-broadcasting location for improved wireless coverage and signal strength or simply in a more convenient location. While both ARX-7234-AC-PD-T and ARY-7234-AC-PD are designed for outdoor wireless access applications and are IEEE 802.3af/at compliant. The difference between ARX and ARY is that one is made of IP67 rated metal housing and the other is made of IP67 rated plastic housing. All three wireless units are embedded with Qualcomm IPQ4029 Quad-Core chipset and supports high-speed data transmission of up to 867Mbps. All three industrial wireless units are capable of operating in different modes, which makes them suitable for a wide variety of wireless applications including long-distance deployments.

Antaira Technologies

/// www.antaira.com



High pressure hydraulic gantry

Enerpac's new SL100 and SL200 Hydraulic Gantries offer customers a high capacity gantry on a narrow two-foot track gage. Enerpac's Super Lift gantries are easy to mobilize and demobilize with high-lifting capacity and accurate load positioning. They also have the ability to operate in confined or limited-access spaces. SL100 and SL200 Hydraulic Gantry key features include: self-contained hydraulics; range from 100 to 200 ton; self-propelled wheels; 2 stage lift cylinders; Intellilift synchronized control system; lifting height up to 15ft (SL100) and 22ft (SL200); and ASME B30.1 compliant. Additional components and accessories are available such as header beams, lifting anchors, side shifts, and skid tracks. There are also tarpaulin covers, transport frames for side shift units, slings, and shackles. The SL100 and SL200 Hydraulic Gantries include the Intellilift control system, providing wireless control, unrestricted operator position, and automatic synchronization for lifting/lowering and traveling. All of Enerpac's gantries are tested at maximum capacity at maximum extension and tested under witness of Lloyd's Register.

Enerpac /// www.enerpac.com



Intelligent dieless crimper

ABB's electrical installation tool, SmartTool+, is a die-less crimper that can scan lug characteristics, automatically configure itself to deliver a solid crimp, check for quality in a finished crimp, and then load detailed data to the cloud for storage and retrieval. The tool can be used reliably with standard Color-Keyed lugs sized 3/0 AWG to 750kcmil for copper and 1/0 AWG to 600kcmil for aluminum but uses its full capabilities when combined with ABB's new RFID-enabled Color-Keyed lugs. The end result is time saved on the job, along with a full array of data collection on critical electrical connections: data that are increasingly specified on QA/QC jobs that require high levels of quality control. SmartTool+ produces an indent-style crimp precisely calibrated to the lug and wire through pressure sensing and preset indentation levels, resulting in solidly bonded connections with predictable configurations. A range of lug sizes can be entered manually for standard Color-Keyed lugs or entered automatically by scanning RFID-enabled Color-Keyed lugs. SmartTool+ features include automatic quality check, data collection and analysis, bluetooth connectivity, and analysis and reporting.

ABB /// www.tnb.com



Hydraulic lock-grip pullers

Energac announces the availability of its LG-Series Lock-Grip Pullers for a simple, safe, and cost-effective way to remove shaft-mounted parts. Both mechanical and hydraulic pullers are offered to suit application requirements. Energac's LGM-Series Mechanical Lock-Grip Pullers are a solution for pulling small- to medium-sized wheels, sprockets, bearings, and other similar shaft-mounted parts. The puller's self-centering closing system allows all jaws to move simultaneously, making it easy for a single operator to mount the puller and to perform the application. The LGH-Series Hydraulic Lock-Grip Pullers provide the same safety and ease of use as their mechanical counterparts, but the pulling force is applied by a standard 10,000 psi hydraulic cylinder. These pullers can apply up to 64 tons of force and can remove larger shaft-mounted objects up to 26" in diameter. The convenient adjustment handle simplifies the position of jaws on application and increases speed of operation, while the locking mechanism helps prevent jaws from slipping off application while pulling. The spreading width on jaws enables use on thicker objects. The LGH-Series Pullers are also available as master sets: complete kits which include accessories designed for pulling limited access applications.

Energac /// www.energac.com

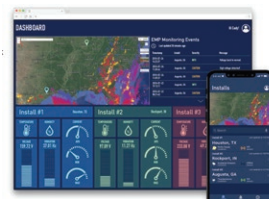


Hybrid towers for high hub heights

With its Hybrid Tower 2.0, Max Bögl Wind AG is introducing a concept for new generations of high-performance turbines. The optimized tower concept enables hub heights of up to 190m and makes the wind energy plants even more cost-effective. Max Bögl Wind AG hybrid towers combine concrete and steel resulting in a tower concept that requires less material while ensuring a high level of stability. Thanks to mobile manufacturing, the production of concrete elements is possible at almost any location in the world.

Max Bögl Wind AG

/// www.mbrenewables.com



21st century lightning protection

One CMCE120 Lightning Suppressor, using the same grounding installation guidelines as outlined in NFPA 780, creates a 393ft spherical radius of coverage. Within that sphere, upward streamers are eliminated, excess current is drained to the Earth and the development of lightning is prevented.

EMP Defense, LLC

/// www.empdefense.us



Icing detection software

Clir Renewables has released a new software feature which detects icing on turbine blades and measures its impact on performance. Clir developed a solution to automatically detect icing and quantify the associated losses. The algorithm uses a probability analysis approach to flag deviations from historical, turbine-specific power curves, based on site-specific climatic conditions and historical icing events. The icing events are automatically flagged to the user as a part of their standard system, including the losses related to the events, which enables users to make informed decisions on how to proceed. The method is based on IEA Task 19's standardized and approved method for ice loss calculations and has been further refined within the Clir system. Based on the results from the algorithm, Clir can make recommendations for optimization when the wind farm is experiencing icing. As part of this optimization work, an evaluation of any installed ice detection and mitigation system is undertaken, and the results are also useful for the evaluation of available third-party alternatives.

Clir Renewables

/// www.clir.eco



Comfortable ventilated helmet for work at height and rescue

With its strong chinstrap, the VERTEX VENT helmet sets the standard in head protection for workers at height. It has ventilation holes with sliding shutters to allow the ventilation to be adjusted as needed. Its six-point textile suspension ensures maximum comfort, and its CenterFit adjustment system adjusts the headband and keeps the helmet centered on the head. The VERTEX VENT is designed for optimal attachment of a PIXA or DUO headlamp, a VIZIR, VIZIR SHADOW, or VIZEN protective shield, and hearing protection.

Petzl /// www.petzl.com

2019 NORTH AMERICAN IRON WORKERS/IMPACT CONFERENCE



THE IMPACT OF CHANGE

SUNDAY, FEBRUARY 24 - WEDNESDAY, FEBRUARY 27, 2019

The Mirage Hotel - Las Vegas



9,215 ATTENDEES HAVE BENEFITED FROM THIS WORLD-CLASS EVENT AND CUSTOM BREAKOUTS! SHOULDN'T YOU?



YOUR COLLEAGUES WILL ATTEND TO FIND OUT:

- How SAFETY has changed the face of the construction industry
- How IMPACT has helped contractors triple their business
- What the next generation of ironworkers are learning to be safer and more productive



Seats are limited! Log onto bit.ly/Events-IMPACT to register today.

Please remember that your Salesforce username is your email address + .impact (jdoe@email.com.impact)



Smart automation not only increases turbine efficiency, but also helps to structure and connect the ever-increasing masses of data involved.

WITH AN AGING FLEET COMES INCREASED EXPENSES, unexpected failures, and unplanned downtime. Regain control over your turbines with CMS and start planning for your tomorrow.

Condition monitoring systems (CMS) equip turbines with sensors that continuously monitor vibrations across the drivetrain at key locations from the main bearing to the generator. As components begin to wear and degrade, very specific patterns appear within the vibrations which are acquired by the sensors and identified by the CMS unit. In near real-time, these patterns are analysed to localize the defect, diagnose the issue, and assess the severity. With this knowledge, operators can then plan targeted maintenance activities around an optimal schedule (low wind speeds, multiple repairs, etc.), resulting in reduced O&M spending and a quick return on investment. "Bachmann also has products that are tailor-made for wind turbines and wind farms. They are easy to retrofit, control integrated and user-friendly. The knowledge from 20 years of monitoring wind turbines in Europe is combined in our wind power SCADA, atvise® visualisations and in the highly robust hardware", says Brian Hill, General Manager of Bachmann's North American office.

Maintenance Advantage:

Make your condition monitoring data work for you

THE COMPETITIVE EDGE: BACHMANN'S PLC INTEGRATED CMS

Utilizing the existing turbine controller to operate the CMS unit doesn't only save money by making use of the existing controller and tower communication, but it provides a future oriented solution. Fully integrated CMS opens the door to smart automation driven by machine health and resulting in optimal yield. With system security at the core of Bachmann's M1 platform, this means safe and reliable results for years to come. "With a capable Bachmann controller already in place, it becomes very cost effective to install a Bachmann integrated CMS with only a few new pieces of hardware. Saving cost by not needing additional networking infrastructure when compared to traditional stand-alone systems," emphasizes Hill. Stand-alone CMS options are also available for wind turbines not controlled by a Bachmann M1 system. "Depending on the design, an integrated installation can be aimed for here as well as a stand-alone solution," adds Brian Hill. ♦



There is a 30 per cent cost difference between being able to use all the available data and not having it at your disposal.



SCADA
webMI

WIND POWER SCADA MORE TRANSPARENCY – MORE POWER

CUSTOMER REQUIREMENTS INCLUDED.

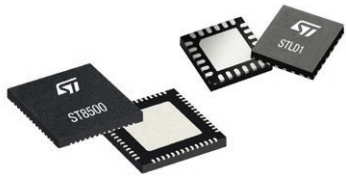
Flexible, configurable, adaptable; Expandable to customer requirements; Access security through user management

READY-TO-USE.

Wind branch requirements integrated; Online configurable and adaptable; Fast efficient overview (dash-board)

INVESTMENT SECURITY.

Based on pure web technology; Responsive design, Standard protocols (OPC UA, IEC 61400-25, ...)



Powerline-communication chipset

The STMicroelectronics ST8500 is a powerline-communication (PLC) solution which features a G3-PLC CENELEC B certified protocol stack for industrial applications beyond utility metering. In addition to covering all G3-PLC standards and frequency bands, ST8500 also offers certified libraries for all PRIME standards, from PRIME 1.3.6 to PRIME 1.4 in CENELEC and FCC bands. Each of the stacks features high-performing routing algorithms to ensure network coverage in all application domains. Fully programmable, containing a dedicated real-time engine to handle the modulation and coding schemes of different PLC standards and a power-efficient Arm Cortex-M4F core for upper-layer processing and system management, the ST8500 allows product manufacturers to address multiple markets and regions with a single hardware platform, and future-proof assets in the field by remote update. Dedicated peripherals for smart-energy applications, including an AES cryptographic engine, are also integrated. Consuming less than 100mW in receive mode, the ST8500 meets stringent industrial specifications to minimize the grid load imposed by new smart meters. With a complete Analog Front End (AFE) on-chip, the ST8500 connects directly to ST's STLD1 line driver to create a complete single-vendor powerline-transceiver solution. The STLD1 ensures reliable communication even across noisy cables, with high drive capability and high linearity over a wide output range of 18V in single-ended or 36V in differential mode. The two-chip set delivers high performance, low power consumption, flexibility, and cost-effective connectivity for smart-grid and IoT applications.

STMicroelectronics /// www.st.com



THE POWER OF QUALITY

Your all-in-one resource for all transportation needs. We tediously manage logistics for all shipments, both domestic and foreign. Streamlining the entire supply chain process for your company so shipments arrive economically, safely, on time and to the quality standards set by the manufacturer.

Services & Capabilities

- Distribution Services
- Inventory Management
- Rail & Trucking Logistics
- Indoor/Outdoor Storage
- Maintenance

North American Locations

- Grand Forks, ND
- Enid, OK
- Casper, WY
- Levelland, TX
- O'Neill, NE
- Pueblo, CO
- Garden City, KS

TPANDL.COM • (307) 337-7991



Service accommodation and transfer vessel

Damen Shipyards Group's new design, The Fast Crew Supplier (FCS) 3410 service accommodation and transfer vessel (SATV) contains numerous design features that ensure its suitability for operations in the developing offshore wind market in North America. The premise of the design is the Damen Twin Axe bow design. The Axe Bow allows the vessel to cut through waves instead of slamming, significantly improves seakeeping and onboard comfort. The FCS 3410 is 6 metres longer than previous FCS types and able to host more on board personnel and accommodation. The FCS 3410 is also designed for transporting and providing accommodation for offshore personnel for up to a month. The FCS 3410 would be built on location in the United States. For many years, US partner yards have built Damen designs at domestic locations, providing American ship owners with access to Damen's designs while complying with the requirements of the Jones Act. This process, the Damen Technical Cooperation, ranges from simple licensing up to the delivery of full materials package, including technical support.

Damen Shipyards Group /// www.damen.com



Identifying wind component failures before they occur

Predict, Greenbyte Energy Cloud's new feature uses statistical models, artificial neural networks, and machine learning to identify wind turbine component failures before they occur. The feature alarms users on changes in temperature that indicate need for maintenance. Predict's advanced statistical models developed by Greenbyte's Head of Research, Dr. Pramod Bangalore have been optimized for high accuracy and in collaboration with Greenbyte's R&D Department, been put to vigorous testing to ensure high accuracy. Predict estimates the expected temperature for critical components, compares that estimated data to the actual measured values, and enables intelligent and early detection of developing failures. The pilot study on Predict detected faults 2 to 9 months in advance, achieved 94% accuracy and showed a 23% reduction of cost, and the software keeps learning and outperforming itself.

Greenbyte /// www.greenbyte.com



Online imagery portal with analytics

Spottitt Ltd. has launched a cloud-based workspace that puts satellite imagery sources and advanced analysis capabilities at the fingertips of energy, environment, and infrastructure professionals. The Spottitt service is available through Veracity, DNV GL's industry data platform and online marketplace. The Spottitt online portal gives users instant access to multiple satellite image sources, including open source data from the U.S. Landsat and European Sentinel-2 satellites and sub-meter commercial image products from Airbus Defence & Space and DigitalGlobe. Other geospatial products include Digital Elevation Models (DEMs) and infrastructure feature layers. The major differentiator of Spottitt is the powerful data analytics it offers in the cloud. The user selects from a variety of enhancement and information extraction algorithms that can be applied to their chosen data set. Spottitt workspaces are securely hosted in the Microsoft Azure cloud, giving clients access from any browser-equipped device at any time. Clients are offered the option of paying for imagery and processing as they go or under subscription arrangements.

Spottitt, Ltd.

/// go.veracity.com/SpottittEnergy



Easy-to-don fall arrest harness

The NEWTON EASYFIT is a durable and lightweight fall arrest harness. It is easy to put on while standing due to its integrated vest that keeps its shape and FAST automatic buckles on the sternal closure and leg loops. It offers ergonomic stowage of MGO connectors, and has integrated fall indicators for easy inspection. It is ANSI compliant.

Petzl /// www.petzl.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.



TEAM-1 Academy Inc.

Training Program: Working/Rescue at Heights - Wind Turbine Series

Hours: 8 - 16 hours

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

Number of Participants: 4

Certifications: GWO (Global Wind Organization), MOL WAH

Course Description: TEAM-1 Academy provides safety and rescue training in North America. This course is the global standard for getting wind turbine technicians trained to work safely and effectively using the on-site rescue/evacuation equipment.

www.team1academy.com

SEE AD ON PAGE 12



Abaris Training Resources

Training program: Composite Windblade Repair

Hours: 36

Classroom/Online/Onsite: Classroom and workshop, at Abaris' facility or client's

Number of participants: 12

Certifications: Abaris Certificate of Completion

Course description: This 5-day course is designed for field technicians, inspectors, and supervisors responsible for performing structural repairs to composite wind blades. In this course the students will first be challenged with determining the extent of damage to Fiber Reinforced Plastic (FRP) sandwich panels and then will perform damage removal and proper repair preparation. Finally the student teams will perform repairs to reconstruct the damaged areas in order to match structural fiber axial loads through the damaged area in the blade structure. This process is repeated with various panels, so that the students obtain solid hands-on skills that they can immediately put to work in the field.



Key Features:

- This course promotes and utilizes multi-person team repair concepts similar to those repairs done in the field;
- The student teams will be introduced to the latest hot-bond repair equipment specifically designed for the industry;
- Learn how to position, secure, and control large area heat blankets in accordance with standard industry procedures;
- Custom courses available for groups.

www.abaris.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

EINPART



Einpart, LLC

Product Name: FAA Light

Effective intensity: 2000cd

Horizontal coverage: 360°

Vertical beam: 3

Expected LED life: 20-years

Input voltage: 110V - 230V

Operating voltage: 24V

Overvoltage protection: Class III according to IEC61643-11

Frequency: 50/60Hz

Power consumption: 1.6W / 8.2W

Operating temperature: -40°F to 131°F (-40°C to 55°C)

Weight: 9.7lbs (4.4kg)

Dimensions: 9.5" x 11" x 11" (24.2cm x 28cm x 28cm)

Cable/Connection: Connection terminal and cable gland for individual installation (standard)

Warranty: 5-year warranty

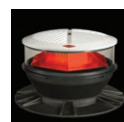
Ratings/Certifications: FAA AC 150/5345-43H & ICAO Annex 14, 5th edition

Key Features:

- Approved FAA Light with GPS synchronized flashing;
- Configurable flash rate;
- Integrated brightness sensor;
- Built in overvoltage protection;
- Combability to: NVG, Lidar, Wireless Mesh radio network, Dimming visibility meter.

www.einpart.com

wind product spotlight: lighting



Hughey & Phillips

Product Name: HORIZON 2000/3000

Effective Intensity: Day White 2000cd; 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: <25W

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



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" (52.3 x 52.3 x 23.9cm)

Cable/Connection: Combined power and alarm connection cable

Warranty: 5-year warranty

Ratings/Certifications: United States Federal Aviation Administration AC 70/7460-1K; Obstruction Marking and Lighting

www.twrlighting.com



Phoenix Contact

Product Name: LED Tower Lighting

Expected LED life: minimum 50,000 hours

Power consumption: +/- 10W (for 230VAC)

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

Weight: 1.51lbs (.687kg)

Dimensions (in/cm): 3.16" x 3" x 12" (9.17cm x 7.62cm x 30.7cm)

Cable/Connection: QPD fast connection, IP67 degree of protection

Ratings/Certifications: UL and ENEC approval

www.phoenixcontact.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 20



EINPART

Einpart, LLC

Product: Lifting Bags

Application: Hoisting and lifting bags

Description: Certified tool bags, safety bags, and lifting bags for the specific needs of the wind turbine and offshore industries.

Key Features:

- Certified high rated tool bags;
- Designed for wind turbine and offshore industries

www.einpart.com

SEE AD ON PAGE 31



Sterling Rope Company, Inc.

Product: Raise and Rescue Elite

Application: A pre-rigged mechanical advantage system designed for simple and efficient victim raising and multidirectional transfers.

Description: When paired with the PDQ2 escape system, the Raise and Rescue Elite makes for a light, compact rescue package. The mechanical progress capture feature allows for secure raising and simple operation, and the mesh sleeve surrounding the 6mm cord prevents tangling during storage and deployment. Two wire anchor slings allow the rescuer to create an anchor around ladder supports or rails, or structural members, and the HollowBlock2 allows for rescue from fall protection



lanyards or longer distance hauling with resets. Kit Components: Mini Haul System, 2 Wire Slings, 19" HollowBlock2, and 2 Osprey Autolock Carabiners.

Key Features:

- Preassembled haul kit, ready to use;
- Progress capture feature allows for secure raising;
- Simple and efficient system for raising a disabled worker from lanyards or cable grab;
- Steel anchor slings allow user to create a secure anchor where needed.

www.sterlingrope.com



Fastenal

Product: Body Guard 260 Series Glove

Application: Box handling, small parts, any application needing extra grip

Description: Body Guard's 260 Micro Foam Nitrile glove provides dexterity, grip, and comfort. Light and breathable, these gloves are oil resistant with their nylon/spandex shell and micro-foam nitrile coating. Abrasion resistant and comfortable, this glove is suitable for almost all applications.

www.fastenal.com



Ropes Park Equipment

Product: Elephant Hub and Phoenix Hub

Application: Rescue and evacuation

Description: The MARK Elephant Hub and Phoenix Hub lifting and lower device is able to lift the personnel upward to unweight their lanyard by easily turning the wheel. After unclipping the lanyard, the person can be lowered to the ground with automatic speed limiting. The participant is never unattached from a safety system during this procedure.

www.ropesparkequipment.com



Skysaver Rescue, Ltd.

Product: IIE Portable Kit – Incapacitated Injured Evacuation Kit

Application: Evacuation of injured or incapacitated workers

Description: A single worker, equipped with a SkySaver IIE Portable Kit, can help lower the injured or incapacitated worker to safety. The easy-to-use SkySaver IIE Portable Kit, which includes a controlled descent device (CDD), portable anchoring accessories, and an ergonomically designed harness, is built to evacuate workers as high as 80m above ground level, within three minutes.

www.skysaver.com

Climb Auto System By 3S Lift

- Single technician, ladder-mounted lift
- Retrofittable to any modern wind turbine
- Improve safety, uptime and employee retention

Learn More at 3SLift.com



Safe · Simple · Specialized
Access Equipment



Corgo Industries

Product: COR-60045

Application: 45 gallon drum bag

Description: The 25" x 25" x 36" lifting bag is a solution for lifting grease or oil drums up tower. This wind turbine maintenance lifting bag is especially designed for oil or grease jobs required in the maintenance of wind turbines. It can also be used as a larger version of the COR-600. This wind turbine lift bag can also be used in any location for work at heights such as bridge work, transmission towers, or stack maintenance.

www.corgoind.com



Hi-Line Utility Supply Co.

Product: QUICKEEZE Adjustable Self-Extinguishing Sleeve Straps

Description: These sleeve straps are self-extinguishing, designed with high quality, FR-Rated materials. Easily adjustable and flexible design allows for comfort all day. Unique oval button design allows for quick and easy attachment with no extra hassles in attaching and detaching. Field-tested for durability and longevity. Made in the USA.

www.hilineco.com

SEE AD ON PAGE 15



SKYLOTEC North America, LP

Product: SKYLOTEC CLAW

Application: Ladder Climbing Safety

Description: The new SKYLOTEC CLAW vertical fall arrest cable sleeve is designed to fit 3/8" and 5/16" diameter wire rope and travels smoothly up and down while providing fall arrest when needed. Weighing only 2.2lbs, the stainless steel CLAW is durable and incorporates redundant safety features reducing the risk of improper installation. The CLAW is independently tested to meet ANSI A14.3-08, CSA Z259.2.5-17, and OSHA requirements.

Key Features:

- Smooth travel up and down the vertical system;
- Replaceable shock absorbing pack;
- Anti-gravity locking system;
- Combinable with all types of chest D-rings;
- Two handed operation for increased safety.

www.skylotec.com



SEE AD ON PAGE 30

3S Lift Safe · Simple · Specialized Access Equipment



3S Lift

Product: Climb Auto System CF-120E

Application: Ladder mounted technician lift for wind turbine generators

Description: The Climb Auto System is wind's next Climb Assist, improving safety and reducing the cost of ownership. The Climb Auto System is a single technician ladder-mounted lift, retrofittable to any new or existing wind turbine ladder, that completely removes the physical and mental stress of climbing, allowing technicians to keep their mind on the job, not on the climb. With over 21,000 units installed globally and certifications from CE, UL, ANSI, OSHA and more, the Climb Auto System is a safe and cost effective way for technicians to ascend a tower.

Key Features:

- Independent fall arrest system for personnel and Climb Auto System;
- Safety control switches on both handles;
- Rated at 310lbs, meeting industry standard for fall arresters and ladder systems;
- Remote mode allows for easy tool transport without an internal hoist;
- Collapsible pedals allow for rapid evacuation in the event of an emergency.

www.3slift.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



Snap-on Industrial

Product: Tools@Height Drop Prevention

Application: Elevated work

Description: Snap-on works with their customers to determine the tools, attachment points, lanyards, pouches, and holsters needed for a turnkey drop-prevention solution. Tools are configured to achieve a reliable system that meets individual safety standards. Snap-on engineers and certifies attachment points that maintain tool functionality and are significantly more durable than "add-ons" which require assembly, frequent maintenance, and replacement. With 70% of drops occurring during tool exchange, Snap-on Tools@Height employs independent tethering to eliminate exchanges. This practice allows tools to be removed from, and returned to holsters or pouches using one hand, maintaining "three points of contact" when working at height.

www.snapon.com/industrial

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: ASAP Personal Fall Arrest System

Application: ANSI Compliant Personal fall arrest system

Description: The ASAP is an easy to install fall arrest system that follows the technician wherever they go without manual intervention. In the case of a slip or fall, the ASAP locks onto the rope and arrests the fall, and it cannot be overridden. The device can be used in vertical or inclined environments.

www.petzl.com

PURE FOCUS GETS THE JOB DONE.

THE RIGHT GEAR HAS YOUR BACK.

Buy Sterling Gear, including the new PDQ2 Rescue System, at your local Sterling Dealer.



PDQ2™ Rescue System

- A lightweight, easily deployable rescue solution for people who work at height
- 6 mm XTEC™ heat-resistant Technora® rope is available in custom lengths
- Standard rope length is 120 M, with a system weight of 8.8 lb
- Certified to ANSI Z359.4



Made in U.S.A.
with U.S. and Globally Sourced Material

© 2018 Sterling Rope Company, Inc. | SterlingRope.com/FreedomToFocus



Freedom To Focus™



February 27th-28th, 2019
Hotel Del Coronado
San Diego, CA

www.awea.org

As the wind energy industry continues to expand, so does the need for an evolving approach to operating the nation's growing number of wind projects. Fortunately, there is no shortage of experience to draw from in this arena. Individuals from across industry sectors and across functional disciplines will join in San Diego in February to set a vision and plan for continued and expanded operational excellence in the wind industry. Be a part of the largest North American gathering of wind energy operational professionals and technicians, as they combine the essential elements of O&M, health and safety, workforce development, and quality assurance to develop a successful partnership for today and beyond.

show in print

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



Carbon brushes and brush holders

Helwig Carbon is a manufacturer of carbon brushes and brush holders used on wind turbine generators. American made ISO certified. Their products are designed to provide long life and low maintenance costs.

Helwig Carbon Products, Inc.
www.helwigcarbon.com



Wind blade repairs

WindCom provides solutions for their customer's blade needs. High levels of technical competence paired with flexible repair options offer customers year-round, reliable outcomes. Every step of the blade repair process utilizes technology so customers can quickly and easily monitor their fleet. From zero-loss, high-speed inspections to online repair documentation and work instructions, WindCom is able to rapidly and safely respond to demanding repairs in the wind market.

WindCom Services
www.windcomservices.com



Lightweight evacuation and rescue system

The PDQ2 descent-control device and the 6 mm XTEC heat-resistant Technora rope form the core of this system whose total weight is under 10lb (for a 100 M system). The fully-assembled kit comes ready for deployment, and packed into a durable, weather resistant carrying bag which allows it to be carried comfortably by the technician until needed. Custom lengths and configurations are available upon request. Weight: 8.85lb, MBS: 3,147lb, Certification: ANSI Z359.4.

Sterling Rope Company, Inc.
www.sterlingrope.com



Fall arrest cable sleeve

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

SKYLOTEC
www.skylotec.com



Tools for in-situ slip ring machining

The Mersen portable lathe for up-tower generator slip ring resurfacing is a quick method to bring a slip ring back into operational specification. By eliminating the need to swap out an affected slip ring, maintenance crews can reduce downtime associated with slip ring issues. Ground rings are known to be susceptible to wear in the brush track under certain operating conditions. Poor grounding ring surface conditions can also lead to erratic temperature readings in a wind turbine and affect other electrical components. The portable lathe allows technicians to resurface just the affected ground ring and bring the turbine back online. Advanced tools to verify slip ring surface condition after machining and the Total Indicate Runout (TIR) are also available. Mersen offers technical training and hands on up-tower training sessions to use these tools which help maintenance crews increase availability numbers at their respective wind farms.

