VOLUME 11 | ISSUE 4

North American Clean Energy

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What's Under Your Solar Panels?

Power Outages and the Failure of Grid-Tied Solar

Emerging Markets: Advice to New Investors

Moving Forward

What lies ahead for the energy storage market in America

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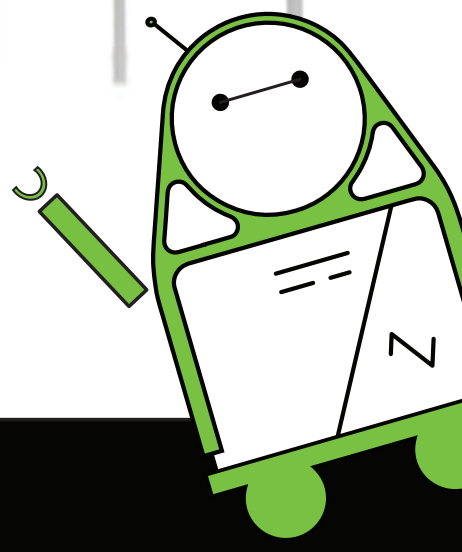

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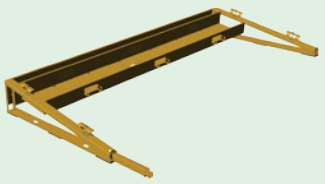

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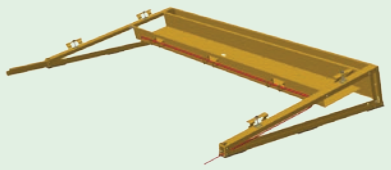

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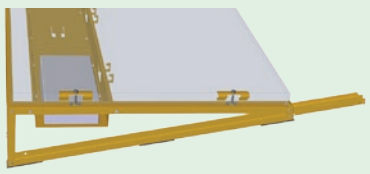

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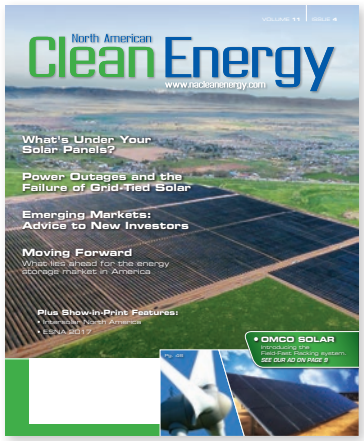

On our cover...

This 28MW project in the mountainous region of Idaho was completed with the GameChange Genius Tracker single axis solar system. The system was chosen for superior power production and long term reliability in harsh wind and snow conditions. GameChange Solar provides fixed tilt and tracker equipment in the United States and internationally.

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AH PARIS... THE FINE WINE, THE HAUTE CUISINE, THE GLORIOUS cathedrals, and, oh, yes, the Accord. Regardless of where you stand on this highly political issue, I'd like to offer a more optimistic take on the current state of the renewables industry. Rather than dampening this country's enthusiasm for clean energy, the exit of the United States from the Paris Accord appears to have had the opposite effect. Almost every day brings news of another pledge by state leaders to continue the drive towards wider access to sustainable power. From agreements among local lawmakers, to a renewed sense of urgency by (formerly averse) beachgoers to pepper our coasts with offshore wind farms – it's clear that renewables will not be dictated by politics. Current research is changing lives and attitudes. Our business is all about what will happen tomorrow.

You've no doubt seen the occasional news story about a centenarian celebrating his or her 100-and-somethingth birthday. Have you ever wondered how it must feel to have lived through all of the technological leaps and bounds that have brought us to where we are today? It doesn't take much imagination – just look at your kids: they've probably never used a corded phone, have no clue what it's like to actually move from the couch to turn the TV channel (much less sit through endless commercials), and worry that if their friends don't immediately respond to a text, they must have fallen off the edge of the earth.

What will their kids think? Will solar shingles be passé? Will major utilities go the way of the street corner pay phone? Will our great-grandkids roll their eyes at the fact that we ever used car keys and wall switches? I don't pretend to be nearly as forward thinking as all of you, but in an effort to imagine what it might be like for a typical kid in a few years...

> *Sammy hopped off the maglev tram and ran up to her house. Nothing happened. She sighed, rolled her eyes, and pulled up the sleeve of her sweater to expose her left wrist. The door swung open with a soft click. "Alarm," she muttered as she slumped into the kitchen – the door closed and beeped. The wall next to the fridge was flashing. Sammy trudged over and stood in front of it, waiting until her mom's message got bright enough to read. The cat was curled on his bed against the wall, fur standing completely on end, tiny sparks flashing on the tips of his ears. She heaved another sigh. Her parents loved torturing her with old-fashioned apps. The kitchen counter lit up with her school assignments, as well as a note from her friend Stacy: "Help! Parents are forcing me to go to camp this summer ON GRID!!! Might as well send me to prison." Sammy smiled and started typing...*

Even though some of this technology is still in its infancy, we are living through an era of staggering breakthroughs. Chances are, the kids born today will grow up thinking we were all a bunch of cave dwellers.

As to the fate of teenagers? Well...I'll leave you with a quote lamenting the sorry state of the youth of "today" (circa 1274 AD):

> *"The world is passing through troublous times. The young people of today think of nothing but themselves. They have no reverence for parents or old age. They are impatient of all restraint. They talk as if they knew everything, and what passes for wisdom with us is foolishness with them. As for the girls, they are forward, immodest and unladylike in speech, behavior and dress."*

Enjoy the read,

Meg

[1] *http://www.efree.org/sermons/commandments/failing_to_honor_our_parents.htm*

"Greening" major sporting events

The Green Sports Alliance presented its annual Environmental Leadership Award to Jack Groh, director of the National Football League Environmental Program. Under his leadership, the Super Bowl is now recognized as one of the greenest professional sports events in the United States. He also oversees greening for the NFL Pro Bowl and the NFL Draft. The Environmental Leadership Award is among the most prestigious. It goes to a person who has demonstrated extraordinary leadership: their contribution to environmental sustainability is so influential that it spurs innovation at the team, venue, league, or with fans – and in so doing, advances the entire sports and sustainability movement. The awards, now in their sixth year, recognize and celebrate the best in sports and sustainability. The Sacramento Kings and their LEED Platinum-certified Golden 1 Center played host.

Green Sports Alliance | www.greensportsalliance.org

Portable solar cooker

One Earth Designs premieres its newest revolutionary solar cooker, the SolSource Sport. The Sport model is the latest addition to One Earth Designs' line of clean energy solar stoves powered by patented solar technology that harnesses 92% of the sun's rays. The SolSource Sport fits into a 2ft carrying case, weighs 10lbs (4.5kg), and cooks a meal in just 10 minutes. It also heats up 5 times faster than a charcoal grill. Made of 100% recyclable materials and designed with Life Cycle Assessment, One Earth Designs has made their product eco-friendly to the core. After a quick and easy assembly, the SolSource Sport heats up immediately. It reaches cooking temperatures in seconds and is capable of boiling water in 10 minutes or less, using only solar power. One Earth's products are fuel-free and produce zero emissions. They harness natural energy from the sun and require no propane, charcoal, electricity, or other fuel. Durable solar reflectors are designed with patented self-heating polymers, which stay cool while heating the grill pan, and are easy to clean with just soap, warm water, and a soft cloth. SolSource Sport is a great backyard grill and is also perfect for beach bbqs, park picnics, camping, sailing, tailgating, and more. SolSource Sport is perfect for people who love fun in the sun.

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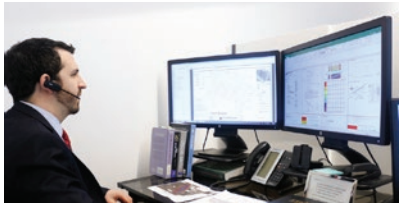

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What's Under Your Solar Panels?

by Chris Mader

Do you know what's really under those roof-mounted solar PVs you just installed? You should. Not fully understanding the commercial roofing system underneath the solar array can have a negative impact on your customer, and leave you exposed to unwanted liability. Learning the fine points of a roofing system will help minimize your risk, and keep your customers happy.

The Composition of a Commercial Roofing System

Commercial roofing systems are far more than just a waterproofing cover – although keeping water out of the building envelope is still its primary purpose. The system, usually referred to as an "assembly," is comprised of several components, including the structural roof deck or substrate, insulation, and the fastening components that hold it all in place. Smart building owners and solar installers know that the roof system under a solar array has to last as long as the solar system does, because once solar is installed, replacing the roofing system is time-consuming and expensive.

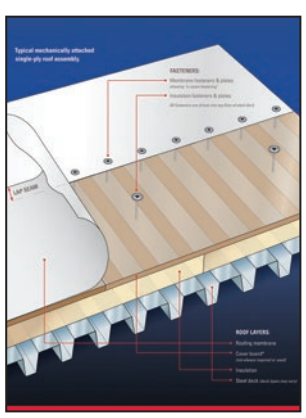

Figure 1: *The roofing system assembly is comprised of several components including the structural roof deck or substrate, insulation, and the fastening components.*

1. The Deck

The structural roof deck – also known as the "substrate"- can be made of several different materials, including steel, gypsum, concrete, or wood. Before installing any solar products, it is important to know the composition of the deck, since that may affect the design, installation, and attachment method of a solar rack system.

2. Insulation

Rigid insulation is usually installed directly on the deck. The most popular type of insulation used in North America is polyisocyanurate (iso). Other insulation choices include extruded and expanded polystyrene, and mineral wool. In addition to these "base" materials, high density cover boards made of gypsum or iso are frequently used in commercial roofing. Generally speaking, high-density cover boards are better able to handle the foot traffic and compressive loading of a PV system, and are also beneficial when additional ballast is needed. Without a hard or dense cover board, the ballast may compress the insulation slightly, creating low spots on the roof where dirt, debris, water, and ice can collect. This ponding water can cause long-term problems - ballasted racks can and do move around on the roof, as the racking system and/or building and components expand and contract. Consequently, any dirt or debris trapped under the rack can be ground into the roofing system, eventually leading to a difficult to detect, and hard to repair, leak.

3. Waterproofing Cover

The final layer consists of a waterproofing cover over the top, which is designed to keep water out of the building envelope. While there are several different types of commercial roofing materials available, the market favors single-ply materials, including white thermoplastics (PVC or TPO), and black rubber (EPDM). Asphaltic materials, called built-up roofing (BUR), and modified bitumen (mod bit) - characterized by redundant layers of roof felts - are also used in commercial roofing. Solar installers need to know what type of roof is installed in order to determine the best way to secure the solar panels, without compromising the integrity of the roofing system.

Roof and Solar Attachment Options

1. Ballast

Today, most roof mounted solar rack systems are designed to be secured in place with ballast (usually cement blocks or pavers). One reason ballast is used is due to a widely accepted perception that penetrating the roof is bad. Many solar installers also believe that, by not penetrating the roof, they will not void the roofing warranty. This is not a good assumption; most commercial roofing warranties include an overburden clause stating, in effect, that anything added to the roof without notifying the roof manufacturer, will void the roof warranty.

Over the past 20 years, the commercial roofing industry has moved away from using ballast on roofs, due to the dead load weight it adds to the structure, as well as the effect wind can have moving the ballast around and off the roof. Additionally, most of the newer commercial buildings aren't designed to accommodate the additional weight of ballast. As a result, the commercial roofing industry has adopted mechanical fastening methods for securing the roof, almost eliminating entirely the use of ballast.

2. Mechanical

Roofs are mechanically attached using screws and "plates", or oversized washers, to attach the roofing membrane to the deck. With thermoplastic membranes, the seams are hot-air welded to create a monolithic, watertight panel.

With the right type of roof mount, solar array systems can be secured to the roof in a similar manner; installers can avoid having to cut the roof open down to the structural deck, installing a support, and then rebuilding the roof and flashing the penetration.

Instead, such roof mounts are installed on top of the roofing system, but secured through the roof and into the structural deck with mechanical fasteners – the same fasteners that likely holds the roof system in place. The mount is then heat welded in place to ensure that they also remain watertight. The end result is a system that not only reduces rack movement on the roof, but can also eliminate the need for ballast.

3. Don't Forget the Warranty

Finally, be sure that installing a solar rack system will not void the roofing warranty. Building owners usually purchase a long-term warranty for the roofing systems. Roofing warranties have terms ranging from five to 30 years, so it's important that, prior to starting any work on the roof, solar installers confirm any limitations of the warranty.

It's also important to understand that most roofing warranties require that a contractor authorized to work on the roof, carefully observe the roof system manufacturer's specifications. So it's always advisable to read the existing warranty; contact the roof system OEM and work with them, through the building owner, to ensure that the roof remains covered under the warranty.

Roof Smarts Means Successful Solar Systems

Solar installers who take measures to understand the roof beneath their racks are more likely to provide their customers with a long-term, dependable, and efficient solar system.

Chris Mader is a codes/approvals support engineer for OMG Roofing Products. He's responsible for helping to evaluate new products, as well as developing and maintaining technical product specifications, maintaining code approvals and keeping abreast of technical changes and advancements in the commercial roofing industry. Chris is a member of the NRCA, SPRI and of RCI.

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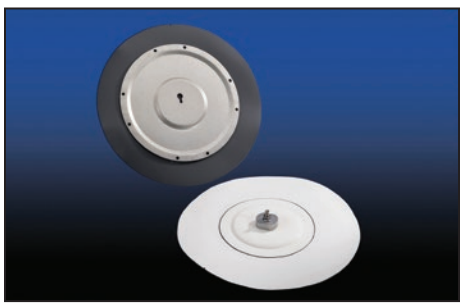

Figure 2: *Some roof mounts are secured through the roof and into the structural deck with mechanical fasteners.*

Figure 3: *These roof mounts are heat welded in place to ensure that they too remain watertight.*

Figure 4: *Mechanical roof mounts not only reduce rack movement on the roof, but can also eliminate the need for ballast.*

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Where Experience Meets Innovation

Robust Solar Energy Plants for Hurricane-Prone Regions

by Thomas Beindorf

LIVING ON SMALL ISLANDS MEANS DEPENDING ON IMPORTED fossil fuels and high-maintenance diesel generators for power. Gradually, however, local governments and private investors are beginning to offset this dependence by applying clean, renewable, and sustainable energy solutions. The most obvious, given the sun-drenched conditions of the island climate, is photovoltaic.

The Caribbean twin island state of Antigua and Barbuda is one such pioneer in this shift to green energy. The government is aiming for the target of generating 20 percent of its electricity from renewable energy sources by the year 2020. Like other small island states, Antigua and Barbuda is exposed to a high risk of storms and weather disasters. Any solar installations must be planned with this higher risk in mind. One case in point is the large-scale solar power plants at Antigua and Barbuda's V.C. Bird International Airport (3MWp) and in the Bethesda area (4MWp).

In Antigua, the design, mounting, and structuring of solar power racking systems must be adapted to the strong wind loads and risk of hurricanes. Further topographical and geotechnical (e.g. earthquake zones) factors have an impact on the mounting process, as well as on the substructures. Issues to be considered in every solar energy plant project planning include:

1. Site preconditions (such as existing trees, drainage systems, rivers, and flooding zones during heavy rain)
2. Ground and soil investigation (such as composition, contamination test, classification of physical parameters, and soil moisture during the rainy season)
3. Weather loads (such as wind or earthquakes)

Load tests for racking systems

Taking into account these preconditions, a special load test report can define the design parameters for the solar module substructures; customized design ensures the best price/strength ratio. In regions with strong wind loads, such as the Caribbean islands, the ramming depth or drilling length for the pillars of the racking system is one of the most important parameters. Prior to the actual mounting, a pull-out and shear test ensures that the pillars will withstand cyclone wind loads without deformation or other damage.

During the pull-out-test, pillars are rammed directly into the ground with a special machine. In the next step, a force is applied in the vertical direction on the

ramming pillar, increasing with a very low speed, until the pillar moves. Two factors are being measured which will later determine the actual ramming depth: The maximum force, which effects a maximum displacement of 20 millimeters, and the load, which causes the complete extraction of the pillar.

A similar test, called shear test, is executed on the horizontal line. The shear test measures the maximum force applied (for a maximum displacement of ten millimeters), and the applied load for a deformation or a constant movement in the pillar. For precise measurability, a dynamometer is attached to the pillar and pulled by an external machine, such as an excavator or crane. The results are aligned with the maximum anticipated wind loads of the region. With the data from these tests, the optimal ramming depth and height of the pillars can be calculated.

At the 3 Megawatt peak solar power facility located at the airport of the Caribbean island Antigua, tests indicated that two meters ramming depth would not be sufficient for the expected wind loads. A variation of pillar length was supplied and installed based on continuous checks during installation. Within 100 feet, the soil changed significantly. Partial concrete reinforcement of the foundation was needed in flood prone areas.

Reinforced frames to withstand hurricanes

Another important consideration in the mounting process of the Antigua airport site was frame thickness. This was also the case for the other large-scale clean energy facilities on the twin-islands state. The usual solar module frame strength of 30 millimeters is designed to withstand wind loads of 80 miles per hour (Eurocode design). In the hurricane-prone region of Antigua and Barbuda, buildings and solar power facilities must be able to withstand hurricanes up to a category 4, or wind loads of 143 miles per hour.

Reinforced frames with a strength of 50 millimeters were chosen. In addition, polycrystalline solar modules were used to withstand salt and sand, a daily hazard from being so close to the water.

One other peculiarity must be considered for the successful installation of a long-lasting solar power plant in the Caribbean and other hurricane-prone regions; hurricanes rotate. No optimizations of the exposure to the wind direction can be evaluated, since the direction changes by 360 degrees during the storm migration. Hence, the inclination of the solar modules needs to be optimized in order to offer minimum drag area to the wind.

Clearly, realizing solar power systems in regions with strong wind loads requires different approaches in the planning and mounting process of a solar installation. But the effort pays off. High solar radiations near the equator promise high-energy yields and independence from expensive and polluting fossil fuels.

Thomas Beindorf is the Chief Technical Officer of The meeco Group. He is an experienced mining engineer with 30 years of experience working on the development and management of technical installations, the supervision of respective teams of engineers and workers and the installation of facilities worldwide.

The meeco Group | www.meeco.net

What Makes a Good Solar Module?

by André Richter

Promises made at the time of sale do not provide module buyers with adequate guarantees in respect of quality and energy yield. Actual performance is what really counts. Knowing what constitutes a good module can mitigate the risk for customers and manufacturers alike.

Inadequate performance guarantee

Manufacturers like to advertise with a performance guarantee, such as a minimum residual performance of 80 percent after 25 years, for example. However, this guarantee is only enforceable if the company is still in existence. Reinsurances, too, are only valid for as long as the insurance premiums continue to be paid, and the company is still trading. Even when these reinsurances exist, they are structured in such a way that they only begin two or five years after production of the modules.

Proof of performance is not exactly unproblematic, either; laboratory measurements today are relatively accurate, but an unaged reference is required for this purpose. And where is such a reference to be found after five or ten years? In its absence, the customer bringing the action must accept tolerances of +/- 3 percent, or even +/- 5 percent. These tolerances are calculated to the disadvantage of the customer. As a result, the limit for claims rapidly drops from 80 percent to 75 percent. The customer is required to supply the evidence for every single module, and the costs for the removal and laboratory measurement can amount to as much as the cost of a new module. Moreover, if the complaint concerns the system as a whole, the customer requires good data from a system monitoring with calibrated solar radiation and temperature measurement.

Certified products

The customer can get around many of these problems, however, by making sure to install a "good" solar module in a "good" solar system (mounting system, DC cabling, inverter, etc.). Then the risk of reduced performance becomes relatively small, and the provisions for further risks can be reduced.

Look for a supplier with systems for the production of wafers, solar cells and solar modules. Because production system performance is linked to the processes used, this type of supplier can provide its customers not only with the system but also, on request, a process consisting of bill of materials and formula. As a consequence, the customer can immediately manufacture and offer products certified to IEC 61215 using this production system, without the need to undergo the certification process himself.

The importance of performance

Certification alone doesn't provide enough information. Only details of the actual performance of a solar module can assure the manufacturer and end-customer. It has become apparent, from a number of trials, that the performance of a solar system is determined by the energy yield. This particularly impacts electricity generation costs.

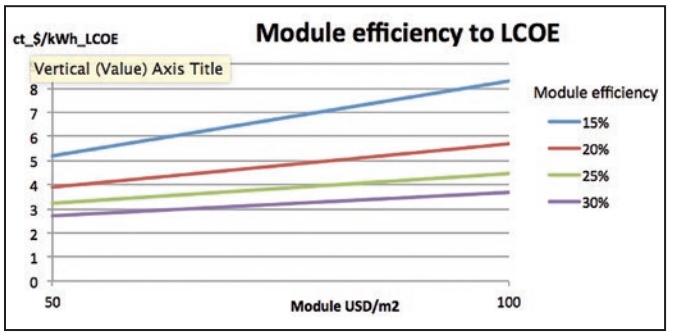


Diagram 1.

Diagram 1: Efficiency and module costs

Diagram 1 shows that more efficient modules may cost more for the same LCOE (levelized cost of energy). Put another way, the LCOE is reduced accordingly for the same costs. The LCOE value in US cents per kilowatt-hour is shown on the y-axis, while the module costs per square meter are represented on the x-axis. The plotted lines always apply for a given module efficiency.

The calculations for Diagram 1 always assume the same WACC (weighted average cost of capital). Since the solar system costs for the mounting system accrue in square meters, and since module efficiency affects the watt peak capacity per square meter relationship, the module costs were calculated per square meter. In the case of crystalline solar modules, the cell efficiency is around 1.5 percent higher in absolute terms, than the module efficiency. In the case of bifacial modules, an actual module efficiency that is typically 10 to 30 percent higher than for monofacial modules may be assumed. Since technologies with higher efficiency also have a better temperature coefficient, typical coefficients were used for the calculation.

This comparison is easiest if different solar modules are compared in relative terms in one location:

- Inaccuracies in the measurement of the local solar radiation and temperature are eliminated.
- There is no need for a physical model for the behavior of the module in different environmental conditions.

These statements, however, have their limitations: Strictly speaking, the comparison is only valid for:

- The small number of solar modules under comparison;
- The current location (solar radiation, temperature, albedo, pollution, etc.).

Nonetheless, these are relatively minor limitations, since the physical properties of the different technologies are quite well known, and estimations can be made with a relatively small margin of error. The inaccuracies due to imprecise climatic measurements are greater by a factor of ten, as such measurements cannot be carried out in laboratory conditions.

Diagram 2: Advantages and disadvantages of performance measurement

The uncertainties in Diagram 2 are estimated, and may be higher in individual cases. Laboratory measurements and outdoor measurements were examined separately.

The comparison offers a further advantage inasmuch as technologies for which there is still no general standard are compared, such as in the case of bifacial modules (for them, an IEC standard is in the course of preparation).

Using a combination of relative and absolute measurements enables the advantages of both worlds to be combined. Moreover, with extremely accurate measurements, second-order effects such as degradation can be identified relatively quickly, and their cause isolated.

	Relative			Absolute		
	Advantages	Disadvantages	Expected yield accuracy	Advantages	Disadvantages	Expected yield accuracy
Module only	Very precise to other modules direct comparison use of existing products	Only to this location (no modeling) only the used module types	Wp: only with model energy yield: better 0.5%	All parameters can be controlled (Laboratory)	Not possible in outdoor	Wp: best is 1.1% energy yield: only with model
Sensors only				Precise climatic measurements	Very expensive for all factors (DNI, GHI, Spectrum, Temperature) no measurements of soiling	Irradiation ca. 2.5% to 10% Temperature 0.1 to 2%
PV system (relative & absolute the same)	Include all factors, like inverters	Includes grid-to-inverter interaction big area reduce accuracy	Yield: better 2%	Include all factors, like inverters	Includes grid-to-inverter interaction big area reduce accuracy	Yield: better 2%

Diagram 2.

Advantages of HJT technology

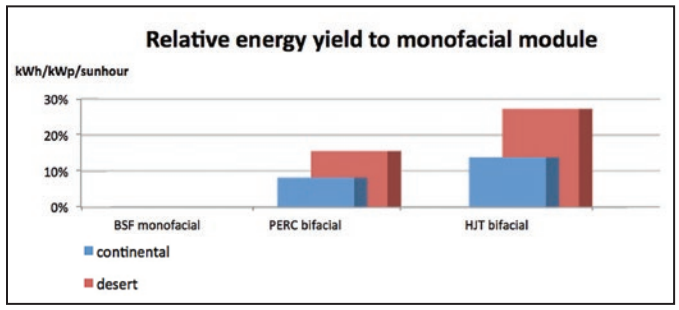


Diagram 3.

Diagram 3: Results from the measurements at different locations with the same technologies

Diagram 3 clearly demonstrates that bifacial technologies add up to a higher energy yield. Moreover, HJT technology has a higher energy yield than modern PERT technology.

All modules were precisely characterized in a laboratory beforehand. The measurements are totally identical and simultaneous. Should one measurement at a particular time exhibit poor quality, the measurements for all modules at this particular time at that location are ignored. Only those measurement times, during which neither the face of the modules nor the reflection from the rear is impeded by shade, are taken into consideration. This enables a fair comparison of the energy yield.

Diagram 3 illustrates the relative results for the energy yields of three technologies. Because two bifacial modules were used, the location's albedo is already taken into account. A typical, non-optimized albedo was chosen. The modules are subject to the normal pollution occurring at the location, and are periodically cleaned, always in the same way. Since the energy yield of bifacial modules is greatly dependent on the installation height, the modules used for the comparison all have the same installation height.

The differing energy yields of the different locations can be clearly seen in this comparison; it is apparent that the new HJT technology always has an advantage. Thanks to the use of n-type wafers and, among other things, the electrically shielded design of the HJT cells, PID (potential induced degradation) and LID (light induced degradation) are not to be expected.

With regard to its anticipated service life, the following statements can be made on the HJT module depicted: This is a glass/glass module with butyl edge sealing and extremely high-quality encapsulant (TPO). The unit costs for a module of this type are only marginally higher in mass production than for modules using other technologies, and incorporating the same number of cells. However, performance, energy yield, and anticipated service life with massively reduced degradation are significantly higher.

