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Energy Storage**

A modern industrial revolution

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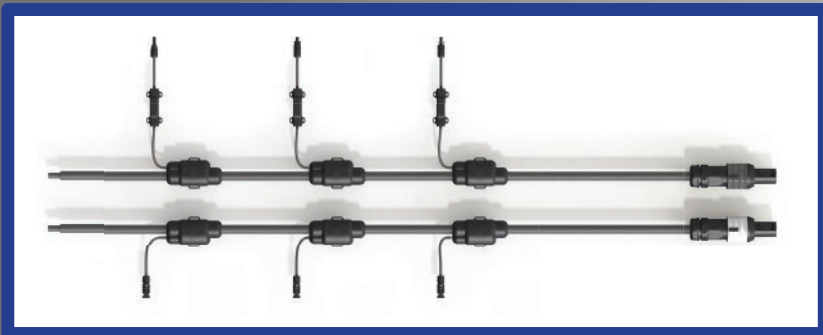
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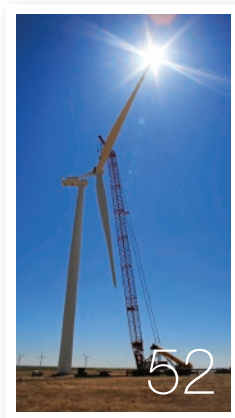
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contents



On our cover...

Swinerton Renewable Energy selected Applied Energy Technologies' (AET) Rayport-G ECO mounting system for their 30 MW-DC project in North Carolina. AET's engineering team provided support for the system due to the unique site conditions and flood plain levels, which ranged from 2ft to 6ft.

Applied Energy Technologies (AET)
www.aetenergy.com

Swinerton Renewable Energy
www.swinerton.com

departments

- 06 News bites
- 08 Top story
- 10 Solar power
- 28 Solar product spotlight: Racking & Mounting
- 42 Solar product spotlight: Solar structures & carports
- 46 Solar product spotlight: Ground screws & anchors
- 48 Solar product spotlight: Metal fabrication
- 50 Wind power
- 60 Wind product spotlight: Torque wrenches & tensioners
- 64 Wind product spotlight: Bolts, fasteners & adhesives

- 66 2016 IEEE PES T&D Conference & Expo
- 68 Energy storage
- 75 ESA 26th Annual Conference & Expo
- 76 Investing in clean energy
- 78 5th Annual NABCEP Continuing Education Conference
- 79 2016 Geothermal Buyers Guide
- 84 Biopower
- 86 Events calendar

- 8 Renewables Plus Energy Storage
A modern industrial revolution
- 10 The Solar Onboarding Experience
From permitting to plug-in
- 12 Transforming the Solar Industry
Breakthrough technology converts solar rays into liquid energy for skyscrapers and tall towers
- 14 Quantum Dot Solar Cells
A promising look to the future
- 16 PV Asset Management
Implementing a solar plant dashboard for reduced O&M costs and increased profitability
- 18 Solar Panel Installers
Thinking "on top" of the box
- 20 Designing a Scalable On/Off-Grid Solar Power System
- 22 Solar Dealers Selling Clean Energy Products
Power conditioning equipment deliver additional energy savings
- 24 Accelerating Customer Acquisition
Helping installers spend less time on the phone and more time on the roof

- 28 Solar product spotlight: Racking & Mounting
- 42 Solar product spotlight: Solar Structures & Carports
- 46 Solar product spotlight: Ground Screws & Anchors
- 48 Solar product spotlight: Metal Fabrication
- 50 The Good News for Renewables
- 52 Wind Plant Modeling Data Essential to Interconnections
- 54 Hydrogen and a New Paradigm for Energy Storage
- 56 Enabling the Wind Power Market in 2016
- 58 Working at Heights
Required training and equipment
- 60 Wind product spotlight: Torque Wrenches & Tensioners
- 64 Wind product spotlight: Bolts, Fasteners, & Adhesives
- 66 Show-in-Print:
2016 IEEE PES T&D Conference & Expo

- 68 Measuring the True Costs and Benefits of Energy Storage
Part Two- How cycle life and environmental factors impact LCOE
- 70 Energy Storage
New technologies address obstacles to system deployment
- 72 Energy Storage Systems for Utility-Scale PV Plants
- 74 Is Your Battery Bank Ready for Spring?
- 75 Show-in-Print:
ESA 26th Annual Conference & Expo
- 76 Key Cost Drivers in the Solar Industry
Four things to know
- 78 Show-in-Print:
5th Annual NABCEP Continuing Education Conference
- 79 2016 Geothermal Buyers Guide
- 84 Biomass Waste is a Problem - and a Resource



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SOMETIMES IT SEEMS WE TAKE TWO STEPS FORWARD and one step back. After the promising end to 2015, culminating with the Paris Agreement, the U.S. Supreme Court granted a stay, effectively halting the implementation of the Environmental Protection Agency's Clean Power Plan pending the Court hearing arguments challenging the EPA's legal authority to impose the CPP under the Clean Air Act.

Meanwhile, on page 6A of the February 15th issue of USA Today there was a funny little comic drawn by Steve Sack. In it, the artist showed two wind farm technicians looking up at a hamster wheel attached to the blades of a wind turbine. Inside the hamster wheel was a car driving fast, turning the blades and powering the wind turbine. The caption read “*@#!&! Cheap Gas!!”.

Oil prices are at a 12-year low, nearly 70% down from their 2014 peaks, and the major oil powers of the world show little to no signs of reducing production. Recent talks between Saudi Arabia and Russia to freeze production at these record levels were spurred on by Venezuela whose economy is crumbling under current low oil prices. Following the talks, Saudi's oil minister Ali Al-Naimi stated they don't want a reduction in oil supply and any cut to oil production by Saudi Arabia will only decrease their market share. Additionally, low oil prices have started an uptick in defaults in the U.S. oil and gas industry as drilling companies are unable to make a profit. Some analysts don't expect oil prices to increase until 2018 and some have even claimed their recent decline may be the end to the clean energy movement.

I beg to differ. Although clean energy expansion may slow in countries who utilize oil for electricity production, it only equates to 5% of the world's electricity demand. We should see little to no changes in our clean energy programs here in North America as the majority of our electricity production still comes from coal and natural gas, which, as we all know, are targets of the clean energy industries. The only threat our industry may face is a decline in the sales of electric vehicles, but I would argue this is often a social choice for consumers rather than an economical one.

Last month I had the pleasure of visiting Somerset County in South Western Pennsylvania. Somerset County is one of the nation's prime locations for wind farms and driving along the PA Turnpike as it runs through the Appalachian Mountains from Philadelphia to Pittsburgh, the Twin Ridges Wind Farm is distinctly visible. This wind farm is one of the eight in Somerset County alone. With over 190 turbines, they produce over 340MW of electricity to power almost one hundred thousand homes.

Businesses all around the country are making changes in the way they use power. Even the Somerset County ski resort, Seven Springs, which relies on snow making machinery, replaced its diesel compressors with energy efficient, low-emission electric ones, which reduces their fuel consumption by 100,000 gallons each ski season.

Conscious, sustainable choices made by individuals, business owners, and governing bodies will ensure clean energy is here to stay and no matter how aggressively foreign states manipulate the oil market, I don't think we will ever look up to see automobiles powering our precious wind farms.

Jill Walters



The best 15km in Canada

The new Massey Bridge wins B15K designation for removing the final obstacle to creating a green super-pathway between Vancouver, BC and the U.S. border. This shared green transportation backbone will serve the movement of people and ideas within the Metro Vancouver region creating a viable year-round transportation grid for carbon-free commuting and new collaborative economic activities between cities north and south of the Fraser River. This super-pathway will share a direct level-grade path from downtown Vancouver to the U.S. border.


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Delta Hotels and Resorts guests make the goal

In less than one year, WEARTH has helped Delta Hotels and Resorts guests to virtually plant more than 30,000 trees in conserved lands across Alberta, Canada through the hotels' GreenSTAY program. The program was launched in February and gives guests the option to virtually plant one tree for each night they have opted out of housekeeping. WEARTH plants the actual trees on behalf of every applicable GreenSTAY guest night, and guests must opt out of housekeeping at least three nights to participate in the program. The 30,000 trees that have been planted by WEARTH are native species and have restored 175,000 square meters of forest, which is the equivalent of more than 110 National Hockey League hockey rinks. The GreenSTAY program provides a branded virtual forest for every Delta hotel location, and guests have the ability to leave a message in each hotel's virtual forest, where each real tree planted is represented by a matching one online. The leading tree planting location, Delta Edmonton Centre has planted almost 4,000 trees thus far. In this way, GreenSTAY has meant environmental action, not only on the ground, but also through engagement and education for everyone involved and connected via social media.


Delta Hotels and Resorts | www.marriott.com
WEARTH | www.earth.farm



On/Off-Grid CyboInverters for Water Heating

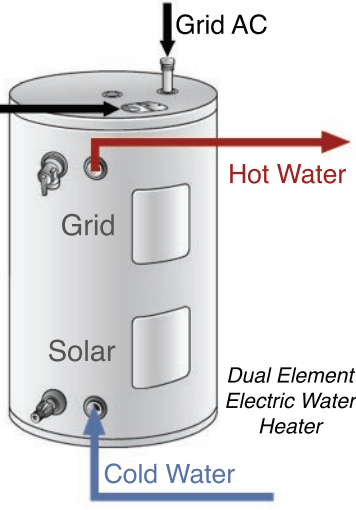
On-Grid Output to Electrical Panel

A Port: 240V, 60Hz



Off-Grid Output

H Port: 100-240V, 60Hz

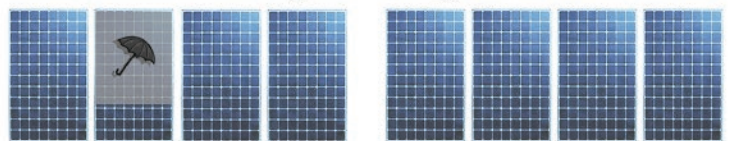


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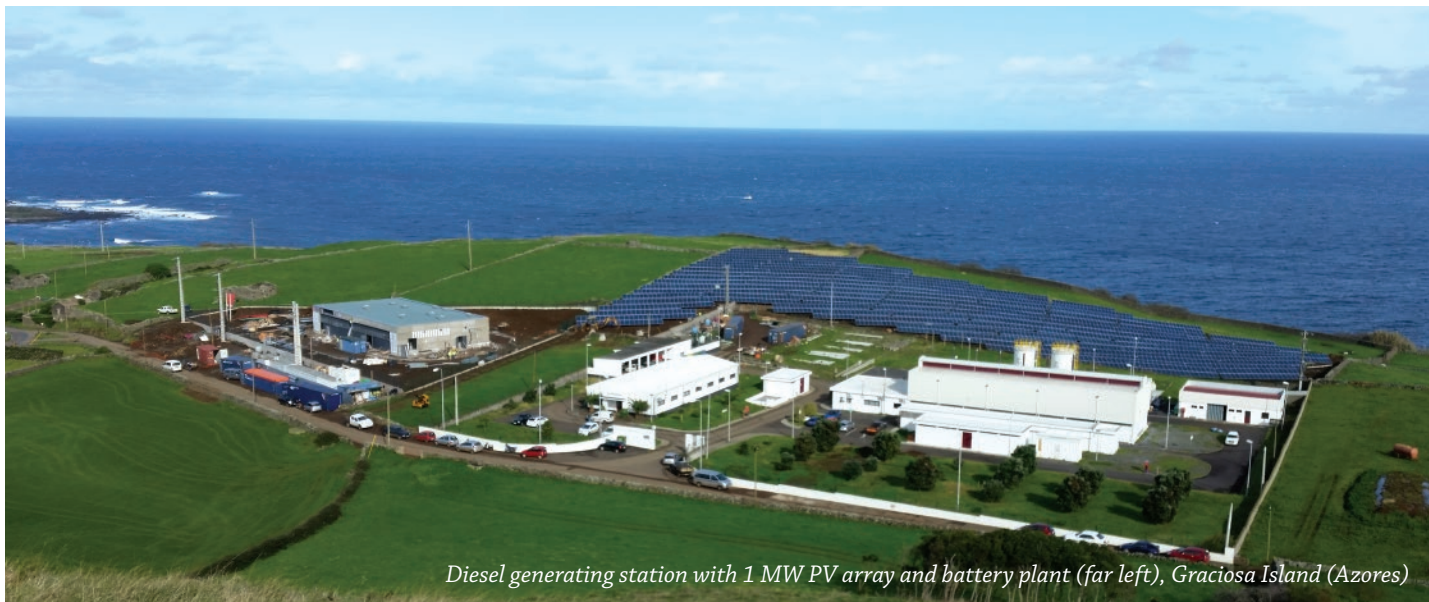
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Diesel generating station with 1 MW PV array and battery plant (far left), Graciosa Island (Azores)

Renewables Plus Energy Storage

A modern industrial revolution

by Stephen Prince

SOMETIMES COMPARISONS CAN BE QUITE ILLUMINATING. Take electricity and telephony, for example: both were invented and came in to widespread use around the same time over a century ago. And both grew into large networks, on the strength of which we've gone through a second as well as third industrial revolution, and built today's modern economy.