Mersen
www.mersen.com



Customizable SCADA analytics

Bachmann's Wind Power SCADA is a customizable, easy-to-use solution that helps manage wind farms. Maximum flexibility ensures rapid implementation, ease of operation, and the possibility to expand the installation efficiently. Users can prioritize the information they want to see and achieve the security levels required to keep data and assets safe. Live data from different farms and turbines can be compared to support detailed analysis, including power curve, wind distribution, energy production, and switch counters in the form of graphs and/or tables. Bachmann's Wind Power SCADA is based on pure web technology, allowing for a wide range of devices; a browser is all that's needed to access secure, extensive, and detailed information on an entire fleet.

Bachmann Electronic
www.bachmann.info



Fully synthetic gear oil

Shell Omala S5 Wind advanced fully synthetic gear oil offers lubrication performance even under severe operating conditions. The formulation is developed to protect wind turbine gears and bearings by minimizing wear, protecting against micro-pitting, maintaining effective fluidity at extremes of low temperature, and minimizing foam formation. Shell Omala S5 Wind is designed to help extend maintenance intervals. It will defend against deposit formation and prolong gearbox life. Shell Omala S5 Wind is designed to meet or exceed OEM requirements of Siemens Wind Power, ZF Wind, Vestas, and Gamesa. It also meets or exceeds following OEM component requirements of Winergy, NGC, Bosch-Rexroth, Eickhoff, Moventas, SKE, Timken, Schaeffler, Hydac, CC Jensen, Mintai, and Freudenburg.

Shell Lubricants
www.shell.us



Elevator safety and training

Highly trained elevator mechanics from the International Union of Elevator Constructors not only keep elevators running, they keep them running efficiently, and above all else, safely. They have over 28,000 trained professionals with over 8000 on the job hours and over 2500 classroom hours. Whether it's installation, repair, maintenance, or inspections they are ready to serve. As well as compliance and safety inspections and repairs across the US, their staff sits on the ASME A17.8 committee that writes the codes for these elevators.

Elevator Industry Work Preservation Fund
www.eiwpf.org

2019 SOLAR BUYERS GUIDE

BayWa r.e. Solar Systems, LLC /// www.baywa-re.com

DIRECTORY

ADHESIVES, SEALANTS, TAPES & PASTES
ALUMINUM EXTRUSION & METAL FABRICATION
ARCHITECTS | BUILDERS
BACKSHEETS
BALANCE-OF-SYSTEMS (BOS)
BATTERY | ENERGY STORAGE
COMPONENTS | ELECTRICAL PROTECTION
CONCENTRATED SOLAR POWER (CSP)
CONSULTANTS | BUSINESS & ENVIRONMENTAL CONSULTANTS
CONTRACTORS | EPC
ECONOMIC DEVELOPMENT
EDUCATION | RESEARCH DEVELOPMENT
ELECTRICAL WIRE, CABLE, & CONNECTORS
ENCLOSURES | COMBINER BOXES
ENERGY STORAGE SYSTEM
ENGINEERING | OPERATIONS & MAINTENANCE (O&M)
FINANCIAL SERVICES
GROUND SCREWS | ANCHORS

HANDLING | MANUFACTURING
INSURANCE SERVICES
INVERTERS
LEGAL SERVICES
LIGHTNING & SURGE PROTECTION
MICROINVERTERS
MODULES
OPERATIONS & MAINTENANCE
PERFORMANCE MONITORING
PERMITTING
POSITION SENSORS
PV DISTRIBUTORS
PV INSTALLERS
PV MANUFACTURERS & EQUIPMENT
PV MODULE INSPECTION
PV WASHING SYSTEM
RACKING & MOUNTING SYSTEMS
RESIDENTIAL OR SMALL OFFICE SOLAR | PV
ROBOTICS

ROLL FORMING
SAFETY
SEMICONDUCTORS
SITE ASSESSMENT & FORECASTING
SOFTWARE SUPPLIER
SOLAR FASTENERS
SOLAR HOT WATER INSTALLERS
SOLAR INTEGRATION
SOLAR SUPPORT STRUCTURES & CARPORT SYSTEMS
SOLAR THERMAL MANUFACTURING & EQUIPMENT
SOLAR THERMAL SYSTEMS
TESTING & CERTIFICATION | TESTING CHAMBERS
THEFT PROTECTION
TOOLS
TRACKING SYSTEMS
TRANSFORMERS
UTILITY SCALE SOLAR | PV
WIRE MANAGEMENT

OTHER
Aerial Imagery Solar Report
Associations
Capacitors
Construction
Equipment Manufacturer
Floating Solar Platform
Ground Cover Seed
High Voltage Electrical Equipment Manufacturer
Industrial Networking
Oil Containment | Spill Prevention
Online B2B Exchange
Portable Solar
Power Engineering & Consulting
Protective Solar System Barrier
PV Off-Grid
Radiant Heating
Rapid Shutdown System
Rock Crusher and Milling
Smart Off-Grid Control | Management
Solar HVAC Equipment Manufacturer
Solar Panel Heating
Solar Pump
Solar Radiometer Calibration
Solar Screen Manufacturing
Solar Slip Sheets and Block
Utility Locating & Concrete Scanning
Vegetation Maintenance

Adhesives, Sealants, Tapes & Pastes



American Polywater Corporation

Polywater FST duct sealant meets the national electrical code for sealing conduit and raceway systems. FST protects electrical equipment and apparatus providing electrical reliability for a user's system. BonDuit conduit adhesive bonds PE conduit to PVC, rigid steel and fiberglass conduits making a water-tight joint. BonDuit creates stronger bonds than push on or reverse threaded couplings. Type RP cable prep and electrical maintenance cleaner offers a safe effective alternative to other cleaners that have environmental and health concerns.

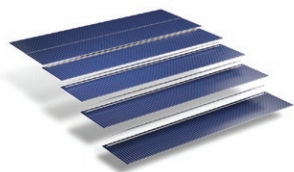
www.polywater.com



CHT USA

Silicone encapsulants and sealants offer environmentally friendly, long-term protection to meet the demands of a variety of solar panel applications from panels to junction boxes. UV resistant encapsulating grades also outperform organics. CHT USA offers optically clear and non-yellowing systems, with corrosion-resistant properties, as well as thermally conductive grades for heat management. UL rated, flame-retardant, potting grades are also available for junction box applications. Additionally, silicones with primer-less adhesion are offered for bonding to a variety of plastics.

www.cht.com/us02.en



Henkel Corporation

Henkel provides electrically conductive adhesives (ECAs) and has a broad technology toolbox and ECA formulation expertise that spans well over 50 years. The company's photovoltaic ECAs and processes are designed to enable heterojunction, shingle, and other solar cell and module types. Henkel supplies unique technology, enabling high volume quality and providing deep process know-how. Henkel's capabilities translate into high quality and low cost per kilowatt-hour for both module OEMs and consumers.

www.henkel-adhesives.com

Aluminum Extrusion & Metal Fabrication



Alexandria Industries

At Alexandria Industries, experienced engineers, manufacturing specialists, and solar market experts help create racking and mounting product solutions to specification. Their recommendations are driven by their customer's part's essential functions and how these interact with, and affect, mating parts and the end product solution.

www.alexandriaindustries.com



HYUNDAI ALUMINUM

Hyundai Aluminum Americas, Inc.

Hyundai Aluminum Americas, Inc. is a subsidiary of The Aluko Group of Seoul, S. Korea. With 5 aluminum extrusion and fabrication facilities in S. Korea and Vietnam, they supply solar panel manufacturers with punched, mitre cut, anodized aluminum extruded panel frame sets. Their frames come with corner keys pre-inserted into the short frame, saving time and eliminating waste. Their new (2017) facility near Hanoi, Vietnam has available extrusion and fabrication capacity.

www.hyundaialuminumamericas.com

Architects | Builders



E8 Energy Group, Inc.

E8 Energy Group is a developer and EPC company for renewable energy projects, including photovoltaic, solar thermal, biomass, hydroponic and green houses, operation and maintenance, EPC contracting, electrical contractor, and LED retrofits.

www.e8energygroup.com

Backsheets



FLEXcon Company, Inc.

Whether it's for use with standard, fast, or ultra-fast cure encapsulants and laminating processes, FLEXcon multiGUARD multi-layer backsheet products offer long-life UV and moisture protection and insulative properties as a back laminate for photovoltaic panels. A high-performing laminating adhesive enhances film bonding for strength and durability. FLEXcon constructions meet strict IEC and UL requirements.

www.flexcon.com



Griff Applied Laminates

ISO Certified manufacturer of traditional and thin film back-sheets, Griff Applied Laminates provides custom extruding of engineered films, barrier films, light management films, EVA extrusion coating, top-sheet coating, and laminating to improve manufacturing efficiencies and custom designs. They also offer complete slitting, rewinding, and sheeting with die-cut notches for connectors. They can assist with product development and complete testing services are offered for existing and new business inquiries.

www.thegriffnetwork.com

Balance-of-Systems (BoS)



Hammond Power Solutions

HPS EnduraCoil cast resin transformers provide a cost-effective solution for utility-scale solar applications. EnduraCoil meets UL standards and is rated up to 35kV and 3MVA. It can be provided within a suitable outdoor rated enclosure or as a core and coil component as needed. Cast resin transformers are environmentally sustainable with low maintenance requirements.

www.hammondpowersolutions.com



HellermannTyton

Announcing two wire fasteners for routing module and homerun wires on utility scale solar systems. The Button Mount with Solar Tie is made of highly engineered plastic and provides a safe attachment point for the tie, isolating it from sharp holes. The Solar Locking Clamp quickly mounts in mounting holes, and an integrated Solar Tie saddle allows installers to add additional cables. Designed to be long-lasting, the locking clamp adjusts to secure up to four cables. Both mounts are made of high impact modified, heat-resistant, UV stabilized material.

www.hellermann.tyton.com



Shoals Technologies Group

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

www.shoals.com



SolarBOS

SolarBOS offers both DC and AC Balance of Systems products for photovoltaic systems. Rapid Shutdown Solutions represent low-cost and space-saving solutions for commercial solar systems utilizing string inverters. AC Combiners then combine multiple string inverter outputs. All solutions are highly configurable to fit any application and are built to customers' specifications. SolarBOS products are designed and manufactured in the USA with emphasis on clean design, quality and cost-effectiveness. SolarBOS products are listed to UL-1741.

www.solarbos.com

From both sides now.



Single-Axis
Tracker



[PV SOLAR TRACKER]
E476688



**SCAN THIS QR CODE
AND DISCOVER ALL
THE SF7 FEATURES**



Soltec

SF7 Single-Axis Tracker standard features provide for drop-in bifacial compatibility with higher mounting height, shadow-free backside, and wide-aisle reflecting surfaces. In addition to intrinsically optimizing bifacial gain, the standard features enable other economic and performance benefits compared to the leading competitors.

Battery | Energy Storage



AIMS Power

AIMS Power introduces its new battery product line of LiFePO4 batteries. The LiFePO4 batteries maintain constant output voltage, providing more efficient power. This allows the cell to deliver full power until it is completely discharged without harming the battery, and it can simplify or eliminate the need for voltage regulation circuitry. The battery has an approximate 10 year cycle life capacity, and is easy to maintain. The LiFePO4 technology has high thermal and chemical stability, which improves battery safety. AIMS Power's LiFePO4 battery line is powerful in a small and lightweight footprint and uses the same space as existing 12V battery systems.

www.aimscorp.net



Battery Systems

Battery Systems provides their customers with battery products, combined with efficient service, offered at competitive prices. Their batteries are suited for applications including, automotive, marine, RV, solar, golf, industrial, and more. They also offer free battery testing.

www.batterysystems.net



Can Solar, Inc.

Can Solar, Inc. presents their Solar Power Bank for Home, which receives up to 2kW solar power, kept in 2.5kWh or 5kWh LiFePO4 batteries and then converts to 110VAC power, with utility charging capability. Users only have to connect their solar modules. The all-in-one design puts necessary functions into a compact enclosure, bringing conveniences to users. Users can check Power Bank status through an optional mobile phone app.

www.cansolarenergy.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



EnerSys

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

www.enersys.com



Fortress Power

Fortress Power offers their new energy storage solution, the G2LFP-15 battery. The V2 battery uses Lithium-Ferro-Phosphate technology and offers a new user-friendly front display, so all aspects of the system can be monitored. Their new V2 series is not only compact, but can power up to 8 stacks in parallel. Fortress Power was able to maximize the power capacity and modernize the V2 battery all while keeping beneficial features such as time-of-use power, self-use, and off-grid. Fortress Power batteries have a 10-year warranty and offer long life cycles (up to 6,000 cycles).

www.fortresspower.com



Leoch Battery Corp.

Leoch's Pure Lead + Carbon Technology has been specifically engineered to support partial-state-of-charge applications where the batteries are cycled regularly. These high power, energy dense batteries offer super-fast charging from 0% to 90% in 1.5 hrs. with high performance in extreme environmental conditions and a long deep cycle life of 2200+ @ 50% DoD. The ABS-poly-carbonate jars enable wide operating temperatures from -30°C to +60°C. Telcordia approved NEBS level III, GR63, and tested to IEC 60896-21-22 requirements.

www.leoch.us



Lithium Werks

Lithium Werks manufactures lithium ion batteries that can be arranged in systems between 12V-1000V, from kWh to MWh. As a result of stable, high-quality, lithium iron phosphate (LiFePO4) chemistry, Lithium Werks' diverse offerings of 12V, 24V, and 36V modules have a high cycle life and float life, suitable for energy storage markets such as renewables and UPS. Through this 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.

www.lithiumwerks.com



MK Battery

MK Battery now distributes the Deka Solar Fahrenheit advanced AGM battery HT200ET which is specifically designed for energy storage in Grid Tied backup systems in high heat applications. Engineered for high power, their exclusive IPF Technology enhances energy capacity, cell consistency, and long-term reliability. The Deka Fahrenheit battery case is constructed of THT Plastic, specifically designed to resist heat and optimize compression, and the TempX Alloy helps inhibit corrosion under high temperature extremes. Epoxy-sealed posts eliminate leaks while the case and cover are heat sealed and 100% tested to prevent overall leakage. To further mitigate thermal buildup and cell dry-out, the Microcat Catalyst is utilized to lower float current and maximize the efficiency in high-heat applications.

www.mkbattery.com



Phocos Americas, Inc.

The Phocos CIS-MPPT Series of charge controllers offer a solution for off-grid applications such as telemetry, outdoor lighting, SCADA, and monitoring. This product was developed to ensure reliable battery protection under extreme weather/environmental conditions that often results in damaged electronics. The robust CIS-MPPT Series also has advanced lighting controls, programmable load timing, is IP68, and can offer 2 years of performance data (with accessory).

www.phocos.com



Repowertek, Inc.

PRIME Battery regenerators were developed using a high-frequency pulse technology and restoration algorithm, which creates micro-bubble featured de-sulfation effects by the real high-frequency pulsations. PRIME can restore inside cells by melting sulfate crystals on the plates and grids, and improve its capacity and life span almost like a new battery. Thus, PRIME provides high charging performance for used-batteries. PRIME battery regeneration technology provides battery life extension and cost savings.

www.repowertek.com



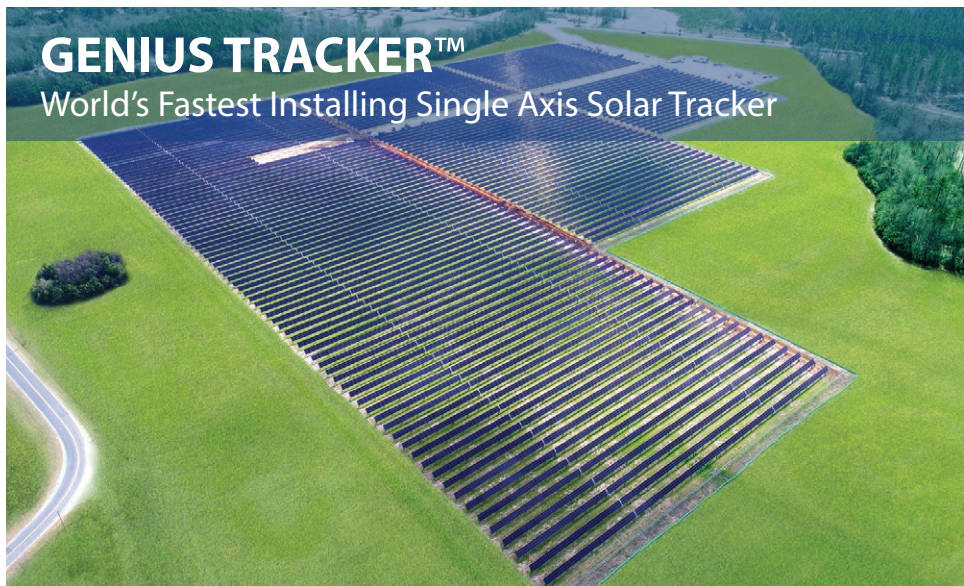
Rolls Battery Engineering

Designed to deliver longterm reliable energy storage in a heavy-duty, dual-container design, Rolls 5000 Series 6 volt models offer heavy-duty thick plate construction for extended cycle life and durability, convenient modular cell assembly for transportation and maintenance, and high Amp-Hour capacity options to suit small to large-scale renewable applications.

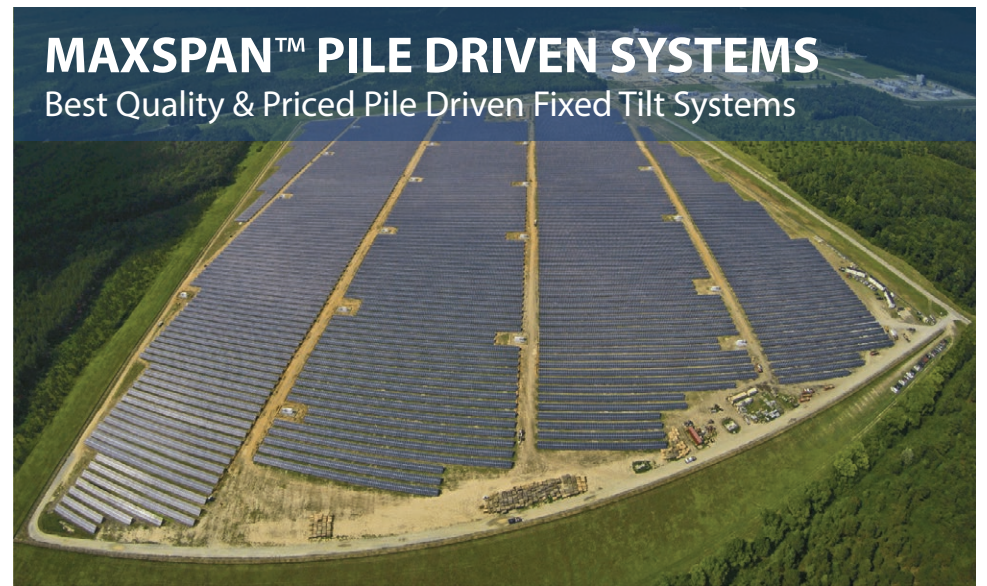
www.rollsbattery.com

OVER 4 GW SOLD

Every System For Your Every Need



GENIUS TRACKER™
World's Fastest Installing Single Axis Solar Tracker



MAXSPAN™ PILE DRIVEN SYSTEMS
Best Quality & Priced Pile Driven Fixed Tilt Systems



POUR-IN-PLACE™ BALLASTED GROUND SYSTEM
Landfill Leader & Best Solution for Rocky Sites



PRECAST BALLASTED GROUND SYSTEM
Fast Installing Solar Mounting System for Landfill Sites



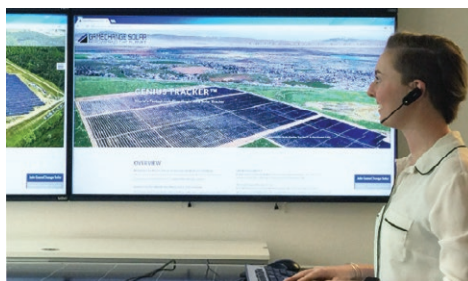
GRID-LITE™ ROOF SYSTEM
Cost Effective Ultra-Low Weight Ballasted Roof System



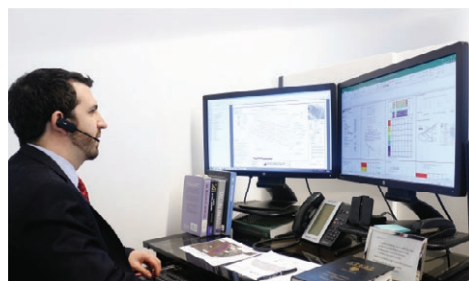
STANDING SEAM ROOF SYSTEM
Complete Solution for Metal Roofs Zero Ballast

BANKABLE QUALITY VALUE PRICING

GameChange Solar is driven by its mission to repower the planet with clean solar energy. We do our part by driving fixed tilt racking and tracker equipment costs lower. With over 4 GW sold, GameChange systems combine fast install, bankable quality and unbeatable value through superior engineering, innovative design and high volume manufacturing.



Best in Class Customer Service



Superior Engineering in Structural, Civil, Mechanical & Electrical



In-House Logistics for On Time Deliveries



One Stop Solution for Geotech, Pull test & Turnkey Services

Capital Intro™



GameChange Solar works with IPP's, Private Equity Firms and utilities that invest in and own projects. We introduce them to developers and EPCs who have projects to build. This enables more projects to be financed and built, furthering our mission to repower the planet with cleaner energy.

GameChange Solar's Capital Intro™ program currently has over \$8 billion in available capital from multiple sources.

**TOGETHER
LET'S REPOWER
THE PLANET**

Headquarters:
152 W 57th Street 44th FL
New York, NY 10019
Phone: (212) 388-5160
gamechangesolar.com

Europe Office:
Dublin, Ireland

Massachusetts Office:
Brimfield, MA





Sun Xtender Batteries

Sun Xtender provides renewable energy storage batteries for off-grid and grid-tied systems. Sun Xtender designs high-density plates specifically for renewable energy applications that reduce impedance and improve charge acceptance for high efficiency, reliability, and extended life. Sun Xtender manufactures sealed Deep Cycle Absorbent Glass Mat (AGM) batteries. They never require watering and pose no risk of spilling with minimal maintenance. Sun Xtender batteries are 100% recyclable and offer 2V, 6V, and 12V models.

www.sunxtender.com



Trimark Associates, Inc.

Trimark develops, installs, and maintains performance management systems for utility-scale power sites. These systems measure, control, and enable users to manage power production, energy storage, and utility interconnections. Trimark's integrated products – SCADA, revenue meters, MET stations, battery energy storage, and microgrid management systems – optimize site performance, resulting in increased revenue. Trimark's advanced control functions guarantee power characteristics at POI. Trimark provides CAISO NRI and NERC CIP consulting that results in regulatory compliance and secure operations.

www.trimarkassoc.com



Trojan Battery Company

Trillium, Trojan's Intelligent Lithium battery is designed and engineered in the USA and is available in 3 popular sizes that can be used in a variety of applications in solar. From its cell and battery design to its intelligent, built-in diagnostics, Trillium offers a range of advanced safety, environmental, and electronic features. With life expectancy over 5,000 cycles, Trillium will deliver outstanding return on investment over time. Trillium is designed as an easy replacement for existing lead acid batteries.

www.trojanbattery.com



U.S. Battery Manufacturing

U.S. Battery Manufacturing has been building flooded lead acid batteries since 1926 and manufactures deep cycle batteries specifically for many industries, worldwide. The company's RE Series batteries are designed to provide high peak capacity, long cycle life, and reliability for use in industrial or residential renewable energy applications. RE Series batteries utilize the company's XC2 formulation and Diamond Plate Technology to create an efficient battery plate, delivering high watt-hours per liter and watt-hours per kilogram.

www.usbattery.com



VRB Energy

VRB Energy's vanadium redox batteries (VRB) store energy in liquid electrolyte in a patented process based on the reduction and oxidation of ionic forms of the element vanadium. Based on a 250kW containerized module, VRB-ESS is typically 1MW / 4MWh up to 10MW / 80MWh in size installed at utility, commercial, and industrial sites, in support of solar or wind farms, or in isolated microgrids. Typical configurations use 4, 6, or 8 hours of storage depending on the amount of energy required. The battery is safe, reliable, and non-toxic. Components can be nearly 100% recycled at end-of-life, dramatically improving lifecycle economics and environmental benefits.

www.vrbenergy.com

Components | Electrical Protection



ABB Installation Products

ABB Installation Products is a solar-power system component and connections supplier. Some of ABB's products that are available for the solar power industry include metal framing, current-limiting fuses, connectors, conduit and fitting systems, and UV-resistant cable ties. For example, the T&B Fittings Sand Cast Aluminum Form 7 Conduit Body is made of CoroStall aluminum alloy, which is a highly corrosion-resistant aluminum alloy. ABB also provides training for the correct installation and maintenance of their products.

www.tnb.com



Allied Industrial Marketing, Inc.

Allied Industrial Marketing has over 30 years of experience specializing in power quality and helping clients diagnose problems through engineering analysis and computer simulation, and they provide recommendations on problem solving methods. For OEMs of power quality solutions, they offer power quality components; Mangoldt Filter Reactors, Line/Load Reactors, Current Limiting Reactors, Low and Medium Voltage Reactors, Frako Capacitors, Contactors, and Power Factor Corrections Controllers. Educational power quality seminars are also available.

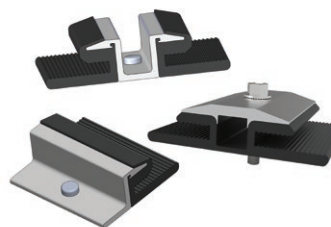
www.alliedindustrialmarketing.com



Bal Seal Engineering, Inc.

Bal Seal Engineering, Inc. works with OEMs and tier suppliers to design and produce sealing, connecting, conducting, and EMI shielding solutions that improve the performance and reliability of equipment used in wind, solar power, 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



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



Day Ahead Instrumentation

Day Ahead Instrumentation (DAI) is a provider of custom protection relays and remote terminal units (RTU) for distributed generation system integration. DAI provides turnkey multi-function relays for utility interconnection requirements for C&I applications. Typical systems include solid state relays, test switches, mini-station batteries, and NEMA 1/3R/4 enclosures. Assemblies can be configured for DTT, MPLS, or SCADA interface with wired, fiber, or wireless communications. Auto-restoration for utility outages and real time monitoring and reporting of power generation is available. Lead times as low as 20 business days from receipt of basis of design and NTP.

www.day-ahead.com



Eaton

Eaton's globally certified Power Defense molded case circuit breakers embed protection, energy metering, intelligence, and connectivity in a foundational electrical system component to go beyond traditional circuit protection by providing deep power system visibility and predictive diagnostics. Real-time data-driven insights help improve reliability and save costs.

www.eaton.com/powerdefense



EMA Electromechanics, Inc.

In Texas, EMA Electromechanics produces the VDH/GSMI, which combines a circuit breaker and a high-speed grounding switch. Concerning PRC-024-1/2, the VDH/GSMI supports differentiation between internal and external faults, signaling the inverter in a fraction of the 150ms required by the standard, and providing valuable information to take the decision to shut down.

www.emaelectromechanics.com

Type 947D

High Density, DC Link Capacitors



DC link power film capacitors

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

TYPE 947D POWER FILM CAPACITORS

85, 90, 100 & 116 mm CASE SIZES

CAPACITANCE VALUES TO 3600 μF

APPLIED VOLTAGE TO 1500 Vdc

RIPPLE CURRENT RATINGS $>100 \text{ A}_{\text{rms}}$

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



ENERGIZING IDEAS

**CORNELL
DUBILIER**





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 UL248-19 requirements 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



LSIS USA, Inc.

LSIS provides solutions for the power distribution network. LSIS presents low voltage DC power products for the renewable energy market, including UL Listed 600Vdc molded case circuit breakers (up to 800Amps), UL Listed 1500Vdc disconnect switches (up to 4000Amps), UL Listed 1500Vdc power contactors (up to 500Amps), and more.

www.lsis.com/usa



Mersen

1500VDC HelioProtection fuse holders for 10/14x85mm PV fuses provide safety for utility scale photovoltaic applications. The newest addition to the HelioProtection Program, HP15FHM32 series fuse holders feature input and output terminals, accept standard PV rated wiring, and comb bus bars, providing added versatility for end-use installations. The body features high performance UL 94V-0 rated polymer material, providing high flammability rating, durability, and dielectric withstand properties.

ep.mersen.com



Phoenix Contact

Phoenix Contact's new UNO Solar DC-to-DC power converter connects directly to a solar array. The UNO Solar converts high voltages from DC strings to 24VDC, eliminating the costs and hassle of trenching for combiner, re-combiner, and inverter control for anti-islanding applications. The UNO Solar accepts the 300 to 1000VDC input generated by the array and converts it to electrically isolated 24VDC/2.5A output voltage. For higher current applications, the UNO Solar can be wired in parallel with the use of a decoupling diode.

www.phoenixcontact.com/unosolar



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. Their specialized energy storage (ES) fuses are available from 400V to 1500V with high breaking capacity and low L/R.

www.siba-fuses.us



SIMPLY INNOVATIVE. BETTER FOR SURE.