A final point certainly concerns the manufacturer's bankability: With HJT technology, almost the only remaining questions are whether the manufacturer is really using the right materials, and has assembled the module correctly. Once the HJT module is on the market, barely any relative performance reduction over that of a PERT module is to be expected.

André Richter was born in Hamburg, Germany, in 1968. He studied electrical engineering at the Technical University Hamburg-Harburg. He has been active in the solar industry as CEO and Technical Director for many years. Since 2010, André has worked as Business Developer Technology in the innovation department of Meyer Burger Technology Ltd, a PV technology company with a holistic offering of equipment, processes and technical expertise.

Meyer Burger | www.meyerburger.com

Structural Effect of Solar Arrays on an Existing Structure

by Christine A Wrobel, SE

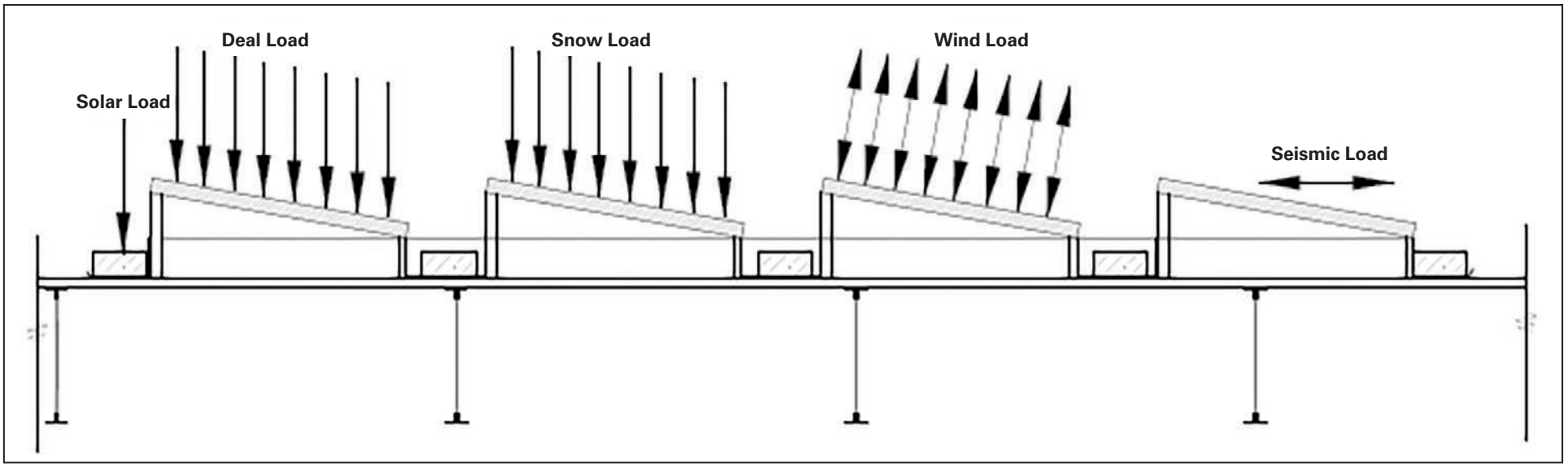


Figure 1: *Loads*

THIS IS AN EXCITING TIME TO BE PART OF THE SOLAR industry. Many people have begun to reap the benefits of incorporating solar into their homes and businesses. This means that not only are new buildings accommodating solar, but also many existing buildings are being retrofit to accommodate roof mounted photovoltaic arrays. Are potential solar customers being informed of the structural concerns associated with this type of retrofitting? Existing buildings should always be reviewed for their ability to support the loads associated with roof mounted photovoltaic arrays.

How do you verify the adequacy of your existing building to support these new loads? First, define the loads imparted on the photovoltaic arrays. Next, determine how the loads imparted by the arrays affect the structure, from roof to foundation. This is referred to as the load path. The phrase, "A chain is only as strong as its weakest link" holds especially true for a structure. Failures commonly occur because the load path wasn't followed properly.

Current building codes provide for various combinations of loading, which includes dead, snow, wind, and seismic. The following list defines each load and how it affects the photovoltaic arrays, while Figure 1 shows how those loads are applied to the array.

Dead Loads

This is the self-weight of the photovoltaic array, which includes the racking components, the panel, and any ballast provided. Most photovoltaic racking is configured so that the panels are supported at each corner. That means the loads from the racking will be applied to the roof as concentrated loads. Beware of the average loads provided by the manufacturer; these are determined by dividing the total load of the array by the total area covered by an array, and are not an accurate depiction of the loading. Ballast is often distributed at corners and edges, where the upward wind load is higher. The resulting large concentrations of load can affect individual components of the roof.

Live loads

Per IBC 2015 section 1607.12.5.1: "the roof photovoltaic live load shall be in addition to the panel loading unless the area covered by each solar photovoltaic panel or module is inaccessible. Areas where the clear space between the panels and the rooftop is not more than 24 inches shall be considered inaccessible." In other words, for most low slope roof mounted arrays, live loads will not be applied in the areas where the arrays occur.

Snow Loads

Snow loads on arrays are increased slightly due to the use of a thermal factor for cold conditions - something not normally required on a warm roof. Arrays that are raised above the roof do not get the benefit of the warm roof to decrease the snow load.

Wind loads

ASCE 7 "Minimum Design Loads for Buildings and other structures" is referenced by IBC codes for determining the loads on a structure. Unfortunately, ASCE7-2010 and its predecessors do not adequately address the effects of wind on a photovoltaic panel mounted on a flat roof. However, there are other sources for determining wind loads on a roof-mounted panel. One such reference guide is published by the Structural Engineers Association of California (SEAOC) PV-2 2012 "Wind Design for Low-Profile Solar Photovoltaic Arrays on Flat Roofs." This guideline helps determine loads, but is considered conservative. However, it allows for the provision of approved wind tunnel studies for a specific product. Most PV racking manufacturers provide approved wind tunnel studies specific to their product which are more accurate for their racking. While the upward wind forces determine the distribution of ballast to counteract the effects of these forces, another aspect of wind loading is often forgotten: the downward wind forces. In the aforementioned SEAOC PV-2 guide, Figure 29.9-1 shows the wind loads acting on the panels as either upward or downward; the accompanying note 1 says "1. (GCrn) acts towards and away from the panel's top surface" (GCrn is the nominal net pressure coefficient). This condition has been confirmed by wind tunnel testing, although testing may provide different coefficients than those used in SEAOC PV-2.

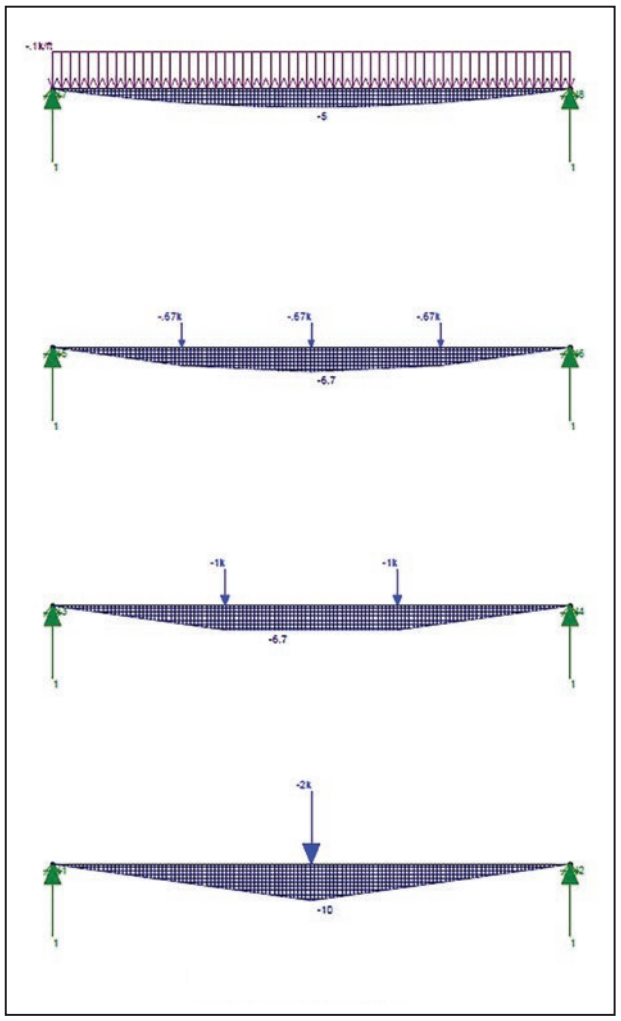


Figure 2: *Beam loading*

Seismic

Seismic loads are primarily lateral, but can impart a vertical load (which is defined as 0.2SdsD based on ASCE 7-10 section 12.4.2.2). This load is very small in comparison to wind load.

Determine the Loads Imparted by the Arrays to the Structure (Load Path)

2012 IBC section 3403.3 allows for an increase in the gravity loads of an existing building by 5 percent, and section 3403.4 allows for an increase of forces to lateral load-carrying elements of no more than 10 percent. In 2015, the ICC adopted a separate code for existing buildings: the International Existing Building Code (IEBC). Sections 402.3 and 402.4 of the 2015 IEBC provides the same criteria as that noted above for the 2012 IBC.

Following the load path, we start with the application of the roof-mounted array to the roof decking. The decking should be checked for a concentrated load where the racking makes contact for downward and for net uplift when mechanical attachments are provided. This load is then transferred to the roof joists. The decking and the joists were originally designed based on uniform loads, but now must support the concentrated loads from the dead load of the arrays, and possible snow and or/wind loads.

Concentrated loads placed on a member (in lieu of uniform loads) can significantly increase the moment on a member. For instance, Figure 2 shows four different loadings on the same 20 foot long member, each of which equate to a total load of 2,000 lbs.

- Load 1 is uniform and a result in a moment of 5,000 lb-ft.
- Load 2 has three separate loads that total 2,000lbs, but provide a moment of 6,700 lb-ft.
- Load 3 has only two loads that result in the same moment as Load 2
- Load 4 has one load of 2,000 lbs which results in a moment of 10,000 lb-ft.

The resulting moments from concentrated loads increased 33 to 100 percent over the uniform loads. This loading is an exaggeration, but it helps to demonstrate the effects of concentrated versus uniform loading. If a joist is designed to its code required capacity, the placement of concentrated loads can result in an increase greater than the additional 5 percent allowed per the IEBC. The gravity loads to the beams, columns, and foundations must be checked by following the load path in a similar fashion. In addition, members should be checked for shear capacity as well as their supporting connections. Concentrated loads may exceed the shear capacity of members that were not designed for constant shear, such as open web steel bar joists.

The increase to the dead load of a building caused by adding arrays should be checked to determine if this will impact the lateral system due to seismic loading. Per IEBC 402.4, if the new total dead load of the building has not increased over the existing total dead load by more than 10 percent, then the additional forces from seismic loading need not alter the existing lateral framing.

Conclusion

When adding photovoltaic arrays to an existing building, we must ensure that the building can support these additional loads. A licensed structural engineer should always be engaged to verify an existing structure's capacity. While it is indeed an exciting time to be part of the solar industry, it's equally important to provide a safe solution for the public's energy needs.

Christine Wrobel is a Structural Engineer at Larson Engineering, Inc.

Larson Engineering | www.larsonengr.com

The Next Big Thing in the Glass and Glazing Industry

Building Integrated Photovoltaics (BIPV)

by Richard Voreis

WHEN CONSIDERING THE IMPACT OF BIPV ON GREEN construction, it's important to clarify the following terminology of the photovoltaics industry applications:

- BIPV, or Building Integrated Photovoltaics, are fenestration applications.
- BAPV, or Building Applied Photovoltaics, are rooftop applications.
- Solar Fields are ground mounted applications.

The U.S. Department of Energy (DOE) estimates BIPV and BAPV applications have the potential to generate up to half the electricity in this country; that includes photovoltaic (PV) modules installed in BIPV curtain walls, window walls, sunscreens, skylights, and related products.

PV modules essentially have the same structural and thermal performance as monolithic glass, spandrel glass, and insulating glass. In fact, PV modules can actually replace these conventional glass applications; new technology has developed transparent PV modules which improve the energy efficiency of a building while generating electricity, and providing an aesthetically appealing appearance.

Fast Facts

Here are some impressive growth statistics from the photovoltaics industry in the United States:

- +109% in 2011 Despite a Struggling U.S. Economy
- +76% in 2012 Despite a Struggling U.S. Economy
- +41% in 2013
- +30% in 2014
- +17% in 2015
- +119% Forecasted for 2016

Since 2010 the U.S. PV market had a compounded growth rate of 58 percent.

The same level of growth hasn't happened for the glass and glazing industry; during the recession years, building construction fell to the lowest level since World War II. However, the U.S. non-residential BIPV segment is positioned for major traction for several very important reasons.

Cost

The average cost of solar panels has declined 70 percent since the beginning of 2009, according to the Lawrence Berkeley National Laboratory. As materials become more easily accessible and more widely used, the market will likely force those costs down even further over time.

Grid Parity

Grid parity is when PV electricity is equal to or cheaper than grid power from utilities. Gird parity is occurring throughout our country because utility rates have increased every year for the past twenty years. Plus, there is increasing pressure on carbon reduction rates. Fewer power plants are being built as a result of higher construction costs, as well as the lengthy delays encountered due to demanding environmental impact studies. The state of California, for one, is counting on installing more solar power, rather than building more power plants, to meet the future needs of its utilities. In fact, most of the United States is expected to reach grid parity by 2020.

Net-Zero

The Department of Energy has set a goal for 100 percent of new commercial buildings to be "Net-Zero" energy buildings by 2025. In other words, new buildings will have to produce at least as much energy as they use. One obvious solution is adopting BIPV fenestration applications, which can reduce a building's energy consumption to the required "Net-Zero" rating.

Electronics enclosures for rugged applications

Phoenix Contact's newest enclosure system protects electronics from potentially damaging elements commonly found in outdoor applications and extreme indoor environments. The two-piece, sealed environmental case system (ECS) creates IP66, IP67, and NEMA 6 ratings with a latch or screw-locking method. The enclosure has integrated connection options with one or two M12 inserts, as well as an option for a cable gland. Alternatively, a blank faceplate can be modified to accommodate any sealed connector that fits within the housing profile. The polycarbonate (PC) enclosure withstands rapid temperature swings, UV exposure, and extreme temperatures of -40°C to +85°C. The integrated connection technology simplifies packaging devices intended for control on vehicles, rugged industrial wireless applications, and even small cell installations. The ECS also offers a PCB lock which prevents falls and allows for easy maintenance. Using an accessory, the ECS can be readily mounted to a pole or a wall without compromising its ease of PCB repair or replacement.

Phoenix Contact | www.phoenixcontact.com

News Flash

In the true spirit of its western pioneering history, the City of San Francisco passed an ordinance that requires, beginning January 2017, that all new commercial buildings with ten floors or less must install solar PV modules. The U.S. Green Building Council has endorsed this move, and predicts that other cities will soon follow San Francisco's lead.

Predictions

The United States is expected to keep its lead as the fastest growing major PV market in the world. This is partly due to the new technology in transparent PV modules, which, due to their appealing aesthetics over "black and blue" modules, will help drive more architects to adopt and incorporate BIPV solutions into their design portfolios.

However, certain obstacles must be overcome if BIPV is to reach mainstream acceptance; the solutions themselves must meet a unique combination of attractive aesthetics, design flexibility, transparency and glare control, high power density, and high performing glass. Plus, BIPV must provide a fast investment payback in order to turn building façades into feasible generating assets.

BIPV should be one of the first considerations of any architect designing a green building today. The construction industry has a major opportunity to unlock the solar power potential in a building's façade. Additionally, the glass and solar industries will reap the benefits of widespread acceptance and adoption of BIPV solutions.

Richard Voreis is Chief Executive Officer of Consulting Collaborative, a management consulting firm specializing in the construction and building products industry. Clients include architects, general contractors, subcontractors, building product manufacturers and related suppliers to the industry as well as trade associations. Richard Voreis was appointed to the Advisory Board of the Solaria Corporation an innovator in building integrated photovoltaics.

Consulting Collaborative
www.consulting-collaborative.com

Canada's Largest University Converts to Solar Energy

by Sandro Costa

In recent years, the University of Toronto has stepped up its efforts to reduce its usage of fossils fuels, and convert its campus buildings to solar energy. Last year, the University placed solar panels on the roof of a building in the center of the downtown campus, that's been used as the Exam Centre. The electricity generated by these solar panels will be fed into the Exam Centre to offset its regular day-to-day electrical energy use. The PV panels, which are expected to last three decades, help offset the normal electricity supplied to the building by Toronto Hydro. Although the Utility makes up for any power shortfalls, whenever the sun is shining, the University is able to purchase less electricity overall. This solar system provides around 75,000 kilowatt hours, almost eight times more energy than an average Toronto home needs each year.

The entire project is part of the University's ongoing energy conversion to solar. The school boasts other on-campus solar energy systems, such as the Green Roof Innovation lab at John H. Daniels Faculty of Architecture, Landscape, and Design; a 10 kilowatt system used for research, as well as providing power to the building. The Mining Building gets part of its electricity requirements with a 35 kilowatt system.

These solar energy installations are part of the University's overriding objective to reduce its fossil fuel usage, and create a greener campus. Recent dramatic declines in the price of solar photovoltaic energy systems have made these systems a highly cost-competitive source of electricity. Not all energy savings initiatives, however, are solar energy based. Initiatives range from controlling the indoor air temperature in buildings, to designing buildings in a way that reduces both energy demand and carbon emissions. There are also a number of projects around campus aimed at converting traditional lighting to high efficiency LED. These significant retrofits can be seen in the Medical Sciences Building, Ontario Institute for Studies in Education, and the Robarts Library. Most recently, the University of Toronto issued a Request for Expressions of Interest for a Battery Energy Storage and Power Conversion System for the Department of Electrical and Computer Engineering microgrid project. The project, which has a target completion date of Q1 2018, represents the next generation of electrical infrastructure. In addition to augmenting the University's renewable energy facilities, this project will enhance the teaching and research activities by faculty and graduate students. The University is transitioning from solar energy systems to solar energy storage systems; the addition of storage to a solar PV installation increases the usefulness and flexibility of solar, enabling the school to store excess solar electricity for later use.

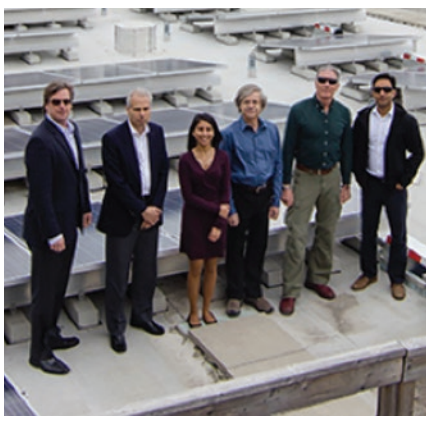
Energy storage is ideal for businesses and institutions subject to large changes in demand throughout the day, or during seasons; peak shaving becomes possible

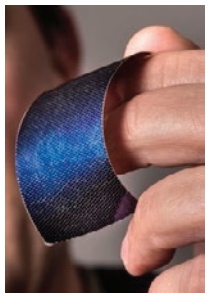
by using lower cost energy during peak hours to reduce energy costs. Additionally, the energy storage acts as an emergency backup, so that sensitive systems are protected from unpredictable power fluctuations, surges, and outages. Another advantage is the system's scalability and reliability; lithium ion batteries can be installed in both small residential dwellings, and large industrial and utility facilities.

To make this significant move to solar energy storage, the project at the University through Hatch Engineering utilizes a solar energy storage product based on a lithium ion battery technology, which has been well-tested and proven throughout the world. In fact, this technology is used in many electric and electric-hybrid automobiles, as well as in utility-scale energy storage applications, ranging from single-family homes, to a 32MWh utility-scale system in southern California. By installing this solar energy storage system, the University of Toronto will continue its efforts to enhance the efficiency of its current renewable energy system, and lower its electricity costs. The University will have a state-of-the-art solar energy system offering one of the most sophisticated energy storage capabilities in the world.

Sandro Costa is the Vice President, Energy Efficiency of ONEnergy, a fast-growing, dynamic energy management firm serving commercial, industrial, multi-residential and residential clients. ONEnergy provides a variety of products and services including sales and rental of energy-efficient, complete turnkey LED lighting retrofits (including financing), a supply of conventional and "green" electricity for homes and businesses, commercial solar PV installations, residential PowerCor energy storage systems, and commercial to utility scale energy storage solutions.ONEnergy is providing technical due diligence and assisting Hatch Engineering in procuring the solar energy storage product to the University of Toronto.

ONEnergy | www.onenergyinc.com





Microsystems enabled photovoltaics

Using microdesign and microfabrication techniques, mPower is commercializing Microsystems Enabled Photovoltaics (MEPV) as Dragon SCALEs – small, lightweight, flexible solar cells that fit into and power devices or sensors of any shape or size, including wearable ones. MPEV allows high-voltage and low-voltage configurations with less metal in the system, and can be folded for easy transport.

mPower Technology | www.mpower.technology.com

Is Crowdsourcing the Future of Solar?

by Jonathan Budd

In his recent book *BOLD*, Peter Diamandis discusses four exponential trends poised to disrupt industries around the world. Diamandis makes the case that crowdsourcing has explosive disruptive power, since the crowd can usually accomplish a single task much faster than any one individual team or company can do alone.

For example, take DuoLingo, a free language-learning platform that's translating the web at the same time. If you were to hire a company to translate every word on Wikipedia into Spanish, it would take 10 years, and about $50 Million. DuoLingo, on the other hand, with its 100,000 users, claims it can accomplish the same task in only 5 weeks, for free.

In recent years, we've seen a sharp rise of the "Crowdsourcing" platform, as evidenced by companies like Uber, Airbnb, and more. Whether it's someone with a spare room to rent in their home, or an individual looking to share a ride and earn a little extra money, these companies deliver their products and services by tapping the power of the crowd. The difference between the old model of vertical integration, and the new model of platforms tapping the crowd, has resulted in almost total industry disruption in several long-standing sectors.

So much focus is put on how solar is disrupting the current utility/energy model - but what if it's the industry itself that needs disrupting?

A case can certainly be made that the current national provider model is broken. Solar has reeled from black eye after black eye in recent months: the bail out of solarcity by Tesla; the bankruptcies of sungevity and sunedison; the full-scale exit of NRG; and the sheltering of oneroof. Virtually every company has struggled financially to achieve significant scale. The vertical integration model creates inefficiency and bloated costs, and, since these costs ultimately make their way to the end user, weakens the customer value proposition as well.

Why, then, are barely any solar companies utilizing the power of crowdsourcing to grow their businesses? The energy sector is ripe for disruption, akin to what Airbnb did to hospitality, or Uber to transportation. We need solutions to scale, without incurring the tremendous infrastructure costs national companies have assumed in the past.

It's not just customer acquisition that has huge potential for crowdsourcing - there is massive fulfillment capacity, yet often weak demand. Companies have installation crews, excess product supply, and engineering capacity, which all frequently sit dormant. What if we could tap the power of the fulfillment crowd to lower built-in overhead, and share resources across the industry?

What if we could tap the trillions of dollars existing in the crowd to provider cheaper project finance, lower crushing dealer fees and onerous interest rates (a common problem in lower tier markets), and provide a competitive value proposition to end customers? In order to compete in states like Michigan or Oklahoma, we need to not just lower module and product costs, but lower finance costs, as well.

No matter how you look at it, it's time for the power of crowdsourcing to come to the solar industry. In order for our product to flourish, our industry desperately needs to achieve scale, lower costs, and create more competitive value propositions around the world. If the crowd has proven anything, it's that we're more powerful together than apart. When companies successfully unite the crowd to help, magic happens.

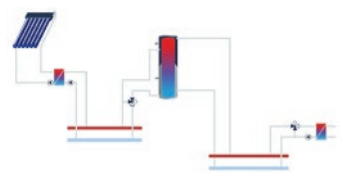
Jonathan Budd is an expert on expanding entrepreneurship and renewable energy. As founder and CEO of Powur, he's working to crowdsource home-based solar energy, halt carbon-based climate change and shift the global energy paradigm. Powur aims to connect 2 million homes to solar by 2025 using a disruptive, decentralized direct sales model.

Powur | www.powur.com

CAD for solar

PVComplete introduces PVCAD, the first and only CAD for solar. With PVCAD software, designers can compare and contrast different array layouts for their various projects. Each design choice can be quantified through a built-in energy production model, and project costs can be estimated with accuracy through the generation of automatic bill of materials. In addition, PVCAD performs all the electrical calculations necessary for solar project design, and generates electrical single line drawings.PVCAD is built with Autodesk technology. Separate AutoCAD license no longer required.

PVComplete | www.pvcomplete.com



Design and simulation software for solar thermal systems

The new version T*SOL 2017 enables its users to work with the program even more flexibly and, above all, to calculate and observe the system's profitability more precisely, which is particularly important for commercial applications. For this purpose, Valentin Software has expanded the automatic functions in the parameter optimization by adding the financial values: net present value, return on capital, and heat price. This makes it possible to determine the influence of the various components of a solar system, e.g. the size of a storage tank or the number of collectors, on the profitability and to optimize the plant. The preconfigured systems in T*SOL have been extended by the additional of a system from the family of process heaters. In the new system "P3 - Preheating with buffer storage", up to 6 collector loops and 6 different loads (process, hot water, and building heating) can be connected. Valentin Software has updated the extensive component databases in the new version and made them even easier to use.