But whereas computers and the internet have revolutionized the way we use phones, most areas of the world today still produce power as in the 19th century paradigm, with large, constantly rotating generators responsible for keeping the grid stable. As the use of renewable energy increases, however, these distributed (and intermittent) resources are disrupting this centralized generation paradigm for the better.

To fully capture the benefits of renewable energy, grid operators need to effectively manage its integration onto a grid that's accustomed to steady blocks of power and a relatively stable load. Energy storage, coupled with intelligent software controls, is the ideal resource to directly manage the intermittency of wind and solar. Such a system can provide instantaneous frequency response, voltage support, and ramp control, allowing renewable energy output to integrate seamlessly into grid operations.

This is particularly the case with island micro-grids in the multi-megawatt range. Such locations already face very high fossil-based generation costs, making it feasible to transition them to renewables-based power grids. Due to the intermittency of wind and solar, coupled with the high minimum production requirement ("must-run") of traditional thermal generators, successfully implementing a high percentage of renewables requires keeping the grid stable without such generators. Batteries are ideally suited for that, but they need to be fully grid-forming batteries.

A well-designed battery-based micro-grid enables multiple benefits, such as greatly reducing the use of fossil-fuel generators (typically diesel); enabling a cleaner hybrid diesel-renewables mix; cutting emissions; and making use of abundant natural resources. Importantly, not all clean energy needs to be stored. So-called excess energy can be used for dispatchable loads that can provide sustainability benefits (e.g. desalination).

One example is the Azorean island of Graciosa, where the world's first stand-alone battery-based energy system with up to 100% renewables is nearing completion. The system will ensure a stable and reliable electricity supply to the island's 4,500 inhabitants, even at night and when there is no wind. It will also allow the island's diesel generator to remain switched off most of the time.

Thanks to intelligent control technology, the battery system on Graciosa will provide stability for the autonomous grid without the rotating mass of fossil generators. The island's combined wind and solar energy generation will not only offset CO2 emissions, but over its lifetime will be more competitive than current electricity production from expensive, imported diesel.

Direct and indirect benefits of solar plus storage

Regardless of where it's deployed, whether on islands or other grid locations, integrating solar plus storage unlocks a multitude of benefits:

1. Enables far greater penetration of clean, reliable, renewable energy.

According to GTM Research, 59GW of solar PV were installed globally in 2015, a 34 percent increase over 2014. The research group forecasts cumulative worldwide PV to reach 321GW by the end of 2016. At the same time, energy storage installations are hitting record numbers. GTM Research tentatively projects 2015 storage deployments to reach close to 200MW worldwide, a three-fold increase over 2014. This growth is being driven by mandates

for greater use of renewables and reduced emissions in many U.S. states. Hawaii, for example, has set a goal of sourcing 65 percent of its electricity from renewables by 2030, and 100 percent by 2045. This will only be achievable with significant use of energy storage.

2. Combining solar and storage can support much broader renewable energy goals.

In areas where fossil-fuel generation is required to provide reliability backup for renewables, this potentially curtails production from the renewable portfolio, as the fossil-fuel generator must remain in "must-run" mode. The implementation of storage as part of the portfolio removes the need to have a fossil-fuel asset online and available, effectively replacing a must-run resource with a "non-spin" resource. Since the battery system can react instantly from a no-load status, it enables much higher limits on the maximum renewable energy output that can be supplied to the grid.

3. Lessens the impact of aging conventional power plants.

The changing nature of the energy supply mix means the types of balancing services required by the grid are also evolving. Balancing resources today must offer much greater flexibility to respond to power supply fluctuations than conventional power plants, which traditionally do not move quickly and require a period of time to ramp up or down to the requested output level.

In addition to increased participation of renewable energy resources in the supply mix, plant retirements also affect the balancing mix as older plants are taken out of service due to age and/or restrictions imposed by environmental regulations. In today's wholesale power markets, with downward price pressure due to low-cost natural gas, ever-cheaper renewable power and the absence of long-term capacity payments, there is limited motivation, and available financing, for new fossil-fuel power plant construction to support the balancing services stack.

As a clean, flexible, and easily located resource with no must-run requirement, energy storage helps mitigate these limitations to provide a new source of balancing services to the grid. This, in turn, facilitates maximum operation of renewable power resources and underpins their long-term investment potential.

4. Creates additional renewable energy value.

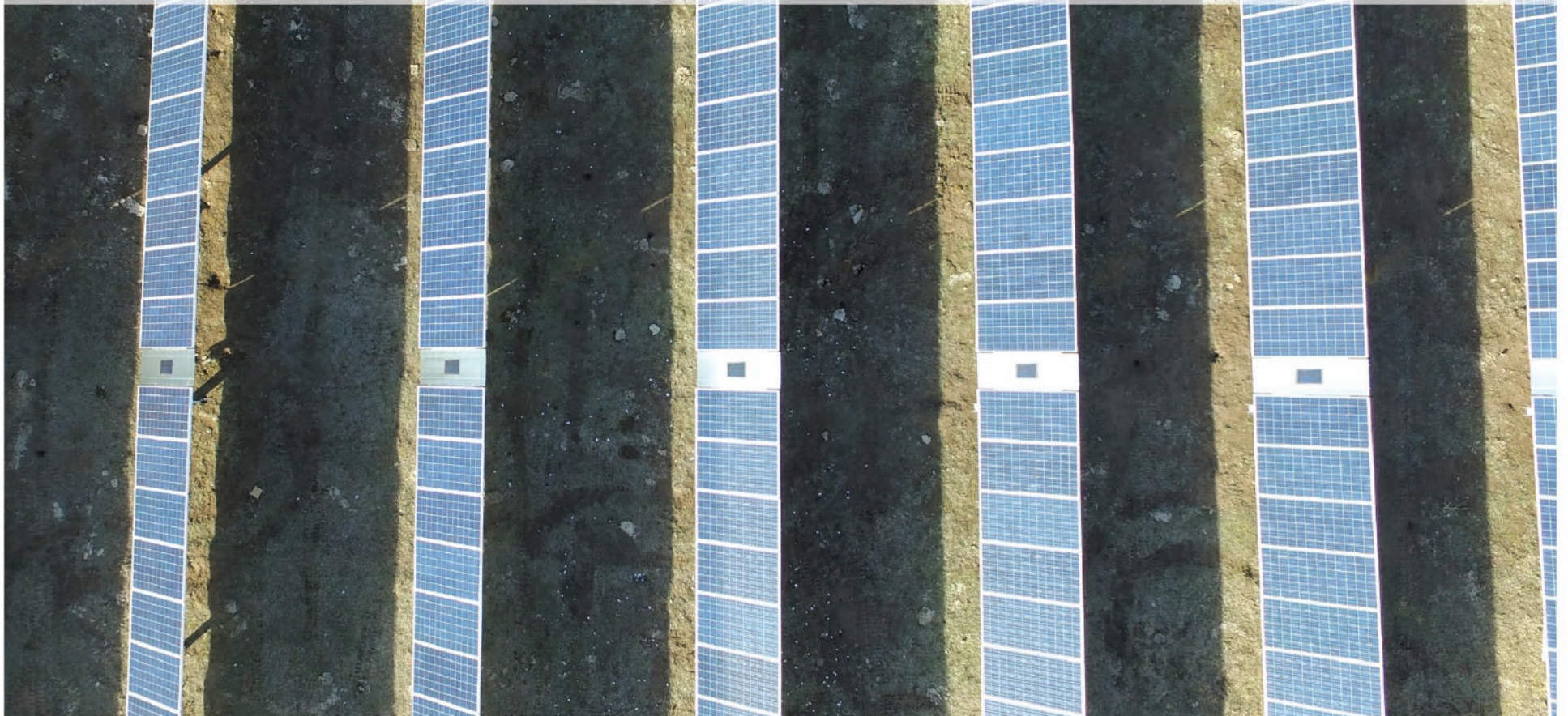
For years, renewable energy resources have been unable to participate in ancillary services markets, due to the variable nature of their supply. When accompanied by energy storage, however, there are now real opportunities for renewables to enhance the value of their Power Purchase Agreements by making additional services, such as frequency regulation, available for bid, or by selling peaking capacity to the utility.

It's clear today's electrical grid is undergoing fundamental change, just as telephony has been transformed in the last few decades by digital technologies. Smart grids, advanced metering, solid-state electronics, and Internet-connected devices are all making the grid more reliable and efficient. The next frontier for transformation is unsustainable centralized fossil-based generation. The growing use of distributed energy resources like renewables, coupled with energy storage and managed by intelligent software, is poised to bring about an energy system disruption that's no less remarkable, and beneficial for its users.

Stephen Prince is CEO at Younicos, a global provider of intelligent grid and energy storage solutions.

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GAMECHANGE SOLAR
REPOWERING THE PLANET

The Solar Onboarding Experience

From permitting to plug-in

by Maury Blackman

In 2015, the solar industry celebrated three historic moments — in Paris, world leaders came together and agreed to reduce greenhouse gas emissions and reach zero emissions by the middle of the 21st century; in Washington, D.C., Republicans and Democrats briefly put aside their differences and voted to extend tax credits for wind turbines and solar panels; and, fortuitously, this came on the heels of new federal regulations mandating a 32 percent cut in carbon from power plants that pollute our air by 2030.



Disrupting the permit expediter

Since 2008, residential solar panel installations are up nearly 2,000 percent. This new industry powered by the sun has taken hold, creating jobs 20 times faster than the national average, while harmful carbon emissions have dropped. And in 2014, more than 31,000 jobs were generated by the solar industry. But, this is only a drop in the bucket for what is needed to meet the ambitious goals set forth in the Paris Agreement.

What is holding us back from a renewable energy revolution in the U.S.?