STEGO, Inc.

For over 35 years, 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

Consulting Services | Business & Environmental Consultants



CWL Energy Management Ltd.

CWL Energy Management is a project and asset management firm specializing in renewable and sustainable energy development across Canada. Through their fee for service consulting business unit, they support clients in the development of their projects, with a focus on project management, land management, environmental services, regulatory and permitting, technical analysis, and design. Through their Special Projects business unit they deploy their own capital on their own projects through unique community, technology, and indigenous project partnerships..

www.cwleenergy.com



DNV GL

DNV GL is 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 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 management and sustainability, grid integration, 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




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

High Precision Instruments for Solar Energy and Meteorological Research.

eko-usa.com







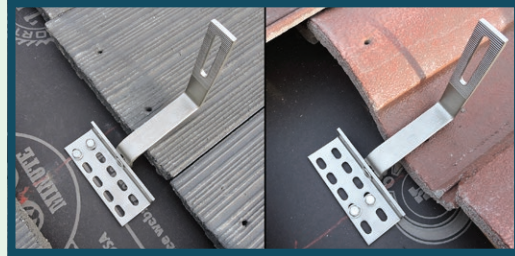
Low Profile QuickBOLT with Microflashing™

The patented Low Profile QuickBOLT with Microflashing™ is SolarRoofHook's most popular and innovative product. Unlike other asphalt shingle roof mounts, the Low Profile QuickBOLT is installed without lifting any shingles, cutting down the installation time to under one minute and reducing the risk of voiding the roofing warranty or breaking code. When driven down, the collar on the bolt compresses the Microflashing™ causing it to adhere to the roofing material and create a leak-proof seal. The Low Profile feature makes creating an array simpler than ever, while the Stainless Steel L-Foot provides a sturdy connection to your rails. Over 300,000 QuickBOLTS have been installed across America with ZERO leaks reported. Save time, money, and the roof with the Low Profile QuickBOLT.



4" Microflashing™

SolarRoofHook's 4" Microflashing™ was created after hearing from installers that they sometimes missed the rafters. This larger diameter adds an extra inch to the original 3" Microflashing design and allows installers to cover extra holes in the installation area if they miss a rafter. The 4" Microflashing™ is available with any of SolarRoofHook's QuickBOLT kits, including the popular Low Profile QuickBOLT. With the same effectiveness and easy installation as the original QuickBOLT with Microflashing™, the 4" Microflashing™ provides installers with more coverage and peace of mind.

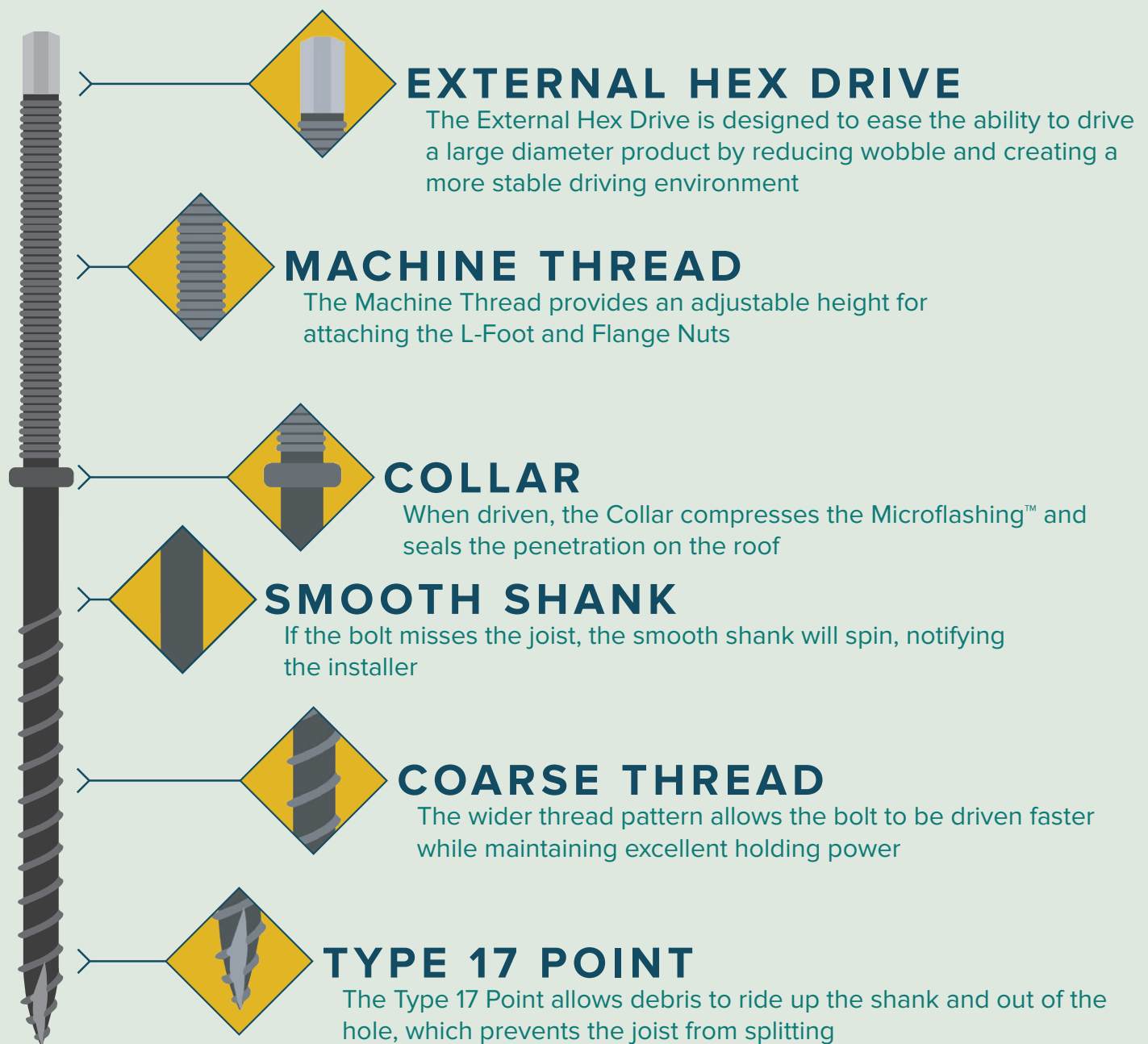


Adjustable All Tile Roof Hook

SolarRoofHook's Adjustable All Tile Roof Hook is the simple solution for installing solar on Curved or Flat Tile roofs. The base has three leverage points, providing flexibility for the installer when mounting to the roof. It is also height adjustable and works on roofs with or without battens. The various mounting screw slots make it easy to work with the placement of the rafters and the 10mm x 46mm rail attachment allows for the flexibility needed to create a level array. Simplify your buying and installing with this versatile tile roof hook.

QUICKBOLT:

MORE THAN YOUR AVERAGE LAG BOLT



SOLARROOFHOOK.COM

(844) 671-6045 • MON-FRI: 7AM-5PM PST



Schlesinger Consulting

Schlesinger Consulting provides consulting services for general management, marketing, and electrical engineering for the renewable energy industry. Specific expertise includes wind and PV projects, and for the mitigation of the effects of lightning on electrical systems.

www.schlesingerconsulting.com



The C Three Group

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

www.cthree.net



Westlake Consultants, Inc.

Westlake Consultants, Inc. offers integrated land use planning, permitting, land surveying, and civil engineering services to support site development. They have worked on energy development projects going back over 15 years. Westlake is licensed in several US states, and is a federally-registered, woman-owned small business.

www.westlakeconsultants.com



Westwood Professional Services

Westwood is a national multi-disciplined surveying and engineering firm with experience gained from supporting more than 7GW of utility-scale, commercial and industrial, and solar-plus-storage across the US. Their in-house expertise includes: environmental permitting, electrical, civil, geotechnical, structural, surveying, aerial mapping, and construction administration.

Westwood has offices across the US and is licensed in nearly every state.

www.westwoodps.com

Contractors | EPC



Black & McDonald, Inc.

Black & McDonald offers solar energy construction management and execution, having provided construction services for solar farms producing over 200MW of power. Their first photovoltaic solar farm was completed in 2010 with an installed capacity of 80MW. The plant covers 950 acres and contains approximately 1.3 million thin film panels. Their knowledge, experience, multi-trade capabilities, and resources allow for project efficiency with minimal exposure to risk.

www.blackandmcdonald.com/us



Black & Veatch

Black & Veatch provides comprehensive bankability, planning, siting, design, operations & maintenance, and full EPC as well as construction only services for all types of renewable energy. From utility-scale plants to commercial and industrial-scale rooftop solar PV systems, Black & Veatch can deliver a complete turnkey solar solution.

www.bv.com



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



Rosendin

Rosendin takes on challenging solar PV projects in different locations, environments, and industries across all distributed generation and utility-scale applications. Project sizes range from 100KW to over 400MW systems utilizing applicable PV or Thinfilm technology in a mix of rooftop, ground mount, single and dual-axis tracker, and canopy-based installations. Rosendin has installed the capacity to harness over 16GW of clean, renewable energy, including 80+ wind energy projects throughout the U.S. and Canada ranging in size from 1MW to over 800MW. Rosendin installs Battery Energy Storage Systems for Frequency Control and regulation, demand response, peak shaving, microgrid applications, and backup power.

www.rosendin.com



Signal Energy, LLC

Signal Energy is an EPC contractor for North American and Australian energy companies. Signal Energy has 8000MW of utility-scale renewable project experience and 1500MW of solar project experience. They support their customers with an in-house Preconstruction Solutions Group, internal mechanical installation resources, and high voltage engineering and design capabilities. This allows Signal Energy to control and coordinate the critical project components reducing schedule risk for their customers.

www.signalenergy.com

Education | Research Development



Solar Rollers

The Solar Roller is a high-tech, customizable solar-powered radio-controlled car. Typically built by high school aged teams, they demand knowledge and hands-on know-how. To make a functional, competitive vehicle, teams design key components such as the chassis and the solar array, plus build the Solar Roller from scratch. Solar Rollers come as a complete materials kit, with all pieces needed to build a basic vehicle. Included is access to the comprehensive online course and registration in one of the regional races. Build as a family, with Girl Scout troops, local high schools, or just for fun. Regional races in Denver, Dallas, San Francisco, and New York.

www.solarrollers.org

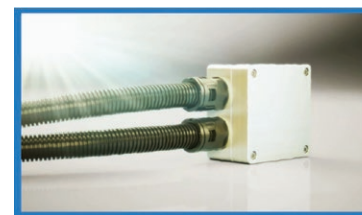
Electrical Wire, Cable, & Connectors



4SProducts

4SProducts increases its manufacturing capacity for PV cables. 4SProducts solar cables are manufactured in a wide variety of conductor sizes and are rated RHH/RHW-2 as per UL44, UL4703, and UL854 standards. Their solar cables are also certified to meet H1Z2Z2-K to EN 50618 and TUV 2 PFG 1169 standards. To meet market demands, these PV cables can be packed with a wide variety of options. The halogen free cables have demonstrated outstanding results in harsh weather conditions and are offered with a 36-month warranty.

www.4sproducts.com



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



SOLA-TECS

SOLAR PANEL
CLEANING DEVICES

PROSOLARCLEAN, LLC.

(707) 327-8997

info@prosolarclean.com

www.prosolarclean.com | www.sola-tecs.com

Semi-automatic, for cleaning commercial and carport solar installations

Effective-motorless technology powered by high pressure water

Brilliant results-maintains solar modules for longer, more productive output



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: 15kV to 35kV 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

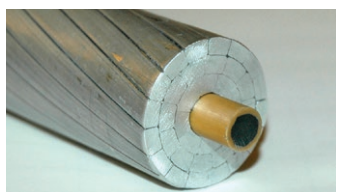


Cameron Wire & Cable, Inc.

Cameron Wire & Cable provides UL 4703 PV 1kV/2kV (aluminum and copper) cables and UL 1072 MV cables. Cameron offers affordable pricing and high performance cables for all applications and will customize the cable package, offering cut-to-length or bulk cables, accessories, labels, and lugs supplied in kits. Cameron also offers inventory management and will warehouse planned goods at no charge, and provides same-day shipping to satisfy tight job deadlines.

www.cameronwire.com

CTC GLOBAL



CTC Global

In association with 25 authorized manufacturing partners, CTC Global produces the high-capacity, low-sag ACCC conductor. The ACCC conductor carries twice the current of other bare overhead conductors with 25 to 40% less line losses. The use of ACCC can help reduce upfront capital costs for the tie line and also improve the overall economics of the generation project as reduced line losses translate into more power delivered for any given investment. The ACCC conductor has been deployed to more than 650 projects in 50 countries.

www.ctcglobal.com



Electrotech Sales Group, LLC

Electrotech Sales Group, LLC offers automation, control, and power products in the industrial market. They specialize in DIN rail terminal blocks, power supplies, counters, relays, motor control, circuit breakers, toggle switch terminal blocks, and more. They partner with synergistic manufacturers and suppliers in order to offer high quality products at competitive prices.

www.esgllc-usa.com



OUR CUSTOMERS EXPECT A LOT.

THAT'S WHAT WE GIVE THEM.

Rolls
BATTERY ENGINEERING



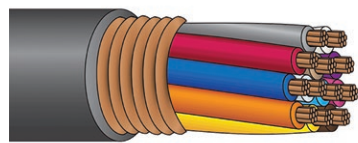
THE LONGEST LASTING BATTERY FOR YOUR OFF-GRID HOME.
ROLLSBATTERY.COM



Nexans AmerCable

Nexans AmerCable manufactures copper-conductor photovoltaic cables used primarily for connection to module junction boxes and required cable routing in balance of system (BOS) integration. AmerSol is a versatile BS EN 50618 H1Z2Z2-K single-conductor PV cable designed to meet the needs of the global solar industry. Type PV is a flexible, single-conductor cable that meets the newest standards as introduced in NEC Article 690. Type TC multiconductor cables combine the requirements for large solar farms and NEC Article 690 into one cable. Install in cable trays, wireways, troughs, etc. that are common while providing individual conductors that are sunlight resistant.

www.nexansamericable.com



Service Wire Co.

ServiceSolar PV wire meets current UL 4703 requirements. It can be used in both grounded and ungrounded solar arrays and is designed to withstand heat, cold, and moisture while meeting US and Canadian standards for safety. ServiceSolar PV wire is available in all industry colors, and comes in 600/1kV XLP/USE-2 or RHH/RHW-2, and in 600V with EnviroPlus (LSZH) Jacket.

www.servicewire.com



Nordic Fiberglass, Inc.

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



Darfon America Corp.

The Darfon H300 energy storage system consists of the H5001 5kW transformerless hybrid inverter and Lithium battery packs. The H300 comes with 3 battery options: B05LM 4.9kWh LNMCM, B07LF 7kWh LFP and B10LF 9.7kWh LFP. The batteries can be stacked so the H300 can be ordered with capacities ranging from 7kWh to 29kWh. The H5001 hybrid inverter has a distribution box where all the connections are made and includes breakers, disconnect switches, and generator support circuitry to simplify the installation process. The H300 supports a wide range of applications, such as, off-grid, self-use, net-metering, backup, and time-of-use.

www.darfonsolar.com



Delta Electronics

Delta Electronics residential energy storage turnkey system, Delta E series, supports DC-coupled and AC-coupled battery systems for pure, or PV-combined storage systems. The Delta E series has built-in EMS and supports self-consumption, zero export, TOU, and off-grid modes with available back-up mode and dark start operation. With smart cloud technology, E series inverters support remote firmware upgrade, parameter modification, and one button RMA service and can also support Wi-Fi/Ethernet, cellular communication, and Bluetooth.

www.deltaww.com



Priority Wire & Cable

Priority Wire & Cable stocks a large inventory of aluminum DC feeder cables PV 2KV, 4 awg thru 1000 MCM, plus 8 and 10 awg copper 2KV string wire in black, white, red, and green. They have supplied wire to over 5GW of projects and can assist in eliminating unexpected costs, and reducing lead time, waste, and labor.

www.prioritywire.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. Sized up to 32" x 24" x 12", Fibox offers large UL Listed NEMA 4x polycarbonate enclosures.

<http://fiboxusa.com>

Energy Storage System



Atlas ESS

Atlas Energy Storage Systems are inexpensive, high performing lithium ion based systems. All Atlas ESS products have approvals from nationally recognized test labs. Atlas products comply with the new provisions for energy storage systems in the 2017 edition of the National Electric Code (NEC). Professionals and DIYers alike can assemble NEC compliant Energy Storage Systems using Atlas components. Cabinets, BMS, and controls are available separately or in pre-assembled systems.

www.atlas-ess.com



Bender, Inc.

Designed specifically for large scale ungrounded energy storage and photovoltaic systems, the iso1685P ground fault detector provides early indication of ground faults before leakage current may even be present. The device detects both AC and DC ground faults by monitoring the entire electrical system for ground faults. The iso1685 can connect to systems up to 1000VAC / 1500VDC. Two separately adjustable response values are available. RS-485 communication is integrated for connection to Bender's remote communication system. The iso1685 also supports connecting to Bender's ground fault location system for ungrounded systems.

www.benderinc.com



Dynapower

Dynapower's family of DC-DC converters for utility-scale solar plus storage are available in 250, 375, and 500kW configurations. Up to 8 DPS units can be paralleled together. Dynapower's DPS family of DC-DC converters reduce the cost of installing energy storage alongside utility-scale solar while also maximizing installation PV energy production through clipping capture and low voltage harvest. Dynapower's family of DPS DC-DC converters are UL-1741 listed and are compatible with any central solar inverter. They are available as part of a fully-integrated BESS as well.

www.dynapower.com



Prysmian Group

Prysmian Group 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 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, Prysmian Group has the offering to comprise a complete cable solution for solar power applications.

na.prysmiangroup.com



ElectrIQ Power

The ElectrIQ PowerPod is a fully-integrated energy storage, management, and monitoring system that includes safe lithium-ion batteries and a hybrid solar/battery inverter controlled by intelligent software. The attractive design minimizes wiring and space requirements while enabling battery capacity to scale up to meet almost any home or light commercial need.

www.electriqpower.com



Hybrid Energy Storage Solutions, Ltd.

HESStec has developed advanced enabling technology in the field of ESS and Smart grids based on power electronics, control electronics, energy storage technologies, software, and energy management systems. All these pieces comprise the SHAD technology, which is the Hybrid Energy Storage System of HESStec. SHAD constitutes a hardware/software platform that integrates the operation of different storage technologies leveraging their synergies thanks to developed behavioral models. The technology offers a continuous range of energy storage solutions from energy to power BESS walking through multiple combinations of storage technologies.

www.hesstec.net



nel

Nel Hydrogen, Inc.

Nel Hydrogen manufactures Alkaline and Proton Exchange Membrane (PEM) water electrolyzers, producing from 0.27 Nm³ to 4,000 Nm³ of H₂ per hour. Units can be grouped together into electrolyser plants for even larger production rates. Electrolysers are used to store excess electricity from renewable resources in the H₂ bond. The H₂ can then be sold to industry (converting curtailed power to cash), or burned in a turbine or run through a fuel cell to put the stored energy onto the grid during periods of low generation or peak demand. Due to their fast response times the PEM electrolyzers are also used by renewable energy plants to balance the power the plant puts onto the grid.

www.nelhydrogen.com



NextGen NRG PTY Ltd.


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

www.nextgenrg.com



We're chasing the sun.

Introducing our latest solution: *Sunflower*™ Single-Axis Tracker

-  One Size Foundation Throughout the Array
-  No Special Tooling Required for Install
-  Over 100 MW Deployed
-  Terrain Following Capabilities



(513) 242-2051 | www.rbisolar.com | info@rbisolar.com



SaltX Technology

Swedish energy storage company, SaltX Technology, is going on a world tour with its large-scale energy storage demo unit. SaltX offers a technology to store excess solar energy in nanocoated salts through a thermochemical reaction. 20kW demo unit is traveling around the world. It's a scaled down version of 1MW unit in Berlin, Germany. SaltX Energy Storage is charged with cheap, off-peak electricity from solar or other renewables and stores energy for long duration. It delivers about 930°F (500°C) steam at an output. The steam can be used for heating or mixed heat and power production.

www.saltxtechnology.com



SunWize Power & Battery

The SunWize Power & Battery Power Online Ready Systems are designed to power remote power loads in extreme weather conditions. They typically ship within five days and can be installed in less than two hours. SunWize has developed a wide range of POR systems to cover most of the standard applications for battery backup systems from 108Ah to over 3,000Ah. The systems come using high-quality components from well-known brands. The POR line comes with a variety of enclosure styles including chest, pole-mounted, and front-opening UPS style. They are a solution for rugged demands. The POR line provides long-lasting backup power in remote applications and can be customized upon request.


www.sunwize.com



Heliolytics


Heliolytics provides aerial inspection, analytics, and consulting services to solve site DC health and performance issues. Their services enable clients to increase energy yields, decrease operational costs, and reduce portfolio risks through advanced analytics and actionable reporting. They have serviced over 15GW of solar projects from 10kW to 750MW internationally. Their proprietary aircraft sensor systems and in-house Artificial Intelligence software have been designed specifically for the PV industry. Their services can turn DC performance from a cost center to a profit opportunity. Based on energy payback alone, their preventative maintenance scans can achieve a positive ROI through a 0.1% improvement in system capacity and on average they find 1.2% of recoverable DC faults offline.

www.heliolytics.com



SimpliPhi Power
PHI High Voltage stacks feature modular battery building blocks that can be sized and scaled and installed without heavy equipment. When a building, facility, or campus requires multiple voltage, capacity, and power output parameters at different locations, PHI High Voltage can be customized and optimized for each unique use case. SimpliPhi's safe LFP chemistry also eliminates the need for complex, expensive, and bulky cooling equipment reducing system cost, footprint, and any parasitic loads.

www.simpliphipower.com



Sinexcel, Inc.
Sinexcel offers their 30kW ETL/CPUC listed storage inverter according to UL1741SA. The PWS2-30K-NA storage inverter has a wide DC range of 250-750V and with its compact size for wall-mount installations, it could be used for various battery types. With different battery vendors and energy storage system integrators, Sinexcel is offering indoor and outdoor applications for commercial and industrial users. The MESA compatible MODBUS protocol is Geli compatible and also offers easy integration with other control systems.

www.sinexcel.us



Tabuchi Electric Company of America

The Eco Intelligent Battery System (EIBS) is a grid-friendly residential solar-plus-storage solution designed to maximize the homeowner's investment while driving long-term grid stability. Flexible operation modes offer the flexibility of off-setting TOU rates, reducing home energy costs, and providing a secure source of back-up power. The system is equipped with a 5.5kW inverter and up to 14.8kWh of battery storage.

www.tabuchiamerica.com



Mott MacDonald

Mott MacDonald has contributed to more than 13GW of solar power generation in over 40 countries, from the Ivanpah power plant in California to the world's largest concentrated solar power facility in South Africa. For more than a century, Mott MacDonald has helped clients meet demand with cost-effective, environmentally responsible solutions. Mott MacDonald's advisors can handle everything from yield assessment to 3D layout and construction monitoring.

www.mottmac.com

1500VDC PV FUSE HOLDERS: THE NEXT LEVEL OF SAFETY, DURABILITY, AND EASE OF INSTALLATION



- FLEXIBLE
- VERSATILE
- GLOBAL

HP15FHM32A

- SCREW CLAMP
- LOCK OUT TAG OUT (LO/TO)
- UL 94 V-0

US15M1HEL

- BUS BAR TERMINAL
- ULTRA-SAFE™

EP.MERSEN.COM

MERSEN
Expertise, our source of energy

Engineering | Operations & Maintenance (O&M)



EDF Renewables

EDF Renewables' 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 Renewables' Asset Administration Services include managing projects and their commercial agreements to optimize returns over a project's lifecycle.

www.edf-re.com/asset-optimization



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

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



Stellar Energy GP, Inc.

Stellar Energy GP Inc. is headquartered in California and is a full service solar O&M company. They offer preventative maintenance, repairs, all the way up to complete re-powering. They specialize in systems that are under performing as well as trackers and utilize a high quality module cleaning process.

www.stellarenergy.com



SunSource Energy

SunSource Energy, a global solar design and engineering firm, provides engineering services from preliminary proposal stage to detailed construction drawings. In the US, SunSource Energy has delivered over 1GW of designs across residential, commercial, industrial, and utility segments. They have also delivered designs with PV + storage or hybrid options.

www.sunsource-energy.com



Taney Engineering

Taney Engineering provides site development services including zoning and entitlements feasibility studies, grading plans, street plans and profiles, hydrology studies, aerial mapping, ground support services, A.L.T.A. surveys, boundary and topographical surveys, and construction staking. Their drainage (hydrology/hydraulic) services include hydrologic modeling, channel and storm drain design, storm drain hydraulic modeling, flood control, masterplanning, sedimentation and erosion modeling, stormwater detention/retention basin design, FEMA flood plain delineation, and letters of map revisions, conditional letters of map revisions, flood plain and open channel hydraulic modeling, as well as hydraulic design of bridges and culverts.

www.taneycorp.com

DYNAPOWER
C O M P A N Y
Trusted Worldwide Since 1963

>475MWs

of energy storage inverters, DC converters and energy storage systems installed worldwide.

INCREASE PV INSTALLTION REVENUES

DC-COUPLED SOLAR PLUS STORAGE

Adding energy storage to a new or existing utility-scale solar installation with a Dynapower DC-DC converter can increase PV energy production through clipping recapture and low voltage harvest. Further adding to your bottom line, DC-coupled solar plus storage has a higher efficiency than AC-coupled storage and is eligible for valuable tax incentives for installation owners.

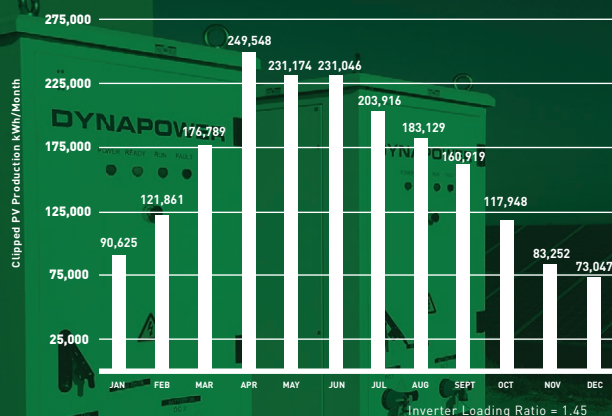
To learn more about how Dynapower's patented line of DC-DC converters can increase project revenues and lower the installation costs of utility-scale solar plus storage, please visit our website to download the white paper.