Valentin Software
www.valentin-software.com

Rugged tablet for mobile field professionals

The Getac ZX70 is a rugged Android tablet designed for comfortable one-handed use in remote and challenging environments. Its IP67 and MIL-STD 810G certification with long lasting battery life allow it to go wherever necessary. The ZX70 is powered by the Android 6.0 operating system, so custom apps can be developed for download and use. The ZX70 features a 7" inch IPS, sunlight-readable, touchscreen display which uses an optically clear resin to bond the display glass to the touch panel and LCD to create a durable and readable single panel. It features two advanced touch modes and the included hard-tip stylus enables users to capture signatures and take precise notes on drawings, maps, and documents. With a full HD webcam, the tablet offers convenient video conferencing, training, and field diagnostics. Its 8MP rear camera delivers high-resolution still images and can capture data and document conditions in the field. The ZX70 is a purpose-built tool with a host of configurable options to fit the way field techs work, including dedicated GPS + 4G LTE cellular data, WiFi, 1D/2D barcode reader, and NFC/RFID. The tablet includes 2GB of on-board storage, expandable to 4GB, and a micro SD card slot permits expansive storage and backup options. Certified for hazardous locations, the ZX70 fully rugged tablet offers optional ATEX and IECEx 2/22 certification for use in potentially explosive atmospheres. MIL-STD 810G-certified for drops up to 6ft, IP67-certified for liquid submersion to 1m for 30 minutes, and endurance under extreme temperatures from -6°F to 140°F (operating temperature) and -40°F to 160°F (storage temperature). The ZX70 is also protected by Getac's three-year, bumper-to-bumper warranty.

Getac | www.getac.com

High wattage power optimizer

With the introduction of higher power modules in the market, SolarEdge now offers a higher wattage power optimizer for residential and commercial installations. This power optimizer supports 60 cell modules up to 370 watts, 60 volts and 11 Amps (Isc). In addition, SolarEdge is providing new string sizing guidelines for HD-Wave inverters on the power optimizer datasheet. HD-Wave inverters can connect a minimum of 8 power optimizers and a maximum of 5,700 watts (6,000 watts with SE7600H-US) per string The new power optimizer datasheet now includes the P370 and the new string sizing guidelines.

SolarEdge | www.solaredge.com

Solar PV testing

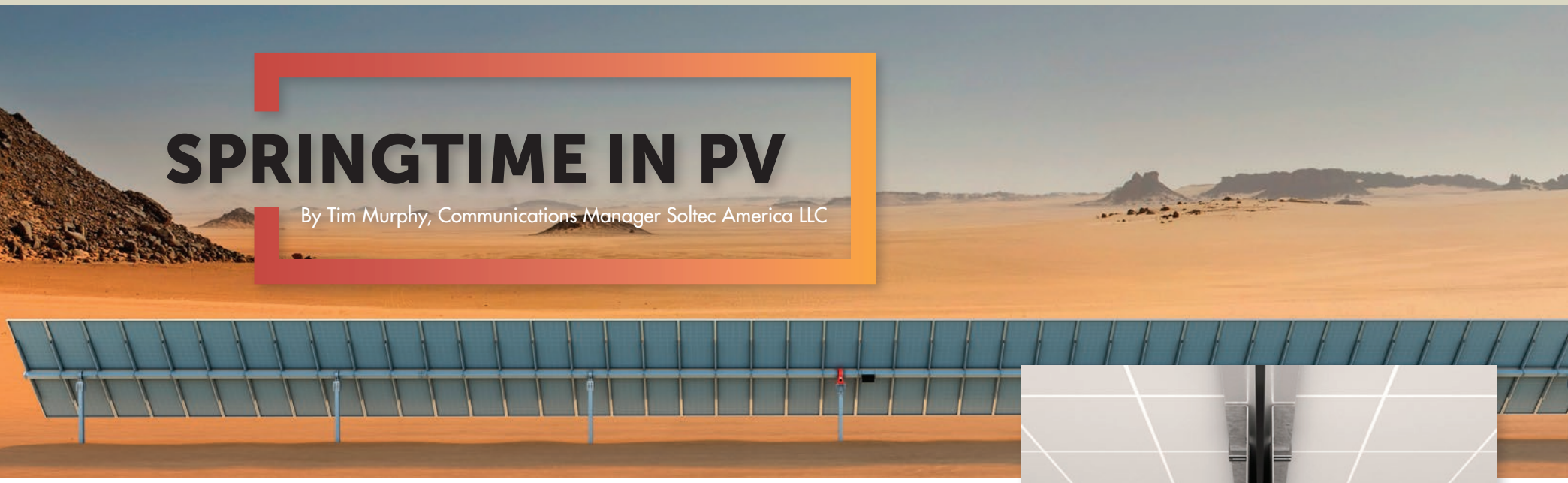
HT Instruments announced production of the I-V500w Photovoltaic Curve Tracer. This new 1,500V PV product is designed for large projects utilizing the savings associated with >1,000V systems. The I-V500w simplifies the complex tasks of correctly testing PV panels and strings. The instrument can be easily set up for the full I-V curve tracing or to measure the Voc and the Isc with their IV FastCheck feature. To reduce test complexity they also offer an auto calculation of the cell temperature and Rs. Finally, the new KitKelvin probes can greatly hasten testing with Auto Sequence capability that reduced full IV test time to <15 seconds and automatically set up the next test. The I-V500w provides a large viewable screen and a medium frame size that is lightweight (1.2kg) to enable full viewing of the curves in real time without the need for an external device. The product is light enough to be operated by one technician yet powerful enough to handle all testing of I-V curves.

HT Instruments | www.htinstruments-us.com

Interactive datalogger for commercial PV applications

AlsoEnergy introduces a new standard gateway for their Commercial PV Monitoring Solution: the PowerLogger 1000. This interactive datalogger introduces a range of practical and time-saving benefits relative to other gateway devices in the PV marketplace. The PowerLogger 1000 adds a rugged interactive touch screen LCD display. This allows workers to commission, bus test, and troubleshoot without the need to interface with a laptop computer or mobile device. This feature, along with an automated configuration process, enables field workers to cut commissioning and maintenance time by more than half. The PowerLogger 1000 more than doubles the processing speed of the previous standard gateway from AlsoEnergy, enabling new applications. The PowerLogger 1000 has a wide operational temperature range, and its low power consumption enables a longer UPS backup window. The PowerLogger 1000 records data in real time from various field devices including weather stations, inverters, trackers, and meters. Data is retained in the PowerLogger in the event of a network interruption and forwarded to AlsoEnergy data servers when the connection is re-established. AlsoEnergy integrated hardware solutions are extensively tested, rated to UL standards, and come with a standard 5-year warranty. The PowerLogger is typically mounted in an ETL-listed NEMA4 enclosure and combined with components such as power supply, cellular modem, network switch, and a revenue grade meter. Hardware is integrated with AlsoEnergy's PowerTrack software platform and combined with professional services to make a complete commercial PV monitoring solution.

AlsoEnergy | www.alsoenergy.com



SPRINGTIME IN PV

By Tim Murphy, Communications Manager Soltec America LLC

Springtime brings new life, and the PV industry tradeshow season. With events on four continents and 25 years of history, Intersolar is regarded as the world's leading tradeshow of PV technology and related equipment and services. This year, at the European edition that takes place every spring in Munich, organizers hosted around 1,200 exhibitors and received more than 40,000 visitors.

It is not surprising that any solar company aims to be there and catching the attention of visitors. Exhibitors commonly try to be noticed by means of hosting cocktail parties or featuring the largest booth possible. Less common for exhibitors to achieve is bringing new life to PV equipment that solves customer problems.

Soltec, a leading manufacturer and supplier of solar PV trackers and related services, achieved that in Munich by introducing its next generation horizontal single-axis solar tracker. It is named SF7, denoting its seventh-generation design that coincides with Soltec's 12-year history as a solar PV tracking specialist.

The principal problems of Soltec customers are achieving greater cost-effectiveness, and forming a reliable tracker supplier partnership. Soltec helps customers find success with their large projects that use ground-mounted solar PV trackers.

Soltec's success is measured by the repeat business of sector-leading customers, and is evidenced by 2.6 GW installed and underway, annual sales of 1+ GW, and annual manufacturing capacity of 2.5 GW.

Cost-effectiveness is a principal criterion of innovation at Soltec. The objective of innovation is to increase competitive advantages for customers, and it has found success by maximizing tracker yield potential and site-filling options while also reducing costs.

By eliminating all array-gaps on the tracker over pile-mounting locations, SF7 enables up to 5 percent greater MW per acre than other trackers. Yield is further enabled with TeamTrack asymmetric backtracking control of individual trackers, and a tracking arc of 120°+.

The SF7 tracker equipment provides the market-highest assembly tolerances to construction variables including steep-slope (17% grade NS), short-steps and irregular site boundaries (<48 meters), and terrain contours (+/- 0.20 meters' pile-to-pile). These features result in simple installation where others simply cannot install without additional cost. They reduce the cost aspects of civil works and site preparation, and reduce the disruption of natural terrain.

The SF7 short-tracker design with two-up portrait module configuration enables greater site-fill options, and results in double-wide aisles between tracker rows that facilitate maintenance and vehicle passage, and results in the lowest piles-per-MW spec on the market.

The self-powered SF7 tracker achieves the lowest cost of operational power thanks to the unique PV Series Power Supply that leverages tremendous PV array power availability to supply the remarkably low power demand of tracker drive, control, and communications. And all of that while imposing no impact on revenue generating PV active-area.

Installation time-saving is at the heart of SF7 innovation. It is evidenced in comparison with a leading competitor: 54% fewer piles-per-MW, 15% less parts count, and 58% fewer screw type connections. That all adds up to faster installation.

PV module mounting is labor-intensive. SF7 incorporates screw-less and tool-less fastening and grounding of PV modules, in less than 30 seconds each. Installation time and labor are reduced dramatically.

Time-saving efficiency is also achieved in supply contract execution that counts on Soltec's Solhub logistics system of synchronized global factory warehouse stock with regional operations per customer project schedule. Just-in-time onsite deliveries are ready to be distributed with reduced onsite handling, and with no intermediate handling companies between Soltec factories and the customer site.

Factory direct standard service saves time and increases quality, it includes plant layout design and dedicated supply contract management. Factory direct extended service plans are available ranging up to the Construction Plan that provides turnkey installation contracting.

Maintenance time-saving begins with Near Field Communications (NFC) at the tracker level to facilitate individual tracker maintenance operations. Washing the PV array is a time-consuming task. With SF7 Face to Face positioning, the washing vehicle is addressing twice the array-area per vehicle pass compared to the leading competitor, reducing proportionately the hours-per-MW washing rate.

With the DC Harness and String Runner innovations, SF7 introduces cabling savings related to managing PV source circuits. DC Harness is factory assembled using automotive type quick-connectors and lower cost aluminum wire. DC Harness performs both the source circuit-fusing and combining functions, eliminating the typical combiner box and its installation. The result is a faster installation and less cost. DC Harness combines with the String Runner cable management technique that uses the tracker torque-tube as a high-protection cable carrier, eliminating material and installation of cable trays, messenger cables, and other typical solutions.

In conclusion, SF7 with all its problem-solving features, breathes new life into tracker equipment this Spring. It is destined to set a new industry benchmark as the essence of cost-effectiveness and standard product maturity.

Soltec

SF7 One Track Zero Gap

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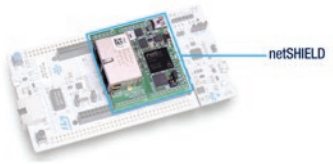


Scalable multi-protocol industrial ethernet platform

The creation of cost-efficient and compact industrial slave devices that can connect to any Real-Time Ethernet network is now simplified through the combination of the STM32 ecosystem with the multi-protocol flexibility of Hilscher's netX control ICs. The results of this collaboration are the I-NUCLEO-NETX expansion board for use with any STM32 Nucleo-64 or STM32 Nucleo-144 development board, and the I-CUBE-NETX, an STM32Cube software expansion for combining Hilscher's netX 52 network controllers with a host microcontroller (MCU) from ST's STM32 family. Combining the strengths of netX with the STM32 family – which ranges from entry-level STM32F0 MCUs to the very high-performing STM32F7 series and STM32H7 series -- creates a flexible, stable, and scalable platform for building products from simple I/O systems to complex, high-end drives and controls. Products for various worldwide markets can be based on common hardware, to cater efficiently for the popularity of different protocols, such as PROFINET in Europe, EtherNet/IP in the US, CC-Link IE in Japan, and EtherCAT in Europe and Asia.

STMicroelectronics | www.st.com

Solar powered vaccine refrigerator

Dulas has announced the launch of its VC60 Solar Direct Drive (SDD) combined vaccine refrigerator and icepack freezer. The World Health Organisation (WHO) accredited VC60 SDD is part of the Dulas Solar Direct Drive product range that features Freeze-Free technology, ensuring that vaccines stored in the refrigerator are never exposed to harmful freezing temperatures. The new model features advanced technology including an icepack freezer with additional storage and an integrated Solar Socket – a solar harvesting device to support vaccine outreach work in remote areas. The Hot Zone rated design of the VC60 SDD provides an extended operating temperature range of +5°C to +43°C that enables it to successfully function regardless of extreme variations in temperature. Dulas' solar-powered refrigerator/freezer also features an integrated Solar Socket for charging mobile phones and other electronic devices. The VC60 SDD features a larger storage capacity and advanced autonomy and holdover rates (i.e., the length of time that it can maintain temperature range with or without solar radiation, respectively) of 94 hours and 11 minutes. The technology is designed to work around the clock, using sophisticated computer modelling that carefully matches the energy from the solar photovoltaic modules to the needs of the refrigerators. Dulas' FreezeFree technology is designed using a combination of advanced solar and temperature control systems, together with phase change materials to ensure that vaccines are kept at the recommended temperature range of +2°C to +8°C.

Dulas | www.dulassolar.org

Solar optimizers

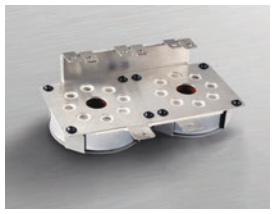
Tigo announces their next generation of solar optimizers featuring UHD-Core (Ultra-High Definition) technology: TS4-M (Monitoring) is a cost efficient MLPE monitoring device providing a high sampling rate, and TS4-S (Safety) which adds to TS4-M's functionality by providing module-level deactivation capabilities. This release completes Tigo's TS4 platform featuring an enhanced design architecture and component rating. Tigo TS4 optimizers with UHD-Core technology support more module types for three reasons. First, the maximum input voltage at standard testing conditions has improved to 90V which allows for compatibility of modules with up to 96 cells. Second, the maximum input current has increased to 12A which enables the use of high efficiency and bifacial modules. Third, the power capacity has upgraded to 475W to support the most powerful modules. These enhanced electrical characteristics of the UHD-Core technology result in higher energy harvest for any module up to 475W. This TS4 UHD-Core platform is fully monitored through Tigo's Cloud Connect Advanced (CCA) data loggers with remotely upgradeable firmware. The high definition sampling rate technology also allows high accuracy remote monitoring of voltage and current - including remote access to individual module information (i.e. panel type, barcode, manufacturing origin, location, and production date). All Tigo TS4 platform products are autonomous and feature selective deployment. They can be fitted to new or existing installations on any string or sub-string size. They are compatible with most of Tigo's inverter partners and any module type including monocrystalline, polycrystalline, thin-film, and bifacial.

Tigo Energy | www.tigoenergy.com

Solar planning portal

Zeversolar, a subsidiary company of inverter manufacturer SMA, has completely overhauled their planning portal, ZeverPlan 2.0. The portal is available in nine languages and is capable of designing systems with differently aligned module fields. ZeverPlan 2.0 can also perform self-consumption calculations and recommend suitable inverters for the chosen system design. ZeverPlan supports not only system designs featuring multiple module fields, but also different alignments and tilt angles that can be connected to an inverter with two MPP trackers. The polystring function also allows the user to combine two equivalent parallel strings with different alignments and tilt angles and a single MPP tracker. Registered users have access to a monthly updated module database, worldwide meteorological data, and the option of inputting their own module information, profiles, and unique project templates. Project files can be exported and shared with other ZeverPlan users. Based on specified load profiles, the software can also calculate how much electricity would be self-consumed or fed into the grid for the system design in question.

Zeversolar | www.zeverplan.com



Integrated capacitor/ busbar assemblies for solar inverters

Rogers Corporation's Power Electronics Solutions (PES) division has developed an integrated capacitor busbar solution for solar inverters applications. The ROLINX CapEasy and ROLINX CapPerformance busbar assemblies contain integrated high-value capacitors and a laminated busbar structure for enhanced power density and low inductance requirements. By teaming low-loss laminated busbars with low-profile capacitors having low equivalent series inductance (ESL) and low equivalent series resistance (ESR), the resulting compact hybrid busbar assembly is ideal for high-density power distribution in small spaces, such as in solar inverters and DC-to-DC converters. The novel integrated busbar assemblies consist of a multilayer laminated busbar with copper or aluminum conductors and polypropylene dielectric film and a single annular capacitor. The unique low-profile format of the capacitors allows them to be mounted back-to-back on opposite sides of a laminated busbar, resulting in an extremely compact power-distribution solution with the high instantaneous current capacity needed for consistent power from a solar inverter even with changing operating and environmental conditions. ROLINX CapEasy capacitor busbar assemblies are rated for maximum DC voltage of 1.5kV and as much as 1MW power. ROLINX CapPerformance assemblies are available with voltage ratings as high as 12kV and as much as several megawatts power-handling capability. Both assemblies are fabricated with tin-plated copper conductors and designed to maintain consistent performance at operating temperatures from -40°C to +105°C. The busbars are combined with capacitors valued at 75 to 1600 µF and DC voltages up to 3kV. The low-form-factor capacitors are fabricated from metallized polypropylene film protected by a molded polymeric case and usable at temperatures from -40 to +85°C.

Rogers Corporation | www.rogerscorp.com

Lightweight 5/40 rails

Alpha+ has been specifically designed to minimize installation times. Labor is decreased by click, set, and done Clickstone technology on all module clamps. Shared rail configurations can drastically increase savings by reducing roof penetrations and material use. Compatible with framed and unframed modules for a wide range of pitched roof surfaces in both landscape and portrait layouts. Expand available options with the new lightweight 5/40 or 10/48 and 13/52 rails. New tool-free, internal structural splice available for all rails. Mounting Systems' MS Design Tool provides the Bill of Materials and PE-stamped structural analysis in just minutes for any Alpha+ project configuration. All components are made of extruded aluminum and stainless steel. This guarantees both full recyclability and maximum service life due to high corrosion resistance.

Mounting Systems | www.mounting-systems.us

High energy density dielectric film

To address the growing need for lightweight, compact, high energy density capacitors able to store large amounts of electrical energy for long periods of time without significant current leakage and loss of charge even at high temperatures, SABIC is launching a new polyetherimide (PEI) film - ULTEM film UTF120. ULTEM film UTF120 is a high heat and high energy density dielectric film that meets stringent technical demands for use in professional-grade dielectric film capacitors. ULTEM film UTF120 exhibits stable properties through a range of temperatures (-40°C to +150°C) and frequency, including stable capacitance, good insulation resistance, high dielectric constant (Dk), and low dissipation factor (Df). The wide operating temperature capability of ULTEM film UTF120 based capacitors increases reliability and reduces or eliminates the need for active cooling for converter applications. ULTEM film UTF120 has excellent metal adhesion, enjoys high temperature dimensional and mechanical stability, and is inherently flame retardant. Capacitors using ULTEM film UTF120 are capable of passing industry-standard 260°C reflow soldering processes. Developed to offer excellent handling through metallization, capacitor winding, and flattening, it is processable on existing equipment and has been validated with both film-foil and metalized electrodes including flat and tapered metalized electrode designs as well as patterned electrodes. Potential applications include in automotive components such as DC/DC converters, electrical compressors and high-intensity discharge (HID) lighting, in electronics such as LED lighting and LCD backlight, and film capacitors for mass transportation and renewable energy.

SABIC | www.sabic.com

Low cost in-line deposition of thin films

The APCVD System from SCHMID includes multiple injector heads in series to maximize process throughput, uniformity, and flexibility while minimizing cost. The HMI allows the customer to easily monitor and control all process parameters in a user-friendly touchscreen environment. The maintenance-conscious design allows chemical injectors and exhaust ducting to be cleaned while in place on the system and without significant process interruption. Modular chemical vapor injector head assemblies allow quick and easy installation and removal from the coating chamber. All injector head parts are durable precision machined structures ensuring accurate chemical delivery even after extended use. The SCHMID APCVD System offers a low cost alternative for film deposition. In the roller transport system, only the substrate is heated during the process, so electricity and cooling requirements are greatly reduced. Multiple injector heads can be used in series within a single APCVD system. Three tiers of graded, power saving insulation further reduce energy bills. The in-line system is available in two configurations: with belt transport or with roller transport. Each transport method has its advantages. Stable, unsurpassed temperature uniformity control ensures consistent process results. In addition, precision process exhaust and precursor flow controls guarantee consistent film results.

Schmid Group | www.schmidgroup.com

Powerful, versatile central inverter

Ingeteam's latest 1,500Vdc INGECON SUN PowerMax B Series inverter makes it possible to deliver an output power of up to 1,800kVA in a single power block up to 86°F (1637kVA @ 122°F). Due to this inverter's power and the possibility of connecting up to three inverters to the same LV transformer winding, Ingeteam achieves up to 5.40MVA in a single turnkey MV Power Station at 1500Vdc. The 1000Vdc version of this central inverter family is able to provide 1300kVA up to 95°F (35°C) ambient temperature, achieving up to 5.2MVA with a four-inverter power station solution.

Ingeteam | www.ingeteam.com

Simple, reliable xenon arc tester

The Q-SUN Xe-1-W xenon test chamber offers precision temperature-controlled water immersion with integral water repurification in a xenon-arc tester. It is now possible to fully submerge test specimens in water while they are exposed to full-spectrum sunlight. This meets water immersion conditions found in several international standards, including ISO 16474-2 and ETAG 002 (Part 1). These tests are designed for materials that are mounted horizontally and subjected to standing water, such as roofing surfaces, sealants, solar thermal and photovoltaic panels, and heating and cooling equipment.
Q-Lab | www.q-lab.com

Low cost, high yield solar tracker

Soltec has launched its next generation solar tracker, SF7. By eliminating array-gaps on the tracker at all pile mounting locations, SF7 achieves complete tracker module fill that enables greater yield. By reducing parts count and installation labor, SF7 also achieves a lower installed first-cost. The net result is a greater benefit/cost ratio that defines Soltec's principal innovation criteria to increase tracker cost-effectiveness. Other key features of SF7 include: fewest piles-per-MW, greatest installation tolerances on steep-slope and irregular land, and the greater site-fill options of a short tracker that mounts twice the modules per independent-row tracker length.
Soltec | www.soltec.com

Optimized polycrystalline solar module

Axitec's AXIplus BLK SE 60-cell polycrystalline solar module has an embedded solaredge power optimizer and saves the installers money on labor and material. It streamlines purchasing and inventory, simplifies the use of rail-less racking, and offers solaredge advantages such as rapid shut down, monitoring, and high performance.
Axitec Solar | www.axitecsolar.us

Remote update feature for inverter software

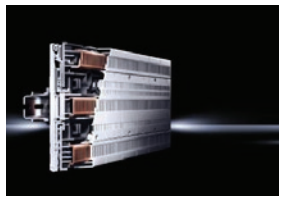
Fronius customers are now able to remotely update the software of inverters over the web with a Fronius SnapINverter that has an internet connection and the inverter or system is registered on Fronius Solar.web, Fronius' free monitoring system. With the Remote Update feature, Fronius SnapINverters can now be updated remotely from any web-enabled device; it just takes a few clicks on Fronius Solar.web which offers remote diagnostics and alerts such as proactive email notifications when an inverter is underperforming and state code awareness. Remote Update via Fronius Solar.web eliminates another category of O&M complexity and cost.

Fronius USA LLC | www.fronius-usa.com

Solar lighting controller technology

Urban Solar introduces a brand new solar lighting controller technology, the ECM Connect. This web-connected Energy Control Module (ECM) technology allows users to monitor and operate solar LED lighting systems remotely from their desktop or mobile devices. Urban Solar's SLL Series, PV-Stop, and PV-Shelter systems already use intuitive power management, and are now further enhanced by the highly reliable, patent pending ECM technology. The new ECM Connect utilizes wireless connectivity to provide several new lighting control features and benefits for reliability. ECM Connect features and benefits include: web-enabled wireless control and monitoring of solar lighting systems, which allow municipalities to control the energy consumption and lighting profiles while reducing maintenance costs; real time lighting management and energy savings, using calendar based scheduling and dimming to optimize performance year-round; secure wireless communications and intuitive user interface, which allow programming of lighting fixtures to turn on, off, or dim on any real time or pre-programmed schedule; data collection and reporting capabilities, which allows municipalities to check active lighting, solar charging, and battery condition warnings; secure wireless connection, to manage or control a lighting network from any browser using PCs or smartphones; internet connectivity; in depth configuration options; and remote lighting control.

Urban Solar | www.urbansolarcorp.com



Power distribution in confined spaces

The new Rittal RiLine Compact is designed for control units requiring a maximum current of 125A. Despite its size, the busbar system distributes power effectively and reliably, in compliance with all applicable standards. The technology is a solution for small switchgear and controllers, and for direct integration into plant and equipment. RiLine Compact comprises a board with busbars entirely enclosed in covers which safeguard against unintentional contact. A connection can be easily established anywhere along the length of a busbar via a series of access apertures (called the pitch pattern) in the board. Switchgear and control units can be simply plugged in using a variety of adaptors. In addition, an adapter for connection to round conductors is available, as well as a variety of functional modules for motor and power control.

One of RiLine Compact's primary strengths is that it can be rapidly configured, assembled and installed. The main board and diverse components can be securely mounted without the need for tools. Because the entire system is shielded by covers, users are protected against live parts. This enhances safety for operators and for the system as a whole. Furthermore, it saves time and cuts costs.

Rittal GmbH & Co. KG | www.rittal.de

Fluxes

In 2016, Emil Otto GmbH expanded the portfolio with ESD products, SMD adhesives, and cleaning rolls for automatic stencil printers. A special focus is on the alcohol-based fluxes, which can be used in wave, selective, and manual soldering as well as in dip tinning. There will also be new products among the alcohol-/water-based as well as purely water-based fluxes. Both flux groups are provided for use in wave, selective, and manual soldering.