Anyone who has ever tried to get a permit to put solar panels on their house knows it can be a soul-crushing and expensive endeavor. On average, it currently takes Americans eight weeks for their potential installation to be reviewed by all the relevant local government agencies. Most cities still do not even have an online process. Instead they force citizens to go to City Hall and stand in line for hours.

In order to speed up the permitting process, many solar companies are forced to pay permit expeditors for access and approvals, adding costs and unnecessary delays. Expeditors are more or less consultants or lobbyists who grease the wheels and know the system well enough to get approvals much faster than an individual or solar company ever could. That makes absolutely no sense.

A recent Lawrence Berkeley National Lab report, “How Much Do Local Regulations Matter?,” found that permitting and other local

regulatory processes now “comprise the majority of total costs for residential PV [solar panel] systems,” thereby adding \$2,500 to the final price tag for a 5kW solar system.

This can be fixed

The U.S. does not control the price of silicon from China that is needed to build solar panels, but does have control over many of the soft costs of solar, such as fees paid to permit expeditors. Bottom line, the permit process should be online for all Americans, not just for the few lucky enough to live in places with local governments that have embraced the Internet.

This is why the U.S. Energy Department has launched a new effort, called the SunShot Initiative — its goal is to modernize the entire solar onboarding experience and get from permitting to plug-in in seven days. A number of cities are taking the challenge a step further — Livermore, California has plans in place to take their process for connecting solar systems down to less than a day.

San Diego to the rescue

In order to speed up the solar permitting process, it is necessary to get people out of line, and instead, get them online.

Turn back the clock a couple years and the County of San Diego, like other parts of the country, encountered massive queues in their permitting offices. So, they decided to do something about it. An audit of their permitting system found that the number one reason people were waiting in line was for solar permits, followed by water heaters and HVAC systems.

San Diego County decided to remedy this situation and bring their solar permitting process online. Their new customer-centric permitting effort has helped launch a solar revolution in the sun-drenched region, dramatically reducing the time and cost to install solar panels. Over the last five years, San Diego County has seen a 300 percent growth in solar permits, and they expect 30 percent growth year-over-year in solar permits for the next five years. The County’s new user-friendly online system has been recognized by the National Association of Counties as one others should replicate.

San Diego County has shrunk the whole permitting process, saving government employees time and the County money. By modernizing this process, it allows government agencies to focus on more challenging and time-consuming projects, like the next potential skyscraper. It also has allowed the County to even out workloads for staff. Not to mention the lessened aggravation and personal time citizens get back for not having to wait in line just to green their homes.

The permitting and code inspection process is an important and necessary function of local governments. These regulations and processes serve to keep us safe in our homes — in this case, so we don’t burn down our houses with improperly installed solar panels. If this country is serious about tackling climate change and living up to the commitments made in Paris, we must start using available technology to change inefficient processes, which add needless costs and delays. And then hopefully our kids’ only experience with a permit expediter will be what they read in their history books.

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Maury Blackman is the president and chief executive officer at Accela, Inc.

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Transforming the Solar Industry

Breakthrough technology converts solar rays into liquid energy for skyscrapers and tall towers

by John A. Conklin



For the average person, the typical image of solar power is large, opaque, expensive panels mounted on a rooftop, or rows of tilted panels on a solar farm, but a new generation of transparent, liquid solar coatings may soon be powering cities by coating the glass windows of tall buildings and skyscrapers.

Looking back at the early 2000s, the price of a solar panel hovered around \$4.00 per watt and solar skeptics strongly believed the price could never drop below \$1.00 per watt due to prohibitive material costs. They also believed the land area required was too vast for solar to become a large-scale power source. At best, solar power was for the remotest of places, and the most affluent enviro-zealots.

Fast forward to 2016, the cost of photovoltaic solar panels has dropped dramatically with the most recent record-breaking panel priced at \$0.55 per watt. Last year was notable as solar was added to another U.S. home or business every three minutes. No doubt this is an exciting time for solar and many believe it is the power source of the future, but solar power still accounts for less than 1 percent of the country's energy consumption.

How can this trend scale to the degree necessary to beat climate change?

In MIT's 2015 report *'The Future of Solar Energy'* researchers declare 'solar electricity generation is one of very few low-carbon energy technologies with the potential to grow to very large scale', and advocates the development of new technologies that maximize the opportunities the sun's energy provides.

Although a silicon solar panel bought today will perform light years ahead of one bought 20 years ago, it is still heavy, rigid, and generally limited to rooftops and solar farms. According to the latest predictions, about 192,000 square miles of solar panels are needed to provide renewable power for the entire Earth. This requirement is roughly equivalent to the land mass of Spain.

Researchers argue that to truly take advantage of the sun's power, it is necessary to expand the amount of real estate which can be outfitted with solar, engineering ways to blend solar panels into our everyday lives.

Every day, sunlight streams through billions of windows—more than two million acres of "skyscraper" glass worldwide

Consider there are an estimated five million skyscrapers, tall towers, and commercial buildings in the U.S. alone; there is a huge amount of surface area on the vertical space of buildings available for energy generation. By applying transparent liquid, organic, photovoltaic coatings to the glass, window panes become electricity-generating. These coatings can be made of earth abundant carbon, hydrogen, nitrogen, and oxygen, organic polymers and other materials which, in liquid form, are ideal for low-cost high-output manufacturing. They can be applied to glass and flexible plastic surfaces at ambient temperature and pressure, and produced in aesthetically appealing colored tints popular to architects, building owners, and developers for skyscraper glass.

Unlike conventional solar photovoltaic (PV) systems, this type of technology can be applied to all sides of tall towers, generating electricity using natural and artificial light as well as shaded, diffused, and reflected light conditions. While conventional rooftop solar systems are limited to a handful of square feet due to congestion from heating, ventilation, and air conditioning, a modeled installation of these types of "solar" coatings could generate up to 50-times the energy and deliver 15-times the environmental benefits when compared to conventional roof-mounted PV. By some estimates, the payback period of this technology is as little as one year, while conventional solar systems have a payback of 5-11 years for the equivalent amount of power, and require an additional 10-12 acres of valuable urban land.

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Transparent solar power coatings on windows, along with other recent innovations in the solar industry such as printing solar panels on smartphones and laptop cases, or embedding solar panels into roadways all recognize that non-intrusively adapting to how humans currently operate means that solar has the real potential to power the future.

The 2015 Paris Climate Conference made it clear that the world has changed and the low carbon economy is not only inevitable, it is now irreversible. On December 7th, the solar industry announced the launch of the Global Solar Council (GSC) in an attempt to share best practices and bring the solar power industry together at an international level.

The Chairman of the GSC, Bruce Douglas stated: "There is consensus that solar power will become the principal source of electricity generation. It has a hugely important role to play in the international efforts to ultimately eliminate carbon emissions from the power sector."

As the world works to implement the Paris climate agreement, market forces are finally working in the planet's favor. In the wake of COP21, U.S. solar stocks rose by 5 percent and weeks later when an extension for U.S. tax credits was agreed upon, those same stocks popped by 30 percent.

For all of the skeptics who couldn't imagine solar technology would come so far, creativity, hard work, and human determination continue to transform the solar industry and those same qualities will drive the transition to a low carbon future.

John A. Conklin is the president and CEO of SolarWindow Technologies, Inc., located in Columbia, Maryland. He possesses more than 30 years of industrial, commercial, renewable and alternative energy experience, and has pioneered many innovative energy approaches. As CEO of SolarWindow Technologies, Inc., Conklin is overseeing the development of the world's first of its kind see-through electricity generating technology for glass and flexible plastic that has the promise to turn tall towers and skyscrapers into electricity generating buildings.

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Quantum Dot Solar Cells

A promising look to the future

by Taylor Hubbard

AS SILICON SOLAR PANELS REACH THEIR FUNDAMENTAL efficiency limit, demand for increasingly efficient and economical photovoltaics must be met by emerging technologies. One promising branch of nascent solar technology, quantum dot (QD) solar cells have progressed substantially over the past five years, from less than 4% efficiency in 2010, to 9% in 2015, although not yet commercialized. In time, QD cells may more than double the efficiency of silicon panels, with lower manufacturing costs and comparable stability.

Quantum dot solar cells utilize nanoscale semiconductor crystals to absorb solar radiation. The sizes and shapes of these crystals, which can be carefully controlled, correspond directly to their bandgaps. This is desirable because the bandgap is perhaps the most important parameter in photovoltaic engineering: it determines what spectrum of solar energy can be absorbed by a material. Semiconductors do not absorb photons with energies below their bandgap, and photons with excess energy are largely wasted by traditional solar cells. The adjustable bandgap of QDs allow for tailored solar energy conversion, with a theoretical maximum efficiency of 86%. Beyond tunable bandgaps, QDs are capable of enabling novel mechanisms for increased efficiencies and unique applications.

Before they are incorporated into a solar cell, QDs must first be created. While there are multiple techniques to accomplish this, colloidal quantum dot (CQD) synthesis is the primary method considered in the realm of solar cells. Within that category there are yet several methods of synthesis, but they all begin with precursor compounds dissolved in solution. In simplified terms, the CQDs are formed within a solution by the addition of heat. Carefully controlling this growth process is essential, as the performance of CQD cells is greatly impacted by deviations from desired specifications.

Though challenges involved in improving CQD quality are non-trivial, their synthesis entails less expense and complexity compared to other QD production methods, significantly less compared to crystal silicon production. Minimal specialized equipment is required, and the temperatures achieved during production vary little from room temperature. CQDs are furthermore suited for production in large batches, and once produced, they are easily stored.

The process of integrating CQDs into the body of solar cells is generally simple. CQDs suspended in a solvent are deposited on an underlying cell substrate, such as glass. The solvent subsequently evaporates and leaves behind a uniform layer of CQDs. While the simplest deposition method involves no more than dipping the substrate in QD solution, cells can also be created autonomously by spray-coating. This is possible, in part, because QDs are stable and resilient once formed: making them more compatible, at this stage, with mass production than other emerging light absorbers such as perovskites.

Quantum dots are innovative light absorbers, but solar cells must both absorb light, and convert the absorbed energy into useful current and voltage. In silicon photovoltaics this is accomplished by means of the p-n junction (the letters p and n indicate whether a semiconductor has a higher concentration of electrons or electron holes). In a p-n junction, the interaction between these two types creates an internal electric

field at the junction between them. This internal field allows solar cells to generate current when electrons are energized by light.

Currently the predominant CQD cells are based on p-n heterojunctions, which are much the same as standard p-n junctions. Until recently, p type CQDs were being used in combination with standard n type materials. However, there is inherent inefficiency in using different materials for each side of these junctions, so researchers have sought n type CQDs to create what is known as a quantum junction. CQD cells based on quantum junctions are not only more efficient, but also easier to form, since the processes involved in creating the layers are the same.

Methods of layer formation in solar cells are an integral part of the manufacturing process. The most efficient existing solar cells are multi-junction cells which, as the name suggests, employ multiple junctions layered atop one another. Each junction features a distinct bandgap, thus enabling absorption from broader swathe of the solar spectrum. Unfortunately, creating these cells has traditionally been difficult and expensive. Both the difficulty and expense are rooted in the necessity of perfectly matching crystal lattices among layers. With their highly tunable bandgaps, CQDs are well suited for layering in multi-junction cells, and they do not require the same crystal matching as traditional multi-junction cells. Yet while the efficacy of CQD multi-junction cells is promising, the most exciting aspect of QD solar is the potential for taking better energetic advantage of high energy light, through a process known as multiple exciton generation (MEG).