To speak with a sales engineer today about modeling your PV installation for energy storage, please call

1.877.215.0487

SAMPLE 20MW PV INSTALLATION WITHOUT DC-COUPLED STORAGE

Annual Lost Production: **1,923,256kWs**



WWW.DYNAPOWER.COM/DC-DC



250kW to 4MW



TRC

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

www.trcsolutions.com



Tropenas Company

Offering engineering services for utility-scale solar, Tropenas Company provides turnkey electrical and civil solar PV and ESS permit packages. With 4+GW of interconnection applications and designs, their multi-state local engineers will lead any portion of a solar project. Designed blending contractor field experience with value engineering, Tropenas' designs incorporate and communicate lean solutions, enabling fast installation and long durability, improving profitability. Example offerings: stamped electrical and civil permit drawings, independent engineering, medium voltage, and substation design.

www.tropenas.com



Ulteig Engineers

Ulteig supports the development, performance, and design of medium to large, grid-connected, solar electric projects including the C&I Distributed Generation and Utility-scale markets. In addition to medium voltage collection systems, substation, SCADA, transmission, civil, and GIS services, they also specialize in performance evaluation and plant design including DC collections and pile design. Their turnkey solar offering includes services that address all stages of a project's lifecycle, including project development, pre-construction engineering and support, construction support, and O&M.

www.ulteig.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



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/μc-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

Insurance Services

York Alternative Risk Solutions

The Renewable Energy Captive is a captive insurance company created to provide a Worker's Compensation, General Liability, and Auto Liability insurance alternative for business owners engaged in the renewable energy industry. The members of the captive have successfully created a program where they take control of their insurance program. Members have the ability to recoup up to 60% of their paid in premium, based on their company's loss experience.

www.renewableenergycaptive.com

Inverters



Analytic Systems

Analytic Systems manufactures DC to AC Pure Sinewave Inverters with inputs from 12 to 125VDC and outputs from 100 to 250VAC with frequencies from 50 to 400Hz at power levels from 300 to 3600W. Analytic Systems has been producing Pure Sinewave Inverters since 1994. Originally designed for running navigation computers on commercial and fishing vessels, the IPSi line has evolved into a range of digitally controlled models with continuous power outputs from 300 to 3600W.

www.analyticsystems.com



Atlantic Clean Energy Supply (ACES)

ACES offers solar products such as string inverters, Tier I solar panels, and BESS systems. As Huawei's partner in the USA, they serve the C&I and utility sector customer with projects below 50MW.

www.atlanticces.com



Fronius USA

The Fronius SnapINverter line offers integrated Wi-Fi and SunSpec Modbus interfaces, NEMA 4X rating, wide voltage windows, multiple MPP trackers, and easy installation in 15 minutes or less. With the identical look and feel, the Fronius SnapINverters reduce cost for training and servicing. Power classes range from 1.5 to 24.0kW. In addition, Fronius offers solutions for NEC 2014 and 2017 requirements including their second generation of Rapid Shutdown Boxes. For online monitoring, the Fronius Solar.web portal provides a complete set of tools beyond basic monitoring.

www.fronius-usa.com



Ingeteam

Ingeteam's Medium Voltage Inverter Station is a compact, customizable, and versatile plug & play solution that can be configured to suit each customer's requirements. This medium voltage solution integrates all the devices required for a multi-megawatt system, customized up to 5.4MVA. With high adaptability and power density of 5.2W/in³, not only does Ingeteam's Inverter Station offer low CAPEX, but also low OPEX, thanks to its long-lasting design, ease of access and serviceability, and maximum protection. The high-performance design uses electronic conversion topologies capable of achieving efficiency values of up to 98.9%. Its dual channel air cooling system makes it possible to increase the ambient operating temperature for enhanced functionality, thus maximizing return on investment. The INGECON SUN PowerMax B Series is certified in compliance with UL 1741 SA and pairs well with INGECON SUN STORAGE PowerMax three-phase bidirectional battery inverters.

www.ingetteam.com



CyboEnergy

The AC assisted off-grid CyboInverters can run AC loads 24/7 with solar power only, grid power only, or combined power and require no batteries. They have panel level MPPT to maximize solar production and can start heavy loads with assisted AC power and run the loads with only solar power. CyboInverters are easy to install. Each CyboInverter is 1.2KW and multiple units can daisy-chain. CyboInverters are patented, UL1741 certified, NEMA 6 rated, and made in the USA.

www.cyboenergy.com



Northern Electric and Power, Inc.

NEP has engineered and produced high quality microinverters and rapid shutdown devices (PVGard) at affordable prices. NEP offers MLPE. NEP module level RSD is designed to meet NEC2017. It has been certified to be compliant with almost all string inverters. It also provides module level monitoring for an additional level of safety and performance enhancement, which simplifies trouble shooting for installers and reduces maintenance costs.

www.northernep.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



Sol-Ark (Portable Solar, LLC)

Sol-Ark Hybrid Inverter demonstrates 96.5% CEC efficiency on-grid and 95.5% off-grid. Because of this efficiency, Sol-Ark 8K uses 5-15% less solar, 5-20% less battery, and 25% lower cost in electronics. There are two charge controllers which can handle up to 11KW of PV input. Sol-Ark has 8KW continuous and 20KW peak power with auto-generator start. The simple, color touch-screen interface is easy to use and also offers remote Wifi based monitoring. Sol-Ark offers multiple modes including grid sell, zero export, and time-of-use. Sol-Ark makes battery-based solar affordable and easy to install with 7 days a week live engineering support.

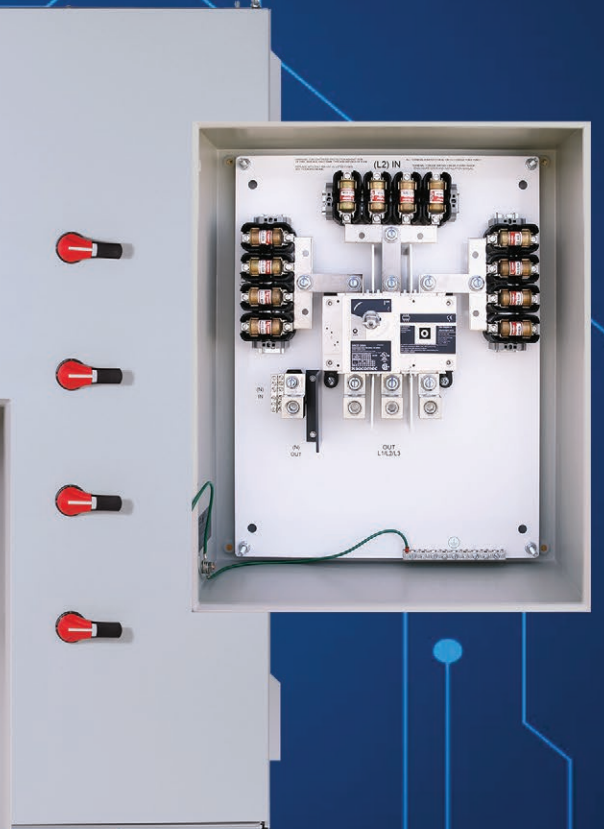
www.sol-ark.com

THINK INSIDE THE BOX

AC Combiners
Built for YOUR application
100kW to 1.6MW units

DC Combiners
Isolating, Floating, AFCI, 1500V,
and String Inverter types

Rapid Shutdown
Code compliance
made easy



Sensata Technologies

Sensata Technologies has battery backup power conversion system configurations for multiple applications. No matter the size of the residential installation, from tiny home to suburban ranch to coastal dream home, the modular design of Magnum Energy power conversion systems meets energy needs. Quickly learn one platform and install in multiple configurations for any application. Magnum Panel Systems (MP) and Magnum Energy inverter/chargers were designed to be easily assembled and programmed on site by one person, saving time and labor costs.

www.sensatapower.com



SMA America

SMA's Sunny Tripower CORE1 was recently upgraded with two new power classes, enhanced safety features, and smart inverter capabilities. The CORE1 will now offer a 62.5kW model optimized for large projects and a 33kW model for projects with smaller or highly segmented arrays and 600V repowering projects. Now equipped with additional safety features, the CORE1, combined with SMA's TS4-R-F module-level retrofit device, supports the SunSpec Power Line Communication signal for module-level rapid shutdown to provide a cost-effective solution to comply with NEC 2017 module-level rapid shutdown requirements in commercial rooftop systems. System communications and control is facilitated by the Data Manager M, powered by SMA's ennexOS platform – winner of the smarter E Award at Intersolar Europe 2018.

www.sma-america.com

Combiners | Recombiners | AFCI | AC Combiners | Wire Solutions
Rapid Shutdown | String Inverter Solutions | Battery Combiners



www.solarbos.com



SolarEdge

SolarEdge's EV charging single phase inverter offers homeowners the ability to charge electric vehicles up to 6x faster than a standard Level 1 charger through its solar boost mode that simultaneously utilizes grid and PV charging. This EV charger is integrated into SolarEdge's PV inverter with HD-Wave technology, which eliminates the need for additional wiring, conduit, and a breaker installation. No additional dedicated circuit breaker is needed, saving space and ruling out a potential upgrade to the main distribution panel.

www.solaredge.com



Tigo Energy

Tigo's RSS (Rapid Shutdown System) Transmitter completes the cost-effective rapid shutdown system architecture when paired with Tigo's UL-certified TS4-F (integrated) and/or TS4-R-F (retrofitted/add-on) solutions. The RSS Transmitter sends a signal to the TS4-F units to keep PV modules connected while powered on and supplying energy. TS4-F units automatically enter rapid shutdown mode when the RSS Transmitter is switched off and resume energy production when power is restored to the RSS Transmitter. This solution complies with NEC 2014 and 2017 690.12 specifications and supports the SunSpec-defined signaling for rapid shutdown with power-line communication. Available as a Kit, DIN Rail, or PCBA.

www.tigoenergy.com



Yaskawa Solectria Solar

Yaskawa Solectria Solar, a wholly-owned subsidiary of Yaskawa America, Inc., offers a wide range of inverters, string combiners, and web-based monitoring solutions for commercial and utility-scale PV systems. Solectria's commercial product offering includes two lines of 3-Ph Transformerless string inverters: PVI 14-60TL and the XGI 1000-50/60/65. For utility-scale applications, Solectria's products include central inverters, the SGI 500/750XTM, and string inverters, the XGI 1500-125/150/166. Solectria's suite of string combiners includes the RSDCOM (commercial rapid shutdown box), ARCCOM, and DISCOM. All of these inverter solutions can be coupled with SolrenView, Solectria's in-house monitoring system.

www.solectria.com

Legal Services



McCauley Lyman, LLC

McCauley Lyman is a renewable energy law firm. They advise and represent business people in their transactions and have particular expertise in the renewable energy industry, including developing and financing energy projects. They help people negotiate contracts, obtain permits, acquire real estate, arrange financings, and buy and sell energy related businesses and their assets. They understand the need for timeliness, cost control, and practicality. McCauley Lyman is in an alliance with Barclay Damon, LLP, a National Law Journal Top 250 Firm, which provides their clients with access to Barclay Damon's 33 practice areas.

www.mccauleylyman.com



Troutman Sanders, LLP

Troutman Sanders Renewable Energy attorneys offer innovative legal solutions to help clients succeed in the solar energy industry. Their understanding of the ever-changing legal landscape is built on over a century of service to the electric power industry. They provide legal advice to independent power producers, developers, and financial, utility, industrial, and government clients in energy-related businesses in the U.S. and internationally.

www.troutman.com

Lightning & Surge Protection

Raycap



Raycap, Inc.

Raycap provides lightning and power surge protection products specifically developed for photovoltaic (PV) power systems and other DC applications with operating voltages up to 1500VDC. Raycap's surge protection devices can reduce repair expenses and eliminate downtime and revenue loss resulting from electrical emergencies. Raycap's power protection solutions are compliant to the EN50539-11, IEC 61643-11, and UL 1449 4th edition standards.

www.raycap.com



SAE Inc.

SAE is a design and build engineering firm specializing in Cathodic Protection, AC Mitigation, and Electrical Grounding. SAE manufactures the patented EnvirAnode CP System, approved for use in deep anode beds by environmental regulatory agencies and a variety of specialty products such as Conducrete (conductive concrete) and ConduFlow (a solidifying conductive liquid backfill). SAE's innovative products are currently used to prevent the theft and corrosion of buried metallic electrodes.

www.saeinc.com

Microinverters



APsystems

The QS1 from APsystems is four-module, single phase microinverter for residential applications. It offers a 75% reduction in installation time, high peak output power, YC600 compatibility, and a 2.4GHz wireless Zigbee mesh network offers enhanced data transmissions speed. A wider MPPT voltage range means a greater energy harvest for homeowners. The QS1 is designed to accommodate today's high output PV panels up to 375W, offering 300W AC output per channel.

www.usa.apsystems.com

LeadSolar



LeadSolar Energy, Inc.

LeadSolar's LS600 series 700W dual microinverters can support both 60- and 72-cell modules exceeding 400Ws each. The integrated 10AWG trunk cable and current selectable option allows for 16, 20, or 24 panels to daisy chain on to one 30A branch circuit. A 6.4kW system can now be deployed on one branch without the inclusion of a subpanel, reducing installation time and cost. Zigbee communication offers per panel visibility and ease of system monitoring without the need for a hardwired communication channel.

www.leadsolarenergy.com

LeadSolar



LeadSolar Energy, Inc.

LeadSolar's LS600X series 700W dual microinverters can support 96-cell modules, such as those offered by Panasonic or SunPower. The integrated 10AWG trunk cable and current selectable option allows for either 20 Panasonic 330W or 18 SunPower 360W modules on a single 30A branch circuit. A 6.4kW system can be deployed on one branch without the inclusion of a subpanel, reducing installation time and cost. Zigbee communication offers per panel visibility and ease of system monitoring without the need for a hardwired communication channel.

www.leadsolarenergy.com

Modules



www.axitecsolar.us

AXITEC
high quality german solar brand

Axitec Solar

The polycrystalline solar modules of the AXIpower series are an all-purpose choice among solar modules. Whether for rooftop or ground-mount installations, AXIpower solar modules with an efficiency of up to 17.72 % provide a high energy yield and return on investment.

www.axitecsolar.us



Boviet Solar USA

Boviet Solar USA's polycrystalline and monocrystalline solar modules are available in 60-cell and 72-cell, positive power tolerance of 5W, 5400 Pa snow load, and 2400 Pa wind load. They are internationally tested and certified; Type 1 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.bovietsolarusa.com

Canadian Solar, Inc.

Canadian Solar HiDM is a high-density shingled mono PERC module providing up to 335W and 20% module efficiency in a residential format. Its sleek, all-black aesthetics (CS1H-MS-AB) blends into the roof, and its stringing design makes it highly shade tolerant in both the horizontal and vertical directions. Also available in larger format (CS1U-MS) for commercial applications up to 405W.

www.canadiansolar.com

CertainTeed

SAINT-GOBAIN



CertainTeed

CertainTeed's Solstice solar system provides a solar solution with a wide range of configuration options to suit each individual project. Powered by high-efficiency solar modules (with US-made modules available), Solstice systems include mounting hardware as well as DC optimizers or micro-inverters. CertainTeed selects high quality components and backs them with a single-source comprehensive warranty, providing end-to-end coverage for both the system and its professional installation for up to 25 years when working with a CertainTeed-credentialed solar installer.

www.certainteed.com



Giga Solar FPC, Ltd.

Giga Solar modules provide the benefits of high-performance c-Si modules, but weigh less than 35% of a same size standard glass module. Because the modules are glass-free and frameless, they are not subject to breakage and do not corrode or suffer PID. The all-polymeric construction eliminates the need for grounding, making installations fast and operation safe. The thick composite back support provides environmental protection for the cells and offers many mounting options. The modules are available with mono or poly c-Si cells. Standard powers are from 140Wp to over 350Wp. Application specific cell configurations (e.g. 12V or 24V systems) are available upon request.

www.gigasolarpv.com



Global Solar Energy

Global Solar Energy has announced the release of its new generation of PowerFLEX+ CIGS (Copper Indium Gallium DiSelenide) flexible thin film solar panels which offer high efficiency, up to 15%, easy installation, and are available in power outputs of 100 to 315W. Their new PowerFLEX+ modules produce up to 1% higher energy yield than polycrystalline silicon systems, especially in hot, overcast, or low light environments, and at higher latitudes. PowerFLEX+ modules make installation quick, easy, aesthetically pleasing, and less costly for commercial, industrial, and residential rooftops with a simple peel and stick design. The installed product provides a low-profile, light weight, pleasing appearance that blends into building architecture, and provides 25 years of reliable power in a rugged non-breakable design.

www.globalsolar.com

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 pyrhelimeter 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
- ✓ Net Radiometers
- ✓ Pyrhelimeters
- ✓ PAR Sensors
- ✓ Pyrgeometers
- ✓ LUX Sensors
- ✓ UV 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



Hanwha Q CELLS America

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

www.q-cells.com/na



Merlin Solar Technologies

Merlin Solar's GX panels offers an elegant solar solution for residential installations. The GX panel has been designed to maximize the amount of energy harnessed from the sun under all light conditions without the need of a bulky frame. Because of this, the GX panel is lightweight and can easily be installed flush on shingle roofs without any roof penetration. Installation is done through a peel-and-stick application, which reduces installation times. Merlin Solar's GX panel offers energy performance, aesthetics, and the ruggedness to withstand harsh environments.

www.merlinsolar.com



MiaSole

The FLEX-03W is a 500W CIGS flexible, lightweight, and shatterproof thin-film PV module that provides high power density for many types of applications, from roofing to transportation and beyond. The modules will not shatter when struck by rocks and hail, and they can conform to curved surfaces, expanding opportunities to add solar to a greater number of surfaces. The modules have >16.5% cell efficiency. The FLEX-03W module bonds to the roof surface with a simple peel-and-stick adhesive. This adhesive approach eliminates the need for racking and surface penetrations and provides strong resistance to wind and seismic events.

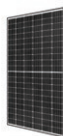
www.miasole.com



PowerFilm Solar

PowerFilm specializes in remote, portable solar solutions designed and built to meet customer requirements for performance and form factor. Controlling each step in engineering, design, and production, PowerFilm delivers high-quality systems with guaranteed performance. Their amorphous silicon functions at low light levels make it a solution for not only traditional outdoor IoT applications but also indoor use. Panels have been used for a wide range of applications including solar tents for the Army, powering electronics on a space exploration vehicle, custom asset tracking solutions, and indoor BLE sensors. PowerFilm has been developing and manufacturing its flexible solar technology for over thirty years in the United States.

www.powerfilmsolar.com



REC Group

The REC N-Peak solar panel combines n-type mono half-cut cells with a twin-panel design. Rated up to 330Wp, it is REC's most powerful 60-cell module, featuring zero LiD, REC's best warranty and super-strong frame design for loads of up to 7000Pa. In addition, REC N-Peak provides improved performance in shaded conditions and allows flexible installation options. Initial field tests carried out by the Solar Energy Research Institute of Singapore (SERIS) have shown the new N-Peak offers a distinct energy yield advantage.

www.recgroup.com



Shinsung E&G Co., Ltd.

Shinsung E&G Co provides solar cell with PERC technology, over 21% and solar modules including PERC cell, half cut cell, or HDM.

www.shinsungeng.com



Silfab Solar

Silfab Solar is a North American automated solar manufacturer with 35+ years of industry experience and offering 25-year product and 30-year performance warranties. Silfab's fully automated facilities ensure precision engineering and reliability to produce high quality modules with a low defect rate. (82.56ppm as of December 2017). Lightweight and durable, their modules are engineered to weather low load-bearing structures up to 5400Pa. Light-weight frame is designed with wide-ranging racking compatibility and durability. With an all-black sleek design, Silfab's SLA-M-320Wp ultra-high-efficiency modules are optimized for both residential and commercial projects where maximum power density is preferred.

www.silfabsolar.com



Solaria Corporation

The pure black Solaria PowerXT-AC panel offers a pre-engineered, integrated solution delivering AC power that lowers costs, reduces design / installation time, and enables more energy production in real world conditions. PowerXT-AC allows greater system modularity and design flexibility by enabling single module building blocks rather than requiring full strings.

www.solaria.com



Suncap Energy

Suncap Energy introduces CIGS Thin Film Modules (Copper, Indium, Gallium, and Selenide) from Eterbright Solar Corporation. Manufactured without hazardous chemicals such as lead, cadmium, tellurium, and arsenic to reduce the environmental impact during manufacturing and disposal at end of life. Sensitivity to low light and off angle sunlight leads to higher power production. The thin film design provides less power loss caused by shadows. No microcrack issues and reduced solder joints to fail. Providing up to 360W per panel and all black.

www.suncapenergy.ca



Transformers & Reactors for Solar applications

HPS has developed a reputation as one of the most capable manufacturers of standard and custom dry-type magnetics in the world. With multiple manufacturing facilities located throughout North America, Europe and Asia, HPS offers a broad range of products for many solar applications.

Our extensive and durable line of VPI and Cast Resin transformers and reactors provide you with a complete magnetic solution for all your solar energy needs.

www.hammondpowersolutions.com



SUNTEGRA



SunTegra

SunTegra's solar roof systems integrate solar with any new roof or reroof project. They offer homeowners a low-profile, roof-like appearance, and replace roofing materials, enabling added savings. A SunTegra Shingle or Tile solar roof system is a solution for builders, roofers and, solar integrators. SunTegra products are designed with proven materials, are easy to install, and feature a patented design which promotes cooling through ventilation.

www.suntegrasolar.com



Talesun Solar

Talesun's HIPRO is a high efficiency PERC monocrystalline solar module providing power output up to 400W and maximizing limited module space. The advanced surface texturing and back surface field allows the HIPRO to provide low light performance. The product is tested for anti-PID by TUV Rheinland to ensure the module's long term performance. The HIPRO is equipped with IP68 junction box and lower temperature coefficients which allow the module to generate a high power output.

www.talesun.com

Performance Monitoring



Apogee Instruments

Designed to optimize performance and price, the upward-looking model combines a blackbody thermopile detector and acrylic diffuser, and keeps the price close to that of silicon-cell pyranometers. The downward-looking model combines a blackbody thermopile detector and flat glass window. It performs similarly to domed downward-looking thermopile pyranometers, but without the cost of the dome. Combine to give incoming and reflected solar radiation.

www.apogeeinstruments.com



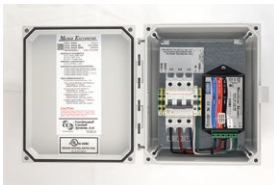
Campbell Scientific, Inc.

The MeteoPV delivers key PV resource data used in PV system analysis and performance assessment. It is a purpose-built data logger and aggregator for distributed PV monitoring or as a secondary weather station on utility-scale solar farms. The MeteoPV scales to read multiple pyranometers, module temperature sensors, and compact weather sensors. As a modbus datalogger and data aggregator, the MeteoPV is a simple solution for increased sensor densification and management in PV SCADA networks. Data is stored in the case of network or power outages. An embedded web server simplifies configuration and device management, including basic data analysis and automatic commissioning report generation.

www.campbellsci.com



Socomec Group



Continental Control Systems

Continental Control Systems is now offering fully assembled WattNode Energy Meters in UL 508A NEMA metal and poly enclosures. Enclosures are available with a three-phase circuit breaker, a fuse block, or without circuit protection. Any model of the WattNode; the revenue-grade meter or standard accuracy meter comes preinstalled when ordered with the enclosure. Designed for indoor and outdoor installations, the enclosure complies to UL 508A Type 3R, 4, 12 and 13. Fully assembled meter enclosures can be ordered through their e-commerce site.

www.ctlsys.com



Curb, Inc.

CURB is the home energy monitoring system that helps users take control of their house, condo, or apartment and all the energy it uses. CURB plugs directly into the breaker panel, providing real-time data on energy consumption and production, allowing users to make smarter decisions about their energy use, recognize abnormal patterns of energy use which can point to potential problems of various appliances, estimate their energy bill to allow them to see the impact of their energy use on their wallet in real time.

www.energycurb.com



EKO Instruments

With revisions to the ISO 9060:2018 Solar energy, specification and classification of instruments for measuring hemispherical solar and direct solar radiation, the MS-80 is Class A (previously referred to as Secondary Standard) with the additional specification of being a spectrally flat and fast response (<0.5 sec) pyranometer. MS-80 utilizes advanced pyranometer technology while remaining cost-effective for all applications. Combined performance gains have occurred in response time (<1sec) and reduction in thermal offsets. These improvements provide low field measurement uncertainty at an affordable price. When combined with the MV-01 heated ventilator, the MS-80 meets high requirements (Class A) for PV monitoring based on IEC 61724-1:2017. Users will also benefit from reduced maintenance costs by not needing to recalibrate or exchange desiccant for a minimum of 5 years. Every MS-80 comes standard with an ISO 17025 calibration including individual instrument directional and temperature response reports.

www.eko-usa.com



HT Instruments

HT Instruments manufactures and fully supports PV testing tools from installation testing through I-V curve tracing to 1500V and also power quality management for the PV system.

www.ht-instruments.us

HEYCO® Wire Management Solutions for Solar Installers & Integrators...

Heyco® Solar Products Warranty

Visit www.heyco.com for information about Heyco's 20 Year Limited Warranty on our solar products.

Helios UVX Clip

The Helios UVX clip installs into a .260" (6,6 mm) mounting hole and holds up to 2 cables between .230-.315" (5,8-8,0 mm) each. Molded from our robust UVX nylon 6/6 with extended UV capabilities, for our Solar 20 Year Warranty.



Heyco®-Tite Cordgrips for Enphase Q Cable

Two new cordgrips now accommodate the Enphase Q Cable. The 1/2" version provides liquid tight entry for one Enphase Q Cable; .24x.38" (6,1x9,7 mm). The 3/4" version provides liquid tight entry for up to two Enphase Q Cables; .24x.38" (6,1x9,7 mm) and an additional .130" (3,3 mm) dia. hole for a #8 solid grounding cable.



Heyco® HEYClip™ SunRunner® 4-2 & 4-2U

SunRunner 4-2 & 4-2U clips are compatible with the Enphase Q cable. SunRunner 4-2 works with Everest, SnapNRack, Solar Mount & similar rack profiles. SunRunner 4-2U works with Unirac, Ironridge & similar rack profiles.



Heyco® HEYClip™ SunRunner®

Double-compression design holds from (1) 12 gauge USE-2 to (2) 8 AWG cables up to 8,3 mm OD.



Heyco® HEYClip™

SunRunner® 90, 90-2 & 90-4

Double-compression, right angle design for use with PV modules mounted in "landscape" mode.



Heyco® SunBundler®

Stainless Steel Wire Cable Ties

Aircraft grade 302/304 stainless wire w/UV protected vinyl jacket and stainless steel crimp sleeve, 8" (203 mm) to 20" (508 mm) lengths—Special lengths available upon request.



For FREE samples or product literature, call toll free 1-800-526-4182, or visit heyco.com



SOLAR COMPONENTS
a PennEngineering® Company
www.heyco.com

"Stay Connected with Heyco" Power Components

Box 517 • Toms River, NJ 08754 • P: 732-286-4336 • F: 732-244-8843

HuksefluxUSA



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



NEXTracker

TrueCapture's disruptive technology is an intelligent, self-adjusting tracker control system that continuously refines the tracking algorithm of each individual solar array in response to existing site and weather conditions. TrueCapture enables solar power plant owners to maximize system performance and increase the lifetime profits of their assets.

www.nextracker.com



Seaward

Seaward manufactures a range of electrical safety and performance measurement equipment for solar PV applications. The PV210 Solar PV Tester and I-V Curve Tracker is a compact and cost-effective multi-function tester. It offers a comprehensive range of tests to quickly prove the safety and performance of PV modules and strings. With simple push button operation, it is an efficient and versatile tester for measuring ground (earth) continuity, open circuit voltage, short circuit current, maximum power point voltage, current, and power (with AC/DC clamp).

www.sewardsolar.com



Solar Data Systems, Inc.

Solar-Log WEB Enerest is an enhanced monitoring and management tool for commercial and residential fleets. Underperforming plants can be easily identified using yield forecasting and kWh expected energy monitoring. These detailed performance insight views compare inverter output and performance deviations before they can have a lasting negative effect on solar plant return. Advanced diagnostics lead to faster recovery and less downtime. Users can even manage the consumption of self-produced power and grid feed-in by defining and controlling inverter output.

www.solar-log-america.com



Storage Battery Systems, LLC

Equalink Battery Management System actively manages batteries to increase reliability and extend life. Equalink can monitor current, ambient/room temperature, humidity, hydrogen gas, and electrolyte levels. Through available Form C contacts/relays, Equalink can also monitor electrical equipment such as UPSs, inverters, transfer switches, generators, and air conditioning systems.

www.sbsbattery.com



SunSniffer GmbH & Co., KG

SunSniffer is condition-based plant analysis with artificial intelligence for all PV plant levels - panel, string, inverter - with high precision measurements and Digital Twin technology. SunSniffer delivers the exact amount of losses of each panel in dollars, together with sound service advice. In addition, the SunSniffer's virtual flasher is able to present STC values of each panel during operation in the field for real comparability. Automated diagnostics provide cost/profit analysis. Each level can be served separately, providing deep insights to minimize losses and maximize profit.

www.sunsniffer.de



Trimark Associates, Inc.