Emil Otto | www.emilotto.de/en/

Helical Rotor Pump

Franklin Electric Co., Inc. offers the new Fhoton HR SolarPAK System, which features helical rotor pumps, as an addition to the current Fhoton SolarPAK product family. The helical rotor pump (sometimes called a progressive cavity or positive displacement pump) generates substantial water pressure at lower flows, providing water even during times of indirect sunlight. Since less energy is required, the Fhoton HR SolarPAK utilizes a minimum number of solar panels, for applications with flexible water volume requirements – such as supplying water to holding tanks for use in livestock watering, rural water supply supplementation, remote cabins, and small irrigation systems. The Fhoton HR SolarPAK System features a Franklin Electric submersible pump and motor, and the Fhoton solar controller in one package. The Fhoton solar controller features a compact modular design, and a robust IP66, NEMA 4 enclosure that protects against wildlife, insects, dust, and weather. The controller includes diagnostic features, and built-in protection from potential harmful conditions such as surge, underload (dry run), overvoltage, locked pump, open and short circuit, overheated controller, and reverse polarity. the Fhoton HR SolarPAK is cULus and UL approved and available in three and seven gpm flow rates with a power rating of 0.75 hp (0.55 kW).

Franklin Electric | www.franklinwater.com

Virtual control room

meteocontrol Energy & Weather Services introduces the VCOM (Virtual Control Room). VCOM is a customizable, web-based solution for managing a modern solar portfolio. VCOM is scalable for individual systems, as well as portfolios spread around the world. Features include an alarm and ticketing system to track performance and coordinate service deployments, customizable reports and data graphs, and mobile apps for Android and iPhone.

meteocontrol Energy & Weather Services
www.meteocontrol.com

Solar tracker purlin jigs

GameChange Solar announced their AutoSpace&Square purlin jig for the Genius Tracker solar tracker. The AutoSpace&Square purlin jig reduces purlin installation time by over 50% and can be used by only one worker. In addition, the jig automatically squares and spaces purlins for optimal module spacing. This design, combined with the preassembled Driving Arm and other features, provides for a fast install of the GameChange Genius Tracker. AutoSquare&Space purlin jigs are custom sized for modules free of charge.

GameChange Solar | www.gamechangesolar.com

Data acquisition products

Campbell Scientific is releasing the CR300-series measurement and control dataloggers. The CR300 datalogger has rich CRBasic command set and serial communication capabilities, and an onboard compiler for larger, more complex programs. The CR310 has the same capabilities of the CR300 datalogger, but includes removable connectors and an integrated 10/100 Ethernet connection. The CR310 also includes an integrated Ethernet interface, making it a solution for applications requiring internet-connected remote monitoring and control. Simple connection to external wireless devices enables remote communication with satellite, cellular, and licensed radios. The CR310 is also available with optional integrated WIFI and license-free radios for wireless networking. Providing complete compatibility with a variety of measurement and communication protocols, the CR310 supports TCP/IP, Modbus, DNP3, SDI-12, HTTP, FTP, and Email. The CR300 series dataloggers are the same size as earlier compact Campbell Scientific dataloggers, so they can be drop-in replacements. They are also the first Campbell dataloggers that can measure 4 to 20 mA sensors natively. They have a 24-bit analog to digital converter, a high-speed processor, and a micro-USB port. For communication, the CR300 has full PakBus capability, and plenty of non-volatile flash memory for storage. The CR300 series dataloggers are programmed with Campbell Scientific's LoggerNet software, which includes a point-and-click program generator, and a network planner for graphical layout of devices.

Campbell Scientific | www.campbellsci.com

Project management tool

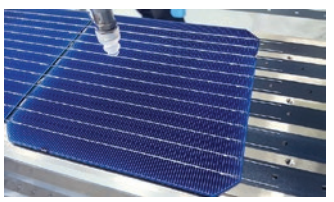
POWER Engineers Incorporated has launched the POWER360 project management tool. It can be adapted for any type of infrastructure project, and uses Microsoft's Azure Cloud hosting platform, which meets more than 25 international and industry compliance standards, including ISO 27001.

POWER Engineers | www.powereng.com

Efficient and robust silicon-carbide diodes

ST's SiC-diode manufacturing process creates robust devices with low forward voltage (VF), giving circuit designers extra freedom to achieve high efficiency and reliability using diodes with lower current rating and therefore lower cost. This makes SiC technology more accessible for cost-conscious applications including solar inverters, industrial motor drives, home appliances, and power adapters. At the same time, performance-oriented applications that demand SiC for superior efficiency, low weight, small size, or best thermal properties can extend these advantages using ST's latest 1200V SiC diodes. The higher efficiency margin provided by their lower forward voltage drop (VF) delivers important benefits for automotive equipment such as On-Board Battery Chargers (OBC) and charging stations for Plug-In Hybrid or Electric Vehicles (PHEV/EV). On the other hand, overall robust electrical performance ensures a perfect fit in telecom and server power supplies, high-power industrial Switched-Mode Power Supplies (SMPS) and motor drives, uninterruptible power supplies (UPS), and large solar inverters. Over and above maximizing SiC efficiency gains, achieving the lowest VF also helps reduce operating temperature and extend application lifetime. In addition, ST's manufacturing process allows to display lower spread on the datasheet-guaranteed VF thereby enabling OEMs to ensure superior reproducibility when building circuits in high volumes. ST's new 1200V SiC diode family covers current ratings from 2A to 40A, including automotive-qualified devices, in surface-mount DPAK HV (High-Voltage) and D^2PAK, or through-hole TO-220AC and TO-247LL (Long-Lead) packages.

STMicroelectronics | www.st.com



Multi busbar connection solution

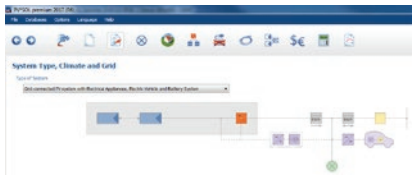
The Multi Busbar Connector connects solar cells to strings with 12 round wires and 20 soldering pads per wire at high-speed. The aesthetic cell design turns modules into a premium product with 6W to 9W more power output. Short and narrow grid fingers result in a high fill factor and a high current at lower costs; up to 25% silver can be saved when screenprinting the cells. Moreover, light hitting the round copper wires is reflected back onto the cell. This efficient light recycling contributes to the minimized cell-to-module (CTM) loss. Modules with 60 cells show a CTM loss of less than 4.5% when using SCHMID's reliable multi busbar connection solution. The solar cells are processed "sunny side up". The wires with a core diameter of 360 µm and a 15 µm SnPbAg coating are covered with flux inside the machine. The front-to-back soldering of the wires to the cells is performed on a preheated chuck. The wires are held by special parallel grippers. A motion axis system together with a high precision imaging system ensures exact cell placement with an accuracy of 0.05mm. Thus, a precise overlap of the small wires and the metallization pattern of the cells is guaranteed, even with minimum solder pad sizes. Existing module production lines are easily upgraded; the Multi Busbar Connector harmonizes with subsequent lamination processes and uses contact-free infrared soldering technology which is compatible with all cell designs.

Schmid Group | www.schmidgroup.com

Energy monitoring tool

The meeco Group has developed a new platform for online monitoring, troubleshooting, and controlling. This new tool enqueues into meeco's range of sun2products and is called sun2see. Through its archiving function, sun2see enables customers to track the performance of their clean energy systems during their entire lifespan. Easily accessible by logging in online, they get a concise and customized overview of all relevant performance parameters according to their individual technical system, such as the energy output or the condition of their energy storage facilities (batteries).

The meeco Group | www.meeco.net



New generation design software

Design of PV systems with an electric vehicle as a consumer now possible with PV*SOL premium. In addition to the possibility of importing floor plans, cadastral maps, and screenshots from web-based satellite maps like Google Earth directly into the 3D visualization, PV*SOL premium 2017 now offers the inclusion of electric vehicles as a direct consumer of grid-connected PV systems. In addition, due to the extended tariff models for electricity use, with PV*SOL premium, plant designers can now take into account any number of different time-variable tariffs (for example, HT/LT) in the profitability calculation. This applies both to the reference tariffs and to the net metering tariffs. The net metering consumption can now also be defined either by means of an annual value or the individual monthly values. PV*SOL is a valuable tool for correctly dimensioning, as well as determining the profitability of PV systems. A newly introduced dimensioning aid for the size of the battery storage unit carries out the calculation of the battery for the user and thus facilitates the configuration. The storage systems have been extended with the addition of DC-coupled systems. All PV*SOL variants are available in English, French, German, Italian, Polish, Spanish, and now Portuguese. The project reports can be created in many other languages.

Valentin Software
www.valentin-software.com

Maximum power in a tiny package

Ingeteam offers its 40kW string inverter, which features two MPP trackers and is suitable for operation in self-consumption mode. This string inverter has been designed in order to harness the maximum power from the sun.

Ingeteam | www.ingeteam.com

DIN-Rail fuse holder for 1500V systems

Eaton's new Bussmann series DIN-Rail fuse holder is specifically designed for 1500-volt (v) photovoltaic (PV) systems. The unique design of the CHPV15L85 fuse holder covers live parts when in the extracted position, offering a high degree of worker safety by preventing accidental contact during fuse replacement. Eaton's IP20 finger-safe CHPV15L85 fuse holders meet global agency standards to simplify designs for worldwide markets, and are engineered for use with 10x85 and 14x85 millimeter cylindrical gPV fuses. The fuse holder is UL and International Electrotechnical Commission (IEC) rated up to 32 amps.

Eaton | www.eaton.com

Utility-Scale, Commercial & Residential Inverters

An integral part of any solar energy system, inverters convert the power generated from the sun into functional energy for grid and even off-grid use. With technology offering ever-more efficient and reliable power generation, herein we highlight the latest in utility-scale, commercial, and residential solar inverters…

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Dynapower

Product: MPS-250kW Energy Storage Inverter

Application: Commercial

Continuous Output Power: 250kW

Peak Efficiency Range: 97.5%

DC Voltage Operating Range: 580V to 830V

Operating Temperature Range: -13°F to 122°F (-25°C to 50°C; De-rated from 45°C to 50°C)

Dimensions: 79" x 41" x 41" (2007mm x 1041mm x 1041mm)

Certifications/Approvals: UI 1741 SA, IEEE 1547, CA Rule 21, HI Rule 14H

Warranty: 5-year warranty

Key Features:

- Dynamic transfer — seamless transition from grid-tied to islanded mode;
- Black start;
- Advanced acoustic signature;
- Multiple units can be paralleled together in both grid-tied and microgrid applications.

www.dynapower.com

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COTEK Electronic Industrial Co. Ltd.

Product: SD3500-xxx

Application: Commercial, industrial

Continuous Output Power: 3.5kW

Weighted CEC Efficiency: 90%

Peak Efficiency Range: 91%

DC Voltage Operating Range: 20V-32V for 24V model

Operating Temperature Range: -4°F to 140°F (-20°C to 60°C)

Dimensions: 11.14" x 5.04" x 19.53" (283mm x 128mm x 496mm)

Certifications/Approvals: UL458 / EN60950-1

Warranty: 2-year warranty

Key Features:

- Parallel N+1 redundancy design for power expansion;
- Built-in ATS & AC circuit breaker;
- RS232 communication;
- Fully isolated input & output;
- Multiple industrial for single and 3-phase applications.

www.cotek.com

Darfon America Corp.

Product: H5000

Application: Residential

Continuous Output Power: 5kW

Weighted CEC Efficiency: 95.5%

Peak Efficiency Range: 96%

DC Voltage Operating Range: 120V to 500V

Operating Temperature Range: 32°F to 131°F (0°C to 55°C)

Dimensions: 27.2" x 17.5" x 5.9" (69cm x 44.5cm x 15cm)

Certifications/Approvals: UL1741, IEEE 1547, FCC Class B

Warranty: 5-year warranty

www.darfonsolar.com

Go Electric, Inc.

Product: LYNC DR

Application: Commercial, industrial

Continuous Output Power: 125kW to 250kW

Peak Efficiency Range: 95% to 96%

DC Voltage Operating Range: 400V to 800V

Operating Temperature Range: 32°F to 122°F (0°C to 50°C)

Dimensions: 94" x 64" x 71.5" (238cm x 162cm x 181cm)

Certifications/Approvals: UL1741 SA, HECO VFRT

Warranty: 3-year warranty with optional 10-year extended

www.goelectricinc.com

Ideal Power, Inc.

Product: 30kW Stabiliti Series Multiport Power Conversion System

Application: Commercial

Continuous Output Power: 30kW

Weighted CEC Efficiency: 95%

Peak Efficiency Range: 95.5%

DC Voltage Operating Range: 100V to 1000V

Operating Temperature Range: -13°F to 122°F (-25°C to 50°C)

Dimensions: 20.5" x 40" x 16" (520mm x 1016mm x 406mm)

Certifications/Approvals: UL1741, EEEE1547a, IEC62109-1,2

Warranty: 10-year limited North America warranty

www.idealpower.com

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PURE ENERGY

Freesun®
SOLAR INVERTER

SOLAR

STORAGE

HEC-US V1500

- *UL1741 Certified 1500Vdc Solar Inverter*
- *Hardware Optimized for both Solar and Battery Storage Applications*
- *True Modular and Redundant Operation Topology*
- *Stainless Steel NEMA3R Enclosure Painted With C5M Anticorrosive Paint*
- *Innovative Low-Pressure Air Cooled Design*
- *Flexible Design for Skid or On-Site Integration*
- *Easy Integration With Customer SCADA System*
- *Customizable Options to Meet a Wide Variety of Project Requirements*

SERVICE
POWER ON SUPPORT
24h

BEST IN CLASS SERVICE

- *24/7 On-Call Service Support and Remote Monitoring*
- *5 Year Standard Warranty With Optional Extensions*
- *Reginal Hubs With Service Personnel and Spare Parts Storage*

EXPERIENCE

Operational Products In USA

- *1.5+ GW Total Commissioned Inverters*
- *200+ MW Operating 1500Vdc Inverters*
- *900+ Inverters Installed*

30+ Years
Power Conversion
Expertise...

SAVING ENERGY FOR THINGS THAT MATTER...

Contact Us
Power Electronics USA
+1 (602) 354-4890
sales@power-electronics.com
www.power-electronics.com

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Rhombus Energy Solutions

Product: Rhombus 125kW-900Vdc Continuous

Application: Commercial, utility-scale, residential, industrial

Continuous Output Power: 125kW

Weighted CEC Efficiency: ±0.5 Power Factor range and with Rhombus advanced controls

DC Voltage Operating Range: 450V to 900V

Operating Temperature Range: NEMA3R

Certifications/Approvals: UL1741- SA, UL62109

Warranty: 5-year and 10-year warranty

Key Features:

- Successfully achieved re-certification of its 125kW Energy Storage inverter to UL1741 with an extended range of 450-900Vdc;
- Includes an improved, more compact cooling system, an LCD touch screen display, and a rugged NEMA3R option suitable for outdoor installations;
- With ±0.5 Power Factor range and advanced controls, Rhombus is poised to meet new UL SA standards by 4Q2017;
- With grid and island mode capability, standard MODBUS controls, fully integrated grid isolation, the Rhombus PCS125 system is a turn-key inverter solution that can be quickly installed into energy storage or PV projects.

www.rhombusenergy.com

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Power Electronics, Inc.

Product: PECS V1500 Series Energy Storage Inverters

Application: Utility-scale energy storage projects

Continuous Output Power: 1000kVA to 3000KVA

Overload Capacity: 120% - 30 seconds (depending on preload conditions)

Power Factor Capability: 0.00 leading to 0.00 lagging

Weighted CEC Efficiency: 98.5%

Peak Efficiency Range: 98.8%

DC Voltage Operating Range: 750V to 1310V

Operating Temperature Range: -4°F to 122°F (-20°C to 50°C); 42.8°F (60°C) with derating; -22°F (-30°C) with optional cold weather kit

Dimensions: 231.9" x 37.2" x 86.5" (5890mm x 945mm x 2198mm) maximum

Certifications/Approvals: UL-1741, CSA 22.2 (pending)

Warranty: 3-year warranty, extended warranty options available up to 20-years

Key Features:

- Compatible with all battery types;
- Modular and fault tolerant architecture;
- Stainless steel cabinet with conformally coated electronics;
- Innovative air-cooled topology;
- Easy integration with 3rd Party SCADA;
- Full suite of utility interactive features.

www.power-electronics.com

Enphase Energy

Product: Enphase IQ 6+ Microinverter

Application: Residential

Maximum Output Power: 290VA

Continuous Output Power: 280VA

Weighted CEC Efficiency: 97%

Peak Efficiency Range: 27V to 37V

DC Voltage Operating Range: 16V to 62V

Operating Temperature Range: -40°F to 149°F (-40°C to 65°C)

Dimensions: 8.6" x 7.5" x 1.49" without bracket (219mm x 191mm x 37.9mm)

Certifications/Approvals: UL 62109-1, UL1741SA, IEEE1547, CA Rule 21, HI Rule 14H, FCC Part 15 Class B, ICES-0003 Class B, CAN/CSA-C22.2 NO. 107.1-01 This product is UL Listed as PV Rapid Shut Down Equipment and conforms with NEC-2014 and NEC-2017 section 690.12 and C22.1-2015 Rule 64-218 Rapid Shutdown of PV Systems, for AC and DC conductors.

Warranty: 25-year warranty

www.enphase.com

Tabuchi Electric Company of America

Product: Eco Intelligent Battery System (EIBS): System Model (EIBS16GU2)

Application: Residential

Continuous Output Power: 4kW

Weighted CEC Efficiency: TBD

Peak Efficiency Range: 95.6%

DC Voltage Operating Range: 80V to 550V

Operating Temperature Range: -4°F to 104°F (-20°C to 40°C)

Dimensions: Inverter: 9.8" x 26.8" x 47.2" (249mm x 681mm x 1199mm) Battery: 21.7" x 22.8" x 23.6" (551mm x 579mm x 599mm)

Certifications/Approvals: Inverter: UL1741/1699B/60950-1, CSA C22.2. No 107.1/ No. 60950-1, IEEE 1547a, CEC, FCC class B. Battery: UL 1973, CSA C22.2 No. 60950-1), System (ANSI/CAN/UL 9540

Warranty: 10-year warranty

www.tabuchiamerica.com

Schneider Electric

Product: Conext SmartGen CS1670

Application: Commercial, utility-scale

Continuous Output Power: +/- 20% (384 - 576 V)

Weighted CEC Efficiency: 98.0% (Target)

Peak Efficiency Range: 98.6% (Target)

Operating Temperature Range: -22°F to 140°F (30°C to 60°C)

Dimensions: 86.6" x 118.1" x 51.2" (220cm x 300cm x 130cm)

Certifications/Approvals: IEEE 693-2005 qualification to high seismic performance levels (ZPA = 1.0g 2% damping), IBC ICC-ES AC156-2012 certification to a SDS equal to 1.78g and with a z/h equal to 0 and IP=1.5 UBC Zone 4

www.solar.schneider-electric.com

AIMS Power

Product: 250 Watt Micro Grid Tie Inverter - 6 pack

Application: Residential

Continuous Output Power: 1.5kW

Weighted CEC Efficiency: 96.0%

Peak Efficiency Range: 96.5%

DC Voltage Operating Range: 27V to 48V

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

Dimensions: 6.5" x 7.2" x .86" (165mm × 183mm × 28mm)

Certifications/Approvals: UL1741, CSA C22.2, FCC

Warranty: 10-year warranty

www.aimscorp.net

Northern Electrical & Power

Product: Microinverter

Application: Commercial, residential, industrial

Continuous Output Power: 220W to 550W

Weighted CEC Efficiency: 95.5%

Peak Efficiency Range: 95.5%

DC Voltage Operating Range: 22V to 60V

Operating Temperature Range: -40°F to 149°F (-40°C to 65°C)

Dimensions: 7.09" x 7.32" x .98" (180mm x 186mm x 25mm)

Certifications/Approvals: California Rule 21 Certified, UL1741, CSA 22.2 No.107.1

Warranty: 10-year standard warranty, with extended options up to 25-years

www.northernep.com/en

Analytic Systems

Product: IPSi3600

Application: Commercial, industrial, military

Continuous Output Power: 3.3kW

Weighted CEC Efficiency: 90%

Peak Efficiency Range: >90%

DC Voltage Operating Range: 20V to 40V, 40V - 80V, 100V to 400V

Operating Temperature Range: -13°F to 104°F @ maximum output (-25°C to 40°C), -40°F/C optional

Dimensions: 15.6" +/- 0.1" x 12" +/- 0.1" x 8" +/- 0.1" (39.7cm +/- 0.3cm x 30.5cm +/- 0.3cm x 21.3cm +/- 0.3cm)

Certifications/Approvals: Built to CSA 22.2.107.1, UL458

Warranty: 3-year parts and labor warranty

www.analyticsystems.com

Delta Products Corporation

Product: Delta M125U

Application: Commercial, industrial, utility-scale

Continuous Output Power: 150kW

Weighted CEC Efficiency: 98.5%

Peak Efficiency Range: ≥99%

DC Voltage Operating Range: 710V to 1450V

Operating Temperature Range: -13°F to 140°F (-25°C to 60°C)

Dimensions: 25.2" x 35.4" x 12.6" (640mm x 899mm x 320mm)

Certifications/Approvals: UL1741, UL1998, UL 1699B, IEEE1547, IEEE1547.1 CSA C22.2, UL 1741 SA

www.delta-americas.com

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ABB

Product: UNO-7.6/8.6-TL

Application: Residential

Continuous Output Power: 7.6kW / 8.6kW

Weighted CEC Efficiency: 97.0%

Peak Efficiency Range: 97.8%

DC Voltage Operating Range: 90V to 580V

Operating Temperature Range: -13°F to 140°F (-256°C to 60°C)

Dimensions: 29.3" x 22.9" x 8.8" (744mm x 581mm x 223mm)

Certifications/Approvals: UL1741, IEEE 1547, IEEE 1547.1, CSA C22.2N 107.1-01, UL1998, UL1699B, FCC Part 15 Class B

Warranty: 5-year warranty

Key Features:

- Transformerless inverter which operates like two inverters, reducing the cost of installation;
- Wide input voltage range makes the inverter suitable for installations utilizing a reduced string size;
- The dual MPPT input enables more orientations of PV strings to be connected at the same time and unbalanced strings on each MPPT channel;
- Lightweight and simple to wall-mount.

www.new.abb.com

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Chilicon Power

Product: CP-250E

Application: Residential, commercial

Continuous Output Power: 0.285kW

Weighted CEC Efficiency: 96%

Peak Efficiency Range: 96.7%

DC Voltage Operating Range: 22V to 47V

Operating Temperature Range: -40°F to 149°F (-40°C to 65°C)

Dimensions: 12" x 8" x 1.8" (305mm x 203mm x 46mm)

Certifications/Approvals: UL1741, IEEE std 1547, IEEE std C62.41.2, CSA C22.2 NO. 107.1, CISPR 22 Class B

Warranty: 25-year warranty

Key Features:

- 60 and 72 cell compatibility;
- 285W AC output;
- Industry's most robust and fully featured monitoring equipment, see CP-100 gateway;
- Fully modular trunk cabling solution;
- Made in USA.

www.chiliconpower.com

CyboEnergy, Inc.