In a traditional solar cell, photons impart energy to electrons on a one photon to one electron basis, with no regard to how much energy was used in the process. But due to the quantum-confinement of CQDs, it is possible to excite multiple electrons with a single photon. The magnitude of this efficiency gain is so great that a single junction CQD cell could reach efficiencies above 60%, as compared to silicon photovoltaics, which are fundamentally limited around 33%. The first MEG CQD cell demonstrating this concept was created in 2011, and work continues to make the concept a commercial reality.

Despite the many advantages of quantum dot solar cells, it will be some time before they are capable of competing with silicon photovoltaics in the marketplace. However, their progress has been significant and steady. The union of affordability, efficiency, stability, and scalability, make them a technology to watch over the coming years.

Taylor Hubbard works at the University of Boston with expertise in Materials Engineering and partners with The European Energy Centre (EEC) on their training programs. The EEC works with the United Nations Environment Programme and major universities promoting best practice in renewable energy and energy efficiency.

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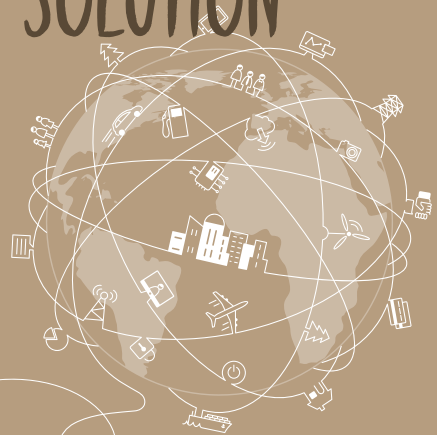


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PV Asset Management

Implementing a solar plant dashboard for reduced O&M costs and increased profitability

by Peter Matthews

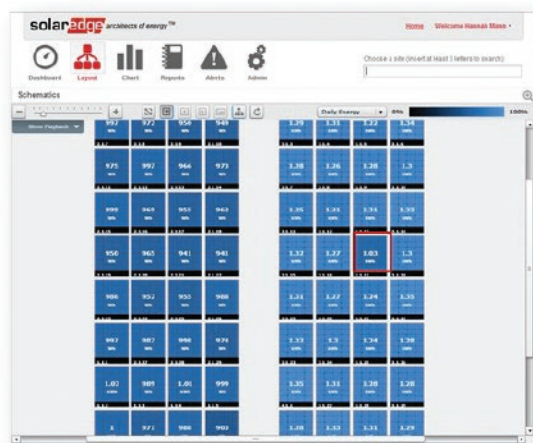


figure 1.

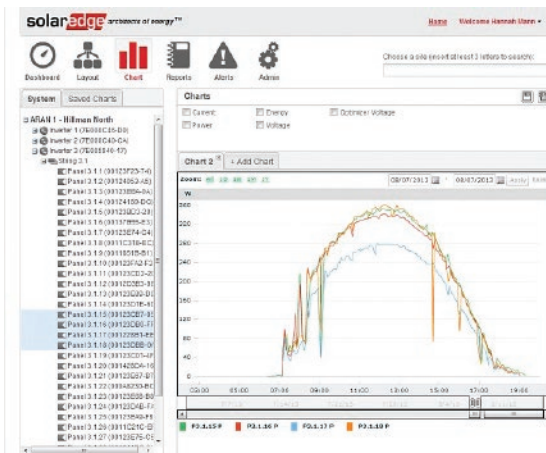


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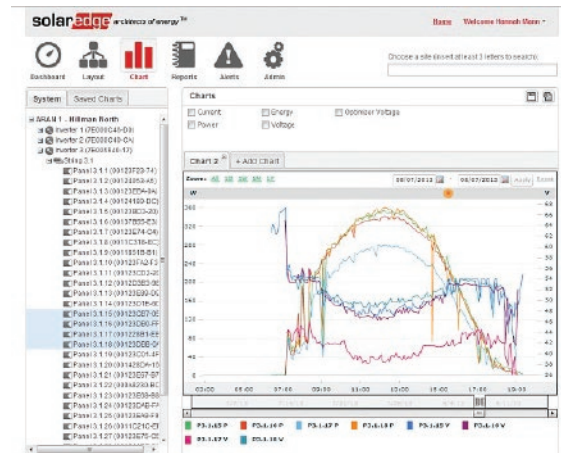


figure 3.

WOULD THE AVERAGE CONSUMER INVEST IN THE STOCK MARKET without real-time insight into financial performance? Not a chance. We live in a world that craves information, preferably easily accessible and digestible information, especially when it pertains to a major financial decision.

Shouldn't the same hold true for PV installations?

PV projects are increasingly seen as secure long-term investment opportunities. Like any financial asset, PV systems must be monitored and managed to realize their full potential.

With traditional string inverters, O&M providers have access to limited information. String level or system level monitoring can indicate underperformance of the array but little else. Skilled technicians have to perform inefficient onsite troubleshooting on

inverters operating under load and on DC lines at nearly 1500V. They connect expensive equipment to the arrays in an effort to 'sift through the tea leaves' of complex IV trace curves to detect issues.

Fortunately, the standard in PV monitoring has been optimized. With MLPE (Module Level Power Electronics) devices, like power optimizers, O&M providers can remotely manage many of the issues. MLPE devices report module-level Voltage and Current at Max Power Point values over the World Wide Web. This provides the O&M company high-resolution data on module-level performance to diagnose many issues, without the need to be onsite.

The most advanced PV monitoring and management solutions have the potential to take O&M from a manual, resource-intensive process to an automated, at-a-glance service. More than just a system overview, MLPE solutions deliver module-level insights and ensure a plant is performing to the best of its ability at all times. Intelligent, MLPE-supported cloud-based solutions also offer the ability for computers to do most of the work with automated reports and alerts:

- In-depth analytics and reporting on energy yield, system uptime and financial performance
- Automated, pinpointed alerts for immediate fault detection
- Remote diagnostics for smarter maintenance planning

For example, figure 1 identifies module 17 in string 1 of inverter 3 as underperforming compared to its neighbors. Today's monitoring systems are able to detect underperformance like this and may be programmed to send automated alerts to the service providers.

Once alerted, the technician, with just a couple clicks of the mouse, can gather more data on the power, voltage, and current output of the problem module (figures 2 and 3). By comparing this module with others in the same array which are performing properly, the O&M provider can make determinations as to the possible failure modes.

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figure 4. Comprehensive performance data, with year-over-year comparisons



Glass-free, frameless solar modules

Giga Solar high-efficiency crystalline-silicon, lightweight photovoltaic (PV) modules have successfully completed a series of environmental and mechanical stress tests at the CFV Solar Test Laboratory in Albuquerque, New Mexico. This work was part of the Boston-based Fraunhofer Center for Sustainable Energy Systems' Plug-and-Play PV Project, funded by the Department of Energy's SunShot Initiative. Giga Solar's high-efficiency, crystalline-silicon, lightweight modules enable innovative, low-cost rooftop mounting methods. Because Giga Solar's modules are glass-free and frameless, they can be flush-mounted directly onto the roof, avoiding the need for racking hardware, eliminating roof penetrations, and shortening the installation time. These benefits all contribute to lowering the cost of solar electricity. Testing was performed in two categories - environmental and mechanical. The environmental tests were a modified subset of the IEC-61215 protocol, a PV module performance standard used by the solar industry worldwide. Environmental testing included hail impact + 50 thermal cycles, 1000 hours of damp heat exposure and 500 thermal cycles. The mechanical tests, including various bending and localized pressure tests, were custom designed by Fraunhofer CSE to simulate the forces a lightweight module would encounter during transportation and installation.

Giga Solar FPC, Inc. | www.gigasolarpv.com

With such precise data at their fingertips, solar professionals and system owners can now easily and accurately identify performance challenges (in the above case, likely a failed diode) and rapidly resolve problems. The result is a win-win; technicians can more efficiently manage portfolios from a central location and identify problems before setting foot at the project site. This gives O&M providers a "Know Before You Go" advantage. They can load the truck with the correct parts to fix the issue the first time. Less on-site maintenance calls (also known as "truck rolls") for the professional means a lower support cost and the ability to support more sites more efficiently. Plus, system owners win with less system downtime eating into their profits.

Since the MLPE devices are persistently connected to the array, they are able to store data in the cloud for the system's entire lifetime. By analyzing historical project data in a monitoring portal (figure 4), module-level monitoring and management tools can also help stakeholders evaluate and predict system performance, and financial returns, for a given period. This comparative year-over-year snapshot enables smarter financial planning for the system owner.

As the global solar market continues to grow at a record pace, project owners and service professionals are recognizing the need to minimize risk and make better-informed decisions on how to support their PV assets for 25 years or more. With the breadth of capabilities offered, it's no wonder that MLPE devices connected to cloud-based monitoring portals are taking root as a de-facto, dashboard-like solution for efficient problem solving, and an indispensable component of lucrative long-term PV investments.

Peter Mathews leads the North America team as general manager for SolarEdge in the Americas and is responsible for all business activities. He is a veteran of more than 25 years in the global semiconductor and solar industries in senior sales, marketing, and business development roles. He has led various companies through the start-up, IPO, and growth phases including Enecsys, Solyndra, and FormFactor.

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Solar Panel Installers Thinking “on top” of the box

by Laurie Anderson & Gary Heslington

Solar panel arrays are installed everywhere these days – ground mounted, flush mounted on slope roofs, elevated to catch as much energy as possible, as awnings, as parking covers, etc. New ideas come up every day. People and entities are searching for ways to go as green as possible or simply to save money on power.

Finding creative ways to get more solar rays sometimes results in obstacles to overcome. Sometimes thinking outside of the box is critical. Sometimes thinking ON TOP of the box is the answer. Such was the case on a business in Watham, Massachusetts.

The problem

The owners wanted to install solar panels on their single story office building but the small roof was a very odd configuration. The flat, membrane roof was only 22.5ft wide, rising on one long side into a 2/12" 50ft roof. Ground snow load was 50psf and wind speed was 127mph with Exposure Category B. The owners desired solar arrays on both the flat and the sloped roof using ballast to anchor the panels and utilize all possible space. They also wanted to install an awning system on the side of the building. Unfortunately they couldn't find a system which would work for their unique situation.

The solution

A standard ballasted system would not work due to the space requires and the weight of the system. A solution was needed to get more solar panels on the small roof-top, and not add too much weight in the constricted space.

The process of designing the lay-out began. Engineers at the solar mounting company and the solar installation company worked over several weeks and through five different configurations and configurations of ballasted mounting systems to achieve the desired KW goal. But they had to think outside the standard box to find a solution.



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RS485 expansion kit

SolarEdge introduces the RS485 Expansion Kit which provides an additional RS485 port inside the inverter or on the Control and Communication Gateway (CCG). The kit contains a module that users can install on the communication board using the ZigBee port. This module has a 3-pin RS485 terminal block increasing the number of available connections. The additional RS485 port makes enhanced communications simpler and more cost-effective with a multiple inverter system which can now be connected to meters, 3rd party gateways, and other devices with the additional RS485 port eliminating the need for a CCG. The RS485 Expansion Kit enables the connection of up to 16 RS485 buses with up to 32 devices each in a daisy chain configuration, That means installers can now connect over 500 inverters in a communication grid without a CCG.

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Due to the roof configuration, the small size, the shape, plumbing and other penetrations, the entire roof could not be covered with solar panels. The array had to be broken up to fit between the roof penetrations. In addition, nothing could be installed on the sloped roof due to local building codes.

The second concept was to use a non-standard type of ballast system to reduce the awning from two panels in landscape orientation to just one row to keep them up high enough to move about underneath. The awning design was rejected because the local building department disapproved of an awning system as low to the ground as was needed on the single story office building.