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

www.trimarkassoc.com



meteocontrol North America

The blue'Log X-Series serves as the central on-site component to monitor and control photovoltaic systems. meteocontrol has enhanced their X-Series and redeveloped the plant control function. In the near future, they will provide two variations of the data logger, blue'Log XM, and blue'Log XC, and offer tailored solutions for their customer's individual photovoltaic projects.

www.meteocontrol.com

Permitting



SepiSolar

SepiSolar is a national solar design and engineering service for solar PV and energy storage projects. Their NABCEP-certified designers and engineers provide complete permit-ready plan sets for residential, commercial, utility, and micro-grid projects, including solar+storage. They also provide electrical and structural PE stamps in all 50 states.

www.sepisolar.com

Kinetic
SOLAR RACKING AND MOUNTING

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

www.kineticsolar.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 suitable for monitoring and controlling the position of solar power systems, including photovoltaic arrays and 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. Communications interface options include analog, SSI, CANopen, Modbus and Industrial Ethernet. With a wide variety of mechanical configurations available, POSITAL sensors are a good fit for projects of any size or budget.

www.posital.com



Belnor Engineering

Belnor Engineering supplies Onyx Solar Photovoltaic Solar Glass Modules for all kinds of buildings. The PV modules are available in almost any size, shape, color, and textural finish possible. From pixelated facades, to skylights, to walkable PV floors, Onyx Solar's clean technology provides long-term renewable energy solutions which cut emissions, reduce the carbon footprint, and cut costs, all while adding to the aesthetic design of the facility.

www.belnor.com



SKY ENERGY, INC.

SKY ENERGY (US) markets and sells new Lightray Solar photovoltaic systems and services to commercial and residential customers. Lightray Solar modules convert light from the sun into electricity used to power buildings, homes, communications, and electric vehicles through solid-state silicon solar cells. Services provided include: site analysis, energy output, benefit analysis, cost analysis, and project coordination including engineering, electrical, financing, developer, and installation contractors.

www.sky-energy.com

PV Installers



Baker Electric

The Baker Renewables C&I Group is an experienced and reputable electrical contractor serving Southern California for the last 80 years. With over 130 installations completed, Baker's team of professionals analyze building data and present best fit solutions. Baker Electric's resume includes projects for commercial buildings, non-profits, education facilities, and government/military installations. Baker provides in-house design and installation services for solar, storage, and microgrid systems. Baker has a large team to support their projects with an in-house staff which includes engineers, designers, estimators, project managers, electricians, and LEED and NACEP Certified employees.

www.baker-electric.com

BAKER ELECTRIC HOME ENERGY



Baker Electric Home Energy

San Diego-based Baker Electric Home Energy has designed, engineered, and installed solar and solar + home battery systems for 10,000 homes in Southern California. Baker gives people control of the way they generate, store, manage, and use energy. This offers homeowners the benefit of significant cost-savings and energy independence.

www.bakerhomeenergy.com



Hannah Solar Government Services, LLC

Hannah Solar Government Services, LLC (HSGS) is a service-disabled veteran-owned renewable energy company with core expertise in providing solar energy solutions for government, utility, industrial, and commercial clients across the continental United States as well as overseas. HSGS is a solar PV project developer and an engineering, procurement, and construction (EPC) firm specializing in the development, design, installation, and maintenance of solar PV energy systems and microgrids.

www.hsgs.solar

PV Distributors



BayWa r.e. Solar Systems, LLC

BayWa r.e. Solar Systems is a national solar distributor, focused on providing reliable and convenient supply chain solutions to their partners.

solar-distribution-us.baywa-re.com

POWER.PLANT.









When you're going off-grid you become the power plant.

And when you need a battery to provide your power needs, depend on the best: **Crown Battery**. Thick energy-dense plates. Heavy-duty construction. More active lead materials. Proven low-maintenance performance. It all adds up to one **World Class Battery. Crown.**

CONTACT US FOR DETAILS: +1.419.334.7181 / commercial@crownbattery.com / www.crownbattery.com



Sullivan Solar Power

Family-owned Sullivan Solar Power's NABCEP certified personnel customize photovoltaic proposals around their customer's needs, size of the home, and financial goals. Commercial-grade insurance and state-certified electrical training protect the property during installation. Sullivan Solar Power delivers peace of mind through their warranties, a 25-year monitoring service, and a 10-year money back production guarantee.

www.sullivansolarpower.com

PV Manufacturers & Equipment



Alencon Systems, LLC

Alencon Systems' Version 6 String Power Optimizer and Transmitters (SPOTs) are the latest version of its galvanically isolated DC-DC optimizers. The newly released SPOT Version 6 includes a high power rating, improved wireless communications, as well as features including optional UL listed ARC and Ground fault detection. The SPOT is suited for use in DC-Coupled Solar + Storage, Microgrid and PV repowering applications, and are compatible with virtually any third party inverter.

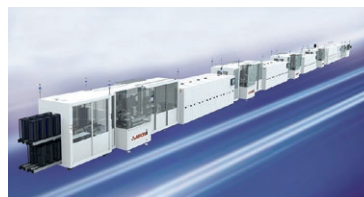
www.alenconsystems.com



Annealsys

Annealsys designs and manufactures Rapid Thermal Processing (RTP and RTCVD) and Direct Liquid Injection deposition (CVD and ALD) systems. RTP systems with cold wall chamber, high temperature lamp furnaces (1450°C), and vacuum capability from 3" to 200mm for RTP and RTCVD processes. Applications include: rapid thermal annealing, RTO, RTN, contact annealing, CVD of graphene and h-BN, diffusion of dopants, selenization and sulfurization (CIGS) Direct Liquid Injection deposition systems for deposition of metals, oxides, nitrides, metals, 2D materials, etc. These systems can perform deposition processes with the widest range of chemicals including low vapor pressure and thermally unstable chemicals.

www.annealsys.com



ASYS Group Americas, Inc.

The 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. The new AIRON Metallization Lines achieve a cycle time of one second. The AIRON systems are equipped with the intuitive SIMPLEX user interface. Due to SIMPLEX, the line can be continuously monitored and machines can be operated in a cluster. In order to be prepared for the high speeds the AIRON machines can be connected to AIVs.

www.asys-group.com



Ecoprogetti

Ecoprogetti offers a solution for PV module testing and IV curve measurement suitable for testing all new generations of solar modules and new high efficiency technologies of solar cells. LED Sun simulator is also available for bifacial panels for fast cycle time and precision quality checks. Ecoprogetti has designed and assembled complete production lines for the manufacturing of high quality PV panels since 1998.

www.ecoprogetti.com



GEMÜ Valves, Inc.

In the GEMÜ CleanStar SmartLine range, the valve body, through which the process medium flows, is available with connection sizes (1/2" up to 1"), and with flare and metric spigots for butt-welding availability in transparent (PP-R) and grey (PP-H) materials. GEMÜ offers an extensive instrumentation line to provide a full control package solution.

www.gemu.com



Kurdex Corporation

Kurdex is a supplier of large area vacuum deposition and etch equipment for R&D, pilot, and high volume manufacturing (HVM). Products include sputtering, evaporation, PECVD, spatial ALD, ARC-CVD and plasma etch tools. Standard and custom systems configured for in-line, cluster, and R2R with full automation. Substrate sizes up to 2300MM rigid or flex, wafers, glass sheets, or roll of flexible materials. They also offer an applications lab for contract coating services, DOE, and technology development.

www.kurdex.com



LI-COR Biosciences

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

www.licor.com/solar




Morningstar Corporation

Morningstar's TriStar MPPT 600V high-voltage controller allows solar system designers and installers to build systems with longer and fewer individual strings. Fanless design improves service life, increases reliability, and raises efficiency. Accepts PV array input up to 600 Voc with 97.9% peak efficiency. A DC transfer switch-equipped version is suitable for retrofitting existing grid-tied solar installations with energy storage for back-up power in DC-coupled configurations connected to batteries.

www.morningstarcorp.com

C&I BES & Micro-grid Driven By *Sinexcel*



AC RACK L3060


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

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

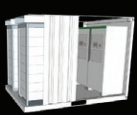
Storage Inverters
30~500kW

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

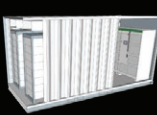
Outdoor Commercial & Industrial Battery Energy Storage Solutions



30kW



50-150kW



250-500kW

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

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

Panasonic



Panasonic

After 20 years of manufacturing high-efficiency solar modules, Panasonic's HIT panels feature -0.258% / $^{\circ}\text{C}$ temperature coefficient and provide impressive performance and efficiency at high temperatures. Strict testing under the most extreme weather conditions guarantee decades of safe, efficient, and worry-free operation. Backed by a complete warranty, it covers product and performance for 25 years.

na.panasonic.com



Quality Transformer & Electronics

QT&E designs and manufactures custom transformers, inductors, reactors, power supplies, PDU's, power conditioners, and other electromagnetic parts and electrical assemblies. Parts are designed and marked NRTL to applicable UL standards. Both open frame parts and assemblies in NEMA rated enclosures are available.

www.qte.com



Robert Bürkle GmbH

Bürkle is a manufacturer of laminators for module manufacturing and roller coating equipment for anti-reflection and photo-resistant coating. Their advanced technology enables fast lamination time with a high quality standard and low operating costs.

www.buerkle-technologies.com



SCHMID Group | Gebr. SCHMID GmbH

SCHMID supplies highly efficient equipment for the total value chain of photovoltaics. The product range includes single equipment for wafer, cell, and module production as well as turnkey production lines and complete factory solutions. SCHMID also offers thin-film process equipment for cleaning the substrate and improving the adhesion of protective coatings.

www.schmid-group.com



SEPCO - Solar Electric Power Company

SEPCO provides solar lighting and off-grid solar power systems. SEPCO manufactures solar lighting equipment using high efficiency LED fixtures from Hubbell, combined with their solar power assemblies to produce everything from large overhead street and area lights to small systems for signs and flags. SEPCO also manufactures solar power assemblies to be used for cameras and other off-grid application requirements.

www.sepco-solarlighting.com



SMARTTECH



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

PV Module Inspection



Measure

Measure's solar solutions allow for fast, safe, and accurate site inspections. Their drone inspections are 95% more efficient and, with 100% IR inspections, they identify defects that manual inspections might miss. Drone inspections take less than 10 minutes per MW and save, on average, \$1200/MW in costs, with larger sites saving more. They can also identify tracker misalignment, assess site shading, map pre-construction sites, and inspect towers and substations. Inspection data can be sent to a convenient smart phone app, which allows maintenance personnel to easily route to damages on site and update inspection results directly from the field.

www.measure.com

PV Washing System



Bitimec International, Inc.

Bitimec's RoboKlin is a solar panel washing machine designed for utility size ground-mount PV power plants. The RoboKlin runs smoothly on an M&S Track Buggy 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. A new Snow Brush option will allow fast snow removal to restart the production of power shortly after a snowfall.

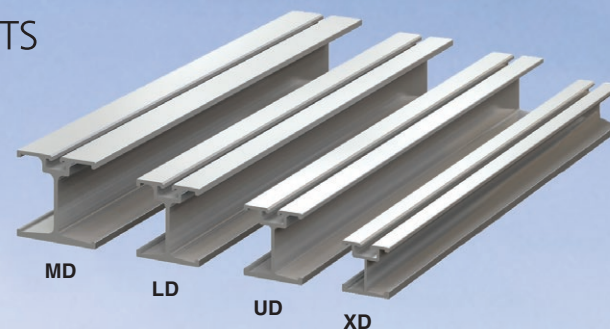
www.wash-bots.com



PREFORMED LINE PRODUCTS

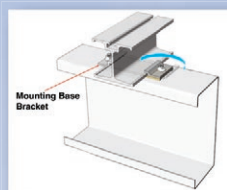
POWER RAIL™

Commercial Mounting System



A COST SAVINGS RAIL SOLUTION FOR EVERY APPLICATION

- Longer spans and cantilever distances
- Fewer penetrations/attachments
- Lock-in-Place patented RAD™ Bolt
- Single tool assembly
- Designed for high wind/heavy snow
- Integrated grounding



Mounting base bracket attaches rail to structural members



preformed.com

800.260.3792



Buffalo Turbine

Buffalo Turbine has been manufacturing turbine style blowers since 1945, which are made using high-precision machined components resulting in long-lasting, dependable products. These turbine units are being used worldwide in a variety of applications. Gas, diesel, PTO, and hydraulic models are available. The newest of all the applications is touchless snow removal from solar panels. The stacked hydraulic unit is popular in this application and quickly attaches to most skid steers.

www.buffaloturbine.com

Racking & Mounting Systems



ACE CLAMP
The PROOF Is On The ROOF™

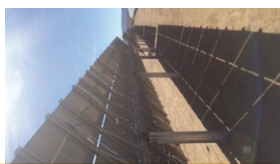
AceClamp

AceClamp by PMC Industries, Inc. is a US-based manufacturer of snow retention as well as precision-engineered, fast-installing standing seam solar clamps. The AceClamp Solar Mounting Kit a fast installing kit, providing a rackless-type hold down. The AceClamp A2, along with the AceClamp Solar Mounting Kit offers a low-cost alternative to secure PV panels to SSMR. Their patented, non-penetrating sliding-pin design helps preserve the panel warranty. The AceClamp can also be used with an L-Foot bracket design for the attachment of rail systems used in other types of PV installations.

www.aceclamp.com



A PART OF **atkore**
INTERNATIONAL



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



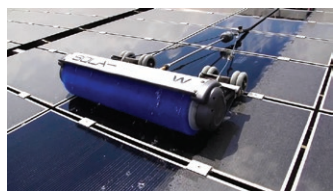
Ecolibrium Solar



Ecolibrium Solar

Ecolibrium Solar provides 5- and 10-degree racking solutions for low-slope roofs. EcoFoot5D 5-Degree Racking delivers 18.4% more power, combining a small modular base and dense 9.9ft inter-row spacing. The tightly packed array enables maximum power density on flat roofs. In 10-degree systems, the installer-centric EcoFoot2+ provides simplicity and an install speed of 13.5 modules per installer-hour, as rated by DNV-GL. Designed by installers for installers, all systems are fast and simple to install and consist of small, densely packable components that are easy to ship, transport, load onto the roof.

www.ecolibriumsolar.com



PRO SOLAR CLEAN

ProSolarClean, LLC

Cleantecs, GmbH Manufacturing Company manufactures Sola-Tecs brushes, a solar cleaning technology which properly cleans solar panels quickly and effectively. The end result is a clean, clear, and spot free surface which will leave the solar panels operating at maximum efficiency. ProSolarClean, LLC offers representation, distribution, and service for the Sola-Tecs solar panel cleaning brushes to the American market. The Sola-Tecs systems are designed to be an effective cleaning method using manual and semi-automatic brushes.

www.prosolarclean.com



Advanced Racking

Advanced Racking has launched the Advanced Rail-Free mount. Designed to work on shingle and metal roof applications, the product is simple and flexible. Certified to UL 2703 standard, the product includes horizontal and vertical adjustment, and a universal clamp to fit modules from 30mm to 50mm thicknesses.

www.advancedracking.com



APA Solar Racking

APA is a fixed tilt ground mount racking manufacturer and installer for C&I and utility-scale projects. APA foundations include ground screws, shallow micro helicals, C-pile, and concrete free ballast. They succeed in tough soil conditions including sites with rock, high topography, sandy/soft soils, shallow bedrock, high water tables, and high snow/wind loads. APA's new TITAN series utilizes 15% less steel and components with longer spans and is an installer friendly system. APA's TITAN Duo is a dual screw foundation designed specifically for the northeast.

www.apalternatives.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.allearthrenewables.com



DynoRaxx

DynoRaxx offers solutions for pitched and flat roof ballasted solar racking and also provides the DynoBond UL2703 module to module grounding product. The flat roof racking is designed to work with all framed modules and does not require tools for assembly or installing which reduces install labor. The DynoBond grounding is used in carports, ground mounts, and other racking products which helps to reduce electrical grounding costs.

www.dynoraxx.com



Ecolibrium Solar



Ecolibrium Solar

Designed by installers for installers, Ecolibrium Solar offers two pitched roof systems: new Metal X Rail-Less for r-panel, corrugated, or standing seam metal roofs and EcoX Universal for composite, tile, and metal roofs. Installation is fast and simple, and cumbersome rails aren't needed, which reduces labor and logistical costs. Metal X requires 73% less aluminum to transport and install, and enables maximized spans. EcoX Universal Rail-Less requires 33% fewer attachments on any pitched roof, making it suitable for large arrays when fast installation and fewer components mean big savings. All systems consist of small, densely packable components that are easy to transport and load onto the roof.

www.ecolibriumsolar.com



KB Racking

EkonoRack 2.0 is a simple non-penetrating solar mounting solution for commercial flat rooftops. The system's ETL Certification attests to its high standard of safety and robust design, allowing it to be grounded with only one grounding lug per array. EkonoRack 2.0's design is composed of only one major component, acting as a ballast tray windshield mount and multiple panel support. Low cost and customizable, the system's pre-attached roof mats save time on installation and provide maximum protection for the roof. KB RACKING offers a 10-year standard product warranty.

www.kbracking.com



Olympic Energy Systems, Inc.

Olympic Energy Systems produces simple, deployable, low impact solar panel mounting systems using tensioned cables, available in kits, including the R1X non-penetrating roof mount, which are a solution for commercial roofs, metal and other specialty roofs, as well as residential rooftops. They also offer the G1M ground-mount with no in-ground foundations, suitable for capped landfills, parking lots, brownfields, farms, or residential yards. These systems advance mounting solar panels with low embodied energy, achieving true sustainability. Installed systems, which use less labor, are re-deployable, with lower cost replacement or end of life retirement, with no lasting impact to roofs or ground surfaces.

www.olympicenergysystems.com



OMG Roofing Products

The OMG PowerGrip roof mount system secures solar racks to commercial roofing systems. Properly installed PowerGrips limit rack movement and remain watertight. OMG PowerGrip assemblies are easy-to-install and compatible with most solar rack systems. Since they eliminate the need to cut open the roof down to the deck, the system saves time and labor. Designed with performance in mind, PowerGrips are available in three sizes to accommodate most applications and provide up to 3300lbf of tensile, 2500lbf of shear and 2000lbf of compressive strength.

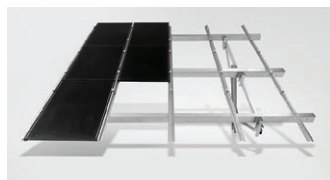
www.omgroofing.com



Kinetic Solar

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



OMCO Solar

OMCO Solar Field-Fast factory-direct, pre-assembled mounting structures reduce build-time and cut costs at every stage of construction. On-site delivery consists of seven, pre-assembled bill of materials items per rack and integrated pre-assembly throughout the components creates simplified staging and a 35% faster installation. Field-Fast mounting systems have an 85% labor efficiency with two-man teams able to construct eight racks per hour. The Field-Fast mounting system works with any framed module, including First Solar Series 6.

www.omcosolar.com



Pegasus Solar

Pegasus Solar's Comp Mount is a cost effective, high-quality option for rail installations on composite shingle roofs. Designed to last decades, the one-piece black flashing uses a 0.9" tall single-formed cone. There are no fused parts or deck-level EPDM washers to fail. Everything needed is provided in one easy-to-carry 24-pack. Fewer boxes means fewer trips up the ladder and less trash to bring down from the roof. The EPDM sealing washer is pre-installed on the lag, so there are no little parts rolling down the roof into a customer's gutter.

www.pegasussolar.com



Magerack Corporation

MagMount II is a rail-less solar mounting system compatible with most solar modules. Similar to previous system MagMount, it separates roof attachments from module connecting components. Roof attachments are only used to attach solar modules to the roof and installed wherever necessary to reduce the number of roof penetrations. Module connectors are only used to connect adjacent solar modules. The improved module connectors can connect two solar modules without roof attachment support and don't require any special module frame. The new module brackets act as attaching devices to attach any roof attachments to solar modules. The system is UL 2703 certified and Class A fire rating.

www.magerack.com



STANDING SEAM POWER CLAMPS

STANDING SEAM POWER CLAMP

- Incredible Strength
- Price Competitive
- Compatible with Universal L-Foot & Solar Connection Kit
- 6061-T6 Aluminum
- Available with 1, 2, or 3 Silver Bullet Set Screw Configuration

SILVER BULLET SET SCREW

- Will Not Penetrate the Roof Seam
- Ball Point Head Eliminates any Marring of Paint or Damage to the Roof Seam
- Patented Design

1703 & 2703



SOLAR CONNECTION KIT
RAIL-LESS

UNIVERSAL L-FOOT

STANDARD



MINI



WIDE



KLOC



KLOC MINI



SOLARCONNECTIONS.COM

800-815-7652

INFO@SOLARCONNECTIONS.COM

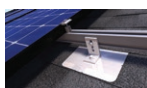
PP PREFORMED LINE PRODUCTS



Preformed Line Products

Preformed Line Products introduces the POWER MAX Ballasted Roof Mounting System. The POWER MAX solar mounting system is engineered to maximize energy output on commercial flat roofs. Developed with the professional installer in mind, this system features 50% fewer components and a simplified design resulting in fast assembly rates and labor savings on every project. Available in a flush mount, 5° or 10° tilt, or higher density dual tilt design, the POWER MAX base arrives stacked on pallets providing easy transport to the roof. Engineered as a fully ballasted, non-penetrating system, it accepts standard concrete blocks and is qualified by wind tunnel testing.

www.preformed.com

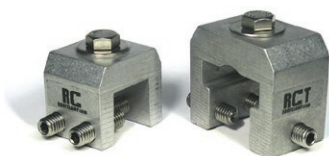


Quick Mount PV

QRail and L-Mount combine seamlessly to provide a complete, fully integrated racking and mounting solution backed by a 25-year product warranty. The QRail System is a new rooftop racking system featuring patented QClick and QSplice technologies that simplify and speed installation. The L-Mount Series is an integrated L-foot and flashing featuring Quick Mount PV's patented Elevated Water Seal Technology for super-fast, cost-effective, single-lag bolt installation with waterproofing.

www.quickmountpv.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-torqueing and re-attachment. Over 95% of today's standing seam profiles are compatible with the universal for Roof Clamp system.

www.roofclamp.com



Solar + Storage for 1/2 the Cost of Tesla



- World's Most Efficient Hybrid Inverter
- Winning International Awards
- As Easy to Install as Grid-Tied
- Batteries optional

Engineered, Assembled, and Tested in USA

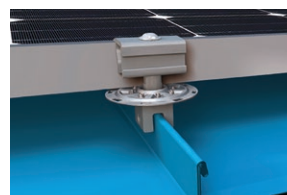
Phone: 972-575-8875 Email: Sales@sol-ark.com www.Sol-Ark.com



Roof Tech, Inc.

RT-MINI is Roof Tech's new self-flashing mounting base designed to attach conventional rail mounting systems and accessories including the conduit. RT-MINI is built to withstand wind speeds up to 180mph and ground snow up to 70psf. RT-MINI offers fast installation time because it is fastened with wood screws, eliminating the need for pilot holes. As a result, there is no damage to the seal on asphalt shingles so the roof warranty remains intact. RT-MINI is fully waterproof and certified by the ICC for Flexible Flashing. Stamped PE letters are available for 37 states in the U.S. and four provinces in Canada.

www.roof-tech.us



S-5!

S-5! offers a new and improved PV Kit, PV Kit 2.0, with low installation time and cost for flush-mounting PV. The kit comes preassembled with MidGrab or EdgeGrab for a comfortable and efficient installation. Using a single tool to drive the top bolt, PV Kit 2.0 eliminates several installation steps with fewer lugs/ground wires required. The PV Kit 2.0 also features more aggressive bonding teeth for better grounding. The S-5! PV Kit 2.0 is UL 2703 listed solar module mounting solution for direct attach standing seam metal roof.

www.s5.com



Sentinel Solar

Sentinel Solar is a Canadian distributor of solar PV products and manufacturer of solar PV mounting systems. Sentinel's mounting systems focus on installation efficiency, versatility, and operability. These criteria are incorporated into their all-new Titan series of ground mount systems, the Titan SP, the Titan AF, and the Titan Lite. Each system is engineered to maximize production of Bifacial PV module technology by using Sentinel's Typhoon Rail. This shared rail minimizes rear-facing obstructions, mitigates balance of system costs, offers numerous layout configurations, and provides support for all standard frame 60- and 72-cell modules.

www.sentinel solar.com



SnapNrack

SnapNrack Ultra Rail is a sleek, lightweight rail solution for mounting solar modules on the roof. The system is easy to install utilizing new Ultra Rail Mounts that include snap-in brackets for attaching rail. The spring-loaded mounts provide full rail leveling capabilities and all components come pre-assembled for a unique install experience and easy tightening. Ultra Rail is an economical solution for projects in more average load conditions, especially when attachment spacing is already dictated by the existing roof structure and more mounts are needed to disperse the weight of the system. The Ultra Rail system maintains a large top channel for running cables and wires as well as attaching all of SnapNrack's wire management accessories.

www.snapnrack.com



Solar Connections International

Introducing the new Universal PowerMount-9000S to be used with virtually any R-Panel Roof System. The single piece design simplifies installation and reduces cost. The flat base allows the mount to be installed between ribs making it universal across all R-Panel metal roofs. Use the PowerMount-S with any manufacturer's L-Foot or Solar Connections' Universal L-Foot to attach any rail system. Go railless and use the Solar Connection Kit with their GroundBonding Technology. The SCI Kit is UL 1703 and UL 2703 listed and approved.

www.solarconnections.com



Solar STACK

Solar STACK's solar mounting technology uses zero roof penetrations.

www.solarstack.com



SolarRoofHook

The Low Profile QuickBOLT with Microflashing is SolarRoofHook's most popular product. The Microflashing is compressed by the bolt to create a leak-proof seal. This affordable asphalt shingle roof mount can be installed in under one minute. Over 300,000 QuickBOLTS have been installed across America with ZERO leaks reported.

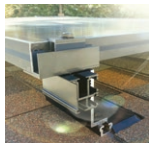
www.solarroofhook.com



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



Spider-Rax

The Black Widow Comp mount for composite shingle applications has been redesigned to improve aesthetics, adjustability, and installation speed. Needing only one part number to order improves job efficiency. The mid clamp and end clamp have a patented panel lock system fitting modules from 1.125" - 2" and the direct to plywood fastening system has a new 2-course aluminum flashing. This system is UL 2703 listed for integrated grounding, a leveling height adjustment of 1.5", snow load rating at 45 lbs/ft, Class A fire rating, and 50 state engineering reports are available.

www.spiderrax.com



SunModo Corp.

SunModo's EZ standing seam clamps make solar PV installations on metal roofs easy. Featuring rust-free aluminum alloy and roof-safe oval end set screws, the clamps work on a wide variety of seam profiles. The set screw of the 1" EZ Standing Seam Clamp can be installed on either the vertical leg of the clamp or on the 10-degree leg of the clamp. The 2" EZ Standing Seam Clamp installs in situ at the desired seam attachment location. No more sliding the clamp up the roof line with this two-part assembly. They offer four different standing seam clamps for specific project needs. Available in 50mm width standard version with 2 set screws or 30mm width mini version with 1 set screw.

www.sunmodo.com



TerraGen Solar

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

www.terragensolar.ca



TRA Snow & Sun, Inc.

TRA Snow and Sun (TRA) is a manufacturer of solar racking and solar mounting systems. TRA's economical solar racking hardware is available direct to installers and project developers to ensure positively impacted profitability. TRA's solar racking and solar mounting systems are durable, code compliant, and price competitive.

www.trasnowandsun.com



Unirac, Inc.