Product: CyboInverter

Application: Commercial, residential, industrial, other

Continuous Output Power: 1.2kW

Peak Efficiency Range: 96%

DC Voltage Operating Range: 15V to 58V

Operating Temperature Range: -40°F to 149°F (-40°C to 65°C)

Dimensions: 12.5" x 9.5" x 2.3" (317.5mm x 241mm x 58mm)

Certifications/Approvals: UL1741, IEEE1547, CSA 107.1, FCC, NEMA6 (IP67)

Warranty: 3-year warranty with extended available

www.cyboenergy.com

REFU / Prettl Energy

Product: REFUsol 48K-UL Inverter

Application: Commercial, utility-scale, industrial

Continuous Output Power: 48kW

Weighted CEC Efficiency: 98%

Peak Efficiency Range: 98.3%

DC Voltage Operating Range: 580V to 850V

Operating Temperature Range: -13°F to 140°F (-25°C to 60°C)

Dimensions: 30" x 32" x 12" (762mm x 813mm x 305mm)

Certifications/Approvals: UL 1741, IEEE 1547, CSA C22.2, CA Rule 21, UL 1741 SA

Warranty: 10-year standard warranty, up to 20-years available

www.refu.com

SMA America

Product: Sunny Tripower Core1

Application: Commercial

Continuous Output Power: 50kW @0.95 PF (53kVA)

Weighted CEC Efficiency: preliminary >98%

Peak Efficiency Range: preliminary >98%

DC Voltage Operating Range: 150V to 1000V

Operating Temperature Range: -13°F to 140°F (-25°C to 60°C)

Dimensions: 24.4" x 28.8" x 22.4" (621mm x 733mm x 569mm)

Certifications/Approvals: pending UL1741, UL1998, UL 1699B, IEEE1547, FCC Part 15 (Class A&B), UL1741-SA

Warranty: 10-year standard warranty

www.sma-america.com

Yaskawa - Solectria Solar

Product: PVI 50/60TL

Application: Commercial

Continuous Output Power: 50kW to 60kW

Weighted CEC Efficiency: 98.5%

Peak Efficiency Range: 99%

DC Voltage Operating Range: 200V to 950V

Operating Temperature Range: -22°F to 140°F (+30°C to 60°C); derating occurs over 122°F (50°C)

Dimensions: 39.4" x 23.6" x 10.24" (1000mm x 600mm x 260mm)

Certifications/Approvals: UL 1741:2010, UL 1699B, CSA-C22.2 #107.1-01, IEEE1547; FCC Part 15

Warranty: 10-year standard warranty with 15- and 20-year extended service agreements available

www.solectria.com

APsystems

Product: YC1000-3 microinverter

Application: Commercial, utility-scale

Continuous Output Power: 900WAC

Weighted CEC Efficiency: 94.5%

Peak Efficiency Range: 95%

DC Voltage Operating Range: 16V to 55V

Operating Temperature Range: -40°F to 149°F (-40°C to 65°C)

Dimensions: 10.2" x 9.5" x 1.4" (259mm x 242mm x 36mm)

Certifications/Approvals: IEEE1547, UL1741, CSA C22.2 No. 107.1-01, NEC 2014 690.12, NEC 2017 690.12, FCC Part 15, ANSI C63.4, ICES-003

Warranty: 10-year standard warranty, extendable to 25 years

usa.apsystems.com

SolarEdge

Product: HD-Wave Inverter

Application: Residential

Continuous Output Power: 12.5kW to 32kW, depending on inverter size

Weighted CEC Efficiency: 99%

Peak Efficiency Range: 99% to 99.2%

DC Voltage Operating Range: Fixed voltage

Operating Temperature Range: -13°F to 140°F (-25°C to 60°C); -40°F/-40°C option

Dimensions: 17.7" x 14.6" x 6.8" (450mm x 370mm x 174mm) with safety switch

Certifications/Approvals: Integrated Arc Fault protection and Rapid Shutdown for NEC 2014 and 2017, per article 690.11 and 690.12

Warranty: 12-year warranty, extendable to 25-years

www.solaredge.com/us

OutBack Power

Product: Radian Series Inverter/Charger

Application: Residential, commercial

Continuous Output Power: 4kW and 8kW models

Weighted CEC Efficiency: 92.5%

DC Voltage Operating Range: 40V to 64V

Operating Temperature Range: -40°F to 140°F (-40°C to 60°C) maximum; rated -4°F to 122°F (-20°C to 50°C)

Dimensions: 28" x 16" x 8.7" / 71.1" x 40.6" x 22.1" (7111mm x 406mm x 221mm / 1806mm x 1031 x 561mm)

Certifications/Approvals: ETL listed to UL1741, CE, CSA C22.2 No. 107.1, UL 778 Annex F, IEC 62109-1 ETL, RoHS compliant per directive 2011/65/EU, FCC Class B, IEEE 1574.1, EN61000-6-1, EN61000-6-3, EN61000-3-2, EN61000-3-3

Warranty: 5-year standard warranty with extended 10-year warranty available

www.outbackpower.com

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Fronius USA

Product: Fronius Primo

Application: Residential

Continuous Output Power: 3.8kW to 15kW

Weighted CEC Efficiency: 96.5%

Peak Efficiency Range: 96.9%

DC Voltage Operating Range: 80V to 600V

Operating Temperature Range: -40°F to 140°F (-40°C to 60°C)

Dimensions: 16.9" x 24.7" x 8.1" (429mm x 627mm x 205mm)

Certifications/Approvals: UL / CSA, or: UL 1741-2010, UL1998 (for functions: AFCI, RCMU and isolation monitoring), IEEE 1547-2003, IEEE 1547.1-2003, ANSI/IEEE C62.41, FCC Part 15 A & B, NEC Article 690, C22. 2 No. 107.1-01 (September 2001) , UL1699B Issue 2 -2013, CSA TIL M-07 Issue 1 -2013

Warranty: 10-year standard warranty, with extended warranty options up to 20 years

Key Features:

- Field serviceable and lightweight;
- Free lifetime monitoring;
- Dual MPPT and transformerless topology;
- Advanced grid features;
- Innovative SnapINverter hinged mounting system.

www.fronius-usa.com

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Power Electronics, Inc.

Product: HEC-US V1500 Series Solar Inverters

Application: Utility-scale solar projects

Continuous Output Power: 1000kVA to 3500kVA

Weighted CEC Efficiency: 98.5%

Peak Efficiency Range: 98.8%

DC Voltage Operating Range: 800V to 1500V

Operating Temperature Range: -4°F to 122°F (-20°C to 50°C); 42.8°F (60°C) with derating; -22°F (-30°C) with optional cold weather kit

Dimensions: 231.9" x 37.2" x 86.5" (5890mm x 945mm x 2198mm) maximum

Certifications/Approvals: UL 1741, CSA 22.2

Warranty: 5-year standard warranty with up to 20-year extended warranty options available

Key Features:

- Modular fault tolerant architecture;
- Stainless steel cabinet with conformally coated electronics;
- Innovative air-cooled topology;
- Thermally insulated cabinet doors;
- Full suite of utility interactive features.

www.power-electronics.com

TMEIC

Product: Solar Ware Samurai Central Inverter

Application: Utility-scale

Continuous Output Power: 3200kW

Weighted CEC Efficiency: 98.5%

Peak Efficiency Range: 98.9%

DC Voltage Operating Range: 875V to 1300V

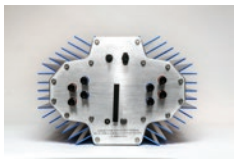
Operating Temperature Range: -4°F to 122°F (-20°C to 50°C)

Dimensions: 92" x 197" x 46" (2286mm x 5000mm x 1150mm)

Certifications/Approvals: UL certification pending

Warranty: 5-year standard warranty, with optional 20-years available

www.tmeic.com



Alencon Systems, LLC

Product: SPOT, GRIP

Application: Commercial, utility-scale, industrial

Continuous Output Power: 25kW to 10MW

Weighted CEC Efficiency: 98% to 99%

Peak Efficiency Range: 99.6%

DC Voltage Operating Range: 600V to 1500V

Operating Temperature Range: -40°F to 122°F (-40°C to 50°C)

Dimensions: 21.65" x 14.96" x 11.02" (550mm x 380mm x 280mm)

Certifications/Approvals: UL 1741

Warranty: 5- to 25-year warranty

www.alenconsystems.com

Magnum Energy, a product brand of Sensata Technologies

Product: MicroGT 500 Microinverter

Application: Residential

Continuous Output Power: 500kW

Weighted CEC Efficiency: 95.5%

Peak Efficiency Range: 95.5%

DC Voltage Operating Range: 211V to 264V

Operating Temperature Range: -40°F to 149°F (-40°C to 65°C)

Dimensions: 8.75" x 6.5" x 1.1" (221mm x 167mm x 29mm)

Certifications/Approvals: Emissions & Immunity (EMC) Compliance FCC PART 15, ANSI C63.4 2003, ICES-003 Safety Class Compliance Grid Connection Compliance IEEE 1547 UL 1741, CSA C22.2, No. 107.1-01, NEC2014 690.12

Warranty: 25-year warranty

www.sensatapower.com

KACO new energy

Product: Preliminary: BP3000 TL3 1500 V

Application: Utility-scale, commercial

Continuous Output Power: 3300kW

Weighted CEC Efficiency: 98.5%

Peak Efficiency Range: 98.5%

DC Voltage Operating Range: 825V to 1500V

Operating Temperature Range: -4°F to 122°F (-20°C to 50°C)

Dimensions: 142" x 50.5" x 78.8" (3600mm x 1283mm x 2002mm)

Certifications/Approvals: UL1741-2015,IEEE1547a, IEEE1547.1a, CSA C22.2 No. 107.1 UL1741-SA, CA(Rule21),NERC-PRC-024-1

Warranty: Contact for details

www.kaco-newenergy.com/us

Huawei Technologies USA, Inc.

Product: SUN2000-40KTL-US

Application: Commercial, industrial

Continuous Output Power: 40kW

Weighted CEC Efficiency: 98.5%

Peak Efficiency Range: 98.9%

DC Voltage Operating Range: 200V to 1000V

Operating Temperature Range: -13°F to 140°F (-25°C to 60°C)

Dimensions: 36.61" × 11.14" × 21.65" (930mm x 283mm × 550mm)

Certifications/Approvals: UL 1741, UL 1699B, CSA C22.2 #107.1-01, FCC Part 15, IEEE 1547, IEEE 1547a, Rule 21

Warranty: Optional 5- or 10-year warranty

solar.huawei.com

Ingeteam

Product: Ingecon SUN 1640TL U B630

Application: Utility-scale

Continuous Output Power: 1637kW

Weighted CEC Efficiency: 98.5%

Peak Efficiency Range: 98.9%

DC Voltage Operating Range: 915V-1500V

Operating Temperature Range: -4°F to 140°F (-20°C to 60°C)

Dimensions: 111" x 36.2" x 86.6" (282cm x 92cm x 220cm)

Certifications/Approvals: CE, ETL

Warranty: 5-year warranty, with extended warranty options up to 25 years

www.ingeteam.com

Growatt Technology USA

Product: GroWatt 40000MTLP-US

Application: Commercial, residential

Continuous Output Power: 40kW

Weighted CEC Efficiency: 99%

Peak Efficiency Range: 99%

DC Voltage Operating Range: 200V to 1000V

Operating Temperature Range: -13°F to 140°F (-25°C to 60°C)

Dimensions: 17.32" x 25.98" x 10.62" (440mm x 660mm x 270mm)

Certifications/Approvals: UL, CEC, ETL, CE, Canada

Warranty: 5- to 20-year warranty

www.growatt-america.com

Small Slip Rings are a Big Deal

by Kyle Riegel and Jesse Shearer

When most people think of wind turbines, bigger components like motors and blades immediately come to mind. Smaller components, on the other hand, are often overlooked. However, it's those small components that can make or break a system.

A perfect example is the slip ring assembly—also known as an electrical rotary union—for pitch control systems. The slip ring is tiny when compared to the whole wind turbine, but its impact can't be ignored. If your slip ring malfunctions or has critical issues, the turbine shuts down.

So even though the slip ring seems like a small thing, it's a big deal. That's why it's important to choose a slip ring that's appropriate for your turbine design. When considering slip ring manufacturers, here's a great question to ask: "Is the slip ring engineered specifically for wind applications?"

A quality, custom-engineered slip ring for wind applications can reduce cost and improve performance, by ensuring unwanted design features aren't included, while critical design features are. A custom design also requires less maintenance, incurs less downtime, and is more efficient. In other words, it's built to last.

When looking at the effectiveness of a wind turbine slip ring, manufacturers take into consideration a variety of factors. The key factors include maintenance frequency, maintenance downtime, and power transfer.

Factor #1: Maintenance Frequency

You might think a longer life requires more maintenance. Actually, if you choose a quality slip ring, the opposite is true. A slip ring should be designed to last the entire 20-year life of a wind turbine. It should also allow for 100-200 million revolutions before brush replacement.

Some questions to ask when vetting slip ring manufacturers:

- Are your brushes robust and solid enough to be resistant to power surges?
- If a brush gets damaged, do I need to replace the whole block or just the individual brush?
- Is the assembly robust enough to handle vibrations and environmental conditions present in a wind turbine?
- Will the slip ring support the communication protocol passing through the communication channels?

Slip Rings can be designed with maintenance in mind. The more that is known about the specific turbine conditions, the better the slip ring can be designed to survive a 20-year lifetime. A quality slip ring will save time and money, on both parts and labor.

Factor #2: Maintenance Downtime

Quality slip rings help you get your turbine back up and running faster.

For example, with quality slip rings, you should only need to replace a single brush—not an entire assembly. With lesser quality slip rings, you can waste time replacing working brushes, and waste money on extra materials.

Also, quality slip rings should only require five minutes of maintenance per year; sometimes annual maintenance isn't even necessary.

Some questions to ask when comparing slip rings:

- How long does it take to replace each brush?
- Is annual maintenance required? If so, how much?
- Do your slip rings have built-in, lifelong lubrication?

With the right slip ring, you'll reduce downtime, and increase productivity and profits.

Factor #3: Power Transfer

There was a time when slip rings had a reputation for power loss and limited capacity. That's no longer true. Today, quality slip rings are extremely efficient, and can transfer higher wattage with decreasing power loss.

Additional questions to ask slip ring manufacturers:

- What is the maximum voltage and ampacity the slip ring was designed for? This will relate to the power (in kilowatts) the slip ring can safely handle.
- What is the slip ring's power factor (efficiency)?

The slip ring should have more than a 99 percent power factor. Without a near perfect power factor, the slip ring will hinder the electrical system and, more importantly, the power lost converts to heat that will damage the slip ring system. There are a lot of factors, specifically contact size and design, that can affect power transfer capacity and power loss. Choosing slip rings custom-designed for the specific wind turbine application can help you ensure proper capability and function.

A Critical Component

Just as in any electrical system, every component has its importance. All these components need to work in series with each other for the greater system to function. So yes, while slip rings are just a small part of the overall wind turbine, they are critical to uptime, efficiency and profitability. All things considered, small slip rings are a really big deal.

Kyle Riegel is R & D Engineer, and Jesse Shearer is Sr. Application/Design Engineer at United Equipment Accessories in Waverly, IA, a worldwide supplier of custom components for motion applications.

United Equipment Accessories
www.uea-inc.com

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Tower climbers face a lot of challenges in their line of work. That's why we've been hard at work, educating climbers and connecting them with our completely redesigned 3M™ DBI-SALA® Lad-Saf™ X3 Detachable Cable Sleeve. With integrated enhanced safety features, the Lad-Saf X3 Sleeve glides smoothly up and down on 3/8 in. cables, providing the confidence and hands-free mobility you need to get the job done safely at height.

Explore our completely redesigned Lad-Saf X3 Sleeve at:
3M.com/FallProtection

DOE's Competitiveness Improvement Projects

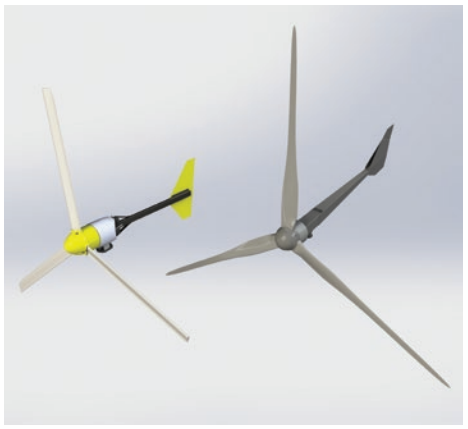
Delivering substantial cost reductions in the U.S. distributed wind industry

by Jose Zayas

COST REDUCTIONS, MORE RELIABLE TECHNOLOGY, and consumer friendly business models are making distributed generation (DG) more accessible to customers interested in producing their own electricity. However, since 2010, the U.S. market for distributed wind systems has not experienced the same boom as other DG sources, such as solar photovoltaics (PV). Manufacturers and developers of distributed wind systems maintained a competitive edge in cost over PV during the first decade of the 2000s, but are now faced with the challenge of developing next-generation technologies capable of delivering electricity at a levelized cost of energy (LCOE) that are competitive with rapidly declining costs for PV, and other DG options.

In consideration of these technical challenges, the U.S. Department of Energy's (DOE's) Wind Energy Technologies Office (WETO) reevaluated the U.S. distributed wind market, and its approach to facilitating development and deployment of distributed wind systems. Working with industry, the department discovered significant opportunities to increase system performance and reduce costs. Additionally, it recognized a major need for certification of distributed wind systems to meet rigorous national and international standards, in order to increase consumer confidence, and more reliably predict system performance. To help distributed wind compete with other sources of distributed generation, WETO launched the Competitiveness Improvement Project (CIP) in 2013.

CIP consists of annual solicitations run through and administered by DOE's National Renewable Energy Laboratory (NREL). U.S. manufacturers of small and medium wind turbines compete for cost-shared contracts to optimize their designs for increased performance, develop advanced manufacturing processes, or certification of system performance. In four rounds of annual solicitations, DOE has awarded $3.6 million to 16 projects with 9 different manufacturers, leveraging an additional $2 million in awardee cost-share.



Since 2013, CIP has yielded numerous successes that have led directly to next-generation technologies, and increased the competitiveness of the U.S. distributed wind industry. Highlights include:

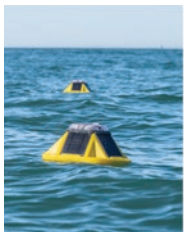
- A company that specializes in residential wind power completed a redesign of their 10 kilowatt (kW) wind turbine.[1] The next-generation design increases rotor swept area by 88 percent over the 10 kW turbine, operates at lower rotations per minute (RPM) for reduced sound, and uses a newly developed carbon fiber blade manufacturing process. It's anticipated to achieve a nearly 50 percent reduction in LCOE over previous models, with an estimated power production cost of 10 cents per kilowatt hour in average annual wind speeds of 6 meters per second. Under a separate award, the company is currently conducting testing to certify its Excel 15 to national standards.
- A Maine-based manufacturer of clean energy products and power electronics, developed innovative tooling for blades that use carbon fiber infused, injection-molded plastic, reducing blade set costs by approximately 90 percent, compared to conventional hand-laid fiber glass methods.[2] This advanced manufacturing process not only provides costs savings, but also dramatically reduces blade production times for the company's 1.5 kW T701 Home Wind Turbine. The T701 has been tested to national standards, and achieved full certification in January 2016.
- An engineering systems company designed a new blade and rotor assembly for its 100 kW wind turbine.[3] The new rotor design increases blade length, and optimizes aerodynamics for reduced sound and greater efficiency, without increasing cost. The newly developed, 100C-24 rotor yields an annual energy production (AEP) increase of 15 percent over the previous models. Under a separate award, the company is currently conducting type certification testing for their 100C-24 turbine.
- An electronics consulting group in New Hampshire developed the first wind energy-compatible power inverter for single and three phase applications up to 25 kW.[4] This inverter allows for larger, grid-connected distributed wind systems to interconnect to single phase distribution feeders, without the added cost of bundling multiple smaller off-the-shelf inverters. Design efforts under this project focused on enabling the use of advanced switching materials, specifically silicon carbide, to deliver a wide bandgap inverter that is quieter, more efficient, smaller, and lighter than alternatives commercially available to the distributed wind industry.
- In addition to the two turbine models previously mentioned undergoing certification, a renewables energy company in Colorado is conducting certification testing of its 160-watt AIR40 and 400-watt AIR30 wind turbine models.[5] Together, all four of these turbine models are on schedule to complete certification testing by the end of 2017, which would increase the number of certified small wind turbine models available to U.S. customers from 16 to 20.
- Accredited third-party verification of test results in accordance with internationally adopted technical standards for testing is critical for industry credibility and maturation. Wind turbine certification provides manufacturers with the parameters for communicating transparent and credible information to consumers, utilities, lenders, and policymakers about the safety, performance, and durability of their commercial products.

Recent NREL analysis suggests there could be a significant role for distributed wind in the nation's electricity future. According to this analysis, cost reductions and performance improvements are necessary, but not sufficient, to achieve this potential. Industry-driven business innovation, such as developing turnkey approaches like wind turbine leasing, are making significant strides in making distributed wind more attainable for consumers.[6] With next-generation technology optimized for distributed applications becoming commercially available and more attainable for consumers, the U.S. distributed wind industry is poised to scale and compete in an expanding global market for distributed generation.

The author is the Director of the Wind Energy Technologies Office at the U.S. Department of Energy. Working with DOE's national laboratories, academia, and industry, the office funds research, development, and deployment of wind energy through competitively selected, cost-shared projects with businesses, federal, state, and other stakeholder groups. Prior to the DOE, Mr. Zayas was the senior manager of the Renewable Energy Technologies group at Sandia National Laboratories, where his responsibilities included establishing strategy and priorities, defining technical and programmatic roles, business development, and performing management assurance for the renewable energy-related activities of the laboratory. Zayas holds a Bachelor of Science in Mechanical Engineering from the University of New Mexico and a Master of Science in Mechanical and Aeronautical Engineering from the University of California at Davis.

U.S. Department of Energy
www.wind.energy.gov

[1] *Bergey Windpower, in Norman, Oklahoma, installs their Excel turbines for both grid and off-grid use.*
[2] *Pika Energy is headquartered in Westbrook, Maine. All of its products are designed, tested, and manufactured in the United States.*
[3] *Northern Power Systems (NPS) of Barre, Vermont, leases its NPS wind turbines, as well as energy storage systems.*
[4] *Intergrid in Temple, New Hampshire, supplies inverters to the renewables industry.*
[5] *Primus Windpower operates out of Lakewood, Colorado, and specializes in off-grid wind systems that incorporate both wind and solar power.*
[6] *In January of 2016, United Wind secured $200 million in project equity capital to expand its leasing program.*



Crowd sensing the ocean

Spoon drift has announced the launch and pre-sales of Spoondrift Spotter, a low-cost, solar-powered ocean wave-current tracker that provides real-time data access anywhere and anytime. Spoondrift aims to get local communities involved in making ocean data available and visible. Spotter builds on years of research and combines design thinking with recent advances in ocean science and sensor technology. As a result it provides exceptional data quality, while offering extreme usability and out-of-the-box real-time connectivity across the globe.
Spoondrift | www.spoondrift.co

Emerging Markets: Advice to New Investors

by Adam Barber

Renewable energy – and wind energy in particular – is increasingly becoming a global industry. More and more investors and developers are looking beyond the traditional European and U.S. markets, towards the emerging markets of Asia, Latin America, and Africa. However, there are a number of risks for those entering unchartered waters. Political risk, for instance, remains a huge factor for wind investors deciding where to do their next deal. Factors such as GDP, population growth, legal and regulatory systems, and local supply chains will also affect the success of projects and investments.

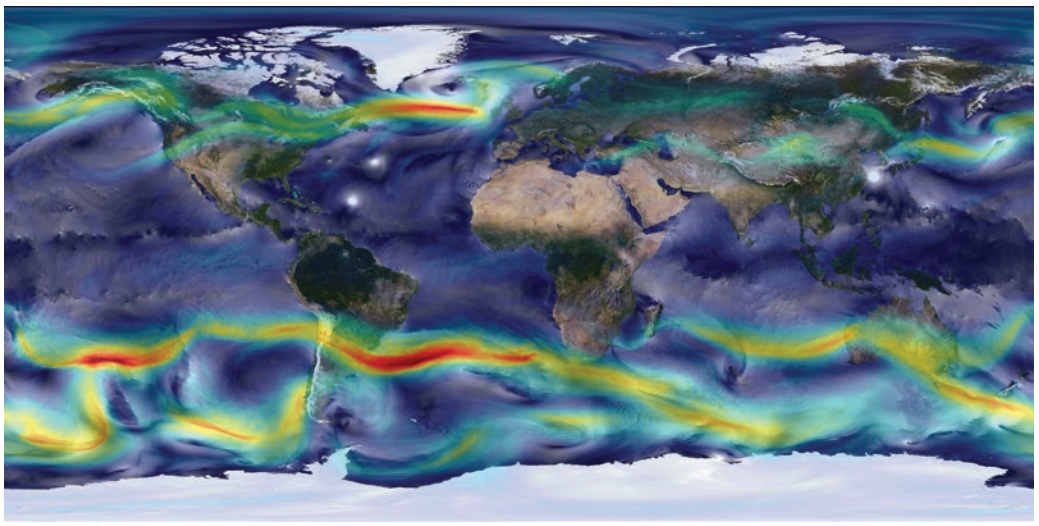
For those with little on-the-ground experience, a lack of information regarding these factors can be a significant impediment to entering these emerging markets. Carefully researched reports will provide the detailed analysis and insight necessary to enter the most attractive emerging markets for wind companies in 2017 and beyond.

Be sure to concentrate on key economic trends affecting the wind market in developing countries in areas like Africa, Asia, and Latin America. China, Chile, and India, for example, tend to lead when it comes to opportunities for investment, along with Mexico and Ethiopia.

That China is the leading emerging market is perhaps no surprise, as it continues to exert huge influence on wind energy investment worldwide. Last year, for instance, its slowdown was a key factor in global investment in wind falling by 23 percent, according to the United Nations. The return to form of China's economy in 2017, therefore, will likely lead to renewed optimism for investors.

The prominence of China and India points to another key trend in the emerging markets of Asia, where these larger markets are running at different speeds to smaller ones, such as South Korea. This is not to say these smaller markets present fewer opportunities for investment; only that the risk profile can be remarkably different across Asia.

In Africa, those markets with the most supportive policies, including Ethiopia, South Africa, and Morocco, tend to be ranked highly, while others carry significant risks for investors. Likewise, in Latin America, Mexico and Chile are among the region's most compelling markets due to their encouraging business environments and wind energy policies.



Overseas investors will benefit from analyses of wind resources in key emerging markets. This data helps to further identify the windiest regions within individual markets such as Turkey or Kenya, as well as assessing the strength of a market's overall resource.

Local knowledge and insight can complement the higher-level analysis. Engage leading developers to identify future prospects for wind in countries recovering from economic turbulence, such as recessions, or government upheaval. As an example, last year was the first since 2009 that the South American nation of Brazil did not tender for new wind capacity. A local expert will be able to outline the fundamental strengths of a wind sector, whether the economy is about to turn a corner, and if that could lead to a one-of-a-kind wind resource that would underpin significant future growth.

Look for the emergence of new opportunities for investment in distributed renewables in Latin America, facilitated by a growing demand for energy. The region's record low auction prices have been making headlines for some time now, with utility-scale renewables becoming more widely accepted and rapidly spreading.

Strong market fundamentals make Latin America very attractive for the deployment of distributed energy; the mass deployment of renewables is helping to bring down the cost of electricity – leading to a virtuous cycle of increased energy demand. However, even in this most promising region, challenges remain. Chile, for instance, risks becoming a victim of its own success, as over-supply of solar in the Atacama Desert area has led to grid congestion. Similarly, while Argentina benefits from excellent wind resource, much of this is located in remote and challenging areas without substantial access to existing transmission.

These examples illustrate that, while the wind industry may be rapidly turning global, investors must weigh numerous factors when committing to any market, as they will inevitably vary in their appetite for risk. Seek out reports that offer a systematic overview of the markets you need to be considering. This will end up being your most valuable tool in selecting the market with an appropriate risk profile for your investment.

Adam Barber is the Founder and Managing Director of The Tamarindo Group, which includes Tamarindo, a strategic PR and communications advisory, and A Word About Wind, an exclusive wind finance and investor community and industry intelligence service.

The Tamarindo Group
www.thetamarindogroup.com
A Word About Wind
www.awordaboutwind.com

Infrastructure improvements to transport wind products by rail

Infrastructure supporting freight movement is a critical component to moving cargo in and out of the Seaport in an efficient and effective manner. The Port of Everett is working on phase II of its Terminal Rail project to add 3,300 lineal feet of double rail siding. This brings the Port's rail capacity to 12,500 lineal feet to accommodate more cargo without congesting the mainline.

The Port of Everett | www.portofeverett.com

U.S. Desert Plan (DRECP) Hurts Building Renewable Energy Projects in California

by Susy Bento

WHILE CALIFORNIA HAS A LOT TO OFFER ANY WIND ENERGY developer, pending legislation may soon change that dramatically.