The third concept was to use a ballast system consisting of tight angles and T connectors rather than a rolled frame, which took up more space. This method left a smaller footprint on the membrane roof.

Thinking outside the box, the engineers and owners designed a fourth and final solution to the problem. A Conex shipping container, was located quite a few feet away from the office building and permanently secured to the ground. Could panels be safely and effectively installed on such a structure? What type of mounting system would work on a container that was only 40ft long and 8ft wide? Utilizing 10 degree ballasted frames on the main building as well as the Conex container, this system fit perfectly on the Conex container without having to penetrate the roof by utilizing only ballast.

The result

One row of arrays was installed on the container and one row was installed on the office building. The resulting energy is almost 9.455 KW of power for the business. All because dedicated professionals worked through the numerous issues and thought not just out of the box but On Top of the Box.

Gary Heslington is the business development manager at TRA Snow & Sun and Laurie Anderson is CEO.

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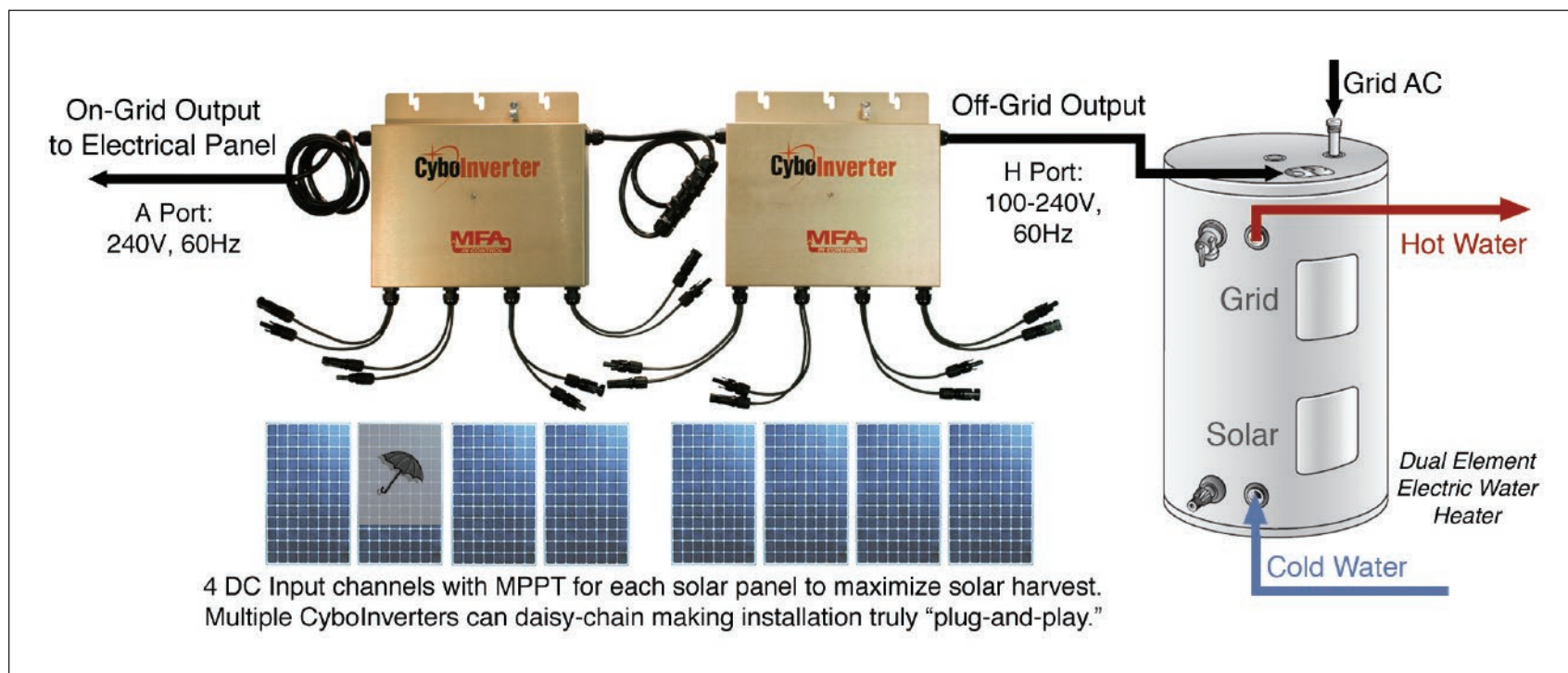


figure 1.

Designing a Scalable On/Off-Grid Solar Power System

by Dr. George S. Cheng

CHANGES IN TEMPERATURE, PRECIPITATION, AND SEA LEVEL due to global warming are causing severe weather events which can shut down power grids for hours and even weeks. Since modern infrastructure is built upon electricity, losing grid power causes significant disruption and hardship. There is a growing need to have backup power readily available when natural disasters occur.

Most installed solar power systems in the US are on-grid systems. On-grid solar inverters must shutdown almost instantaneously when the grid goes down to keep it safe. These on-grid inverters

are designed to deliver power to the grid and cannot run critical AC loads during a power outage. On the other hand, most off-grid power backup systems are complicated and costly to install.

One solution is a scalable on/off-grid solar power system, operating in both on-grid and off-grid modes, and switching between the two automatically depending on grid condition. When using one or more on/off-grid mini-inverters daisy-chained with on-grid mini-inverters, the installation of such a system is simple and cost effective.

The general design rules shall include the following:

- A larger system can be designed with multiple on/off-grid sub-systems of different sizes;
- Design the sub-systems based on the critical off-grid AC loads;
- The total on-grid output power from each sub-system can be combined in an electric panel to be sent to the grid;
- Each sub-system will have its own independent off-grid circuit to power the connected AC loads when the grid is down;
- No need to combine the off-grid circuits, doing so could make the system much more complex and costly;
- To use the existing AC circuits to run the AC loads when the grid is down, install proper AC switches to totally isolate the grid AC. A professional licensed electrician should help design and wire the system properly;
- To have a large off-grid system running all the loads of the entire house when the grid is down, it is a good idea to use the AC coupling design where a large battery inverter is used as the lead inverter. The on-grid mini-Inverters discussed in this article can be used to work with the battery inverter and supply solar power to the system.

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AC standards

In North America, split-phase AC standard is used. The Line-to-Line (L1 to L2) output voltage is 240V, and the Line-to-Neutral (L1 to N, or L2 to N) is 120V. An on/off-grid power inverter must supply 240V AC to the grid in its on-grid mode, and 120V or 240V AC in its off-grid mode.

On/off-grid modes

An on/off-grid mini-inverter runs in on-grid or off-grid mode, never both at the same time. When the grid is on, it operates in the on-grid mode sending generated AC power to the grid. When the grid is down, it goes to off-grid mode, automatically powering AC loads. The on-grid AC line may be manually disconnected to "force" the inverter into the off-grid mode.

Battery charging

Most off-grid inverters are called battery inverters because they can only accept battery as DC power inputs. An on/off-grid mini-inverter has multiple input channels, each of which can connect to solar, wind, or battery. This means the inverter can run with or without batteries. Battery charging can be done using a solar charge controller or an AC battery charger.

On/off-grid for electric water heaters

Figure 1 portrays a daisy-chained on/off-grid mini-inverter twin pack connected to 8 solar panels. This powers an electric water heater in the off-grid mode. When the hot water reaches its temperature setpoint, the system automatically switches to the on-grid mode, supplying solar power to the grid. The system can also be set to run in the on-grid mode whenever the grid is on. When the grid is down, the system keeps the electric water heater running in the off-grid mode.

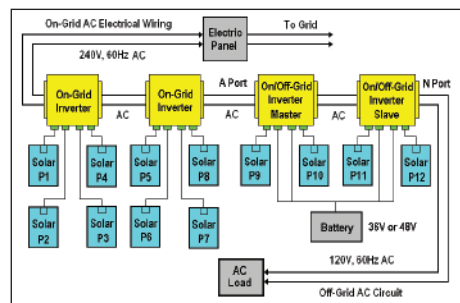


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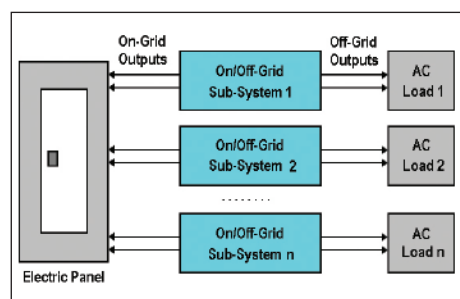


figure 3.

On the roof or ground-level

Most microinverters are installed under the solar panel on the roof. On/off-grid mini-inverters and on-grid mini-inverters in the same family can be installed on the solar racks, if there are no batteries in the system, and an AC wire is run from the roof to inside the house, supporting an off-grid AC circuit for backup power.

If an on/off-grid mini-inverter must connect to batteries, the inverter can be installed in the garage. Its on-grid AC output of the on/off-grid mini-inverter connects to a 20A branch circuit in the electric panel directly. In this case, DC wires from the inverter are run to the solar panels on the roof. A multi-conductor wire is used with junction boxes and MC-4 connectors.

System sizing

Table 1 lists system options. Each inverter is 1.2KW and has 4 input channels connecting to solar, battery, or wind directly. 300W solar panels are used and a 36V or 48V battery connects to multiple input channels in parallel.

Figure 2 shows a 4.8KW on/off-grid system including twelve 300W solar panels, one battery, two on-grid mini-inverters, and one on/off-grid mini-inverter twin pack (Table 1, Row 8). The on/off-grid mini-inverter twin pack has 8 input channels; 4 connected to solar panels, and 4 connected to the battery in parallel.

The system produces up to 4.8KW AC power to the grid, but if the battery channels are idle when the grid is on, the system supplies 3.6KW to the grid. When the grid is down, the on/off-grid mini-inverter twin pack produces 1.2KW backup power at night and up to 2.4KW backup power during the day when both solar panels and batteries supply DC power. Note, this system is designed for backup power and should only run critical loads. It may not support a whole house's electrical needs at one time.

Table 1.

No.	On-Grid Power	Backup Power for Off-Grid Loads	On-Grid Inverter	On/Off-Grid Inverter	Total
1	1.2KW - 4.8KW	0	1 - 4	0	4
2	1.2KW	1.2KW	0	1	1
3	2.4KW	1.2KW	1	1	2
4	2.4KW	2.4KW	0	Twin Pack	2
5	3.6KW	1.2KW	2	1	3
6	3.6KW	2.4KW	1	Twin Pack	3
7	4.8KW	1.2KW	3	1	4
8	4.8KW	2.4KW	2	Twin Pack	4
9	6.0KW	2.4KW	3	Twin Pack	5

On/off-grid system scalability

One key advantage of such a system is its flexibility to scale, which can be seen from the block diagram in Figure 3.

The scalable design is adaptable for small to large-scale on/off-grid solar power systems sending power to the grid, and providing power to run critical electric devices and appliances during a power outage. These simple, scalable on/off-grid solar power systems are affordable to most residential and commercial solar customers.

Dr. George S. Cheng is the CTO at CyboEnergy, Inc.

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Solar Dealers Selling Clean Energy Products

Power conditioning equipment deliver additional energy savings

by B.D. Erickson II

PROACTIVE SOLAR DEALERS ARE NOW adding a power conditioning and protection component to the solar panels, racking, and inverter systems they are supplying to customers.

By providing a more complete electrical solution which handles household dirty power such as surges, spikes, interference, and harmonic distortion to increase overall electrical efficiency in the home, solar dealers are distinguishing themselves from the competition and adding an additional profit center.