UNIRAC announces its new lineup of residential roof attachments, including tile replacement, tile hooks, and composition shingle roof flashings, which integrate with its SOLARMOUNT mounting system, and feature Unirac's patented Shed & Seal technology, a weather proof system which provides the ultimate protection against leaks. Full integration between SOLARMOUNT and the roof attachment allows for seamless designs and fast, easy installations. Plus, Unirac attachments are covered under the company's 25-year full system warranty.

www.unirac.com

Intertie Solution

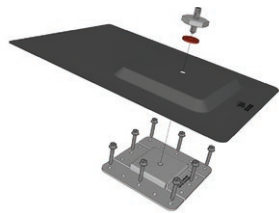
For Distributed Solar-Grid Interconnection

15.5 kV - 38 kV

Southern States

770-946-4562
sales@southernstatesllc.com
www.southernstatesllc.com

Minimize system voltage dips and potential ferro-resonance issues caused by transformer inrush currents



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 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

Residential, Small Office, and Community Solar



ARC Design & Consulting, LLC

ARC Design & Consulting LLC's design portfolio includes a list of projects of all sizes, from residential and commercial systems through large, grid-direct utility scale arrays, and battery storage. Founded in 2004, ARC has designed more than 15,000 roof and ground-mounted solar energy systems in 16 states and four countries totaling more than 500MW. ARC offers a complete suite of renewable energy solutions to developers, sales teams, and installers nationally and internationally.

arcdesignllc.net



BlueWave Solar

BlueWave Solar is a developer of community solar projects and works with developers and asset owners on subscribing their projects without needing to build out new management systems. Using their new Solar Management Platform, customer acquisition, onboarding, and billing is easy. Their client services team is available to answer any questions during the sign-up process and for the entire contract term.

www.bluewavesolar.com

Robotics



US Digital

US Digital was founded by David Madore in 1980 with the goal of producing cost effective practical solutions to motion control challenges. Their core products are rotary and linear encoders using optical and magnetic technologies. US Digital encoders are available in a number of configurations: 32 to 10,000 CPR, incremental and absolute, rotary and linear, optical and magnetic, with and without index, single ended and differential output, kit and shafted versions, as well as stock and custom options.

www.usdigital.com



Washpanel Srl

Washpanel is an Italian company that has designed and produced PV plants washing technologies since 2010. It provides a range of 10 different robots for plants such as solar parks, roofs, carports, greenhouses, and agriculture farms. The key product offered by the company is SERIE "EVO" machine which is a portable semi-automatic robot. It represents a solution for the tracker market and can be used both in wet and dry modes, depending on the needs. Two operators are needed to clean 1MW/day per robot. This machine helps keep the panels efficient and reduces maintenance costs (NPV impact). Washpanel robots are awarded with a TUV certification which ensures the machines cause no damages to the panels.

www.washpanel.com

Roll Forming



Johnson Bros. Roll Forming Co.

Johnson Bros. Roll 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



RPM Rollformed Metal Products

RPM Rollformed Metal Products is a New Era Group company with 2 fabrication facilities located in Ontario Canada. Plant 2 is the heavy steel division dedicated to roll forming complex steel profiles; thickness between 0.108" to 0.179" in a variety of finishes and material yield strength. Plant 1 is dedicated to thinner steel and lighter metals which are laser welded and unique configuration. Both divisions use USA or Canadian steel mills as their prime source for raw material. RPM has roll formed millions of pounds of custom steel for the global solar racking industry.

www.rpmroll.com



Samson Roll Formed Products Co.

Samson Roll Formed Products Co produces channels used by the solar industry as brackets, photovoltaic array supports and solar panel framing/trim, including a parabolic shaped channel, the main component in compound parabolic collectors, as well as custom shapes. Samson was founded in 1946 and is located in the Chicago metro area in a 200,000sq/ft facility housing approximately forty roll form lines and an array of ancillary equipment to provide stamping, bending, assembly, parting, in-house design, and production of pre-notch, pre-punch tooling, as value-added services. Samson holds ISO9001:2015 Certification.

www.samsonrollform.com

Safety



Blaklader

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

www.blaklader.com



TOUCHLESS SNOW / DUST REMOVAL



Available in
Standard & High Speed

- Increase Profits & Minimize Labor
- Return On Investment = 1 Day*



HYDRAULIC, GAS & PTO MODELS AVAILABLE



CONTACT (716) 592-2700 • BuffaloTurbine.com



Kong USA, LLC

Made in Italy, the KONG BACK-UP ANSI/ASSE Z359.15-2014 is an ANSI certified version Back-Up fall arrester. Safe and simple to use with only one hand. The KONG BACK-UP is a fall arrester that follows the operator in both directions. Shifting the special button to lock mode, the BACK-UP can be used as a positioning device. The KONG BACK-UP supports the strongest stress in a semi dynamic way, avoiding the shock effects on the rope caused by the traditional self-locking devices with toothed cams. Connector/lanyard included.

www.kongusa.com



Marking Services, Inc.

Marking Services, Inc. (MSI) improves and standardizes solar identification to promote safer work environments and minimize downtime due to errors or accidents. They enhance the overall efficiency of solar energy plants by providing photovoltaic solar labeling products and identification services which effectively communicate valuable information to all who need it. MSI offers a one-stop, comprehensive source for solar labeling with quality products, fast turnaround times, and on-time delivery.

www.markserv.com



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

Semiconductors



Nor-Cal Products, Inc.

Nor-Cal Products is a source for prototype and production quantity custom vacuum chambers and weldments. Spherical, cylindrical, or rectangular bodies can have single-wall, double-wall, or channeled construction and are value-engineered to reduce cost, and increase reliability and performance. All welds are reviewed for vacuum integrity, structural strength, heat resistance, and flange distortion to minimize or eliminate secondary machining. In-house fabrication capabilities allow exhaust weldments to be fabricated from a single piece of tubing, eliminating welds and manufacturing steps while improving cleanliness and fit.

www.n-c.com

Site Assessment & Forecasting



GroundWork Renewables

The GroundWork Rey MET System is a rugged, revenue-grade weather station which accelerates solar adoption by providing MET data to reduce the uncertainty of energy production assessments. The Rey is smart and configurable with options for soiling measurement and diffuse irradiance. Designed for multiple redeployments, the value of the Rey MET System can be realized year after year. Together with GroundWatch, their data quality program, the Rey offers high measurement accuracy and availability to produce a ground dataset. When combined with satellite data, the result is a dependable resource assessment and correlated long-term solar resource dataset.

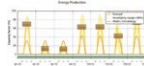
www.grndwork.com



NRG Systems

NRG's SRA System is a turnkey solution for the early prospecting, formal resource assessment, and performance monitoring stages of utility-scale PV project development and operation. These systems deliver accurate, site-specific data via an integrated package that is easy to install and maintain. All relevant meteorological conditions are captured, including solar radiation, wind speed and direction, ambient temperature, relative humidity, barometric pressure, and precipitation. Their complete package approach ensures that the entire system ships quickly and arrives together, simplifying installation schedules and saving time and money.

www.nrgsystems.com



WPred, Inc.

WPred offers solar and weather forecasting services for up to 14 days ahead for the specific location of a solar park. Multiple meteorological parameters tailored to their client's operations are available, such as precipitations and accumulation by type, temperature, solar flux, etc. They offer expert tools that help plan and optimize maintenance operations, identify under-performances due to dirt and snow, and allow their customers to base financial decisions on historical and forecasted data.

www.wpred.com

Software Supplier



Aurora Solar, Inc.

Aurora Solar is a design-to-proposal 3D solar software for residential and commercial solar projects. It enables solar installers to accurately determine a site's solar potential, design the optimal PV system, perform financial analysis, and create a highly-customized sales proposal. With Aurora, the process of designing and selling solar, which used to rely on "best guess" estimates and require costly site visits to confirm measurements, layout, and shading, can now be completed remotely and accurately in under 10 minutes. The new Aurora reDesigned features a fully 3D design experience, a simplified interface, automatic-stringing functionality, and 10X performance upgrades for multi-megawatt solar projects.

www.aurosolar.com



MORE CHOICES, MORE VALUE.

WHAT'S IN YOUR LAMINATOR?

Let Smartech help you find the best diaphragm for your laminator:

- Seamless widths up to 3500mm
- Three different durometers + Steinbach's EVA-resistant Lamibran®
- Textured or smooth surfaces

Lower your production costs by choosing quality Steinbach materials.



SmartechOnline.com
704 362 1922





Green IT Energy Applications

Green IT Energy Applications provides software solutions and comprehensive SCADA IT/OT services to the renewable energy industry. Green IT offers industry-specific software, IT engineering, and cybersecurity expertise. With 15+ years of experience, 100+ GW of projects in development, and 20+ GW operating projects, Green IT optimizes how the renewable energy industry does business.

www.greenitea.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



Nearmap US, Inc.

Up-to-date HD aerial maps helps users swiftly produce quotes with realistic visuals, precise measurements, and greater accuracy. Nearmap captures 72% of the total US population, often multiple times per year. Leaf-off surveys aid solar design, and Nearmap's affordable imagery and reliable aerial maps stream instantly from the cloud. View and measure through MapBrowser or integrate further with popular PV design platforms.

go.nearmap.com



PVComplete

Enable seamless design from concept to completion. PVSketch is an easy, intuitive sales proposal tool for all solar professionals. Quickly transfer PVSketch designs to PVCAD. PVCAD is the only CAD for solar, allowing users to engineer full, detailed solar plan sets. PVComplete now offers full design services. Their experienced team of professionals design small residential through large scale utility. They provide a hands on service with personal support for the duration of the project design.

www.pvcomplete.com



SalesRabbit

SalesRabbit optimizes every aspect of a sales and management process. Track leads, manage areas, collect data, and improve sales records with their approach. View demographic data and homeowner details, schedule appointments, and share leads and notes. Set and track personal and team performance records. Receive, upload, and create leads on the go. Leaders can also view real-time reports on performance metrics as well as assign territories, track rep locations, and identify behavior trends. It integrates with software and data providers, including Salesforce, JobNimbus, Faraday, and e-Original.

www.salesrabbit.com



Sighten

Sighten offers a powerful toolset for solar, enabling hundreds of installation companies to close more deals, access financing, and streamline operations. Sighten includes tools for project design, automated shading analysis, financing options, customized proposals, and seamless agreement e-signing. Sighten recently launched SOLAR+ battery and energy efficiency project support, allowing installers to seamlessly tie in other project types into proposals and savings estimates. All Sighten subscriptions come with unlimited users, proposals, and contracts for a flat, low monthly fee.

www.sighten.io



Solargis

Solargis helps the solar industry manage weather-related risks. They provide solar, weather, and solar electricity data that are used in the whole lifecycle of solar power plants, from prospection to development and operation. Solargis platform offers fast access to historical, recent, and forecast data for almost any location on the Earth. Several independent scientific studies have confirmed that Solargis database is reliable and accurate. Solargis' photovoltaic software applications help optimize the construction, evaluation, and management of solar power assets. Their solutions are supported by a custom-tailored consultancy.

www.solargis.com



Valentin Software

PV*SQL premium is a professional software for the design, simulation, and yield calculation of solar electric systems. PV*SQL premium 2019 has additional features for electric vehicles and includes the calculation of bifacial modules. The revised detailed circuit diagram simplifies construction work. 3D models can be imported via an interface, for example using photos from drone flights, and the energy flow diagram represents the overall system, including the battery system and consumers. A trial version is available on the Valentin Software website, as well as video tutorials and introductory online webinars.

www.valentin-software.com



Veriforce

Veriforce is a provider of software and services that enhance workforce and community safety. They deliver comprehensive solutions, combining VeriSource, their integrated software to manage Safety, Certificate of Insurance Tracking, Drug and Alcohol, and Operator Qualification programs, with value-added audit and consulting services and complementary training offerings. Using Veriforce solutions, organizations are able to efficiently manage their contractor workforce, centralize and streamline critical compliance processes, effectively mitigate third-party, supply chain, and regulatory risk, as well as drive ongoing improvement to safety.

www.veriforce.com

Solar Fasteners



ARCONIC

Innovation, engineered.

Arconic

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

afshuck.net/us



EJOT Fastening Systems L.P.

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

www.ejot-usa.com

Solar Support Structures & Carport Systems



Baja Carports

Baja Carports serves solar integrators, developers, and contractors nationwide, in Mexico and Canada. Baja's Solar Support Systems offer dozens of configurations including; Braced Single Post, Full Cantilever, Full Cantilever Offset Tapered, Long Span Double Post, and Single Post B2B to customers specifications. Hundreds of solar solutions for government, hospitals and health care, schools, and multi-housing. All structures are engineered in-house, pre-fabricated using pre-galvanized framing and components; cold-rolled, high-tensile, light-gauge material. Bolted connections with no intended field welding. All structures meet local loading requirements, live/loads up to 60psf, and wind speeds up to 160mph.

www.bajacarports.com



Brooklyn Solar Canopy Co.

Designed in Brooklyn, New York by a team of architects and seasoned solar professionals, the Brooklyn Solar Canopy is suitable for backyard pergolas, carports, and rooftop applications. The canopy's core modularity and minimal aesthetic make it versatile and adaptable for different contexts. Available in any color, the canopy can be modified to integrate with a range of aesthetic and functional enhancements to integrate a variety of architectural styles. Built to withstand heavy snow, wind, and seismic forces, the UL certified canopy is a creative solar solution for every market.

www.brooklynsolarcanopy.com



Kinetic Solar

Kinetic Solar's new seasonally adjustable ground mount brings versatility and strength while being economical and fast to install. Each module section is balanced in order to make seasonal adjustments with 60- or 72-cell modules simple and easy, no heavy lifting required. Seasonal adjustment can offer a yearly increase of in production of up to 14%, without the added cost of a tracking system. Standard tilt angles include 20°, 45°, and 60°. It is engineered to withstand 1kPa of wind and 2.5kPa of snow, making it suitable for use in nearly any location in North America. It's innovative design tilts flat for fast and easy construction. Available with optional string inverter mount, micro inverter mount, and rear cable shielding panels. The structures sturdy steel construction and hot dip galvanized coating stands up to even the most hostile environmental conditions.

www.kineticsolar.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 and parking structure canopies. M Bar C installs approximately 70 - 80MW 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



Quest Renewables

The newest addition to Quest Renewables solar canopy portfolio is the QuadPod double cantilever. With just 3 foundations per 100kW, the double cantilever can easily be applied to any parking lot configuration regardless of parking spot width or drive aisle dimensions. After its on-the-ground assembly, solar panel placement, electrical inverter mounting, and wiring, the canopy units are erected and connected to foundations. This construction method significantly minimizes work at height and optimizes worksite safety. The short on-site time with QuadPod double cantilever reduces construction management costs, increases throughput, and limits disruption to parking lot operations.

www.questrenewables.com



S:FLEX, Inc.

S:FLEX PV Carports are designed to maximize solar production and can be engineered to meet all space requirements. Typically columns are spaced at 27' on center and a range of standardized designs for fast and cost-effective solutions is available. S:Flex systems are designed for solar module attachments with grounding, and for any wind, snow, and seismic region. The foundations are completed prior to steel delivery on-site, and pre-assembly options reduce time on-site and working at height. Complete engineering services are also available.

www.sflex.com



SCARLET Solar

SCARLET Solar, a Silicon-Valley-based designer of advanced solar systems, revealed TiltPort, a high-efficiency modular, tilting roof carport. TiltPort has two white columns which support a slender roof that tracks the sun. TiltPort cuts complexity and increases reliability and power output by tilting the whole roof. Rated for winds up to 130mph (210km/h) TiltPort comes prefabricated for installation in hours. TiltPort is controlled remotely and offers a waterproof option. Any number of TiltPorts can be installed adjacent to each other. TiltPort generates up to 44% more energy than traditional fixed carports using similar panels, and can cost less.

www.scarlet.red



Skyline Steel, Inc.

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

www.skylinesolaraz.com

Solar Thermal Manufacturing & Equipment



Beijing Sunda Solar Energy Technology Co., Ltd.

SUNDA has solar thermal experience for over 30 years. With Germany technology and standards, SUNDA's products include the Metal Absorber Evacuated Tube Solar Collector series: 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, SEIDO6 receiver tube and parabolic trough concentrating collector, which are applied on domestic hot water, industry process, pools and spas, space heating and solar air-conditioning, sea water desalination, and CSP fields. SUNDA owns over 10 international certificates including, Solar Keymark, and SRCC. Their products have been exported to more than 80 countries and regions all over the world.

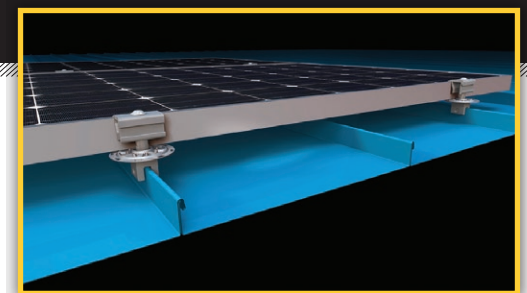
www.sundasolar.com

TESTED. TRUSTED. ENGINEERED.
THE RIGHT WAY!™

PV KIT™ 2.0

Designed to save you time and money.

S-5! offers a new and improved PV Kit—PV Kit 2.0—boasting lower installation time and cost for flush-mounting PV. The kit comes preassembled with MidGrab or EdgeGrab for a more comfortable and efficient installation. Using a single tool to drive the top bolt, PV Kit 2.0 eliminates several installation steps with fewer lugs/ground wires required.



- Preassembled EdgeGrab and MidGrab
- Low profile bolt head provides a sleek and clean finish
- 1" gap between Midgrab, providing wind load reduction per ASCE 7
- UL 2703 Listed

CONTACT YOUR S-5! DISTRIBUTOR TO LEARN MORE



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



Chromagen Hot Water Solutions

Chromagen has developed, manufactured, and sold advanced solar and hot-water solutions since 1962, for projects including single-family homes, multi-story apartment buildings, hotels, hospitals, and industrial plants. The company's products are manufactured using advanced technologies and processes to ensure product quality, safety, longevity, and energy efficiency. Chromagen's products comply with, and are certified by the SRCC USA.

www.chromagen.com



Rheem Water Heating

Rheem offers a variety of solar water heating solutions allowing use of the sun's power to provide hot water with great efficiency and low energy costs. A variety of options are available to store hot water and provide backup capabilities, if necessary.

www.rheem.com

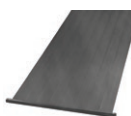


SunEarth

SunEarth services the residential, commercial, and industrial sectors, manufacturing a range of flat-plate solar thermal collectors, solar pool collectors, and solar electric options, such as the newly released PV Water Heating Solution. SunEarth also supports a broad line of balance-of-system components, including solar storage tanks with or without internal heat exchangers, vertical and horizontal ASME storage tanks up to 37,000 gallons, pump stations, hot water stations, advanced differential controls, circulating and pressure boosting pumps, mounting hardware, racks and roofing specialties, and drainback tanks.

www.sunearthinc.com

Solar Thermal Systems



Aquatherm Industries, Inc.

Aquatherm Industries offers unglazed polymer solar thermal collectors, primarily used in residential and commercial pool heating applications, solar heat for industrial processes (SHIP), and low-cost thermo-siphon systems. Their products are manufactured in the USA to ISO 9001 quality standards, NSF-50 listed, and IAPMO performance certified.

www.aquathermsolar.com



Digital Solar Corp.

DSH provides a patented solar heating system with inter-seasonal storage. Primarily this system is for new homes and commercial buildings, or for hydronic retrofitting. The heating system is capable of offsetting up to 70% (100% in Net Zero homes) of heating costs and 100% of the offset GHG carbon emissions. Each system is designed to suit the application and is capable of storing MW of thermal energy in summer for later use. New 2019 developments include snow melt, spa, pool, and process heat for industry, commercial applications such as car washes, hotels, and motels for heat and laundry. A new version suited for Canadian winters has been developed with Wifi access and data storage.

www.digitalsolarheat.com



Solcan

Solcan solar thermal systems contribute to GHG reduction targets for residential and commercial applications. 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



Stiebel Eltron

Stiebel Eltron SOLKits thermal solar systems are Energy Star Rated and have SRCC OG300 system certification. Each closed loop system includes SOL 27 Premium flat plate collector panel(s) and mounting hardware, SB/SBB storage tank with heat exchanger(s), pump station with expansion tank, temperature / pressure gauges, pressure relief and check valves, and controller unit with corresponding sensors. Stiebel Eltron has a 10-year warranty on solar panels, and a lifetime warranty on tanks.

www.stiebel-eltron-usa.com



TIGI Solar

TIGI developed a new type of solar thermal collector and system targeting higher temperatures, as required for commercial and industrial users even in cold climate conditions. The patented technology is based on transparent insulation and focuses on minimizing energy losses with additional related innovations including collector-level overheating prevention and system innovation that increases performance and decreases cost. Certified in Europe and the USA, with sales and working projects in Israel, Europe, and the USA, including for wineries, laundry, senior citizen homes, hatching farm, large dish washing, and more.

www.tigisolar.com

Testing & Certification | Testing Chambers



Advanced Test Equipment Rentals

Advanced Test Equipment Rentals offers a variety of test and measurement equipment for all types of solar testing. They provide the latest technology in I-V curve tracers, solar PV analyzers, power supplies, DC solar array simulators, PV inverter tester, battery testers, and more. Equipment can be rented at affordable prices with short-term or long-term rentals available. Advanced Test Equipment Rentals provides an extensive inventory of test equipment to meet all industry compliance and pre-compliance testing needs.

www.atecorp.com



EYE Applied Optix

EYE Applied Optix produces accelerated UV and weathering test equipment as well as solar simulation systems. Off the shelf, turn-key, component, or customer design/build options available.

www.eyeppliedoptix.com



Honle UV America, Inc.

The Honle Group is an international supplier of industrial UV/LED, and Sun Simulation technology. Honle UV Technology develops, manufactures, and distributes UV systems, UV lamps, LED systems, and measurement instrumentation worldwide. The equipment is used in the curing of photo reactive substances as well as surface sterilization and sun simulation. At the heart of every UV system is the Honle Lamp. Honle manufactures its own high-performance UV discharge lamps and apart from standard spectra lamps, customer specific and process specific lamps are produced.

www.honleuv.com



Q-Lab Corporation


Q-Lab provides accelerated weathering and corrosion test equipment and test services. Comprehensive accelerated testing of materials and modules helps to develop higher durability solar solutions. In addition, Q-Lab offers contract test services, which include accelerated laboratory testing, at locations worldwide. Outdoor exposure testing for weathering, light-fastness, and corrosion is available in both Florida and Arizona locations.

www.q-lab.com

www.axitecsolar.us

AXITEC[®]
high quality german solar brand

High Performance Solar Modules



15
YEARS
Warranty

25
YEARS
85%

- AXIpower POLY up to 330 Watt
- AXIpremium MONO up to 360 Watt
- AXIblackpremium MONO ALL BLACK up to 300 Watt

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



Spectral Evolution

Test and classify solar simulators for spectral match, uniformity, and temporal stability with Spectral Evolution spectroradiometers: the SR-3501 and SR-1901 for continuous solar simulators, and the SR-1901PT and SR-2501PT for pulsed solar simulators. Solar simulators can provide an accepted method for measuring and testing the power ratings of photovoltaic modules and solar panels at the manufacturer's facility. Uncertainties in the validity of these measurements can significantly impact a manufacturer's revenue. DARWin SP Data Acquisition software allows users to measure irradiance and spectral match over a full 280-1900nm range or 280-2500nm range depending on model.

www.spectralevolution.com

Tools



ILSCO

TaskMaster Tools from ILSCO feature an extensive offering of manual, remote, and battery-powered hydraulic crimping and cutting tools, as well as hydraulic pumps. Battery-powered tools run on the M18 Milwaukee battery platform which offers cross functionality with tools an installer may already have in their possession. ILSCO offers connector, conductor, and compliance versatility with their 12-ton die taking and 6-ton dieless tools. Their tools are supported by the TaskMasterPRO service protection program which includes 5-year tool and 3-year battery warranties as well as a 5-day repair pledge.

www.taskmastertools.com



McCann Equipment, Ltd.

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

www.torque-tools.com



WEH

WEH designs and manufactures high-quality nozzles, breakaways, receptacles, filters, and check valves for hydrogen refueling and has become a partner to the automotive industry in this technology. Safety, ease of operation, and the well-executed design make WEH H2 products a solution for manufacturers for H2 filling stations and fuel cell vehicles worldwide.

www.weh.us

Tracking Systems



Array Technologies, Inc.

The DuraTrack HZ v3 offers features including a single-bolt per module clamp and flexibly linked architecture. The single-axis tracker delivers a variety of efficiencies allowing for quick installation, zero scheduled maintenance, and extended uptime to deliver the best levelized cost of electricity (LCOE).

<http://arraytechinc.com>



FTC Solar

FTC Solar's new Voyager single-axis tracker provides ease of installation, performance, and reliability, with a low total installed cost. The Voyager tracker requires no special tools and only two wrench socket sizes to be fully assembled. It features few foundations per module and employs a fast and intuitive clamping system. The balanced DC string architecture reduces the overall DC collection cost and is suitable for DC cable harness systems. And, the single row, 2-portrait module mounting architecture allows engineers to make the most of the available land while maintaining suitable accessibility in higher GCR designs.

www.ftcsolar.com



GameChange Solar

The GameChange Solar single axis Genius Tracker offers several features and benefits to the owner and the installer. The Genius Tracker provides up to 6.75% more power production with low O&M costs. The systems increased row spacing with higher module density means more time facing the sun. Installers will benefit in having fast install speed with the Genius Tracker's pre-assembled Drive Arm combined with using the SpeedClamp when installing modules. The GameChange Solar Genius Tracker has Black & Veatch technical assessment, CPP Wind Tunnel tested, rated 175 mph, and is ETL /UL 3703 tested.

www.gamechangesolar.com



GP JOULE

GP JOULE is a global renewable energy company developing, engineering, constructing, operating, and financing commercial and utility-scale projects. Globally, the company has installed 550MW of PV projects and manages 600MW of assets in Europe and North America. GP JOULE combines turnkey EPC expertise with its proprietary PHLEGON single axis tracker to deliver low total installed cost. Designed specifically for harsh climates and challenging sites, PHLEGON uses heavy-duty linear actuators that intelligently integrate German-engineered control systems. This cost-effective tracker utilizes up to 60% fewer piles, has a low fastener count, and offers easy ground maintenance access.

www.gp-joule.com



CAB SOLAR Cable Management with Integrated Grounding

Patent Protected www.cabproducts.com/patents

Thick PVC Coated Steel Seats Firmly and Prevents Slippage

HIGHEST QUALITY
Over 5 GW Installed
INDUSTRY FAVORITE

2018 NECA Show Stopper

ETL LISTED US Intertek

Greatly Lowers Project Costs
Simplifies Electrical Design
Quick & Easy to Install
Easy Maintenance

Patent Protected www.cabproducts.com/patents

CAB® Integrated Grounding System uses CAB® multi-carrier hangers together with specially designed copper composite messenger wire which provides structural support for the cable system and at the same time provides sufficient ampacity for fault current duty, both EGC and GEC. Meets NEC, UL and IEEE standards. ETL Safety Listed by Intertek to UL 2703. Contact CAB® for Engineering Reports.

www.cabproducts.com Call: 814.472.5077

Cambria County Association for the Blind and Handicapped



Ideematec, Inc.

Ideematec's SafeTrack Horizon System is installed in 25 countries globally and designed to be close to O&M free. The system is often used for utility scale installations between 50 - 350MW and can easily be built on undulated terrain up to 36%. Due to its low number of foundations (160/MW) the installation process is very fast. Ideematec provides full foundation design, full structural reports, and installation and commissioning services. Due to its patented drive mechanism, the Ideematec SafeTrack Horizon can absorb dynamic effects specifically in high wind regions. Ideematec Tracking Systems can be individually adjusted in undulated terrain to optimize the output with its 3D backtracking.

www.ideematec.com



Nclave

Nclave works in the development, design, manufacturing, installation, and maintenance of fixed structures and photovoltaic solar trackers, including dimensioning and implementation of any foundation solution. Nclave has the ISO 9001, ISO 14001, ISO 14064, UNE-EN 1090, UL2703, IEC 62817 certifications that accredit the quality of performance, structural calculations for component sizing, factory production control procedure, and component performance.

www.nclavegroup.com

American Earth Anchors
The best screw you will have in the dirt™

46" Penetrator™
Field-tested to 9,000 lbs downward pressure

REPLACES CONCRETE FOOTINGS

- No digging
- No pouring
- No forms
- No waiting

EASY LEVELING Screw down, screw up

2" Schedule 40 pipe fits over
Custom brackets for any pipe size

americanearthanchors.com
corinne@americanea.com 1-508-520-8511



RBI Solar, Inc.

RBI announces the formal launch of their Sunflower single-axis tracker. This tracker system is designed to accommodate undulating topography and it's tabled design allows for more site flexibility when laying out module locations on a given site. Tracker rows can be designed up to 120 modules in length.

www.rbisolar.com



Solar FlexRack

Solar FlexRack TDP 2.0 Solar Tracker with BalanceTrac is now available with a self-powered option for crystalline and thin film solar modules. Solar FlexRack's latest tracker technology bundles an advanced tracker design with full project support services. Features include: up to 90 modules per row, rotational range of 110° (± 55°), optimized for 1000V and 1500V modules, and low per-unit fixed costs for BOS savings and more.