DRECP was designed to help protect the state's environment but may actually set its progress back considerably.

What Is the DRECP?

The DRECP (Desert Renewable Energy Conservation Plan) is an Environmental Impact Report/Environmental Impact Statement (EIR/EIS) initiative that covers 22.5 million acres of land in California.

Its main goals are:

- Restore, preserve, and enhance natural ecosystems and communities and protect sensitive species
- Conserve and enhance other natural resources and values of BLM (Bureau of Land Management) lands (e.g. cultural resources, visual landscapes, recreation opportunities, etc.)
- Identify suitable sites for utility-scale renewable energy projects
- Simplify environmental reviews and the permit processes required by those areas

The overall goal of streamlining the development of renewable energy sites in this area and conserving critical desert ecosystems is supported by three initiatives:

- A Natural Community Conservation Plan (NCCP)
- A General Conservation Plan (GCP)
- BLM Land Use Plan Amendments

While the goals of the DRECP are clearly well intentioned, the execution is making it difficult to develop clean energy projects.

SB 100 Bill Would Require Clean Energy While Impeding Its Development

Although this landmark bill was already passed by the California State Senate, SB 100 is pending consideration by the California Assembly. The bill would ensure that the Golden State runs on 100 percent clean, renewable energy by 2045.

At the moment, California has a mandate to derive 50 percent of its electricity from renewable resources by 2030. If SB 100 passes, the new timetable would look like this:

- 45% by 2023
- 50% by 2026
- 60% by 2030

Once again, these goals were made with the best of intentions. The problem is that, in order to reach them, California will need to develop more energy projects.

Unfortunately, some of DRECP's regulations are standing in the way.

DRECP Provides Insufficient Land Allocation for Wind Energy Generation

Of the 22 million acres set aside for the DRECP, 9 million will be used for conservation and recreation.

Fewer than 400,000 acres will be open for renewable energy exploration. At most, only 121,000 acres can be used for wind energy developer projects.

Previously, approximately 3 million acres in the area covered by the DRECP were available for both solar and wind production. DRECP would make this land off-limits.

These limitations provide an almost insurmountable challenge to the wind energy developer community. The ambitious milestones required to reach 100 percent clean energy by 2045 require far more space to build wind generation sites.

At the same time, the BLM has been very generous to other forms of energy. According to Nancy Rader, the executive director of the California Wind Energy Association (CalWEA), 80 percent of BLM land in California is available to gas and oil companies for development. This kind of allocation, she points out, is not consistent with the government's commitment to breaking our country's reliance on fossil fuels.

CalWEA has stated that, if the plan passes in its current form, approximately 80 percent of the best BLM land for wind energy development – which are really the best in the entire state – will be eliminated.

Furthermore, CalWEA believes that the proposal will only manage to produce 1,000 MW of wind capacity. This is not nearly enough to reach the state's ambitious goals for renewable energy. About 7,000 MW of wind energy out of a portfolio of nearly 19,000 MW worth of new sources are required for California to cost-effectively meet these targets.

How the Need for Wind Development Advancements Would Be Affected

Even if the allocation of land were not such a stifling problem, other parts of the DRECP would be; specifically, the plan would put rigid restrictions on what kinds of advancements in wind generation technology would be acceptable.

Such advancements could go a long way toward reducing the minimal impact a wind energy developer currently has on the environment.

Along the same lines, future technology is expected to help wind energy generation sites and wildlife coexist, something that should fit right into the stated goals of DRECP. This would also make it permissible to use many of the areas the plan has marked off for conservation, as sites for wind generation, since wildlife would remain undisturbed.

The Threat of Climate Change

While one of DRECP's main goals is to save desert wildlife and other natural resources, the limitations it places on energy project development in the Golden State is a much larger threat.

If California cannot meet its power requirements through renewable means, its wildlife and natural resources will suffer far greater consequences due to climate change, than those posed by a wind energy developer building new sites to harvest clean energy.

Renewable Energy Will Always Have an Impact

There is no way of generating renewable energy without making some kind of impact. It is simply a question of minimizing that impact as much as possible. Wind energy is clearly the best option available.

Wind energy does not cause air pollution, and it's unimaginable that a wind energy developer will spill oil that goes on to destroy millions of plants and animals.

The renewable energy industry holds itself to a very high ethical standard and does its best to minimize the impact it does have, which is already small to begin with.

Yet wind energy's potential is very real. If sufficient land is made available for development, California could definitely reach the goals put forth by SB 100.

The problem is that not enough people factor in the very real ramifications of climate change when they are deciding how to balance a wind energy developer's plan with the need for conservation.

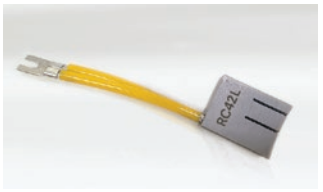
DRECP May Do More Harm than Good

Unless lawmakers understand these key points about how DRECP limits a wind energy developer from helping the state meet its renewable energy goals, the entire plan will probably do more harm than good.

The good news is that the technology and amount of wind required for California to run on 100 percent renewable energy is there. If lawmakers can appreciate the potential that DRECP has in time to make necessary changes, there is no reason the state cannot lead the country toward a cleaner future.

Susy Bento is the marketing and communications specialist for Alcen Renewable.

Alcen Renewable | www.alcenrenewable.com



Metal-graphite grade RC42L for wind power generators

Special metal-graphite grade specifically designed for low absolute humidity conditions: low temperatures and/or low relative humidity. Suitable also for all other climate conditions. With reduced content of metal and special high conductivity graphite to achieve: very high electrical conductivity; no material expansion in all brush life; minimal wear even in the worst climate conditions; very quick patina formation in all operating conditions; all brushes are silver tamped; and this graphite for electrical applications is always manufactured in the same location under the same standards for 100% traceability.

SGL Gelter Electrical Contacts
www.sgl-gelter.es

Brush spring kits for generator maintenance

Brush springs are one of the most neglected critical components of the generator. Springs are often replaced only when there is obvious damage, which can lead to mixing of unequal spring forces. Unequal spring forces cause unequal brush pressure, causing unequal current distribution between brushes, often leading to catastrophic failure. Old sluggish springs are slow to react allowing long duration of loss of contact between the brush and slip ring, arcing is the result, wearing on brushes and damaging the slip rings. Changing springs as a set every 3 to 5 years is a good maintenance practice giving better performance and longer slip ring and brush life. Morgan's complete generator spring kits contain all new phase and ground brush springs of proper and equal forces.

Morgan Advanced Materials
www.morganplc.com

Rescue and rapid evacuation device

In wind energy, the Milan has established itself as a standard device for rescuing injured people or for the rapid evacuation of several people. Centrifugally controlled brakes prevent free fall and allow safe, hands-free abseiling at a constant speed. Two users can be rescued from great heights at the same time using the Milan; the abseil distance can be up to 1640ft (500m). An additional benefit is that the Milan can be stored in a sealed box on site so it is close at hand in an emergency. The Seal Pac has an operating time of ten years and makes it easy to carry out the compulsory annual check. With the Double Seal Pac, SKYLOTEC has also responded to the trend for more and more people working simultaneously on increasingly large-scale wind turbines. This pack ensures that two rescue devices are available at the same time from a sealed box.

SKYLOTEC | www.skylotec.com

Heavy duty, rough terrain telehandler

Xtreme Manufacturing's Xtreme XR2045 is a high capacity rough terrain telehandler, designed to handle the toughest environments and jobsites. Weighing in at 44,750lbs. (20,300kg), this heavy-duty, all-steel telehandler can lift up to 20,000lbs. (9,071kg), and has a forward reach of up to 27ft. 4 in. (8.3m). It shares the same standard features as the rest of the Xtreme telehandler range, including 360° operator visibility from the cab, long-life boom rollers instead of wear pads for smoother boom operation and reduced maintenance, plus an integrated boom lift point. The boom lift point is designed to safely handle suspended loads and can lift the maximum rated load of the telehandler. This makes it a solution for applications such as lifting turbine blades during the transportation process from the manufacturing facility to the site. All Xtreme telehandlers are backed by a 10 year-5 year-2 year warranty, and are built in the USA.

Xtreme Manufacturing | www.xmfg.com

Versatile utility bucket light

Hi-Line Utility Supply and Milwaukee tools are excited to share the M18 Utility Bucket Light. With 2500 Lumens and a 500-yard beam distance, the M18 Utility Bucket Light offers versatility with its three light modes, dual light head design, each with 180° of vertical and horizontal head rotation, and its extreme weather and high voltage durability constructed for use in harsh conditions and environments. Its patented spring-loaded bucket clamp fits all size bucket lips and allows the user to move the light around the bucket effortlessly. The M18 Utility Bucket Light can run up to 4 hours on flood mode and spot/flood mode with an M18 REDLITHIUM High Demand 9.0 Battery and up to 6 hours on spot mode. It features a low battery indicator to alerts users when the battery is nearing end of charge. Its high-quality LEDs provide high definition output with true color, and never need to be replaced and are backed by a limited lifetime warranty.

Hi-Line Utility Supply Company, Inc.
www.hilineco.com

Lubricants & Greases

An important part of the planned maintenance of a wind turbine, proper lubrication will help keep the machinery working well for years. Keeping a wind turbine's gearbox properly lubricated is essential to extending the life of the turbine. Herein we highlight some of the solutions available on the market today…

SEE AD ON PAGE 43

AMSOIL, Inc.

Product: Synthetic Power Transmission EP Gear Lubricants

Application: AMSOIL PT Series Synthetic Power Transmission EP Gear Lubes are designed to provide protection for wind turbine and other industrial gearboxes requiring EP protection, such as those found in the textile, paper, steel, cement, plastic, and lumber industries. AMSOIL PT Series Gear Lubes are formulated to meet the listed standards and requirements.

cSt @ 40°C: 326.7 cSt

cSt @ 100°C: 34.8 cSt

Viscosity Index: 151

Pour Point: -36°F (-38°C)

Flash Point: 473°F (245°C)

Key Features:

- Solids-free additive technology provides protection against micro pitting and scuffing wear;
- PAO synthetic base oils to improve oxidation resistance and extreme temperature performance;
- Water-resistant to improve filterability and filter life as well as inhibit rust and corrosion;
- Shear stable which enhances viscosity retention and film thickness for dependable wear and EP protection;
- Internal coating compatibility so can be used in multiple manufacturer-branded gearboxes.

www.amsoilwind.com

Mobil Industrial Lubricants

Product: Mobil SHC Gear 320 WT

Application: Synthetic wind turbine gear oil

cSt @ 40°C: 320 cSt

cSt @ 100°C: 40.6 cSt

Viscosity Index: 181

Pour Point: -27.4°F (-33°C)

Flash Point: 541.4°F (233°C)

Guarantee: 7-year limited warranty - subject to the terms and conditions of the warranty, the company will bear any costs required and adequate to repair and/or replace any equipment damaged as a result of a lubricant defect or malfunction.

www.mobil.com

Petro-Canada Lubricants, Inc.

Product: HARNEX 320 Wind Turbine Gear Oil

Application: HARNEX 320 Wind Turbine Gear Oil is specially formulated for lubricating wind turbine gearboxes for reduced downtime and less maintenance. HARNEX 320 has GE service fill approval for 1.x and 2.x platforms with Winergy gearboxes. In addition, HARNEX 320 meets the technical requirements of Shanghai Electric, and is approved for use in any gearbox on a Shanghai Electric wind turbine.

cSt @ 40°C: 323 cSt

cSt @ 100°C: 34.9 cSt

Viscosity Index: 153

Pour Point: -44°F (-42°C)

Flash Point: 459°F (237°C)

www.lubricants.petro-canada.com

Klüber Lubrication NA LP

Product: Klübersynth GEM 4-320 N

Application: Gear drives

cSt @ 40°C: 320 cSt

cSt @ 100°C: 36 cSt

Viscosity Index: >155

Pour Point: <95°F (<35°C)

Flash Point: >392°F (>200°C)

www.klueber.com

American Chemical Technologies, Inc.

Product: EcoGear 270XP

Application: Wind turbine gearboxes

cSt @ 40°C: 270 cSt

cSt @ 100°C: 39.5 cSt

Viscosity Index: 215

Pour Point: 13.9°F (-25.5°C)

Flash Point: 426°F (219°C)

www.americanchemtech.com

Motion Industries

Product: CRC Sta-Plex Extreme Pressure Premium Red Grease, 14 Wt Oz

Application: A multi-purpose certified lithium complex grease recommended for many uses including bearings, and all moving and sliding surfaces to reduce friction in extreme environments. Applies for use in industrial mining, metal production, machining, plastic molding, pumps, electric motors, ball and roller bearings, kilns, assembly plants, drying ovens, trucks, automobiles, buses, construction equipment, off-road operations, tractors mowers, reapers, and water pumps.

cSt @ 40°C: 200 cSt to 260 cSt

cSt @ 100°C: 16.5 cSt to 19.5 cSt

Viscosity Index: 85

Pour Point: 5°F (-15°C)

Flash Point: 475°F (246°C)

Dropping Point: 500°F

Soap Type: Lithium

PAO: Synthetic

NLGI Grade: 2

www.motionindustries.com

Fuchs Lubricants

Product: Urethyn XHD 2

Application: Generator Bearing Grease

cSt @ 40°C: >260 cSt

Temperature Range: -40°F to 356°F (-40°C to 180°C)

Dropping Point: 500°F (260°C)

Soap Type: Polyurea

PAO: Synthetic

NLGI Grade: 2

SRV Test: 1200N

www.fuchsus.com

INTERSOLAR NORTH AMERICA

July 11-13, 2017
Moscone Center — San Francisco, CA

Intersolar's exhibition and conference both focus on the areas of photovoltaics, PV production technologies, smart renewable energy, and solar thermal technologies. Since being founded, Intersolar has become an important industry platform for manufacturers, suppliers, distributors, service providers, and partners of the solar industry.

www.intersolar.us

show in print

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

Balance on tracker solution

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

Shoals Technologies Group
www.shoals.com
Booth L9007

Solar warning labels

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

PV Labels | www.pvlabels.com
Booth 8621

Off-grid water pumping

Franklin Electric's new Fhoton SolarPAK system utilizes Franklin's solar technology with the Fhoton solar drive which features a smaller modular design, providing flexibility and simple maintenance for the installer. The new Fhoton solar drive features a robust IP66, NEMA 4 enclosure that protects against wildlife, insects, dust, and weather. The system is available in a variety of flow rates from 2.5 to 90 gpm and power ratings of 0.75 and 1.5 hp. Franklin Electric has a network of water systems professionals available, for solar installers looking to partner with a driller.

Franklin Electric | www.franklinwater.com
Booth 8327

Solar structures & carports

Baja Carports provides pre-fabricated, pre-engineered, high-tensile, and light-gauge steel structures that serve as the mainframe of a solar energy facility. They design, engineer, supply, and install Solar Support Systems, an integral component of a solar ground-mount, solar carport, and/or solar RV and boat storage solution. Baja's Solar Support Systems are being built at schools, train stations, sports complexes, shopping malls, medical facilities, office buildings—and any place where a parking lot is a location for solar shade that can generate power to offset energy costs or generate revenue from a Feed-in-Tariff. Baja is a nationwide company with its own in-house engineers.

Baja Carports | www.bajacarports.com
Booth 9501

Standing seam metal roofing solution

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

EcoFasten Solar
www.ecofastensolar.com
Booth 9433

Innovative Solar Systems, LLC (ISS) is the largest developer of utility scale solar PV systems in the USA. With a portfolio of 10GW per year in over 35 States, ISS has projects that will suit your needs.

Innovative Solar 37 - 80MW$_{ac}$

Innovative Solar 46 - 80MW$_{ac}$

Innovative Solar 47 - 35MW$_{ac}$

Innovative Solar 43 - 40MW$_{ac}$

Innovative Solar 34 - 50MW$_{ac}$

Innovative Solar 31 - 35MW$_{ac}$

- #1 USA developer with a 10GW yearly pipeline
- Developed 1GW of projects in the USA by 2016
- Projects sold at early stage, shovel-ready, NTP or COD
- Portfolio diversity: projects in over 35 US States
- 300MW to 2GW project portfolios for sale
- Ability to provide sRECs and PPAs to corporate offtakers

CEO John E. Green - (828)215-9064 - JohnGreen@InnovativeSolarSystemsLLC.com
CFO Craig J. Sherman - (828)767-1015 - Craig@InnovativeSolarSystemsLLC.com

Optimize commercial projects

SolarEdge offers a cost-effective module-level optimization solution for commercial systems that enables harvesting more power from a PV system, simplifying the design process, reducing O&M and installation costs, while also meeting the latest safety requirements for a fastest return on investment (ROI) and a lower levelized cost of electricity (LCOE).

SolarEdge | www.solaredge.com
Booth 9421

Versatile solar wire management

WILEY, a product line of BURNDY, offers wire management solutions for all types of solar applications. The WILEY mounting base ACC-FBC clip paired with any of the many BURNDY UNIRAP cable tie options is a solution to route cable bundles without the need for mounting holes or additional hardware. The ACC-FBC is a 304 stainless steel clip that installs onto the module frame flange and allows a cable tie to be routed in both landscape (on the horizontal portion of the module frame) and portrait (on the vertical portion of the module frame) orientations. The ACC-FBC fits various BURNDY UNIRAP cable ties from Nylon 6/6, Nylon 12 to tough stainless steel. BURNDY provides the right type of cable tie needed for ACC-FBC cable bundling applications.

BURNDY | www.burndy.com
Booth 9639

Bankable and competitive solar trackers

Scorpius Trackers is a tracker solution supplier and has an aim to accelerate wholesale grid parity for the IPP's. The Scorpius tracking solution features a patented IP including 35-year maintenance free bearings, wireless power and communication, and Storm Detection. Scorpius trackers have been wind tunnel tested and are certified by Black & Veatch. Scorpius offers a 10° tilt for higher latitudes and also has designs for different wind speeds. Scorpius' advanced end-to-end tracking solution requires minimal installation time and its self-powered system design is flexible to varying site conditions. Scorpius now offers ROW and BLOCK trackers, as per land and customer requirements.

Scorpius Trackers Pvt., Ltd.
www.scorpiustrackers.com
Booth 9717

Time saving, yield increasing landscape rack

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

TerraSmart | www.terrasmart.com
Booth 9711

Powered enclosure kit

The Powered Enclosure Kit (PEK) is designed for installation of the eGauge in combination with one of several communication protocol devices. The kit comes with components that complement the eGauge main unit, decreasing installation time and reducing complexity. The PEK can be utilized with 3p/4w, 120/208vac and 2p/3w,120/240vac services.

eGauge Systems, LLC | www.eGauge.net
Booth 9236

Cable management system

CAB Solar's cable management system for use in large-scale PV ground-mount projects is in use in over 1.6 GW of solar power plants. The CAB Solar Cable Management System is simple and easy to use. The system helps save money on labor and material costs, will not suffer from weather or ground-water related delays, offers reduced engineering and more predictable costs across an entire portfolio of projects, benefits the environment by having less soil disruption, and provides for ease of trouble-shooting should problems arise. Assistance in planning the implementation of the CAB System and onsite training is offered as a free service to customers. CAB Solar has over 25 designs and modifications available to meet any cable management need.

CAB Solar | www.cabproducts.com
Booth 9448

Trojan BATTERY COMPANY®

Introducing

SOLAR AGM

Trojan Battery's new line of Solar AGM deep-cycle batteries delivers extraordinary total energy over the life of the battery. These maintenance-free batteries can be counted on day in and day out as a highly reliable power source for a wide range of off-grid, grid-tied and unstable grid applications.

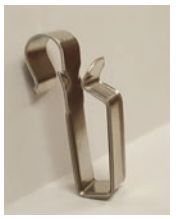
Clean energy for life™

trojanbattery.com/GoSolarAGM
800-423-6569 / +1-562-236-3000

Rail-less mounting system

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

DPW Solar | www.dpwsolar.com
Booth 9449



Stainless steel wire management

Nine Fasteners highlights their newest solar wire management clip; NFI-1701. The NFI-1701 was designed in conjunction with Enphase Energy for use with their newly released 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 in the U.S.A incorporating a rolled outer edge for maximum wire safety. The NFI-1701 is produced using .025" thick 301 ½ hard stainless steel material. Nine plans on having the clip UL certified by August of 2017.

Nine Fasteners, Inc. | www.ninefasteners.com
Booth 9545

Simple solar racking solution

The FastRack510 (FR510) is a universal one-piece ballasted mounting system compatible with all framed modules. It is lightweight, stackable, ships efficiently, and is quick to stage and install. FR510s are injection molded in California from Ultramid – a glass reinforced nylon developed in partnership with BASF. Ultramid is engineered to withstand extreme weather conditions and has a 25-year warranty. Sollega offers full engineering support services with every project, including layouts, ballast, and optional anchor plans. The FR510 arrives on site ready to install with no assembly required (500 kW fits in a 40-ft shipping container). All module attachments are top-down and require one size tool. Built-in reference tabs ease the alignment process.

Sollega, Inc. | www.sollega.com
Booth 9446

Bidirectional, revenue-grade electrical meters

CCS is featuring the WattNode Revenue meter and the customizable Meter Module with ANSI 12.20 accuracy – system accuracy to 0.5%, as well as its full line of high accuracy split-core current transformers with accuracies of 0.3%. The newly released meter module offers fast power for rapid production turn down requirements and is instrument powered. All metering products are bidirectional, designed to measure energy production, consumption, and AC from storage through a variety of communication protocols including Modbus.

Continental Control Systems | www.ctlsys.com
Booth 9233

Intelligent, versatile string inverter

The SUN2000-45KTL (1500V) string inverter features 4 MPPTs for versatile adaption to different layouts, and 8 strings of intelligent monitoring for fast trouble-shooting. It is Power Line Communication (PLC) and String I-V diagnosis supported. Safety features include: DC AFCI compliant to UL 1699B Type I, Type II surge arresters for both DC and AC, Residual Current Detection (RCD) protection. This inverter is naturally cooled, has a protection rating of NEMA Type 4X, maximum efficiency of 98.7%, and CEC efficiency 98.5%. The maximum input voltage is 1500V, maximum current per MPPT 22A. The minimum operating/start voltage 600V-650V. and output, AC active power 45000W.

Huawei Technologies USA, Inc. | solar.huawei.com
Booth 9521

Ground mount, ballasted, roof mount, and canopy solutions

RBI Solar is a turn-key solar mounting solutions supplier for ground mount, ballasted landfills, roof mounts, and canopy/carport structures. As a single-source provider for commercial and utility-scale PV projects, all responsibility for the design, engineering, manufacturing, and installation of efficient PV racking systems is completed in-house by the RBI Solar Team. Committed to providing value from conception to completion, RBI Solar's customers receive a cost-effective and durable racking solution for each project site to aide in reducing the overall project costs.

RBI Solar | www.rbisolar.com
Booth L9008

High energy capture hybrid solar system

SunDrum Solar has been working with both residential and commercial clients since 2008. The design of their HarvestHP system combines an efficient hybrid solar collectors, developed and patented by SunDrum Solar, with water heat pump technology to provide high performance. Their Hybrid PV/Thermal system is capable of capturing energy on cloudy/rainy days and even in the dark of night. SunDrum Solar also supplies solar heating and A/C cooling. SunDrum Solar's PV/Thermal system delivered 86% of solar energy collected on a roof top to the house.

SunDrum Solar | www.sundrumsolar.com
Booth 9940

Solar project developer

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

Innovative Solar Systems (ISS) | www.innovativesolarsystemsllc.com
Booth 8321

Reliable, maintenance-free deep cycle batteries

From small to large-scale off-grid and backup applications, Rolls Battery offers a wide range of dependable, long lasting maintenance-free AGM and GEL VRLA deep cycle batteries in a variety of capacity options. Chosen for their high quality, Rolls AGM-S, AGM-R and GEL models, like the popular 6 volt S6-460AGM, deliver exceptional cycle life and are backed by a 2-year replacement, 5-year pro-rated warranty when installed in renewable energy applications (AGM-S Series).

Rolls Battery Engineering
www.rollsbattery.com
Booth 8251

Mounting solutions for composition/ asphalt shingle roofs

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

Quick Mount PV | quickmountpv.com
Booth 9411

Photovoltaic fuses with low minimum breaking capacity

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

Mersen | www.mersen.com
Booth 8330

Solar panel mounting system

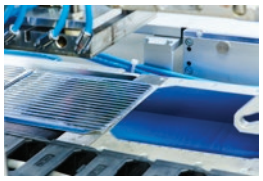
The Solar Connection Kit is a UL 1703 and UL 2703 Listed, solar panel mounting system which attaches to virtually any solar panel frame using GroundBonding Technology to create a conductive bond from panel to panel without extra tools or parts. Each solar kit utilizes the cable management disc which allows for cables to be top loaded and secured, making cable management clean and simple. PushLock Technology secures the cable management disc to the standing seam base clamp without extra nuts or bolts. The Solar Connection Kit is compatible with the Standing Seam Base Clamp which attaches to virtually any standing seam profile and provides unparalleled strength using patent-pending WaveLock technology with optional 1, 2, or 3 points of attachment. Offering ease of installation, the Silver Bullet set screws include a rounded bullet tip to maximize strength and won't damage paint or pierce the seam. The Solar Connection Kit is available in standard mill finish aluminum material, making it easy to keep in stock when the need arises.

Solar Connections Intl.
www.solarconnections.com
Booth 9552

PV sales and design software

Aurora streamlines and automates the solar design process, empowering solar installers to focus on what matters most—satisfying customers. Whether residential, commercial, or both, Aurora provides the tools needed to go from address and electricity bill to full PV design and sales proposal within 15 minutes. Aurora is used by solar installers across the U.S. and around the world, with over 10,000 installations designed in their software every week.