Since the U.S. grid uses alternating current (AC) power, the direct current (DC) created by a solar inverter is converted into AC power. This makes it compatible with the grid and usable for home electronics and appliances such as TVs, computers, and vacuums.

Yet residential solar inverters must accommodate a wide range of loads, everything from a single low-wattage bulb to a power tool with a big start up surge. While the battery voltage of a solar system can vary by up to 35%, depending on charge and activity, it must narrowly regulate its output.

In the solar inverter DC to AC conversion process, some power is lost as heat, with high heat being a sign of low-efficiency conversion. The process often creates nano-surges and spikes, causing damage to sensitive electronics, as well as higher than desired electro-magnetic fields (EMFs) and levels of harmonic distortion (THD). Electricity with high levels of EMF and THD is not clean electricity.

Since AC power travels in a wave, disrupting the wave can rob it of its power and introduce interference. Appliances and equipment in the home such as vacuums, hair dryers, refrigerators, and dishwashers

can also disrupt AC current, creating dirty electricity which degrades the ability of solar units or other equipment to function.

Solar dealers are discovering line conditioning, power quality, and phase quality increasing devices reduce the amps needed to run residential electrical appliances. Installed at the breaker panel, these devices have been proven to reduce EMFs by up to 99% and THD up to 98%, depending on the system. Reducing EMFs and THD to this degree can significantly improve the DC to AC conversion rate and reduce the energy lost as heat.

Using harmonic-resistant power quality and phase quality correction modules which correct the electrical phase causes the waves to move in synergy with each other. This helps homeowners optimize usable power in home electrical lines up to 95%, and increases electrical panel capacity by lowering amperage and temperature. The result saves energy and further lowers homeowners' utility bills.

Normally, electronics will dissipate excess power from the electric panel as heat, which can shorten their effective lifespan. A power conditioning device turns this wasted heat energy into real working power, which prolongs the life of electronics. Some devices also deliver whole-home surge protection, extending the life of electronics and appliances even further, decreasing maintenance and replacement costs.

In addition to providing cleaner power, these devices can also improve audio-visual performance in TVs, stereos, and other equipment. Homeowners who experience an improvement in the performance of their electronics are more likely to act as referrals to friends and family.

Know the Efficiency of your Solar Plant

WS310

WS510

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www.lufftsolar.com



Proactive solar dealers are now adding a power conditioning component to typical solar panels, racking, and inverters.



Solar dealers have even discovered power conditioning and energy saving devices to be an effective profit center with those not able, or eligible to install a solar system due to having the wrong type of roof, excessive tree shading, condo association rules, or a lack of sufficient credit.

A growing number of consumers are concerned about the potential loss of privacy caused by utility companies' introduction of smart meters into homes. Smart meters, which are replacing traditional electric, gas, and water analog meters, transmit a host of data to utility companies. For those concerned about privacy in an age of home smart meters, some power conditioning equipment can block the majority of data retrieved over the hard-wired electrical system.

Smart meters also emit EMF radiation to communicate with utility companies along smart meter networks. Some power conditioning equipment can significantly reduce EMF exposure, which is a particular concern among pregnant women, children, and the elderly.

In addition to the wire-in power conditioning devices installed at the electrical panel by a licensed electrician, easy-to-use, plug-in models are available for any residential electrical outlet. Power conditioning devices offer quick ROI, can be included in a rooftop solar installation package as a free purchase incentive, or sold with an appropriate mark up.

B.D. Erickson II is an engineer and president of Satic USA based in Montana, a company that develops clean energy products.

Satic USA | www.saticusa.com

Fusion splicer

AFL introduces the Fujikura 22S active cladding alignment fusion splicer. With moveable v-grooves, splicer errors due to dust and other contaminants are virtually eliminated. Removable sheath clamps allow the use of fiber holders and the large monitor provides a crystal clear image, even in bright sunlight.

The fully ruggedized chassis provides for shock, dust, and moisture protection while the two camera observation system provides for accurate fiber alignment and loss estimation calculations. Additional features include a long-life battery which provides power for up to 200 splice cycles (including the application of the splice sleeve), and the electrode life which has been extended to 5,000 splices, minimizing downtime for replacement and stabilizations. The transit case and work tray provide multiple options for utilizing workspace.

Software updates are available via the Internet allowing users to quickly update their software as new splice programs become available. The Fujikura 22S is also fully compatible with the FUSEConnect line of fusion installable connectors.

AFL | www.aflglobal.com

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The proven, reliable solar battery choice for off-grid power needs in harsh conditions... and just about everywhere else!

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Accelerating Customer Acquisition

Helping installers spend less time on the phone and more time on the roof

by Kathir Kuppen

Across the United States, the solar energy market is expected to grow by as much as 60 percent in 2016, with a healthy portion of that coming from residential installations. And, according to GTM research, the nation's share of expected global PV demand between 2015 and 2020 has increased from an average of 10 percent to 15 percent with the recent extension of the federal Investment Tax Credit (ITC).

While current policy initiatives and technological advancements in the solar supply chain are working in tandem to ramp up residential solar installations worldwide, there is still work to be done in order to reach peak adoption.

For some, it's the lingering myth that only the wealthy and the environmental diehards are going solar. However, studies show on average, solar PV systems return two to four times their cost in saved electricity bills, and installations typically pay for themselves entirely within just seven to 15 years. If a homeowner lives in a state with solid incentives, such as California, this payback period can be as short as two to four years.

But what about those homeowners who want to go solar, and just aren't sure where to begin? Add to that an ever-expanding array of options and stress of cold calls from solar companies, it's easy to give up on the idea entirely. For this group, the solar adoption process feels a little too much like walking onto a car lot. They might be more interested in information gathering and test drives than committing to a same-day purchase, but they're immediately surrounded by pushy salespeople practically screaming, "Buy, buy, buy!" before they've had a chance to really research their options.

Today, smart online platforms are bridging the divide between homeowner and installer by empowering the customer from day one. These dynamic tools offer homeowners the opportunity to vet their options for adopting solar from the comfort of their couches, the e-commerce experience many consumers have come to expect. Homeowners can quickly input monthly electricity use and billing information to calculate the economic benefits of

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Congratulations!
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14 Calvert Drive, Syosset, NY 11791, USA

Your roof can produce
4464 kilowatts from 16 panels

- Roof Space: 728 sq ft
- Roof Angles:
 - Mounting plane 1: 33.7° [May we help you?](#)
 - Mounting plane 2: 33.7°
- Sunlight Data: 1431 hours

[View Solar Providers](#)

Your Home: Grid vs. Solar

Rising Trends of Energy Costs

Energy costs in dollar (\$) vs Year (1995-2015)

Monthly Cost 1995: \$70.25
Monthly Cost 2015: \$134.89

Solar Power Potential

33%

Grid vs. Solar

Bar chart showing Electricity (kWh) by Month (Jan-Dec) for Solar and Grid.

Executive Summary

Cash Purchase		PPA	
System Cost(\$)	\$8,051.80	Current Cost of Electricity(\$ per kWh)	\$0.17
Federal Incentive(\$)	\$2,415.48	PPA Rate(\$ per kWh)	\$0.09
State Incentive(\$)	\$17,865.38	PPA Discount to Current Cost of Electricity(%)	48.1%
Net Cost(\$)	\$-12,320.38	Net 20 Year Savings(\$)	\$7,472.00
Net 20 Year Savings(\$)	\$33,093.64		
Payback Period(Years)	7		

Your Home: Environmental Benefits over the Year

- Save 3 tons of Carbon Monoxide
- 82 Tree Seedlings aged 10 years
- Conserved 361 barrels of Oil
- Saved 78 Light Bulbs (60 watt) for 1 year at 8 hours/day
- Saved 8928 Gallons of Water

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going solar. Then, using satellite-supported mapping technology, homeowners can view their rooftops to better visualize a potential PV system. The most sophisticated options offer further customization, allowing homeowners to specify the precise rooftop area they would consider for solar panel installation to generate more accurate reports on potential savings and environmental impact. If, and when, a homeowner decides to take the next step, he or she can connect with qualified local installers with a few simple clicks.

For installers, these platforms are ushering in a new era where every lead is pre-qualified and eliminating the marketing headache of costly mailers and door-to-door canvassing. Today, nearly half of all leads aren't appropriate fits for solar. To better qualify these leads, installers are generally using a combination of tools including shade analysis, credit analysis, address verification, service territory restrictions, and state laws. This is time-consuming, expensive, and often difficult to monitor.

With the support of online platforms, installers can access a customized portal which enables filtering by a number of criteria, including available rooftop area, rooftop shading, credit-worthiness, and customer interest level. When a promising lead is identified, installers can arrive to each meeting armed with a copy of the potential customer's profile. This detailed report accelerates the "kitchen table conversation" and gets installers' boots on the roof as quickly as possible. Studies show online tools can improve operational efficiency and deal conversion ratios by as much as 40 percent, saving precious time and capital.

In an increasingly connected world, it makes sense that solar adoption expands to the web. Smart online marketing and sales tools are giving homeowners the ability to explore the potential of rooftop solar without feeling pressured or overloaded, a crucial step toward taking solar to the masses. By putting the power into consumers' hands, the solar experience is improved, while also streamlining processes for the installers at the heart of the market. This is just the type of win-win scenario that can catapult solar into its next phase of growth, in the U.S. and abroad.



Kathir Kuppan is the CEO of SolyMoly, the one-stop shop for the solar curious. Whether a customer's goal is energy independence, carbon-footprint reduction, or simply

saving money, SolyMoly does the heavy lifting. Starting with the specifics of a customer's roof space and structure, homeowners can determine how to use solar to achieve their financial and environmental goals.

SolyMoly | www.solymoly.com

Keeping solar panels clean and efficient

DryWired has released their new Perma-Clean Solar, a weather resistant, self-cleaning, anti-static coating for solar panels. This transparent coating prevents dust and other pollutants from contaminating a glass surface thereby enabling solar panels to maintain performance while also reducing maintenance cycles. Perma-Clean Solar is easily applied and dries in seconds at room temperature, providing a protective layer that will not alter the appearance of the panel and will increase efficiency by keeping the panels clean.

DryWired | www.drywired.com



Taking solar attachment **beyond** the Stone Age.

When it comes to securing solar panels to commercial rooftops, most racking systems are designed to be secured in place with ballast blocks or cement pavers.

Trouble is that even ballasted rack systems can still move around on the roof. Plus sharp or broken pieces of ballast can damage roof covers, leaving the building vulnerable to leaks and other roof problems. More important, many buildings cannot accommodate the dead load weight that ballasted systems require.

OMG PowerGrip and PowerGrip Plus were designed to help reduce the ballast from these racking systems, and are ideal for use on roofs covered with TPO or PVC roof membranes. OMG PowerGrip products provide a secure connection directly to the roof deck or structural members and once heat welded in place, properly installed PowerGrip products help minimize rack movement and remain watertight.

Let us show you how the OMG PowerGrip or PowerGrip Plus can help bring your next installation beyond the stone age!



Scan the code to see how PowerGrip works, then visit OMGPowerGrip.com or call 800-633-3800 for more information.