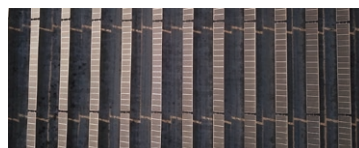
www.solarflexrack.com



Soltec America, LLC

Soltec is a manufacturer and supplier of horizontal single-axis solar trackers. The company has manufacturing facilities in Argentina, Brazil, China, and Spain, as well as offices in Australia, Chile, Denmark, Egypt, India, Israel, Italy, Mexico, Peru, and the United States. SF7, Soltec's next generation PV tracker, enables high yield and achieves low installation costs. SF7 Single-Axis Tracker is the seventh-generation of their 14-year work as a tracking specialist. SF7 is a solar tracker with high yield-per-acre performance and versatile land-use options, suitable for large-scale PV tracking projects.

www.soltec.com



Sunfolding

Powered by AirDrive technology, the Sunfolding T29 installs up to two times faster with its three simplified components and uniform posts site-wide. Maximize capacity and energy yield with a modular layout that allows for flexible row lengths, and design a system that makes the most of any piece of land. A motor-free tracker with fewer components and 95% fewer maintenance locations, the Sunfolding T29 delivers serious durability and uptime so projects perform well into the future.

www.sunfolding.com

Transformers



Virginia Transformer

The Alliance of Virginia Transformer & Georgia Transformer Corporations provides 45 years of growth with technology, short lead time, wide range for main power transformers up to 400MVA / 345kV in core type, and up to 1400MVA in shell type and pad mount transformers up to 4MVA custom built to renewable energy characteristics. They also offer transformers for energy storage applications. Reliable, custom designed, and built to last the lifetime of the clean energy farm.

www.vatransformer.com

Utility Scale Solar | PV



Coronal Energy

Coronal Energy, powered by Panasonic, is an independent power producer focused on utility-scale solar and storage projects. The firm provides turnkey solar energy solutions tailored for diverse enterprise customers across North America, including utilities, corporations, and the public sector. Uniting 3GW of completed project experience with the financial strength of a Fortune Global 500 company (#110), Coronal Energy, powered by Panasonic, owns and manages a 333MW operating portfolio and a multi-gigawatt development pipeline in more than 20 US states.

www.coronenergy.com



Inovateus Solar, LLC

Since 2003, Inovateus Solar has been creating energy solutions for their clients. With the ability to offer customers a wide variety of solar energy products and services, Inovateus Solar has built a strong portfolio of customers ranging from fortune 500 companies to utilities, universities, municipalities, and the federal government. Inovateus has completed over 364MW of solar installations in the USA and the Caribbean, and has delivered services in over 15 countries.

www.inovateus.com

NAI Capital

NAI Capital provides services including site locations, creative financing, contract negotiations, escrow and title insurance coordination, and marketing, acquisition, and liquidation services.

www.naicapital.com

SUNENERGY1

LEADERS IN UTILITY-SCALE SOLAR



SunEnergy1

SunEnergy1 is a U.S. solar developer, owner, and operator of utility-scale solar projects with close to 1GW installed. The company has developed large-scale solar power on the East Coast for nearly a decade. SunEnergy1 is vertically integrated and controls all stages of development in-house, creating affordable, low risk solar power for corporate, institutional, and utility partners. The company has the financial strength to own and maintain a 5GW pipeline of solar-ready development sites and over 250MW of owned solar facilities.

www.sunenergy1.com



Terra Posts PV

Terra Posts PV offer nationwide utility-scale post driving.

www.terrapostspv.com



TerraSmart

For nine years, TerraSmart has provided solar racking, engineering, design, and manufacturing of turnkey, ground-mount racking solutions for commercial to utility-scale solar projects. With over thirty years of experience in structural engineering and steel fabrication, TerraSmart has built and installed 2GW's of ground-mount projects across the United States. TerraSmart's ground screw foundation and racking systems help minimize project risks, ensure successful installation in all soil types resulting in cost-effective solutions.

www.terrasmart.com

Wire Management



Cambria County Association for the Blind and Handicapped

The patented Integrated Grounding Solar Cable Management System is the newest solution from CAB Products. Listed by Intertek to UL 2703, the new system uses a proprietary copper composite messenger wire and special hardware to allow it to act as the EGC and GEC, while also providing for cable management in CAB's patented solar hangers. The hangers are available in numerous configurations to support a variety of cabling. CAB can help identify which of the hangers will work best for a project.

www.cabproducts.com



Heyco Products

Heyco recently added two new SunRunner clips to its line of wire management products for solar installations. The SunRunner 4-2 and 4-2U both work with the new Enphase Q Cable and work with a variety of racking profiles. The 4-2 works with Everest, SnapNRack, and other similar racking profiles whereas the 4-2U works with Unirac, IronRidge, and other similar racking profiles.

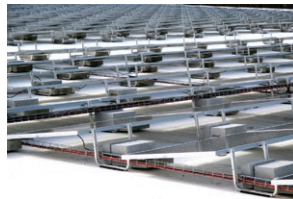
www.heyco.com



Nine Fasteners, Inc.

Nine Fasteners' DCS-1307 solar wire management clip is designed to hold 1 or 2 PV wires securely to most standard module frames. As with all of NFI's solar wire management clips, this clip is manufactured entirely in the U.S., is UL Listed for installations in both the U.S. and Canada, and incorporates a rolled outer edge for maximum wire safety.

www.ninefasteners.com



OBO Bettermann of North America, Inc.

OBO Bettermann of North America provides specially designed wire management products for solar installations. Their hot dip galvanized wire basket trays are self connecting. The 10ft section connects in a single snap, making installing tray on rooftops fast and easy. Their tray systems are UL classified and feature a lightweight aluminum cover to protect cables from direct sunlight and extend cable life. Most sizes and finishes are in stock and ready to ship. They can also help select the right size tray and mounting options for custom applications.

www.obous.com



Snake Tray

Snake Tray manufactures a series cable management systems for utility and commercial grade solar installations that are designed with features to lower the total cost of construction. Products are made in the USA.

www.snaketray.com



WAGO Corporation

Complete with CAGE CLAMP technology, the 811 fuse holder is reliable and easy to use. Available in Class CC and Midget style fuse holders, they provide maintenance-free, vibration-proof, and corrosion-resistant connections. Class CC fuses are compact branch circuit protection fuses. The 811 series is available with indication and multipole configurations. WAGO also offers a 1,000V rated version that is suitable for photovoltaic (10mm x 38mm) applications. Lever actuation makes for a user-friendly experience, further simplifying installation in applications such as motor control, power distribution, HVAC, and solar.

www.wago.us

FALL PROTECTION DISTRIBUTORS

WE OFFER A FULL LINE OF FALL PROTECTION PRODUCTS

CALL NOW!
863-703-4522 OR
TEXT **SSRRM** TO **95577** FOR MORE INFO

www.fallpd.com

Watch for more messages, up to 4 messages per month. Data/Message Rates may apply. Reply HELP for help or reply STOP to stop.

wiley



WILEY

Engineered for high-quality wire management solutions, Wiley Cable Clips simplify wire management and create a clean aesthetic to solar PV arrays. The clips are made of corrosion resistant stainless steel, which makes for a durable, long lasting, and reliable solution in all environments and are designed with coined edges to prevent damage to cable insulation. Custom designs are available upon request. The Wiley Bundle Strap is made of corrosion resistant 304 stainless steel, which makes them a durable, long lasting and reliable solution for all environments.

www.hubbell.com

Other Aerial Imagery Solar Report



EagleView

The EagleView SunSite Report delivers precise roof measurements and 3D models designed to meet the needs of solar installers and designers at multiple stages of a photovoltaic project. With data derived from high-resolution Pictometry aerial imagery, the report offers far greater accuracy than satellite images can provide. Enterprise and smaller residential installers save hours on each project with EagleView's guaranteed-accurate measurements and data, including azimuth calculations, roof area and pitch diagrams, and roof penetration locations. SunSite Reports include DXF or JSON files that easily import into popular solar design products for a fast and efficient workflow.

www.eagleview.com

Associations



Ironworker Management Progressive Action Cooperative Trust (IMPACT)

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

www.impact-net.org

Capacitors



Cornell Dubilier Electronics

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

www.cde.com

Equipment Manufacturer



GRT Utilicorp, Inc.

GRT Utilicorp is a manufacturer of 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 equipment for smaller post driving jobs.

www.grtutilicorp.com

Floating Solar Platform



Ciel & Terre USA, Inc.

The floating solar platform, Hydrelio, allows standard PV panels to be installed on large bodies of water such as drinking water reservoirs, quarry lakes, irrigation canals, or remediation and tailing ponds. A simple and affordable alternative to ground-mount solar systems, Hydrelio is particularly suitable for energy and water-intensive industries who cannot afford to waste either land or water. Wineries, dairy farms, fish farms, mining companies, wastewater treatment plants, irrigation districts, and water agencies are all examples of organizations who benefit from the synergy this system creates between sun and water.

www.cieletterre.us

Ground Cover Seed



Roundstone Native Seed

Roundstone's native seed mixes are designed for a wide variety of land uses and project objectives including erosion control, water quality, native landscaping, and pollinator habitat. They have mixes specially designed for solar applications that will build the soil, increase infiltration, and provide pollinator habitat while improving public acceptance. These mixes are designed to provide wildflower blooms starting in the spring and continuing through the fall. Roundstone Native Seed has a large selection of native seeds, seed mixes, naturalized seeds, and plant materials to meet project objectives.

www.roundstoneseed.com

High Voltage Electrical Equipment Manufacturer



Southern States, LLC

Southern States, LLC, a designer and manufacturer of high-voltage switching devices, increases utility system reliability by delivering next generation switching, automation, and protection solutions built on a century of service and customer care.

www.southernstatesllc.com

Industrial Networking



Antaira Technologies

Antaira Technologies' ARX-7234-AC-PD-T is designed for industrial and enterprise outdoor wireless access applications. The operating temperature range is -40°F to 158°F (-40°C to 70°C) and has an IP67-rated metal housing. Embedded with the Qualcomm IPQ4029 Quad-Core chipset, it boasts network robustness, stability, and wide network coverage. Based on IEEE 802.11a/b/g/n/ac, the access point supports high-speed data transmission of up to 867Mbps. The ARX-7234-AC-PD-T is capable of operating in different modes, which makes it suitable for a wide variety of wireless applications including long-distance deployments.

www.antaira.com

Oil Containment | Spill Prevention



Solidification Products International, Inc.

SPI has a variety of products designed for wind and solar applications such as their Petro-Pipes, Petro-Barriers, and Pump-Thru Barrier Systems. Each has been designed to allow rain water to drain while completely filtering out all hydrocarbons, vegetable oils, "natural ester oils that are soy based", and fuel sheen to non-detectable levels. In the event of a major spill, the SPI- Oil Containment Systems will totally shut down and prevent all flow from discharging. It will then back the spill into the containment area preventing an environmental release. SPI products are currently being used at wind and solar farm operations around the world.

www.oilbarriers.com

Online B2B Exchange



EnergyBin

EnergyBin is a wholesale solar B2B exchange, allowing users to buy and sell new, used, excess, refurbished, and hard-to-find solar panels, inverters, racking, batteries and more at 20% - 70% below cost. Customers can build new business relationships, search pricing on major brands, gain real-time market intelligence on pricing, supply, and demand, and send and respond to quotes for single parts and full systems. Over 1000 solar companies, including solar manufacturers, distributors and suppliers, developers, EPCs, and installers, are members of EnergyBin. Members oversee projects in the residential, commercial, agricultural, industrial, and small-scale utility markets.

www.energybin.com

Portable Solar



California Sunlight Corporation

California Sunlight Corporation offers cost-effective, high efficiency, and portable solar energy systems such as solar generator, solar security light, solar table lamp, solar-powered BBQs, solar water heaters, and solar balloon cookers. The latest product line is a solar powered portable AC generator from 100W to 3,000W with integrated solar panels, battery, inverter, and controller. It's suitable for use in everything from camping, emergency responses, sustainable living, to lighting, charging, cooking, and cooling in developing countries.

www.california-sunlight.com

Power Engineering and Consulting



Electric Power Engineers, Inc.

EPE Consulting provides the following services; transmission and distribution planning and design, energy market analysis, project/system design, interconnection testing and commissioning, NERC compliance services, integrated resource planning, smart grid modeling, and power system studies.

www.epeconsulting.com

inter solar

connecting solar business

NORTH AMERICA

North America's Premier Exhibition
and Conference for the Solar Industry
MOSCONE CENTER, SAN FRANCISCO

JULY
09-11
2019

www.intersolar.us

- Be part of North America's most exciting solar event
- Gain a critical edge in solar business - California is the epicenter of innovation and groundbreaking policies
- Showcasing solutions for the energy transition to solar, storage, electric transportation, smart energy

Special Exhibit

**POWER
DRIVE**
| NORTH AMERICA

co-located with

e es
electrical energy storage

**SEMICON
WEST**

Protective Solar System Barrier



SOLATRIM
 Beautify your system. Protect your investment.

SolaTrim

SolaTrim is a barrier system for rooftop solar that provides an easy-to-install perimeter skirting giving an aesthetic, completed look to solar arrays while eliminating any potential damage from pests, debris, and environmental threats. Squirrels, pigeons, leaves, snow and ice dams are no longer a problem with SolaTrim. SolaTrim uses a peel and stick adhesive designed to withstand extreme climate conditions and is designed to last for the life of the solar system. SolaTrim is a permanent solution that beautifies rooftop solar, raises customer satisfaction levels and referral rates, increases closing percentages, and mitigates long-term O&M costs.

www.solatrim.com

PV Off-Grid



Steca Elektronik GmbH

Climate-friendly and convenient refrigerators made by Steca have always been energy efficient. Now filled with the new R290 refrigerant, they are even more climate-friendly, and also include an interior LED lamp. They are fully programmable, and the inside temperature as well as the other configuration values can be set by the user. Therefore, the appliances are suited to all DC applications, including the refrigeration of medicines in hospitals. Efficient use of energy can be guaranteed by the optimum electronic controls and speed regulation of the compressor.

www.steca.com

Radiant Heating



Electro Plastics, Inc./STEP Warmfloor

Electro Plastics manufacturers STEP Warmfloor heating elements based on self-regulating PTC Nano Poly Carbon Technology. The system operates on low-voltage and is extremely energy efficient. The elements can be connected to AC power supplies or directly to DC solar panels. Because the elements are self-regulating, they cannot overheat. The elements are cut to length on site, making the system suitable for both new construction and remodeling, for primary heating and floor warming. Other applications include snowmelt and deicing for roofs, decks, pipes, containers, and ships. All products are made in the USA with environmentally friendly and recyclable materials.

www.warmfloor.com

Rapid Shutdown System



NEF Power, Inc.

This module-level Rapid shutdown device and monitoring is NEC 2014/2017 690.12 (CEC 2015 64-218) rapid shutdown compliant, and provides over temperature protection.

www.nefpower.com

Smart Off-Grid Control | Management



Clear Blue Technologies

Clear Blue's Smart Off-Grid technology and managed service delivers low-cost, centrally managed, wireless, off-grid power for telecom systems, industrial controls and sensors, street lights, security systems, emergency power, and Internet of Things devices. Smart Off-Grid combines a multi-load solar and solar-hybrid controller, built-in communications, and an advanced off-grid intelligent management and control cloud software. Their remote management service and Illumience Smart Off-Grid software enables all the systems to be managed, controlled, and proactively serviced over the Internet.

www.clearbluetechologies.com

Solar HVAC Equipment Manufacturer



Multiaqua Inc.

The MHRC-AE chiller features a built in solar inverter that allows a connection from solar power directly to the chiller. The chiller captures 100% of the refrigeration process waste heat that is normally rejected to the air. The unit will operate in dedicated cooling, dedicated heating, or water to water simultaneous heating and cooling modes. It does not have to be in the cooling mode to make heat. With this system, it is possible to cool rooms as well as heat showers, sinks, or a swimming pool with the same outdoor unit thereby eliminating the need and cost of traditional water heating methods.

www.multiaqua.com

Solar Panel Heating



X3 Energy / Van Straten Enterprises, Inc.

The Van Straten Heated Solar Panel Kit keeps snow and ice buildup from occurring on solar panels. The easy to install kit is available for any size solar panel and grid size. Their patented "Smart Control" measures daylight, temperature, and snow. The sensors know if there is sunlight and if there is snow on the panel, turning it on and off as needed. One "Smart Control" will run an entire solar panel array. Unattended grids are no longer a worry. This product also works in conjunction with their patented X3 Energy Portable Hybrid Power Module.

www.x3energy.net

Solar Pump

Shakti Pumps USA, LLC

India's solar pump manufacturer, Shakti Pumps can supply needs from 5GPM to 950GPM. They also have line of 3" helical solar pumps for replacing old wind turbines. For the USA market, they have stocking locations in Florida, Texas, and California.

www.shaktipumps.us

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

Utility Locating and Concrete Scanning



GPRS

Private service provider, GPRS, offers many utility detection reporting options, from marks on the ground, to a basic field sketch, to a full-blown AutoCAD report. Their report provides customers with a permanent utilities location record for future reference.

www.gprsinc.com

Vegetation Maintenance



Superb Mowing Company

Since 2015, Superb Mowing Solutions has been providing solar field and roadside maintenance equipment needs. They specialize in distributing solar field mowers and roadside mowers to businesses all over North America.

www.superbhorticulture.com

COAST TO COAST, FIND A SOLAR POWER EVENT

SOLAR POWER FLORIDA

March 12-13, 2019

Bahia Mar Fort Lauderdale Beach
Ft. Lauderdale, FL

Recent policy advances in Florida's solar market have invigorated the solar industry in the Sunshine State. Join us as we help grow Florida's solar capacity.

Join over 70 exhibitors and 1,500 attendees during this interactive event which features a full slate of education alongside exhibitor-led interactive training seminars for installers, contractors and developers.

CALIFORNIA SOLAR POWER EXPO

April 25-26, 2019

Marriott Marquis San Diego Marin
San Diego, CA

February 5th-6th, 2019
 Westin Boston Waterfront Hotel
 Boston, MA
events.solar/northeast/

Solar Power Northeast is the largest forum in the Northeast for the solar and energy storage industry to come together and learn about the trends and legislation impacting grid resilience and reliability in New England states. This event will feature multiple tracks of education – including operations & maintenance (O&M) and energy storage – plus extensive networking opportunities. Attendees can also expect over 80 exhibitors, 1,500 attendees, and expanded energy storage business opportunities on and off the show floor.

show in print

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



Solar developer

BlueWave was founded as a solar development firm, focused on delivering renewable projects to local communities. They also provide comprehensive solar solutions to their customers and partners. They build solar projects that power communities in New England and beyond.

BlueWave

www.bluewavesolar.com



Helping installers capitalize on opportunities in solar energy

After 43 years of solar research and development, Panasonic continues to drive innovation in solar performance. Advances include a unique cell structure that minimizes carrier loss and a panel surface that reduces reflection. A low temperature coefficient of $-0.258\% / ^\circ\text{C}$ provides impressive performance at high temperatures.

Panasonic

na.panasonic.com/us/solarpanels

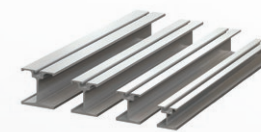


Simplified, single piece mounting solution

Introducing the new PowerMount-7545S to be used with virtually any R-Panel Roof System. The single piece design simplifies installation and reduces cost. Use the PowerMount-S with any manufacturer's L-Foot or Solar Connections' Universal L-Foot to attach any rail system. Go railless and use the Solar Connection Kit with their GroundBonding Technology. The SCI Kit is UL 1703 and UL 2703 listed and approved.

Solar Connections

www.solarconnections.com



Commercial mounting system

The POWER RAIL commercial mounting system is engineered for longer span and cantilever distances for rooftop or open-structure applications. Designed with the professional PV solar installer in mind, both the XD/UD and LD/MD rails feature single-tool assembly and a patented RAD Lock-in-Place bolt for fast and secure module clamping. The high-strength aluminum mounting rails also include an integral wiring channel that secures cables and provides a clean, professional appearance.

Preformed Line Products

www.preformed.com



Solar plant performance monitoring

Solar-Log Skill is now available in the Amazon Skill store. Plant owners and O&M providers can now monitor their solar plant performance through voice command. Future functionality will mean this smart solution can even suggest the best time for plant owners to run specific appliances based on production forecasts. Solar plant O&M providers will be able to prioritize critical performance errors among their fleets and request that emails be sent to their customers alerting them of the issues.

Solar-Log America

www.solar-log-america.com



Large capacity three-phase inverters

SolarEdge's expanded offering of three phase inverters with synergy technology up to 100kW combines large capacity with ease of installation. The inverter design is based on small, lightweight, and easy-to-carry primary and secondary units. They are wall mounted for a minimal footprint, with installation only requiring a one or two-person crew. No crane or special tools are needed for installing the inverter. Installing SolarEdge's large capacity inverters will further reduce setup times and costs.

SolarEdge

www.solaredge.com



Renewable energy solutions

Founded in 2004, ARC Design & Consulting LLC has designed more than 15,000 roof and ground-mounted solar energy systems in over 16 states and four countries, totaling over 500MW. A growing design portfolio encompasses projects of all sizes, from residential and commercial systems through large, grid direct utility scale arrays, now also incorporating battery storage. The experienced team at ARC offers both structural and electrical design services and provides efficient and economical solutions to the renewable energy market.

ARC Design & Consulting, LLC

arcdesignllc.net



Solar wire management clip

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

Nine Fasteners

www.ninefasteners.com



Fixed-tilt ground-mount system

RBI Solar's Dahlia (4P) fixed-tilt ground mount system is designed to increase the Ground Coverage Ratio (GCR) of a potential solar site. As the first of its kind, Dahlia (4P) serves as an efficient and affordable mounting solution aimed to maximize the amount of PV deployed on a given site. Engineered with a low tilt and clearance, this system has a streamlined design to minimize materials cost and reduce installation time in the field.

RBI Solar
www.rbisolar.com



Black mono modules

Axitec's AXIblack premium solar modules are suited for installations where the black exterior design must match performance. These high performance monocrystalline solar modules reach efficiencies up to 19.55%, guarantee high power output, and a spinning meter.

Axitec Solar
www.axitecsolar.us



Custom solar support structures

Baja Carports offers an extensive solar support system product line customized to customers' site specifications by in-house engineers, meeting their coverage plus optimal PV production needs. Baja's Full Cantilever Tee is often paired with its Semi and Full Cantilever carports to meet live/loads up to 60psf and wind speeds to 160mph. All products are pre-fabricated, bolted connections, pre-galvanized steel for fast on-site installation.

Baja Construction
www.bajacarports.com



Heavy-duty, long-lasting deep cycle batteries

Rolls improved premium deep cycle 5000 Series flooded batteries offer increased charge efficiency and extended cycle life providing long-lasting energy storage in a wide range of voltage and capacity options (80AH - 4860AH @ 20 hr rate). Suitable for use in small to large-scale off-grid, grid-tied, and backup applications, Rolls 5000 Series combines high quality, heavy-plate construction with Advanced-NAM additive for improved charge efficiency and cycle life in a durable, dual-container case design. The 5000 Series premium line-up delivers superior cycle life, backed by a 60-month full replacement warranty.

Rolls Battery Engineering
www.rollsbattery.com



Rapid shutdown solutions

SolarBOS' Rapid Shutdown Solutions represent low-cost and space-saving solutions for commercial solar systems utilizing string inverters. Combiners and pass-through disconnecting units with integrated load break contactors provide string level rapid shutdown functionality when it isn't feasible for the string inverter to be within the array boundary (per NEC 690.12). Products can be configured for grounded or floating systems and can accommodate inverters with single or multiple MPPTs. Additional options include capacitor bleed down and Low Voltage Ride Through functionality. All use compact NEMA-4X polycarbonate enclosures.

SolarBOS
www.solarbos.com



Solar equipment brokering

EnergyBin, the wholesale solar B2B exchange, has launched a new Resources page on the company's website featuring material on solar equipment brokering. The resources are useful tools for full-time solar brokers, solar companies who want to adopt broker best practices, brokers from other industries interested in expanding into the solar industry, and individuals interested in learning more about equipment brokering. The information presented is based on industry research and over fifteen years of company experience working with more than 13,000 equipment brokers. Resources explore topics of why the solar industry needs equipment brokering, common characteristics and skills of equipment brokers, buying and selling solar equipment, and how brokers are using online B2B exchanges to reduce solar soft costs and increase profit margins.

EnergyBin
https://resources.energybin.com

SOLAR CLIPS



NFI-1701
Brand New rail mounted clip for use with Enphase IQ microinverters

NFI-1306-V90

90° oriented clip intended to secure two USE-2 wires or a single PV wire to standard module frame.



DCS-1306
Designed to secure two USE-2 wires or a single PV wire to standard module frame.

DCS-1307

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



NFI-1307-V90
90° oriented clip intended to secure one or two PV wires to standard module frame.

NFI-1463

Clip designed 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*



233A South Street | Hopkinton, MA 01748 | 800.539.3939
www.ninefasteners.com

Warranties and Performance Guarantees in the Stationary Energy Storage Market

How are they validated?

by Davion Hill, Ph.D.

The growth of the energy storage industry comes with greater exposure to commercial risk. Battery manufacturers are addressing this risk with warranties built on self-developed testing and models. But this creates inconsistency on warranty offerings in terms of cycles or throughput and operational limitations. Buyers and sellers, seeking a way to objectively match technology to its intended market, need a standardized testing approach that supports guarantees with objective data.

Most battery manufacturers have developed standard (unadjusted) warranties for stationary storage, based on their experience in the automotive industry. The legacy automotive battery system was expected to meet a 10-year, 100,000-mile warranty. In the late 2000's, an electric car was expected to have a range of 30-60 miles, and charge once per day. This use case amounted to 300-365 cycles per year, a 10-year calendar life, and an average total cycle life of ~3,000-3,650 cycles, until reaching 80 percent remaining capacity. Today, battery manufacturers are still using this data to market their product.

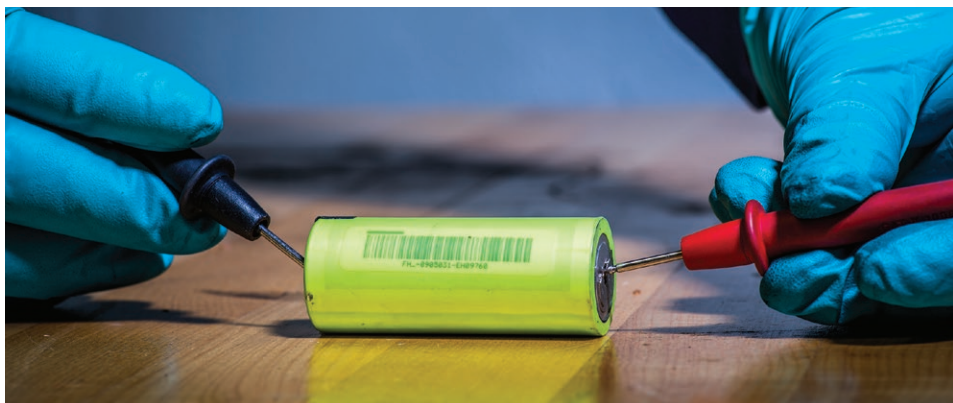
However, this convention is no longer relevant to stationary storage, or electric vehicles. Modern electric vehicles have 200+ miles of range with larger battery packs. Battery costs are almost 1/10th of what they were 10 years ago, and a vehicle may only be charged once per week. In a 10-year period, this amounts to 500-600 cycles, with the battery pack spending most of a week in intermediate states of charge (SOC), especially if the vehicle is opportunistically charged; the cycle life is less important than the amount of time the battery spends at different SOC's. Because of these uncertainties, automotive manufacturers have invested millions in their own battery testing facilities to perform their own diligence on battery lifetimes. Recent, independent testing has shown that battery degradation is dependent on the SOC rest states of a battery, and that the most sensitive SOC conditions vary greatly across batteries.

Another precedent from the lead acid and uninterruptible power supply (UPS) battery industry is the concept of "Depth of discharge" (DOD), which implies the battery must always start from a full SOC before discharging. The DOD is measured as the percentage of discharge, i.e., if the battery discharges to 75 percent SOC, the DOD is 25 percent. In many stationary markets, Li-ion batteries can operate at many SOC conditions without reaching a fully charged state each cycle. Therefore, the term DOD has very little meaning for Li-ion batteries, which make up 95 percent or more of the market in stationary storage.