Aurora Solar | www.aurorasolar.com
Booth 8441



Solutions for wafer, cell and module processes

Meyer Burger offers high-efficient solutions for wafer, cell, and module manufacturing. With their mass production Heterojunction (HJT) equipment, an increased energy yield of +30% over conventional cells can be reached. Their PERC equipment lowers production costs in PECVD deposition by 20%. They offer smart solutions for cell connection and encapsulation. Their SmartWire Connection Technology (SWCT) is capable of high power extraction with pleasing aesthetics. Their Module Inspection System (MIS) is fully integratable into existing lines and has a quality LED light source.

Meyer Burger | www.meyerburger.com
Booth 8735

Open access testbed facility

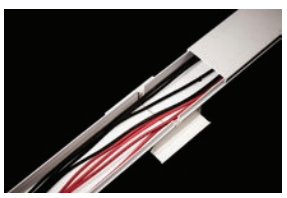
The Washington Clean Energy Testbeds are a new user facility at the University of Washington, designed to assist in the prototyping, at-scale manufacturing, testing, and validating of clean energy innovations. The staff are experts in clean energy research and are available to provide consulting and hands-on project assistance. The specially-designed laboratories allow researchers to test materials across various size scales. Furthermore, hardware and software operating systems can be tested for deployment at the utility scale. The testbeds have advanced fabrication and characterization equipment – including roll-to-roll printing, a 3-D printer, a sheet coater, solar simulators, battery testers, spectrometers, high-magnification imagers, real-time digital simulation, and power hardware in the loop. The Testbeds help reduce the capital and risk associated with research and technology transfer from concept or a lab bench to industry, enabling users to maximize the value of investments and awards as their research discoveries build toward new commercial opportunities.

Clean Energy Institute
www.wcet.washington.edu
Booth 8426

72-cell mono module

The monocrystalline modules of the AXIpremium series are the specialists among the AXITEC solar modules. These high-performance solar modules with efficiencies of up to 17.83% and excellent low light performance guarantee high power output. These modules are a solution for maximizing power on commercial projects.

Axitec Solar | www.axitecsolar.us
Booth 8717



Efficient wire management system

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

RayTray Solar Wire Management
www.raytraysolar.com
Booth 9435

Precision motion control technology

Cone Drive offers slewing drives and worm drives which deliver high dynamic and static load capacity in a small package. For pointing accuracy-critical applications, their double-enveloping worm technology provides precision and accuracy, with up to absolute zero backlash. Their V Series is a foot-mounted slewing drive equipped with a square output flange for ease in mounting and installation. The V Series offers a robust, enclosed-gearing vertical slewing solution, ideal for low-speed, outdoor applications. With 5 distinct size offerings up to a 21" bearing diameter, multiple precision levels for customizable positioning accuracy, and custom gearset designs for superior static load capacity, the V Series is a versatile, customer-oriented tracking drive.

Cone Drive Solar | www.conedrive.com
Booth 9644

DC/DC power converter for photovoltaic applications

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

Phoenix Contact
www.phoenixcontact.com/unosolar
Booth 9336

250kW DC-to-DC converter

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

Dynapower | www.dynapower.com
Booth 8159

Power conversion system and storage

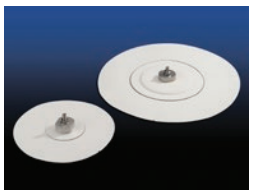
The SUNSYS PCS² bidirectional converters and their control systems follow a charge and discharge profile corresponding to the required functions. From 33kW to several MW, they provide a maximum efficiency of 98%. The modular rack provides flexibility and compatibility with a large number of brands and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

Socomec, Inc. www.socomec.us
Booth 8136 ees

Solar thermal energy systems

Stiebel Eltron manufactures the energy saving Tempra Plus tankless electric water heaters, Accelera heat pump water heaters, and solar thermal renewable energy systems. Tempra Plus tankless electric feature advanced flow control to automatically keep output temperature constant and provide an unlimited stream of hot water. Units are also ideal backups for solar thermal systems. Accelera 220E (58 gal) and the new 300E (80 gal) heat pump water heaters are designed to rely on the heat pump, not the back-up element. Energy saving heat pump mode requires just 650 watts and daily hot water needs may be satisfied without the back-element - and may be able to run on a solar PV system.

Stiebel Eltron
www.stiebel-eltron-usa.com
Booth 9845



Watertight solar rack connection

The PowerGrip line of products from OMG Roofing Products are watertight, easy to install, and provide a secure connection directly to the roof deck or structural members, taking the wind load off the roof cover and onto the structural deck where it belongs. Once properly secured in place, PowerGrips remain watertight and can help to eliminate rack movement that can damage commercial roofing systems. With superior shear and tensile strength, PowerGrips are compatible with all types of commercial roof systems.

OMG Roofing Products
www.omgroofing.com
Booth 9827

Residential and commercial grid

The POWERGRID is available to both residential and commercial customers to create an independent system combined with solar that can replace the power grid. The new LiFeMnPO4 battery system takes up a small 2 sq.ft. foot print and is safe for indoors, with no fumes or toxic chemicals of any kind. Built to last 20 years with no maintenance, Clean Energy Storage systems are easy to install, come with online monitoring, and offer tools to help customize any system within minutes.

Clean Energy Storage | www.cleanenergystorage.net
Booth 8236 ees

Reliable PV connectors

Stäubli Electrical Connectors, Inc.'s MC4 connector system is rated up to 1500V UL, 1500V TÜV safety class 0 and is available for 14 through 8 AWG cable configurations. Also available is their in-line fuse PV-K/ILF connector for very low energy loss and heat generation featuring a robust IP68 enclosure. Stäubli Electrical Connectors, Inc. offer custom solutions tailored to their customers' needs.

Stäubli Electrical Connectors, Inc.
www.staubli-alternative-energies.com
Booth 9321

High yield single axis tracker

Soltec's SF7 is a solar tracker with high yield-per-acre performance and great land-use options, and is a solution for large-scale PV tracking projects. This cost-effective innovation and operation utilize fewer parts, allowing for fast installation, and a DC harness and string runner.

Soltec | www.soltec.com

Booth 9821

Smart home monitoring hub

The Chilicon Power Cortex gateway is a graphical tablet smart home and monitoring hub. The device communicates via powerline with Chilicon Power microinverters, but also controls other devices via zWave wireless networking. The Cortex supports wireless home energy (net meter) monitoring with automated setup for two CT clamps and can be customized for up to 10 CT clamps. The gateway also incorporates a stand-alone home security system which detects wireless door/window sensor trips and sounds an alarm based on programmable rules. All site configuration and setup is done directly on the Cortex device. This includes adding installer and customer email address for access to cloud monitoring. WiFi, Ethernet, zWave, and PLC are included in every gateway.

Chilicon Power

www.chiliconpower.com

Booth 9139

Versatile ground mount system

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

AP Alternatives

www.apalternatives.com

Booth 9721

Maintenance-free AGM batteries

Sun Xtender Deep Cycle AGM Batteries are manufactured in the USA by Concorde Battery Corporation and are built to the same standards crucial to supporting the aircraft industry. Sun Xtender batteries are built with features which maximize life and performance in renewable energy and photovoltaic applications. Sun Xtender batteries are constructed with copper alloy corrosion free terminal connections and other low impedance design elements such as robust over the partition intercell connections. These characteristics facilitate maximum conductivity and charge acceptance. Deep cycle endurance and optimal float life are achieved through exclusive manufacturing processes and robust grid materials. Sun Xtender batteries' AGM design recombines hydrogen and oxygen gases so watering is never required. The maintenance-free design is a solution for both off-grid and grid-tied renewable energy systems.

Sun Xtender | www.sunxtender.com
Booth 8027 ees

Batteries engineered at the nanoscale

Lionano offers a large family of advanced drop-in cathode materials, including its flagship Faratrode and Galvatrode. Their materials have been engineered at the nano scale to unlock improved capacity, cycle life, stability, temperature tolerance, and rate capability in lithium-ion batteries. Their battery technology enables lighter and lower cost electronics, and longer range for electric vehicles.

Lionano, Inc. | www.lionano.com
Booth 8051 ees

Diaphragms for module laminators

Smartech International will display Steinbach's silicone diaphragm materials. Steinbach diaphragms have a reputation for quality and consistency. Their EVA-resistant Lamibran Diaphragm and three different types of solid silicone are made in Germany in widths up to 3200mm as well as a variety of thicknesses and surface treatments, all backed by Smartech's made-in-USA service.

Smartech International | www.smartechonline.com
Booth 8837

Hybrid lead-acid battery

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

MK Battery - Deka Solar | www.mkbattery.com

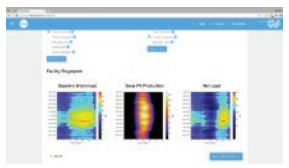
Booth 8240 ees

Mounting solution for trapezoidal roofing profiles

S-5! announces the release of the RibBracket I-IV products, shaped to fit most common trapezoidal roof shapes. Thoroughly tested for strength, RibBracket I-IV has no moving parts and is flexible enough to fit varying trapezoidal widths. A high profile ensures more space between the roof and any devices attached to the roof, while the four attachment points offer greater holding strength. RibBracket I-IV is designed for convenient wire management and ease of installation for a solar system. RibBracket I-IV and the accompanying fasteners come with a factory-applied EPDM rubber gasket seal attached. The S-5! reservoir conceals the bracket EPDM from UV exposure, preventing drying and cracking. With four different shapes, RibBracket I-IV can properly fit the vast majority of trapezoid profiles found globally, giving the installer the confidence of having the right bracket for their roof and project.

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

Booth 9650



Software tools for energy storage

Geli's software tools enable integrated, cost-effective energy storage to any solar PV project. The Geli EOS can be deployed in behind-the-meter solutions to perform advanced functions such as, demand charge management and demand response. With multiple hardware vendors embedding Geli software products at the factory, it's easy to design and deploy a plug-n-play, scalable solution. The Geli EOS can be deployed in mass-market products, as well as advanced energy storage projects, including sophisticated EV charging applications and large-scale microgrids.

Growing Energy Labs, Inc. | www.geli.net

Booth 8211 ees

Modular, customizable energy storage solution

The Alevo GridBank is an advanced lithium-ion energy storage system using Alevo's patented battery technology, integrated hardware, and software solutions, as well as its unique GridBank engineering. The GridBank is a vertically engineered 2MW / 1MWh storage system. At the heart of the GridBank is Alevo Battery Technology (ABT) that uses Alevolyte, a powerful inorganic electrolyte. It is non-flammable and has a very long predictable life of over 50,000 cycles. Available also in GB50 and GB35 configurations for C&I, the GridBank ESS is suited for a wide range of applications. The GridBank is a modular system, fully customizable providing ultimate flexibility. No matter the configuration, Alevo GridBanks are safe, reliable, and robust making it possible to get storage on the grid in almost any location.

Alevo | www.alevo.com

Booth 8011

High voltage battery test system

NH Research, Inc. (NHR) has released the new 9300 series which provides a 100kW power module with a software-selectable high voltage range (1200VDC / 167A) and high-current range (600VDC / 333A) allowing for efficient testing of single-voltage and double-voltage Electric vehicle (EV) batteries as well as high-voltage Energy Storage Systems (ESS) used in grid-tied applications. The 9300 modules are independent allowing for testing of multiple batteries, each with a different test plan, power levels and start/stop times. When higher power is needed, the 9300 modules may be paralleled providing 200kW, 300kW, or up to 1.2MW capability. The standard 9300 system is outfitted with an internal controller, system software, and advanced touch panel for manual control. The system is highly efficient and regenerative returning more than 90% of the energy removed from a battery is returned as usable AC facility power.

NH Research, Inc. | www.nhresearch.com

Booth 8137 ees

True deep-cycle batteries

Trojan Battery now offers the Solar AGM line of maintenance-free, true deep-cycle absorbent glass mat (AGM) batteries, which are specifically designed for solar and other renewable energy applications. The Solar AGM line is tested to an eight-year design life under the IEC 61427 testing standard for solar batteries, and offers a three-year warranty for stationary applications. Trojan's Solar battery line incorporates a wide range of advanced technical features including a robust proprietary paste, advanced plate design, and premium separators for overall extended lifecycle and optimized for total cost ownership. With its non-spillable design, the new Trojan Solar AGM batteries enable installers to customize the use and position of the batteries in customer applications. These features make this battery a solution for the harsh and demanding environments of off-grid as well as grid-connected systems with frequent cycling needs.

Trojan Battery Company
www.trojanbattery.com
Booth 8128 ees

All-in-one energy storage management and monitoring

ElectrIQ Power's IQ System is an intelligent, all-in-one home energy storage, management, and monitoring system. They offer a high efficiency - 93% roundtrip integrated system. It is modular and scalable to any energy or power need. It can integrate easily with existing solar or can stand alone for a new solar installation. Their system doesn't require a renewable energy resource to function; it offers microgrids, self-consumption, and rate arbitrage. Their software provides energy automation to reduce energy costs and analytics to provide insight. Access insights anywhere around the world on any device to see production, consumption, battery analytics, and monthly bills.

ElectriQ Power | www.electriqpower.com
Booth 8116

Fast installing single axis tracker

Genius Tracker's pre-assembled drive system and easily assembled components combine to make install quick. It has completed, Black & Veatch technical assessment, CPP wind tunnel testing (rated 150mph), and has been ETL / UL 2703 tested. With a 99.5% panel density on rows, the rugged design aims for 30 year field life in harsh environmental climates: -30/+65°C rated, actuators IP67 submersible rated motor end/ IP66 rated front end. Every drive actuator has its own battery backup and wirelessly linked controllers, eliminating all trenching, and Tru3D-Gimbal bearings account for pile installation being out of plumb, out of azimuth, and out of vertical and east-west alignment. The self-powered rows eliminates the central drive, and allows for uninterrupted grass cutting and panel washing.

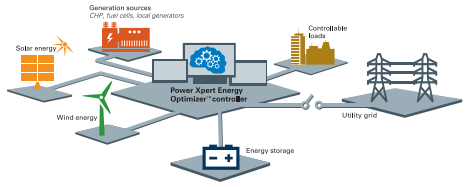
GameChange Solar | www.gamechangesolar.com
Booth 9733

Aesthetic and functional solar roofing tiles

DeSol Power Tiles, LLC provides solutions for home efficiency upgrades, reducing carbon footprint, and improving property values with aesthetically pleasing tiles that resemble regular roofing shingles. Manufactured in the US, this unique, affordable solar roofing system can be used right over top of an existing roof, or on a new build. Integrating design and functionality, this patented system uses roof tiles, not solar panels, so it won't affect the aesthetic or architectural appeal of the roof. DeSol roof tiles complement a home or business with a completely sealed, walkable surface that covers the entire roof. Offering high quality and extensive support for buyers, roofers, and contractors, DeSol Power Tiles guarantees its solar tiles for 30 years for performance and durability.

DelSol Power Tiles | www.delsolpowertiles.com

Booth 8557



Microgrid control system

Eaton's microgrid energy system is designed to help simplify and expedite the deployment of complex microgrid and energy storage systems. The system incorporates Eaton's new Power Xpert Energy Optimizer controller and provides a modular, scalable approach to microgrid control in military, campus, utility, healthcare, commercial, community, and other applications. The services provided with Eaton's microgrid energy system include microgrid feasibility studies, total system design, control system deployment, integration with existing third-party generation assets and critical loads, project implementation, commissioning and system start-up, and ongoing maintenance. Eaton can also deliver a complete microgrid or energy storage system with turnkey system design and project management. The modular approach allows the system to efficiently scale to meet a wide range of applications, and adapt to evolving generation and load assets. The system's control module helps maintain stability, shave peak demand, shift load, and manage black start. The system can also maximize renewable energy contribution and/or provide utility demand response functionality. With weather and price forecasts, the Eaton technology can provide predictive control strategies which help proactively manage generation assets to maximize system performance.

Eaton | www.eaton.com

Booth 8310 ees

Renewable energy insurance

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

South Bay Risk Management & Insurance

www.sbrmins.com

Booth 8724

Low profile, leakproof mounting system

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

SolarRoofHook | www.solarroofhook.com

Booth 9645

Digital training solution

InterplaySolar delivers a training solution for solar companies looking to improve company performance by making their employees more efficient, more dedicated, and more effective at their job. Interplay's online software platform features 3D simulations, gamification, and a smart system of learning to drive new hire productivity for immediate on-the- job results. Interplay's training platform also integrates a manufacturer training portal to deliver simulation-based training on specific equipment. This scalable learning helps installers provide an accurate install on all types of equipment.

Interplay Learning

www.interplay-learning.com

Booth 9031

Flexible, versatile tracker technology

Array Technologies, Inc. presents an evolved tracker solution which is engineered to deliver a low cost of ownership to solar asset owners. Their DuraTrack HZ v3 is a 2017 Intersolar AWARD Technology finalist. This flexibly linked tracker technology adapts to challenging terrain, reliably handles wind events, and delivers advanced asset performance at a low cost of ownership.

Array Technologies, Inc.

arraytechinc.com

Booth 9811

ENERGY STORAGE NORTH AMERICA

August 8-10, 2017
San Diego Convention Center – San Diego, CA

Energy Storage North America (ESNA) is the largest conference and expo for grid-connected energy storage in North America. ESNA 2017 will include energy storage site tours, networking, workshops, and learning sessions featuring the leading policymakers, utilities, and commercial and industrial customers focused on building the grid of the future. Participants will learn firsthand about the key use cases, successful implementations and potential risks in a fast-growing industry in the United States, Canada and Mexico.

www.esnaexpo.com

show in print

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

BoS solutions

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

Shoals Technologies Group
www.shoals.com

Distributed electricity and storage

EDF operates in excess of 318MW/824MWh of battery storage worldwide. In North America, EDF has installed more than 250MW (2000 projects) of distributed PV solar. EDF Renewable Energy is a holder of a 2017 U.S. DOE Energy Savings Performance Contract (ESPC) and is ready to design, develop, and manage holistic energy solutions for federal agencies, including: renewable and traditional energy generation; sustainable communities; energy efficiency and cost savings; microgrid expertise; and energy storage.

EDF Renewable Energy
www.edf-re.com

Single service and turn-key EPC construction

With over 700MW commissioned, Ryan is able to organize, schedule, and manage complex projects for customers constrained by strict timelines and regulations. Ryan offers a full menu of project management, planning, engineering, procurement, construction, commissioning, and maintenance capabilities to respond to the needs of their customers in the power generation market. This provides flexibility in choosing a single service or full EPC services. Utilizing their extensive experience in the power and energy sector, Ryan meets client expectations and maximizes efficiencies throughout the duration of their renewable energy project.

Ryan Company
www.ryancompany.net

Power conversion systems

Rhombus Energy Solutions has successfully achieved re-certification of its 125kW Energy Storage inverter to UL1741 with an upper continuous operating voltage of 900Vdc. This extended range of 450-900Vdc will allow Rhombus to service customers with high battery voltages while maintaining full power delivery. In addition to the operating range, the new PCS125 model will have an improved, more compact cooling system, an LCD touch screen display and a rugged NEMA3R option suitable for outdoor installations. With a ±0.5 Power Factor range and with their advanced controls, Rhombus is poised to meet new UL SA standards by 4Q2017. With grid and island mode capability, standard MODBUS controls, fully integrated grid isolation, the Rhombus' PCS125 system is a turn-key inverter solution that can be quickly installed into energy storage or PV projects.

Rhombus Energy Solutions
www.rhombusenergysolutions.com

Maximum capacity deep cycle battery

Leoch Battery Corp's EV6390, 6V 390Ah (C20 rate), deep cycle battery incorporates proprietary paste and separator material to lower internal resistance and minimize water loss while providing maximum capacity and cycle life. Built in 'L16' size PP case, this maintenance-free AGM battery is spill-proof, safe when installed on its side, and ideal in a wide operating temperature range.

Leoch Battery Corp. | www.leoch.us

Compact lithium and flexible flow systems

Lockheed Martin Energy provides turn-key energy storage solutions for utility, commercial, and industrial applications. Lockheed Martin Energy's GridStar energy storage systems reduce facility energy costs, improve the efficiency and stability of the electric grid, and enable the increased use of renewable energy. Lockheed Martin Energy has two core energy storage offerings: GridStar Lithium systems for short- and medium-duration energy storage, and GridStar Flow systems for long-duration energy storage. GridStar Lithium energy storage systems are compact, easy to install, modular, and scalable for 100kW to multi-MW projects. GridStar Flow systems feature Lockheed Martin Energy's proprietary flow battery and offer flexible, durable, and affordable long-duration energy storage for utility-scale projects.

Lockheed Martin Energy | www.lockheedmartin.com/energystorage

Integrated, behind-the-meter energy storage system

Dynapower is pleased to offer the BTM-250kW/500kWh integrated energy storage system for behind the meter applications. The modular system is available in 2, 4, and 6 hour configurations. Multiple units can be paralleled together to meet larger grid-tied and microgrid installation requirements. The system has been purpose built for cost-effective installation, high efficiencies, and safety features. The system couples Dynapower's MPS-250kW UL 1741 SA listed inverter with Samsung SDI E2 batteries. In addition to integrated AC breaker with shunt trip, DC disconnect, DC input fuses, and redundant HVAC cooling system, the system features an optional direct release fire detection and suppression system, Black Start, all AC and DC switchgear in an outdoor NEMA-rated, climate controlled battery enclosure. The BTM-250 also features Dynapower's proprietary Dynamic Transfer technology which allows for the seamless transition to stand alone mode on the load connection when a grid disturbance is detected.

Dynapower | www.dynapower.com

Hybrid converter for innovative grids

Distributed and renewable energy sources are playing an increasingly important role in power generation, and their integration often brings more system complexity and greater stability risk. New technologies are needed to minimize installation costs, reduce the solution complexity, and improve the overall system reliability. SINACON HC processes energy from various sources before it is converted to reliable grid power. It can connect up to three different generation and/or storage technologies simultaneously to provide three-phase AC power to a public grid and/or a microgrid. It eliminates the need for installing multiple single-source inverters, reducing the number of conversion components, transformers, and switchgear in a system. This reduces costs and improves efficiency. The wide DC input voltage range allows flexibility in source and storage technologies of today and the future. SINACON HC is certified according to UL1741, CSA 22.2 107.1 and other international standards.

Siemens | www.siemens.com

Sustainable long duration energy storage

The value of long duration (> 6 hours) energy storage is increasingly recognized by regulators, utilities, and thought leaders for its flexibility in addressing multiple energy storage (power and energy) applications with a single energy storage asset. Utilizing earth-abundant iron, salt and water for its electrolyte, and simple materials for battery components, make the Iron Flow Battery (IFB) from ESS Inc. a durable, environmentally safe, long-duration storage solution that is suited for time-shifting renewable energy on a daily basis, managing a facility's demand or TOU charges, and smoothing the intermittency of renewables on a constrained grid. The ESS team has developed this all iron electrochemistry allowing the IFB to operate at high efficiency over an unlimited number of deep charge and discharge cycles, with absolutely no degradation or capacity fade over a 25 plus year operating life with minimal annual Operations & Maintenance (O&M).

ESS, Inc. | www.essinc.com

Solar plus batteries

Clean Energy Storage's off grid packages include every circuit needed for the system in a lightweight, small footprint. With no harmful fumes, odors, or chemicals, these systems are safe for both indoor use and storage and are land-fill legal. They will never catch fire from any extreme condition, such as bullet from any fire arm, punctures, crushing, vibration, or extreme heat. They have UL1642 and UL 1973 and are also tested SAE, safety tested TUV SUD, and field and battle tested for extreme temperatures: -40°F and 149°F with little power loss. There is 100% available power in each cell, even at 100% depth of discharge, and no memory losses over time. Clean Energy Storage provides a warranty for unlimited cycles in the first 10 years and offers an extended 20-year extended warranty option. POWERGRID is contains fast charging batteries which can be charged to 90% in less than 10 minutes.

Clean Energy Storage
www.cleanenergystorage.com

Carbon foam batteries

Firefly Energy's Microcell Carbon Foam delivers long service life, increased energy efficiency, and quality performance under extreme conditions. Firefly carbon foam design resists sulfating and corrosion, while increasing the surface area within the battery, resulting in great energy capacity, faster recharges, and deeper discharge capability. Firefly carbon foam is thermally conductive, resulting in uniform current density distribution, high overall active material utilization, less localized positive grid corrosion, and less localized positive active material wear out.

Firefly Energy | www.fireflyenergy.com

Power Outages and the Failure of Grid-Tied Solar

by Catherine Von Burg

On Super Bowl Sunday this year, 1,700 people on Hawaii's main island of Oahu lost power during the first quarter of the game. As if this was not disappointing enough, the grid failure happened during what turned out to be one of the most suspenseful football games in history, tormenting fans with an early glimpse of the action, but offering no solution to watch the game through to its gripping conclusion.

Luckily, for some very fortunate neighbors hosting a Super Bowl party, the President and CEO of a solar supply company had recently installed a solar-plus-battery system in his home to take control of his own power, provide backup, and charge his electric car. It was a retrofitted integrated system to optimize his grid-tied (NEM) solar system that was installed 10 years earlier.

With some quick thinking and an extension cord, Rolf Christ connected the house hosting the Super Bowl party, to the power being generated by his backup system - a 20kWh installation consisting of six 2.4kWh lithium iron phosphate batteries, and two inverters powered by three solar panels. As a result, the Super Bowl partygoers continued to watch the game uninterrupted, while the lights flickered on and off, the refrigerator loaded with cold beer warmed, and other household equipment in the grid-tied home became unusable. Fortuitously, the most important equipment, the cable box and television, temporarily powered by Christ's backup power system with a 50-foot extension cord, kept the spirits high and the historic game playing.

During a power outage, you never know what electrical loads are going to be considered "critical" until the power is off. However, if you own, control, and have access to your own power (in this case with solar-plus-storage), it doesn't matter whether you are on or off grid - you decide what's critical, even if that means a party with friends and family. Unfortunately, if you don't own and control your own power, the decision is out of your hands.

Christ's story is a perfect example of the experiences of countless people around the world; our surprisingly fragile electrical grid suffers intermittency that can threaten the safety and health of entire populations.