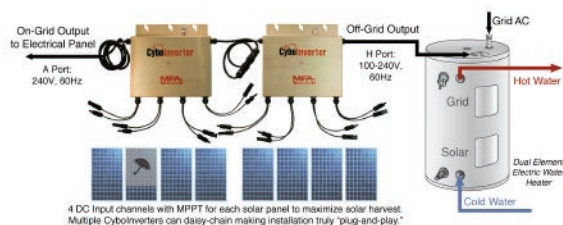


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www.OMGRoofing.com

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Inverter for PV water heating

CyboEnergy, Inc. released an On/Off-Grid CyboInverter that can operate in either on-grid or off-grid mode, switching between the two modes automatically, and can also run an electric water heater in the off-grid mode. A daisy-chained On/Off-Grid CyboInverter A/H model twin pack is connected with 8 solar panels. There are no batteries in the system to save cost. The system can be set up to power an electric water heater as the primary goal in the off-grid mode. When the hot water reaches its temperature setpoint, the inverters will switch automatically to the on-grid mode to supply solar power to the grid. The system can also be set up to run in the on-grid mode all the time while the grid is up. When the grid is down, it can keep the electric water heater running in the off-grid mode.

CyboEnergy | www.cyboenergy.com

Pipe fitting with increased pullout strength

Hollaender Manufacturing has developed a new line of "X series" fittings that increases pullout capacity by 60% over the single set screw designs and 40% over the current two set screw (in line) designs. The added pullout strength adds increased security and durability to a wide variety of solar panel installations.

The new Hollaender Speed-Rail "X Series" design incorporates a second set screw set at 90° in the vertical barrel to achieve the increase in pullout strength.

Hollaender Speed-Rail slip-on pipe fittings are used with aluminum, galvanized steel, stainless steel, or black iron pipe to easily and cost-effectively build solar panel racking systems. They are strong and lightweight, and come in a wide variety of fixed and adjustable configurations, including the tees and flanges most commonly used in solar panel installations. The versatility of the fittings allows dependable support structures to be constructed virtually anywhere a solar panel needs to be installed. The same versatility also allows the systems to be easily uninstalled and moved if necessary. They are backed by a 10-year warranty against corrosion, will not rust, and can be used with galvanized steel or other metals without concern for galvanic corrosion.

Hollaender Manufacturing | www.hollaender.com

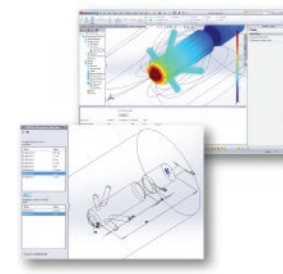


Intrinsically safe overvoltage protection with high surge current capability

TDK Corporation presents the new T series of EPCOS ThermoFuse varistors for intrinsically safe overvoltage protection. These components are based on disk varistors with diameters of 14mm (T14 series) and 20mm (T20 series) connected in series with a thermally coupled fuse.

If the varistor of a ThermoFuse overheats, the fuse trips and isolates the varistor from the grid. This prevents fires on the printed circuit board or damage to components located near the varistor. Fuse and varistor are housed together in a plastic enclosure that, like the coating of the varistor, is made from flame-retardant material. The components have three connections: Two for the power cable and one as a monitor output, which enables the display of the status of the component with an LED, for example. The main applications for ThermoFuse varistors are home appliances, power supplies, photovoltaic inverters, frequency converters, ballasts for lighting systems, surge voltage protectors, and electronic meters.

TDK Corporation | en.tdk.eu



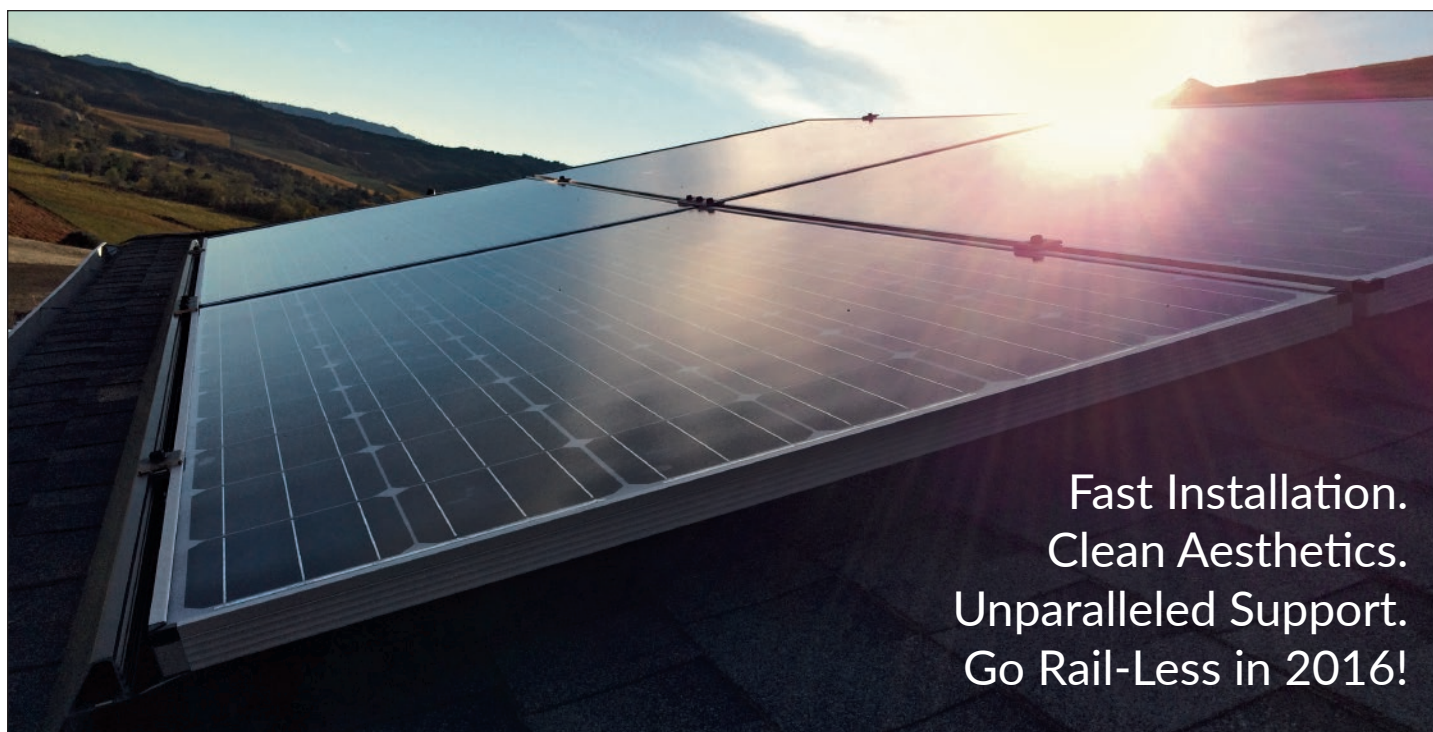
Integrated simulation and 3D design applications

COMSOL, has announced support for app development in the latest version of LiveLink for SOLIDWORKS. Part of COMSOL Multiphysics software, the only fully integrated environment for creating custom simulation applications, LiveLink for SOLIDWORKS connects COMSOL software simulations and 3D design and its latest version allows users to build apps with the Application Builder. With LiveLink for SOLIDWORKS and the Application Builder, engineers can build apps based on COMSOL models created from a SOLIDWORKS software geometry. LiveLink for SOLIDWORKS allows them to import and perform operations on their CAD geometries from within an app and then synchronize the final geometry with SOLIDWORKS software.

LiveLink for SOLIDWORKS includes a bidirectional interface between the COMSOL Desktop environment and SOLIDWORKS software. For even closer integration, the One Window interface makes the familiar windows, tools, icons, and menu items from COMSOL Multiphysics available within the SOLIDWORKS software user interface, enabling users to set up simulations without leaving the CAD design environment.

LiveLink for SOLIDWORKS also supports user-defined selections for an easier and more efficient simulation set-up on the synchronized CAD design. Users can also create selections from features of the Feature Manager Design Tree in SOLIDWORKS software, or from the components of the CAD assembly. In addition, LiveLink for SOLIDWORKS can automatically generate and synchronize selections based on the material assignments in the CAD design in SOLIDWORKS software.

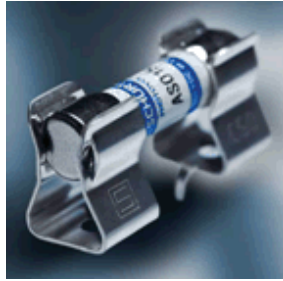
COMSOL | www.comsol.com



Fast Installation.
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www.ecolibriumsolar.com
740-249-1877



Heavy duty fuse clip

SCHURTER, expands its CSO heavy duty fuse clip family with a cost-effective tin-plated version. The CSO clip, designed for 10.3mm diameter fuses, is suitable for applications with voltages up to 1500 VAC/VDC and currents to 32A. These characteristics are in response to the increasing photovoltaic system voltage requirements.

The CSO clip is available in solder and screw/rivet versions. The solder version allows direct mounting on a printed circuit board by means of through-hole technology. The screw/rivet version provides additional flexibility for basic designs. Due to the special copper alloy all versions are characterized by a strong clamping force resulting in minimal power loss.

The CSO fuse clip provides for a wide range of PV and other DC applications including inverters, battery charge controllers, and string fuse holders. Furthermore, the CSO is well suited for applications in the industrial and mobile electronics sectors. The fuse clip conforms to RoHS specifications and is currently the only photovoltaic clip on the market with cURus approval.

SCHURTER Inc. | www.schurterinc.com



Advanced smart inverter

SMA's new Sunny Tripower 30000TL-US is a cost-effective, 30kW, three-phase inverter. Also available in 12, 15, 20 and 24kW models, it features design flexibility, high efficiency, and enhanced safety. The Sunny Tripower TL-US enhances safety and reliability with advanced features such as all-pole ground fault protection, integrated AFCI, reverse polarity indicator, and granular dual MPPT DC monitoring. It can be mounted on the SMA ReadyRack—a fully integrated, preassembled and prewired roof-mount racking solution—for rapid deployment and compliance with the 2014 NEC rapid shutdown requirement.

The Sunny Tripower TL-US delivers advanced smart inverter features including active power curtailment; adjustable power factor and reactive power supply; frequency and voltage ride-through; and soft-start reconnection ramp controls. These features ensure the Sunny Tripower TL-US is prepared to meet emerging interconnection requirements such as the recent revisions to California's Rule 21 and HECO's transient over-voltage and ride-through requirements. Moreover, innovative monitoring and communications features allow for remote configurability and performance monitoring, all backed by SMA Service technical support and optional plant-wide O&M services.

The SMA Group | www.sma-america.com

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THE MAN ON THE ROOF



WWW.SOLARROOFHOOK.COM

PH: 844.671.6045

Racking & Mounting

Along with quality panels, it's important to ensure a solid base and a supportive structure for a successful solar installation. The following highlights a variety of mounting and racking solutions available, along with their key features, to help solar designers and installers find the best option for their project.

SEE AD ON PAGE 7



Array Technologies, Inc.

Product: DuraTrack HZ v3

Application: Ground-mount, utility-scale, distributed solar, community solar, and commercial

Type: Tracking

Angle: 0° tilt (single-axis, horizontal tracker); range of motion available from +/- 52°

Material: High-strength steel and anodized aluminum

Pre- or Post-assembly: Nearly all components pre-assembled, and/or kitted for rapid install

Certifications/Approvals: UL 2703, and 3703

Warranty: 5-year warranty with a 10-year extendable available

Key Features:

- (R)evolutionary tracking system designed to lower lifetime costs and deliver measurable value to solar power plant owners;
- Flexibly linked row design, with each industrial-grade motor driving up to 750kW, effectively reduces the number of potential failure points to a minimum and allows quality sourcing of key components for long-term reliability;
- Ease of installation and significant upfront cost savings through ATI's single-bolt module clamp, material kitting, pre-assembled components, and relaxed installation tolerances;
- Zero scheduled maintenance for 30 years. The DuraTrack HZ v3 drivetrain is lubricated and sealed for life. ATI designs for the full site-specific wind load at full tilt angle without relying on active wind stow or UPS. v3 features a passive wind management system which mechanically responds to loads on a row-per-row basis, improving tracker performance.