When energy storage project developers issue requests for proposals (RFP) from stationary storage vendors, these legacy conventions are still evident in the responses. The standard offering from a battery manufacturer is a 10-year warranty, guaranteeing 80 percent remaining capacity at the end of life, under an assumed DOD of 100 percent. The senior engineering, procurement, and construction contractor (EPC) will usually base their capacity guarantee on this warranty. Yet, these criteria are inappropriate for most stationary storage markets.

Once the vendor is selected, the battery manufacturer will likely revise the warranty offering with linear capacity degradation models (based on data that the manufacturer will not disclose). However, publicly available testing results demonstrate that degradation is not linear; it's greatly dependent on the SOC, temperature, and current (Amps) to which the battery cells are exposed. Therefore, the original warranty offerings in RFP responses have no lasting impact, and should not be considered empirical in the evaluation of preliminary bids. The later revisions to the warranty lack transparency, and introduce technical risk to the contractual guarantees in the project.

The cycling needs of a stationary storage battery are rarely as simple as one cycle per day with a 100 percent SOC setpoint. In frequency regulation markets, the battery transits the entirety of the SOC range multiple times daily, in partial cycles, with an intermediate SOC setpoint. In a demand charge avoidance use case, the battery may cycle infrequently, and idle in a partially charged state. In a weather-dependent solar self-supply scenario, a battery is charging with solar power during the day, while remaining in a partially depleted state overnight. Given these complexities, it is better to discard the convention of "cycle life", and instead think in terms of "throughput", or the condition-dependent





Dr. Davion Hill is an energy storage expert managing DNV GL's energy storage business for the Americas region. He is an Executive Board member for NAATBatt International, former President (2015) and Chairman (2016), and also serves on the Board of Directors for NYBEST. As an energy storage expert serving the energy project development and energy finance communities, Dr. Hill has been principle investigator for R&D programs with ARPA-e, NYSEDA, the US Department of Transportation,

the Federal Aviation Administration, and the California Energy Commission, Dr. Hill also led DNV GL's North American joint industry guidelines for energy storage on hybrid vessels in the oil & gas sector, and was one of several authors for DNV GL's GRIDSTOR RP-0043. As primary author on the Consolidated Edison Battery Energy Storage Safety report, Dr. Hill led an industry-wide conversation in 2016-2017 to address fire safety issues in energy storage. Dr. Hill's expertise spans energy storage business models and project development, safety issues and integration, and

long-term performance to support warranties. In 2011 Dr. Hill was a co-awardee of the TechColumbus Innovation award for DNV's analysis of grid scale energy storage via CO2 conversion, and also chaired panels for the National Academy of Engineers on energy storage across scales. He is an accomplished author with over 30+ peer reviewed publications and articles, and acquired his PhD in applied materials physics from The Ohio State University in 2006.

DNV GL /// www.dnvgl.com

number of amp-hours or watt-hours a battery can discharge over its life. The throughput should be quantified subject to these conditions: 1) temperature, 2) average SOC, 3) SOC change per cycle (or SOC swing), and 4) C-rate (an indirect measure of battery current). Battery performance ranked in these terms can be used to validate a warranty.

There are two factors that must be addressed to estimate whether the warranty and/or capacity guarantee is sufficient. First, the system design comprises a number of battery cells configured in series and parallel, to achieve the desired power and voltage of the system. This configuration will impact the current and SOC conditions for the battery cells. The battery management system (BMS) imposes static upper and lower SOC limits on the cells. These limits should be compared against the SOC and C-rates that maximize the life of the cell. It is for these reasons that the electrochemical SOC at the cell and the system SOC are two different numbers. If the warranty is offered in the context of system conditions, the cell-level implications will need to be back-calculated. Second, the control of the system—as it pertains to its use case and environmental conditions—will need to be analyzed to determine if the SOC, temperature, and power of the system are detrimental to the warranty.

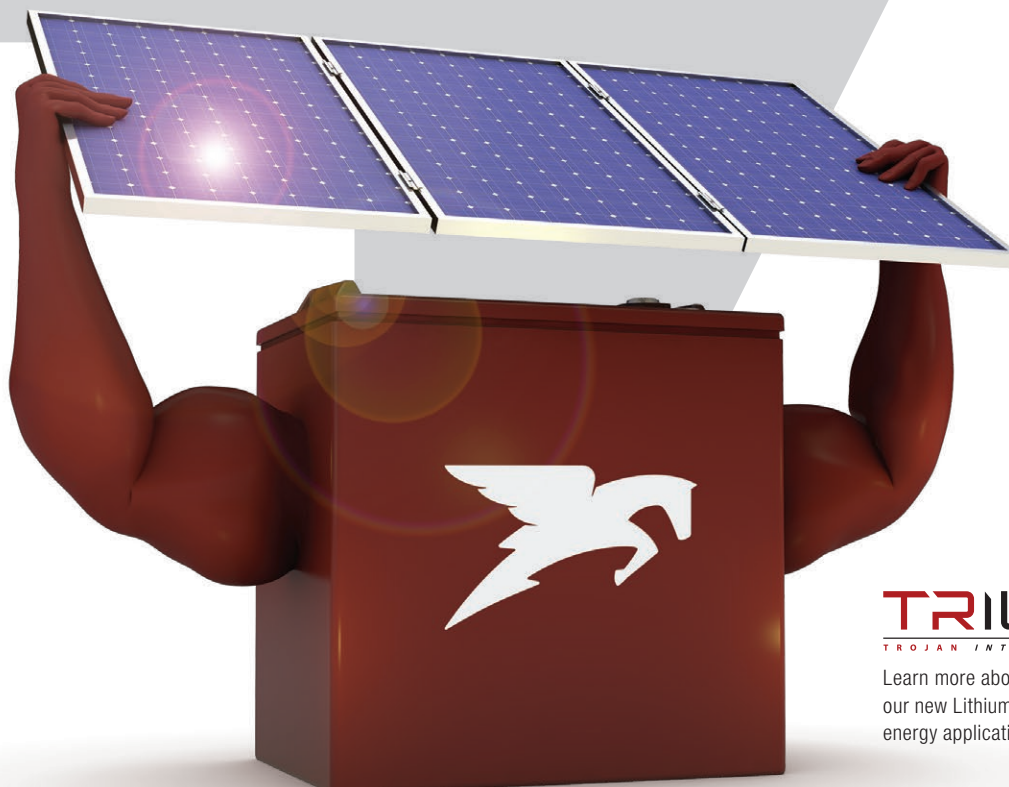
The old legacy of a 10-year warranty with 80 percent remaining capacity fails to acknowledge condition-dependency on battery throughput. As projects are being deployed at the gigawatt scale, it is evidential that there are commercially viable and technically sound solutions in the marketplace. Unfortunately, due to lack of transparency in warranties and performance, their viability is not apparent to the greater market. The industry precedent of relying on the manufacturer's self-validation of the warranty is exposing the industry to technical risk. Buyers and owners of energy storage systems can mitigate this risk by participating in independent testing programs to validate warranties and performance guarantees. This ultimately leads to more certainty in transactions, which increases investor confidence, and accelerates the market.



ENERGIZING

THE SOLAR STORAGE NEEDS OF TOMORROW.

We don't just manufacture batteries - we innovate, engineer and develop energy solutions. At Trojan Battery Company, we're charging forward.



TRILLIUM
TROJAN INTELLIGENT LITHIUM

Learn more about Trojan's products including our new Lithium Ion solutions for renewable energy applications.

trojanbattery.com



Utility-Scale Storage Across the Grid

by Randolph Mann

AS FOLLOWERS OF THE ENERGY INDUSTRY

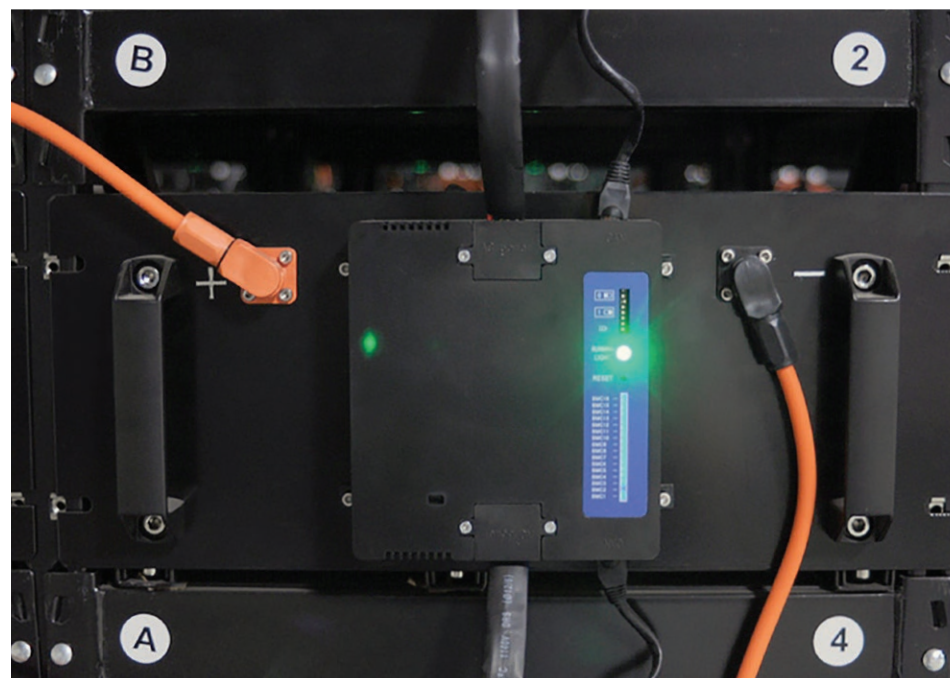
know, energy storage is growing at a phenomenal rate. Install size predictions that seemed aggressive only a few years ago, now look to have been far too conservative. The pace of projects is not only picking up in places industry insiders would expect, like California, but also gaining traction in newer markets such as Canada, Arizona, and Indiana.

Developers and owners of utility-scale energy storage projects across North America are witnessing the expansion of the energy storage market firsthand. Leading U.S. utilities are actively implementing storage systems that will provide incremental capacity to the grid. Each system is designed to deliver slightly different services. Here is a brief list of projects that demonstrate the broad set of capabilities which today's advanced storage systems can provide.

- Providing critical peaking capacity and grid support services:**
The Grand Johanna system in Irvine (2 MW/9 MWh)
 Developed in response to the Aliso Canyon gas leak in 2015; it has been operational since the beginning of 2017.
- Primarily intended to relieve local capacity constraints caused by retiring fossil fuel units:**
The Hummingbird Energy Storage project in Santa Clara County in Northern California (75 MW/300 MWh) Pending CPUC approval, it's slated to be in service by December 2020.
- Intended to bolster local distribution networks enabling wires upgrades to be deferred:**
The Wildcat Energy Storage project near Palm Springs (3 MW/12 MWh).
Three separate Acorn Energy Storage projects under development in Thousand Oaks, California (with a total combined storage capacity of 6.5 MW/26.5 MWh).
- Providing critical local capacity to a transmission constrained area of the grid:**
The Quarantina project in Santa Barbara (10 MW/40 MWh)
 This energy storage facility will be operational by 2021.

In many of these cases, the utility customer purchases capacity, while the developer retains the ability to provide additional value-added energy and ancillary services into the local market. Sometimes, however, a utility customer will purchase a bundled product including capacity, energy, and other ancillary services. This is the case with the 6.5 MW/26 MWh Don Lee system in Escondido, due to go online by 2021. Currently, several large utilities and Community Choice Aggregators have RFPs planned or ongoing in California, highlighting the success of the state's energy storage goals. In fact, those targets are already being surpassed due to the ability of energy storage to provide capacity at rates competitive with natural gas generation.

California isn't the only place in North America where energy storage is booming, though. Ontario, Canada, has been a hotbed of energy storage activity: The Stratford Energy Storage project is an 8.8 MW/40.8 MWh system located in the city of Stratford, and is the largest battery storage facility in Canada. It provides voltage control,

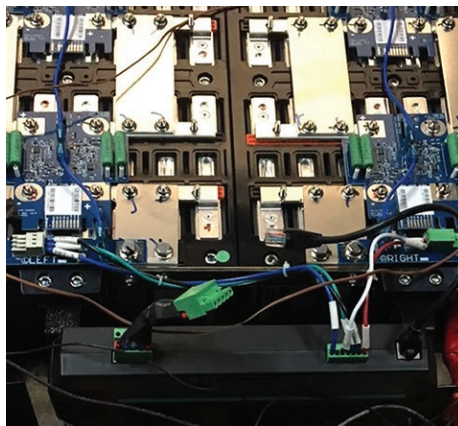




Battery energy storage skid solution

The Delta Battery Energy Storage Skid (BESS) Solution is a fully integrated battery storage system with power of 250kW and 500kW and energy storage up to 2MWh. The system is capable of adapting to the various energy, power, and performance requirements of commercial energy users, including peak shaving, optimized load management, self-consumption, backup power, and optimization of renewable energy sources. The BESS system consists of two main components: (1) Delta's battery power unit (PCS - power conditioning system with AC and DC combiner panels); (2) the Delta-BESS-DC solution, which includes its battery modules, battery management system, and active cooling. All components are factory-assembled and tested, reducing installation time and costs normally associated with field assembly.

Delta Americas /// www.delta-americas.com



frequency regulation, and system peak reduction operations. Thousands of megawatt-hours of energy storage projects are being developed for utility RFP procurements planned or underway across the United States, including New York, Washington, Alabama, Oklahoma, New Mexico, and Arizona.

It is clear that grid operators across North America are embracing battery energy storage, and the numerous services it can provide at an attractive price. Whether as a capacity resource, transmission and distribution deferral, renewable energy integration, ancillary services, or other functions, energy storage is proving to be a valuable asset that is a key component of the grid's future.

Randolph is President of esVolta. He has over twenty years' experience identifying, creating, and scaling strategic growth initiatives in the energy business. Prior to founding esVolta, Randolph served as President of Salt Creek Energy Advisors which provided energy clients with services including strategy consulting, transaction diligence and execution, project development, and economic analysis. He was previously VP of Development for NRG Energy, where he led utility-scale wind and solar development and directed a new platform to develop renewable energy-led microgrids. He also served as VP Development for Edison Mission Energy, where he positioned that company among the largest wind owner/operators in the United States. Randolph has a Master's of Science in Management from the Sloan School of Management at Massachusetts Institute of Technology, and a Bachelor of Arts from University of Virginia.

esVolta /// www.esvolta.com

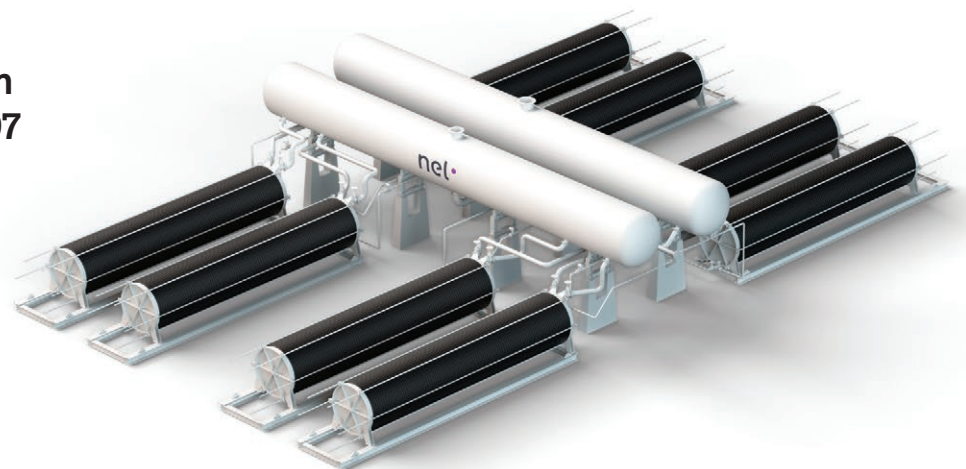


THE STORAGE REVOLUTION

Stop curtailing excess power. Nel Hydrogen electrolyzers will help save lost energy, balance electric output and increase your bottom line.

- Alkaline and Proton® PEM Technologies
- Safe, Clean and Cost Effective
- 90 Years of Field Experience
- Ideal for Energy Storage and Grid Management
- Scale to Match Any Application

Visit us on-line at
www.nelhydrogen.com
 or call +1-203-949-8697



nel •
 number one by nature™

Who's Going Green?

Maybe not who you think

by David Bywater

There are plenty of pre-conceived notions about going green, from the cost of eco-friendly measures, to the lifestyles and political leanings of those who employ them. But according to results from a recently-completed 2018 report, people across political, cultural, and generational spectrums are likely to find it equally easy being green.

Surprisingly, older generations lead the way in eco-consciousness

Among the 3,000 American adults polled for the study, 60 percent consider themselves to be conscious of environmental issues. Broken out by age demographics, a large portion of millennial (58 percent) and Gen Z (57 percent) respondents considered themselves eco-conscious, but baby boomers outpaced both groups, with a full 66 percent saying they considered themselves eco-conscious.

Contrary to popular perception, green consumers are both red and blue

Regardless of age, the study found several touchpoints of common ground between the 60 percent who did consider themselves green, and the 40 percent who considered themselves to be more conventional consumers. Politically, one in four of the eco-conscious respondents voted for Donald Trump in the 2016 election—the same rate as their conventional counterparts. And green consumers were just as likely to identify as Democrat as Republican—28 percent on both sides of the aisle. The bulk of respondents overall (43 percent) identified politically as independents. Even on controversial political issues, both sides were generally in harmony. The majority of both groups (68 percent of green respondents, and 59 percent of conventional respondents) similarly supported the legalization of marijuana.



More similarities than differences

For too long, perceptions of green consumers – the young vegan who cycles to farmers markets – have not aligned with reality. As our report indicates, the bulk of the population with an interest into being eco-conscious, or going green in the future, is far more diverse.

While differences certainly abound, the results suggest that the gulf between green and conventional consumers is much narrower than originally believed; it likely has more to do with perception, not practice.

What divides green and conventional consumers

Of course, the two groups don't see eye to eye on everything. There is a considerable gap between the groups' belief that climate change is real (83 percent of green respondents versus 65 percent of conventional respondents). Green consumers were twice as likely to believe that it could be reversed, as opposed to the 14 percent of conventional respondents who said they felt nothing could be done about the issue.

Differences also abound in the perception versus reality of eco-friendly folks. One quarter of conventional respondents viewed green respondents as a group keeping vegan diets, yet just 4 percent of green consumers reported being vegan. In fact, 88 percent of them said meat is a regular part of their diets.

What are the barriers to going green?

It starts with education. Research found that the more education respondents had, the more likely they were to report being eco-conscious. Learning more about our planet, and our responsibility to be environmental stewards, is a proven way to inspire behavioral change.

While the majority of conventional consumers (59 percent) have a desire to become more eco-conscious, they see a number of roadblocks getting in their way. Among these barriers was a belief that going green would be inconvenient; many conventional respondents believed their green counterparts engaged in significant lifestyle changes, like composting or driving an electric vehicle.

The data debunks this myth. Out of a list of 25 activities that might contribute to a green lifestyle, the top three among all respondents were recycling, using reusable shopping bags, and conserving water. In fact, people who consider themselves green and those who self-identify as a conventional consumer, exhibit many of the same behaviors.

The largest single reason conventional respondents gave (at 41 percent) was that going green would be too expensive. This is an outdated perception. Across the board, energy-efficiency products such as electric vehicles and solar panels are becoming more affordable and easier to adopt. The price of solar energy has plummeted 86 percent since 2009; one megawatt of solar power now costs just \$50 to produce at utility scale. Going green also delivers a tremendous return on investment. For example, smart thermostats can save the average customer up to \$145 per year, paying for themselves in less than two years.

Solar is a gateway for embracing a green lifestyle

More than half of survey respondents have already installed solar panels, or were likely to do so in the next five years. Notably, younger people are leading this charge.

Among all respondents, solar seemed to serve as a kind of gateway to going green. Not only is installing solar panels becoming much more of a mainstream move, it also serves as an introduction for those who want to be more eco-friendly for ideological reasons, as well as those who are primarily focused on their finances. It's a middle ground for both camps that makes a positive impact on both the environment, and their wallets.

David Bywater is CEO of Vivint Solar, a full-service residential solar provider. Vivint conducted a nationwide survey that polled more than 3,000 Americans, the results of which can be found in its 2018 Environmental Consumer Report.

Vivint Solar /// www.vivintsolar.com



Tailor-made energy efficient axial piston pumps

Rexroth's energy-efficient axial piston variable pumps reduce diesel consumption in fork lift trucks - power class up to 3 tons load capacity. With size 28 in the AIVO axial piston pump series, Rexroth offers an even finer gradation for application oriented, easy to install solutions. The variable pumps supply different functions of the working hydraulics, such as lifting and lowering, or the steering. The new variant increases the scalability of the AIVO series, which Rexroth already offers in sizes 18 and 35. Despite the cube number of 28 ccm, the new size shares the same compact housing as the existing size 18. It can therefore be compactly installed in tight spaces. The connections, which can be positioned laterally or to the rear, are easily accessible. At a nominal pressure of 250 bar and a maximum pressure of 280 bar, the AIVO size 28 provides a high power density in a compact installation space and achieves an efficiency of nearly 90%. The high permissible self-priming speeds further complement this power comparison. Adjusting the cradle decouples the speed of the diesel engine from the pump power and produces the flow, according to the actual need. The speed in continuous operation and at maximum swivel angle has been set to 3,200 rpm, as a result, the AIVO size 28 covers a wide performance range.

Bosch Rexroth /// www.boschrexroth.ca



Connectivity and control

The new SeaConnect 370 IoT edge device allows users to monitor and control real-world processes and trigger actions with SeaCloud, a cloud-based, built-in event engine. Ideal for a variety of applications including asset management, data acquisition, environmental monitoring, and facility management, the SeaConnect 370 offers an all-inclusive IoT solution that successfully enhances existing systems. Sealevel's product assesses environmental conditions and responds accordingly, as well as provides historical reporting. The SeaConnect 370 can configure trigger actions, configures to the web by mobile device, and has integrated Wi-Fi or cellular connectivity. The SeaConnect 370 features two Form C relays, four digital inputs (wet or dry contact), two 12-bit A/D converters, a 1-Wire bus interface, and a TI SimpleLink CC3200 ARM Cortex-M4 microcontroller unit. An optional QuickStart Demonstration Kit is available for demonstration and testing purposes. With integrated Wi-Fi capability, the SeaConnect 370 can also be configured with a Verizon Cat 1 cellular modem. For applications where geolocation is required, the SeaConnect 370 is available with an optional cellular and GPS module. For data logging, the 370 interfaces with Sealevel's optional SeaCloud service. SeaCloud offers a secure, robust, scalable, Industrial Internet of Things (IIoT) software platform and is designed to monitor, track, analyze, and control data from Sealevel I/O devices. SeaCloud can be private-labeled and customized to meet specific user needs. The current iteration is designed for data-at-rest applications such as condition monitoring and operational intelligence. Other options include dweet.io and custom interfaces to existing customer cloud applications.

Sealevel Systems /// www.sealevel.com



JANUARY

23-24 The Energy Expo
Miami Airport Convention Center (MACC) – Miami, FL; www.theenergyexpo.com

FEBRUARY

05-06 Solar Power Northeast
Westin Boston Waterfront Hotel – Boston, MA; www.events.solar/northeast/

27-28 AWEA Wind Project O&M and Safety Conference
Hotel Del Coronado – San Diego, CA; www.awea.org

27-28 GLOBE Capital 2019
Four Seasons – Toronto, ON; www.globeseries.com

MARCH

05-06 AWEA Wind Power on Capitol Hill 2019
Washington Court Hotel – Washington, DC; www.awea.org

27-29 Progress Summit 2019
Westin Hotel – Ottawa, ON; www.broadbentstitute.ca

26-28 AWEA Wind Project Siting and Environmental Compliance Conference 2019
Hyatt Regency Hotel – Albuquerque, NM; www.awea.org

MAY

01-02 Midwest Solar Expo
Radisson Blu Aqua – Minneapolis, MN; www.midwestsolarexpo.com

15-16 International Solar Power & Technology Summit
San Francisco, CA; <http://usa.solartech.global>

20-23 AWEA WINDPOWER 2019 Conference & Exhibition
George R. Brown Convention Center – Houston, TX; www.awea.org

JUNE

05-06 37th West Coast Energy Management Congress (EMC)
Santa Clara Convention Center – Santa Clara, CA; www.energyevent.com

21-23 The 30th Anniversary Energy Fair
Custer, WI; www.midwestrenew.org

JULY

09-11 Intersolar North America
Moscone Center – San Francisco, CA; www.intersolar.us

SEPTEMBER

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

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

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

OCTOBER

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

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

NOVEMBER

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

Page	Company	Website
30	3S Americas Inc	3slift.com
12	Abaris	www.abaris.com
68	American Earth Anchors	americaneearthanchors.com
9	Amsoil	amsoilwind.com
23	AWEA	www.windpowerexpo.org
66	Axitec, LLC	www.axitecsolar.us
27	Bachmann Electronic Corp	www.bachmann.info
5	Baja Carports	www.bajacarports.com
62	Buffalo Turbine	buffaloturbine.com
67	CAB Products	www.cabproducts.com
39	Cornell Dubilier Electronics, Inc.	cde.com/solutions/inverters
55	Crown Battery	www.crownbattery.com
47	Dynapower	www.dynapower.com/dc-dc
20	Einpart, LLC	www.einpart.com
40	Eko Instruments (USA) Inc	www.eko-usa.com
17	Elevator Industry Work Preservation Fund	www.eiwpf.org
69	Fall Protection Distributors	www.standingseamroofanchor.com
37	GameChange Solar	gamechangesolar.com
52	Hammond Power Solutions	www.hammondpowersolutions.com
16	Helwig Carbon	helwigcarbon.com
53	Heyco	www.heyco.com
51	HuksefluxUSA Inc	www.hukseflux.com
26	IMPACT	impact-net.org
24	Indji Systems	www.indjiwatch.com
71	InterSolar North America	www.intersolar.us
51	Iso-Cal North America	www.isocalnorthamerica.com
54	Kinetic Solar	www.kineticsolar.com
13	Mersen France Amiens S.A.S.	www.mersen.com
46	Mersen Solar Division	ep.mersen.com
7	MK Battery	mkbattery.com
79	Nel Hydrogen	www.nelhydrogen.com
75	Nine Fasteners	www.ninefasteners.com
19	Nordic Fiberglass	www.nordicfiberglass.com
3	Panasonic	na.panasonic.com/us/solarpanels
IBC	Port of Stockton	portofstockton.com
57	Preformed Line Products	www.preformed.com
42	ProSolarClean	www.prosolarclean.com
IFC	RAD Torque Systems	www.radtorque.com
45	RBI Solar	www.rbisolar.com
43	Rolls Battery Engineering	rollsbattery.com
65	S-5	www.s-5.com
11	Shell	shell.us/power
OBC	Shoals	www.shoals.com
56	Sinexcel	www.sinexcel.us
15	SKYLOTEC North America LP	skylotec.com
63	SMARTTECH	smarttechonline.com
59	Solar Connections International	solarconnections.com
73	Solar Power Events	www.events.solar
49	SolarBos	www.solarbos.com
60	Sol-Ark	www.sol-ark.com
41	SolarRoofHook	www.solarroofhook.com
35	Soltec	soltec.com
61	Southern States LLC	www.southernstatesllc.com
31	Sterling Rope	sterlingrope.com/freedomtofocus
28	Transportation Partners and Logistics LLC	tpandl.com
77	Trojan Battery	www.trojanbattery.com
21	WindCom Services	windcomservices.com

Send us your clean energy show and event listings.

Email information to the editor at editor@nacleanenergy.com

THE PORT OF STOCKTON YOUR PERFECT PIVOT POINT



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

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



Port of Stockton

CALIFORNIA

209 • 946 • 0246

PORTOFSTOCKTON.COM

imagine...

- NO combiner boxes
- NO field o&m
- NO torquing
- NO cable trays
- NO trenches
- NO re-combiners
- NO custom power stations

bla
big lead assembly™

Combining the function of:

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

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



shoals®
technologies group