In its most recent report, the Eaton Blackout Tracker revealed that, in 2016, 4,000 blackouts caused problems for roughly 17 million utility customers across the United States. Together, those blackouts totalled 130 days without power. The annual monetary damages resulting from power outages, surges, and spikes, are estimated to cost the U.S. economy more than $150 billion. That's a 45 percent increase from 2008 in 10 short years, highlighting how the nation's electrical grid has grown more and more unreliable.

The Chokehold of Grid-Tied Solar

Many people affected by an unreliable grid turn to solar energy, thinking it will provide them back-up power when the grid goes down. However, many are left disappointed with their new NEM system, because the first time they lose power, they realize they don't have access to the PV generation on their rooftops. They thought they would have more control over how and when to use that generation.

As many in the renewable industry discover, in times of grid failure, all grid-tied solar inverters are required to immediately shut down their connection to the grid. This safety precaution, known as "anti-islanding", ensures that workers repairing the affected power lines do not accidentally encounter a live wire.

Rather than creating energy security and resiliency in times of catastrophic or local failure, grid-tied systems without storage promise the same chokehold over end-users as a centralized grid-tied building. This is because the energy generation of a PV system does not match a typical end-user's energy usage in terms of time of day, or amount of energy consumed. Instead, the industry relies on NEM agreements or feed-in tariff (FIT) structures to handle energy generated beyond the end-user's consumption requirements or time-of-day. The solution to this mismatch between generation, time of day, and consumption, is storage.

Resilient Back-Up Power on Your Terms

With the growth of the energy storage industry, new opportunities for independent power production and storage are more accessible than ever. Solar-plus-storage systems (like the one that saved the Super Bowl party) have the ability to intentionally island, allowing critical systems to operate and 'fail back' to local, autonomous control, and thus meet the needs of the end-user who owns and controls them. Inverters in these behind-the-meter assets immediately disconnect from the grid when it fails, and direct the distributed generation to power local electrical loads.

During a centralized grid outage, this 'intentional islanding' is the most basic kind of resiliency. The system utilizes equipment with the capability to remain operational in the absence of the grid or centralized control systems. At the 48-volt level, the inverter charge controllers sense when the grid is operational; they go back on-line through pre-programmed settings and software, without the need for high-voltage specialty personnel.

To ensure full use of a solar generating system, storage can be designed to cover a variety of loads, from critical to full. However, it is important for installers and end-users to understand the fine print of their NEM agreements with local utilities. In some markets, adding a battery storage system to an existing NEM contract may void the agreement with the utility. This was the case with Christ's house, and the reason why he installed a separate backup system for his storage and EV charging. The system's low levelized cost of energy, and non-toxic battery chemistry (which did not pose the risk of spontaneous fire) also influenced his decision.

From extreme weather, to cyber attacks, to general electrical failures, the grid is extremely vulnerable to various scenarios that can cause outages. True and complete energy independence means building distributed energy systems that keep running, regardless of the larger utility grid. Customers must fully understand their NEM contracts before adding energy storage to cover critical loads; they must ensure the option to island initially, if they have a NEM contract and it is allowed. By practicing these steps, the industry can work towards building greater energy resilience and flexibility into the grid, while reducing some of the pain and significant costs of blackouts, and allowing customers to use their power on their terms.

Catherine Von Burg is President and CEO of SimpliPhi Power, a technology company that designs and manufactures intelligent, non-toxic, efficient, energy-dense storage and management systems. Her career spans a diverse portfolio of strategic planning, policy development, and executive management in organizations such as Pew Charitable Trusts, Rockefeller Institute, Columbia University, and NY March of Dimes Foundation.

SimpliPhi Power
www.simpliphipower.com

Residential battery systems

LG Chem Ltd. has formally launched its range of residential battery systems in the North American market. The launch follows successful completion of UL certification and represents LG Chem's initial foray into the North American residential market. LG Chem's North American residential battery range offers AC- and DC-coupled solutions with capacities up to 9.8kWh. Two voltage options are available, pre-matched with compatible inverters and suitable for both indoor and outdoor installation: Low-voltage 48V: with capacities of 3.3, 6.5, and 9.8kWh; and, high-voltage 400V: with capacities of 7.0 and 9.8kWh. The 400V RESU10H (9.8kWh) product is compatible with SolarEdge's StorEdge, which is a DC coupled storage solution based on a single inverter for both PV and storage. Additional inverter compatibility options will become available later in 2017 to provide homeowners with a range of pre-tested solutions from the industry's leading suppliers. LG Chem's residential batteries will be available via a number of solar/storage providers. Sunrun will be supplying LG Chem's RESU systems. Advanced, safe, and highly reliable automotive quality lithium-ion battery cells are used throughout LG Chem's range of residential and grid-scale battery systems.
LG Chem, Ltd. | www.lgchem.com

Green energy storage batteries

iDemand Energy Storage (iDES3) has developed a single conversion charge controller that will shorten the time needed for electrical current to travel from solar panels to storage batteries, and in so doing, save energy. Under development for nearly a year and a half, the new charge controller, which eliminates AC loss, is best suited for large scale commercial and industrial operations that use a vast amount of electricity. iDemand's battery lineup includes the 9-36kWh Echo Indoor series suitable for most residential needs, the 9-72kWh Echo Outdoor, and 36-108kWh Indoor/Outdoor Alpha. Commercial systems include the 36-108kWh Indoor/Outdoor Alpha, and the Mega, the smallest of which comes in at 500kWh, and can be customized in 108kWh increments. They are all comprised of fifth-generation lithium iron phosphate, LiFePO4, prismatic cell technology, which is safe and will not self-ignite.
iDemand | www.ides3.com

Moving Forward

What lies ahead for the energy storage market in America

by Olaf Lohr

THE U.S. ENERGY MARKET IS IN A TRANSITIONAL PERIOD AS uncertainty, new technology, and global trends have created an emergence of innovations in the industry. Players have taken note and continue to push forward, developing new approaches to and incentives for renewable energy use. Eco-conscious consumers continue to look for improved energy independence, and ways to store and manage their clean energy efficiently.

As the energy market in the United States continues to evolve, the leaders who emerge will be those who implement creative approaches, and forge strong partnerships that yield positive results for consumers and the industry overall.

The economics of energy storage

There are many drivers pushing energy storage forward and keeping the market viable. One of which is policy. Incentive programs and green mandates, in states like California and Massachusetts, are making energy storage technologies not only attractive, but more affordable for consumers. As these programs expand, and more energy storage systems are deployed, the market will only continue to grow, further driving down costs to the manufacturers and end-users.

Energy storage incentives, combined with a trend against selling excess energy back to the utility, make energy storage an even more financially viable option. The option to sell excess energy back to the utility at retail rates (a solar-friendly mechanism called "net metering") is being phased out and replaced with compensation closer to wholesale energy prices. Overall, incentives will be instrumental in the growth of the national market, until utility rates, and battery pricing, create a market where energy storage provides a better ROI than PV alone.

Another key factor that goes with incentive programs is overall cost of power. Clean energy is more affordable than ever, currently below the cost of traditional forms such as coal or natural gas. Consumers generating clean energy can make the most of their power by pairing their solar, wind, or biogas systems with a smart storage solution. This enables the retail customers to utilize most of the energy they produce, making them more energy independent, lowering their energy bills and decreasing their carbon footprint.

As storage has become an attractive addition to consumers' clean energy goals, a number of options have emerged in the market. The term "energy storage" can mean anything from a standalone battery, to an all-in-one intelligent home solution. Pricing tends to parallel the system quality, and the long-term value it offers in terms of ROI and durability. As top storage players continue to work with local installers and partners to communicate the long-term value of these systems, the market will continue to thrive and evolve, giving way to new technologies and more affordable solutions.

How to handle a new energy economy

With a growing energy storage market, the industry faces challenges implementing these systems to work in tandem with the existing utility structure of the U.S. Pairing the traditional grid with decentralized energy generation and storage systems can have significant benefits in terms of stability, and in emergencies. While excess solar generation can create a disruptive surge of energy to the grid, combining PV

Integrated design-to-automation tool

Geli ESyst is a free web-based design tool to aid project developers in right-sizing and selecting energy storage and solar-plus-storage systems for commercial and industrial facilities. With ESyst, users can analyze sites and generate project proposals using: 75+ different hardware solution combinations from leading suppliers such as Dynapower, Ideal Power, LG Chem, and many more; 10,000+ commercial & industrial tariffs in 1,300 U.S. utility territories; and Geli demand charge management & ITC-compliant solar PV management energy applications. Designing systems in ESyst is the first step to deploying advanced energy storage and solar-plus-storage systems with the Geli Energy Operating System (EOS). ESyst is an onramp to the Internet of Energy, an intelligent network of distributed assets, the foundation of which is built with energy storage.

Geli | www.geli.net

Smart, efficient off-grid system

PowerHunt has developed an innovative, expandable battery system that can give consumers energy independence in a variety of scenarios, from backwoods camping to power outages. The Cortex system is designed to work seamlessly with all PowerHunt appliances, which run off DC power. Therefore, the system doesn't need an inverter to transform DC to AC power. There are multiple ways to charge the batteries inside Cortex. When camping, one or more 100w solar panels are a good option. Other charging methods include a 110-240V AC plugin for power directly from the grid, as well as 12V DC hookup for recharging directly from another battery sources. The Cortex base model consists of a 340Wh lithium-ion battery pack. Two additional packs can be added to the unit when more power is required. An expansion pack brings the total number of batteries to five, which is sufficient to run multiple appliances, even space heaters and coolers. Cortex also includes 4 USB ports for charging mobile devices. PowerHunt designed Cortex to be more than an off-grid power source. The system comes with a host of smart, added features intended to maximize safety and efficiency. An auto-scheduler lets users control when each port powers on and off. The Cortex system's display includes a budgeting screen showing how long each PowerHunt appliance can operate, based on available power. Finally, the system provides long-term battery health updates and charge notifications.

PowerHunt | www.personalpowergrid.com

with a smart storage system significantly reduces that risk, and allows for benefits both behind and in front of the meter. Leading solar installers and developers are taking responsibility to reduce the impact of the intermittent generation of PV plants – and positioning energy storage as the solution to fast ramping, the California "Duck Curve", and other issues that plague distributed power generation.

The ideal execution will involve multiple segments of the industry, with partnerships at every level. Installers, utility providers, storage companies, and traditional/renewable power generators will need to work together to take the American renewable energy market to the next level. So far, we've seen the most success among companies willing to work collaboratively toward a creative solution, rather than attempting to own the entire process.

Battery manufacturers must work with installers to ensure products are being properly integrated in homes. Homeowners need to understand how their system works, along with its various components, and any local net metering policies or incentives available. In many cases, a customer must apply for state incentives through the installer; this makes the installer responsible for supporting informed decision-making around brand, type, and size of system to best suit their needs. At the same time, energy storage manufacturers are accountable for keeping installers informed on the benefits of various offerings.

Grid-connected storage systems represent an opportunity for utilities, as well. They provide a source of backup power that can be accessed during peak demand, or for instabilities like surges. Some U.S. energy storage companies are already partnering with local utilities and solar installers to create community models of this nature. To introduce a virtual power plant-like model, energy storage providers need to understand regional landscapes, and forge partnerships with local utilities. Understanding the utility operations model will help storage companies better communicate the potential value these intelligent storage systems offer the grid.

Communicating the energy storage plan to investors

With any emerging technology, investment partners should be aligned with the overall mission and commitment to a clean energy future. Since utilities function differently in different areas of the country, it can be challenging to manage the expectations of national investors. For this reason, we've seen success in targeting smaller, regional financiers who understand the local landscape.

It is crucial to convey the nature of an energy storage investment over the long-term. In a growing, uncertain, and fluid industry, it's not about immediate payoffs. The market is young, and more suited to long-term investments; energy storage companies have an obligation to manage the expectations of investors, and communicate the value of their investment over time.

Olaf Lohr is Director of Business Development at sonnen, a provider of energy storage solutions that utilizes intelligent energy management software.

sonnen | www.sonnen-batterie.com

VRLA AGM GEL batteries

The 12V E31 battery developed by Firefly Energy maintains long life even under partial state of discharge operation. It has a throughput efficiency greater than 90% and improved high/low temperature performance. It provides superior protection against corrosion and sulfation related problems due to the implementation of Firefly's Microcell Carbon Foam technology. With their disruptive technology, they offer 3-4 times the cycle life than conventional battery; 800+ cycle @ 100% DOD and 3600+ cycles @ 50% DOD; throughput efficiency > 93%; operation in partial state of charge for days without loss of capacity; high rate of charge @ 1C; excellent recovery from 100% depth of discharge; high shelf-life; highly Immune to corrosion and sulphation; superior performance in extreme climatic conditions (-4°F to 122°F: -20°C to 50°C); and capable of very high rate of discharge.

Firefly Energy | www.fireflyenergy.com

Cloud-based asset management software

PowerHub has released Lithium, the third version of its cloud-based asset management software. This version marks a significant leap forward for PowerHub and will help keep them in sync with the growing needs of the renewable energy industry. This new release boasts advanced features such as the ability to pick custom modules, advanced automation, a robust suite of reporting and invoicing tools, and more. PowerHub is an advanced and flexible solution.

PowerHub | www.powerhub.com

Commercial Buildings

Learning from the smart home

by James McPhail

Buildings consume a vast amount of energy. Heating, cooling, lighting and appliances all combine to make a hefty dent on a building's electricity bill – be it residential or commercial. We are finally waking up to the great necessity of energy management solutions that can provide benefits to both businesses and homeowners. However, the adoption of energy management technologies by these two parties has been anything but equal.

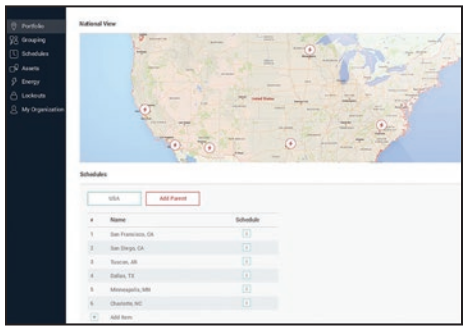
In recent years, the 'smart home' has taken off. Substantial progress has been made in transforming the way we view our homes – from simple brick and mortar structures, to technologically-integrated smart buildings. According to the research organization IHS Markit, 80 million smart home devices were shipped in 2016 – a 64 percent increase from 2015. Homeowners used to be confused and intimidated by the plethora of new gizmos and gadgets available, but they now express an increasing curiosity and demand for automation through home technology. While voice activated speaker systems, and other early stage gimmicks, may be catching the eye of the wider consumer market, most people have yet to recognize the true value in the rise of the smart home – energy management.

While the residential sector has made great headway in integrated energy management solutions (intelligent thermostats, or smart home hubs with connected lighting), the commercial market remains practically overlooked. What makes this more bizarre is that commercial buildings are much larger consumers of energy than their residential counterparts. They are bigger, have more light fixtures, and much greater requirements for temperature regulation through large HVAC systems. Of the 5.6 million commercial buildings in the U.S., fewer than 10 percent have energy management systems installed to monitor and manage energy use, in an effort to contain those costs. There is no justification for commercial buildings to continue living in the energy dark ages, when very simple adjustments in energy use can cut consumption dramatically.

Installing simple energy management devices is the quickest and most cost-effective way for businesses to realize cost savings. Shifting the responsibility of energy management from one individual to a simple platform of smart devices, avoids scenarios like leaving the air conditioning on during a hot summer night, or lights being left on 24/7. Businesses can instantly slash overhead expenses due to energy consumption, by making simple changes that have far-reaching effects. The results are immense, whether you are a single coffee shop, a small set of office buildings, or a national retailer. If such adjustments in energy use were implemented across all commercial buildings, the energy savings would be equivalent to over 500 million tons of CO_2. Aside from achieving environmental benefits, businesses could collectively save tens of billions of dollars in costs.

When looking for an energy management offering, business owners can learn from the residential sector, and carry over smart home innovations to the office or store. Sadly, most of today's energy management solutions are either too complex, or too costly, to implement. Furthermore, these energy management systems often require software licenses, wired infrastructure, licensed electricians, and often permitting, which results in significant downtime – an unacceptable cost for many. It's a financial headache, especially for businesses that don't have the capital to invest in the adoption and operation of complicated and expensive energy management systems. However, it is still inexcusable for smart energy infrastructure in buildings to be entirely disregarded, especially when the technologies have recently become so streamlined, affordable, and user-friendly.

These exact obstacles were faced by National Stores, a California-based retailer with more than 350 retail locations across the nation. National Stores was not only discouraged by the complexity of typical energy management systems, but frustrated by having to rely on the memory and willingness of store managers to turn off the HVAC and lighting controls at the end of a work day. The company sought out a simpler, more 'set-it-and-forget-it' system that required minimal modifications to current infrastructure (no store closures), and allowed the company to reap immediate savings. The system that was put in place was targeted specifically at the company's biggest source of wasted energy consumption (and the main culprit



for many commercial buildings with multiple facilities), HVAC. The solution they identified coupled IoT connected hardware and easy to manage software, to deliver a comprehensive energy management platform. As a result, National Stores experienced enormous benefits of reduced energy consumption across its large fleet of buildings. Interestingly, the selected technologies would more typically be found in a smart home offering, but were designed to deliver benefits to commercial users. Energy bills dropped by more than 25 percent, relative to the previous year. As to ease of installation, National Stores was able to roll out the thermostat in nearly 200 stores after only a few months, and is on schedule to roll it out to the entire chain. The retailer also has a greater awareness of its energy usage, and found additional revenue streams from participation in Demand Response programs. In the end, National Stores evolved from being entirely blind to its energy consumption patterns, to learning how to eliminate energy waste, and boost its bottom line.

This is just one example of how smart home innovations can be leveraged to develop a simple energy management solution that dramatically reduces energy consumption in commercial buildings. Our homes are not the only buildings that need to get 'smarter' about their energy use. The necessary technology is market ready, easy to implement, and will be found in more and more commercial-scale buildings in the coming years.

James McPhail is CEO of Zen Ecosystems, focused on building the business and channel relationships with utility providers, reseller and technology partners. He was EVP Sales at REGEN/Encycle for over four years, building sales from the ground floor. He led Western US Sales at EnerNOC, with a focus on bringing commercial and industrial customers together with utility-funded DR programs and data-driven energy management solutions. He served as Distribution Sales Manager at EnergyLogic, where he was responsible for building the US and International Sales distribution network. He is also the Chairman of the Board at Enersponse, and sits on the Board of Huevos Wax.

Zen Ecosystems | www.zenecosystems.com

Install-friendly LED linear strip and retrofit fixtures

Orion Energy Systems, Inc. has added two LED linear strip products to its HARRIS Class product line. The new LED Linear Strip | SFHC and LED Strip Retrofit | SFHR are designed for new construction, renovations, a one-for-one replacement, or a quick retrofit from traditional fluorescent linear fixtures. The energy savings to Orion customers who upgrade from fluorescent linear strip fixtures to the Harris Linear Strip or Retrofit Fixture can be as much as 75%. The HARRIS Linear Strip and Retrofit Fixture is easy to install by one person, potentially reducing labor costs by up to 50% when compared to fixtures requiring two people for installation. The series is engineered using efficient and current LED technology that performs at up to 138 lumens per watt (LPW). The LED Linear Strip and Retrofit series is designed for worry free maintenance up to fifteen years and has a rated life of 100,000 hours. Distributors and contractors will find the single packaging option convenient for site verification or single fixture orders. The job pack option reduces jobsite waste by shipping the product in kits that are labeled and staged by install order and facility layout. The same packaging can be reused for securely packing and shipping existing fixtures for recycling. The Harris LED Linear Strip and Retrofit series is manufactured in Wisconsin and Buy American Compliant. Orion offers fast lead times, meaning customers start saving money faster by reducing energy consumption sooner.

Orion Energy Systems | www.orionlighting.com

Low-watt, high-output LED flat panel lights

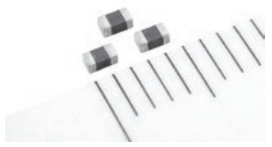
EarthTronics now offers three energy-efficient LED Flat Panel Lights to replace fluorescent fixtures in existing and new construction ceiling applications. The 1X4, 2X2 and 2X4 LED Flat Panel Lights feature 4000K bright light with smooth dimming and a high color rendering of 82+ to provide a natural lighting solution. Employed in offices, schools, healthcare facilities, and other commercial applications, the LED Panel Light is constructed using an extruded aluminum frame with an impact resistant acrylic lens which helps achieve a wide light distribution pattern. The 1X4 and 2X2 LED Flat Panel Lights deliver 4000 initial lumens using only 40 watts, while the 2X4 Flat Panel Light produces 5000 initial lumens using only 50 watts. These panel lights feature 120/277v dual voltage operation and are equipped standard with a 0 - 10 Volt continuous dimming driver that works with any standard 0 - 10 Volt control/dimmer. 347 volt models are available for use in Canada. In addition, each of the light panels have a long-performance, rated life of 50,000 hours and come with a five-year warranty. The LED Flat Panel Lights are approved by the DesignLights Consortium (DLC), Federal Communications Commission (FCC) and Electrical Testing Laboratories (ETL).

EarthTronics | www.earthtronics.com

Axis controller

The Rexroth 1-axis motion control simplifies automation processes through open interfaces to Ethernet based real-time protocols SERCOS III, EtherCAT, and VARAN, as well as integrated hydraulic controllers. It includes software, pressure sensors, and a valve platform of NG 10. Controllers for position, pQ, pressure, differential pressure, and volume flow speed up the realization of hydraulic functions. For axis control, the decentralized electronics unit evaluates the readings from up to two analog sensors and an absolute position measuring system SSI; the ability to process both digital and analog signals increases the control's flexibility. Cabinet-free installation significantly reduces the amount of cabling work. For design, start-up, parameter setting, and diagnosis, Rexroth offers the IndraWorks engineering environment. It provides consistent software tools and a homogenous structure, thereby simplifying the overall engineering process across all drive and control technologies.

Bosch Rexroth | www.boschrexroth.ca



Low loss thin-film metal inductors

TDK Corporation presents the new TFM160808ALC thin-film inductor for power supply circuits, which features a maximum DC resistance of 62 mΩ that is 30% lower than for existing types (e.g. TFM160808ALM, 0.47 µH). The new type, whose compact dimensions are just 1.6mm x 0.8mm x 0.8mm, also offers a high rated current of 2.6A and an inductance of 0.47 µH. In addition, due to its metal core, the thin-film inductor features lower losses. As a result, the component has a high efficiency over a broad output current range of 10mA to 2.5A and can improve the efficiency of DC-DC converter power supplies by nearly 1%.

TDK Corporation | www.global.tdk.com

events**calendar**

JULY

10-13 **ees North America Exhibition & Conference**
Moscone Center – San Francisco, CA; www.ees-northamerica.com

11-13 **SEMICON West**
Moscone Center – San Francisco, CA; www.semiconwest.org

11-13 **Intersolar North America**
Moscone Center – San Francisco, CA; www.intersolar.us

25-26 **AWEA Regional Wind Energy Conference 2017**
Hyatt Regency Lake Washington – Renton, WA; www.awea.org

25-27 **SEPA Grid Evolution Summit**
Washington Hilton Hotel – Washington, DC; www.sepapower.org

AUGUST

08-10 **ESNA 2017**
San Diego Convention Center – San Diego, CA; www.esnaexpo.com

SEPTEMBER

08-10 **The 28th Annual Energy Fair**
St. Paul, MN; www.energyfair.org

10-13 **SPI 2017**
Mandalay Bay Convention Center – Las Vegas, NV; www.solarpowerinternational.com

19-21 **tcbiomass 2017**
Radisson Blu Aqua – Chicago, IL; www.gastechnology.org/tcbiomass

OCTOBER

03-05 **The 33rd CanWEA Annual Conference & Exhibition**
Palais des Congres de Montreal – Montreal, QC; www.windenergyevent.ca

12 **ACORE Finance West**
The Bently Reserve – San Francisco, CA; www.acore.org

19-20 **Solar Power Midwest**
Sheraton Grand Chicago – Chicago, IL; www.events.solar/midwest

22-24 **Renewable Energy Markets 2017**
New York Hilton Midtown – New York, NY; www.renewableenergymarkets.com

24-25 **2017 AWEA Offshore WINDPOWER Conference & Exhibition**
The Roosevelt Hotel New York – New York, NY; www.awea.org

NOVEMBER

29-30 **Solar Business Festival 2017**
Hilton Downtown Hotel – Austin, TX; www.sbftexas.com

DECEMBER

04-05 **Solar Canada Annual Conference & Exposition**
Metro Toronto Convention Centre – Toronto, ON; www.solarcanadaconference.ca

11-12 **Solar Power New York**
New York Marriott at the Brooklyn Bridge – New York, NY; www.events.solar/newyork

MAY 2018

07-10 **AWEA WINDPOWER 2018 Conference & Exhibition**
Chicago, IL; www.windpowerexpo.org

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38	Chilicon Power	www.chiliconpower.com
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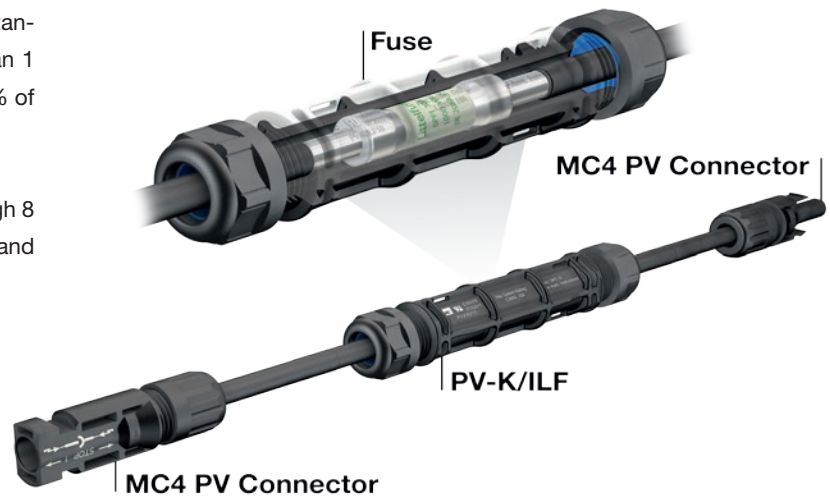

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