<http://arraytechinc.com>

SEE AD ON PAGE 30



DPW Solar

Product: POWER XPRESS

Application: Roof-mount

Type: Fixed

Angle: 5° or 10°

Material: Galvanized steel

Pre- or Post-assembly: Pre-assembled

Certifications/Approvals: UL 467

Warranty: 10-year manufacturer's warranty

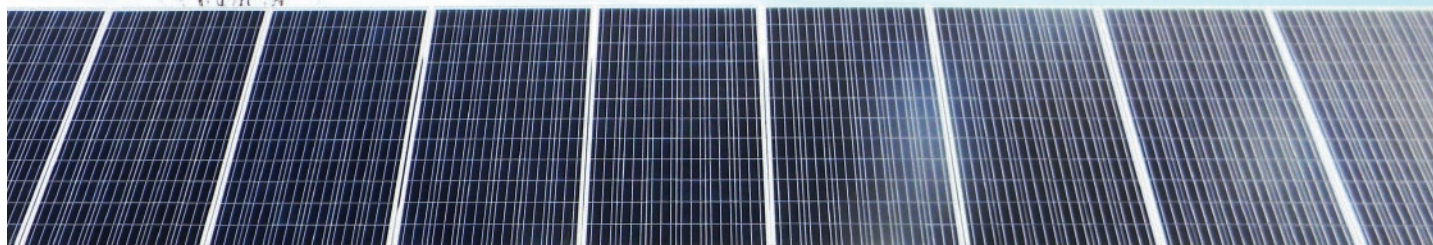
Key Features:

- Two main components;
- EPDM roof protection;
- Full containment ballast trays;
- Pre-assembles module clamps

www.dpwsolar.com

Meet the Only Tracker Solution with Full Design, Installation + Commissioning Services:

TDP™ TURNKEY TRACKERS



The next generation TDP Turnkey Tracker is backed by Solar FlexRack's complete suite of industry-leading services and support. With advanced technology and expanded capabilities, you're leveraging 40+ years and over 1GW of experience.

Project management is simplified, redundancies are eliminated and the end result is the absolute lowest total cost for your tracker project. Learn more at:



Sollega, Inc.

Product: FastRack

Application: Commercial flat-roof, ground-mount

Type: Fixed

Angle: 5°, 10°

Material: BASF Ultramid Nylon

Pre- or Post-assembly: No assembly required

Certifications/Approvals: Boundary layer wind tunnel tested, UL467, UL1703

Warranty: 25-year warranty

www.sollega.com

Want to talk? 1.888.830.8138

TURNKEYTRACKERS.COM



Steel Tree Structures, Ltd.

Product: Elevated East West or North South

Application: Roof-mount

Type: Fixed

Angle: 15° to 30°

Material: Light-gauge galvanized or galvalume steel

Pre- or Post-assembly: Pre-assembled

Warranty: 2-year manufacturer's warranty

www.steeltreestructures.com



ILSCO

Product: BPad Solar Bonding Clip

Application: Roof, ground-mount, utility-scale

Type: Fixed, tracking

Material: Approved for use with anodized aluminum, mill finished aluminum, and galvanized steel rack mounting systems

Pre- or Post-assembly: Pre- and post-assembly

Certifications/Approvals: UL 2703 Recognized, UL 467 Listed

Warranty: One-year manufacturer's warranty

www.ilsco.com



Rack 10 Solar, LLC

Product: Shark Series

Application: Ballasted roof-mount

Type: Fixed

Angle: 0° to 20°

Material: Marine grade aluminum

Certifications/Approvals: Listed to UL467, wind tunnel tested

Warranty: 20-year warranty

www.rack10solar.com



PV Racking

Product: Clamp-Free Solar Racking and WireClips

Application: Pitched roof, ground-mount

Type: Fixed

Angle: 9° to 45°

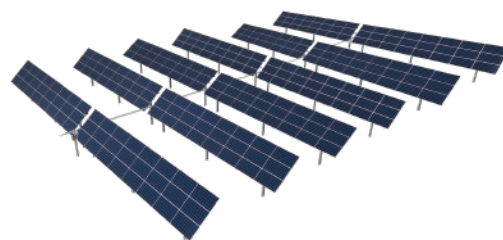
Material: Extruded aluminum and galvanized steel

Pre- or Post-assembly: Post-assembly

Certifications/Approvals: UL 2703 testing in progress

Warranty: 15-year warranty

www.pvracking.com



PST-1AX6 Single Axis Tracker

- + Actuates up to 100kWp with single DC motor
- + Real-Time Sensing
- + Magnesium Alloy Coated Steel
- + Industry Best 6.75 modules per post
- + Reliable actuator driving system with lower maintenance

PST-1AX6 Dual Axis Tracker

- + Real Time Sensing Technology
- + Produces 30-40% more power than traditional fixed arrays.
- + Magnesium Alloy Coated Steel
- + No in-field welding
- + High reliability and low maintenance

210.503.6101
www.sat-energy.com



SEE AD ON PAGE 38



Roof Tech, Inc.

Product: E Mount Air

Application: Asphalt pitched roofs

Type: Flush, fixed-mount

Angle: 1:12 to 12:12

Material: Anodized aluminum

Certifications/Approvals: UL2703, ASTM 2140, ICC ESR-3575

Warranty: 10-year warranty

Key Features:

- Integrated flexible flashing;
- Fully waterproof;
- All-in-one;
- Pre-engineered (P.E. stamped letters ready);
- Certified to UL and ICC.

www.roof-tech.us

SEE AD ON PAGE 78



ISA Corporation

Product: WSS Trellis

Application: Commercial roofs, existing parking structures

Type: Fixed

Angle: 0° to 40°

Material: High strength aluminum and stainless steel

Pre- or Post-assembly: Post-assembly

Certifications/Approvals: PE certified in many states

Warranty: 15-year warranty with extension options

Key Features:

- Fully kitted for quick assembly, pre-assembly available;
- Elevated arrays to reduce shade potential and maximize roof usage;
- Mounting posts support 6-12 modules to reduce roof penetrations;
- Customized designs available to conform to space requirements;
- 3D layout of racking on proposed roof provided with quote.

www.isa-corporation.com

SEE AD ON OUTSIDE BACK COVER



DCE Solar

Product: Contour DB

Application: Ground-mount

Type: Fixed

Angle: 10° to 30°

Material: Galvanized steel structural members

Pre- or Post-assembly: Pre-assembly of C-beams to angle braces

Certifications/Approvals: UL 2703

Warranty: Up to 25-year warranty available

Key Features:

- Single point purlin connection allows the rack to pivot and seamlessly follow the topography;
- Top beam adapter provides adaptability and ease of alignment;
- Integrated wire support provides ease of wiring while eliminating the need for further wire trays;
- Also available in a ground screw variant (Contour GS)

www.dcesolar.com



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...but we perfected these mounting systems.



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Power Peak™
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Power Rail™
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SnapNRack Solar Mounting Solutions

Product: 100 UL Residential Roof-Mount System

Application: Roof-mount

Type: Fixed

Angle: 0° to 60° flush mount, 0° to 45° tilt kit

Material: Aluminum and stainless steel

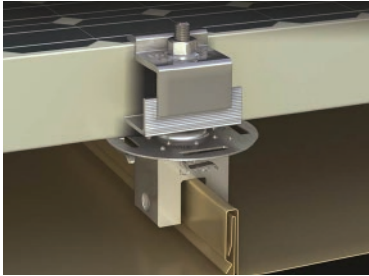
Pre- or Post-assembly: Pre-assembled hardware

Certifications/Approvals: UL 2703 Standard for Grounding and Bonding, Class A Fire Rated when installed with Type 1 and Type 2 Modules

Warranty: 10-year limited product warranty, 5-year limited finish warranty

www.snapnrack.com

SEE AD ON PAGE 32

**S-5!****Product:** S-5 PV Kit**Application:** Roof-mount, standing seam and exposed fasten (trapezoidal and corrugated)**Type:** Fixed**Angle:** Flush to roof**Material:** Aluminum 6061 T6**Pre- or Post-assembly:** Either pre- or post-assembly**Certifications/Approvals:** UL 2703 listed for bonding and mounting, and ETL 1703**Warranty:** 25-year manufacturer's warranty against manufacturer defect**Key Features:**

- Works with all S-5 clamps and S-5 brackets;
- Unprecedented holding strength with S-5 clamps;
- Costs less than .08 cents for mounting hardware;
- Direct attach solution, no rails or racks necessary.

www.s-5.com**Anar Solar****Product:** Surface-Ballast and Racking System**Application:** Utility-scale, ground-mount, flat roof**Type:** Fixed**Angle:** 0° to 30°**Material:** Aluminum**Pre- or Post-assembly:** Post-assembly**Certifications/Approvals:** Certified for landfills and 2.5:1 sloped surfaces**Warranty:** 20-year structural warranty**www.anarsolar.com****Exosun****Product:** Exotrack HZ single-axis solar tracker**Application:** Utility-scale**Type:** Tracking**Angle:** Daily tracking +/- 50°**Material:** Hot-dipped galvanized steel, galvanized steel, stainless steel, composite, and aluminum**Pre- or Post-assembly:** On-site assembly**Certifications/Approvals:** UL 3703/2703, CE, Eurocodes, ASCE 7-10 & 7-5**Warranty:** 5-year product warranty, 10-year structure warranty, both extendable to 20-years**www.exosun.net**

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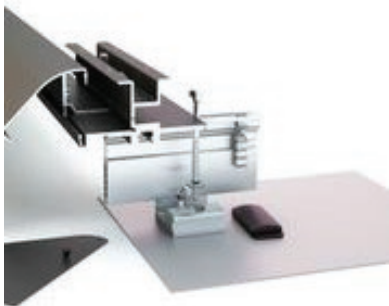
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Quick Mount PV
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Quick Mount PV

Product: Quick Rack

Application: Roof (composition/asphalt shingle)

Type: Fixed

Material: Aluminum

Pre- or Post-assembly: Pre-assembled

Certifications/Approvals: UL SUB 2703, UL System Fire Class Rating A, Type 1 & 2 Modules, 2009 International Building Code, 2013 California Building Code, ASCE 7-05, ASCE 7-10

Warranty: 10-year limited product warranty

Key Features:

- Works with standard module frames, providing greater flexibility;
- Patented rail-free system means mounts to modules vs. mounts to rail to modules, saving installation time;
- Ships in small boxes making handling and transport easy;
- Cost savings with integrated grounding, requiring less copper and grounding hardware;
- Superior waterproofing with Quick Mount PV's patented Elevated Water Seal Technology.

www.quickmountpv.com



PROINSO

Product: PROINSO PV Rack

Application: Roof-mount

Type: Fixed

Angle: Flexible

Material: Aluminum

Certifications/Approvals: All components tested by TUV

Warranty: 2- or 5-year warranty, extendable to 10-years

www.proinso.net/solar-racking

SEE AD ON INSIDE FRONT COVER

nice track



Shoals Technology Group

Product: Shoals NiceTrack

Application: Ground-mount, utility-scale

Type: Tracking

Angle: +/- 45°

Material: Hot dipped galvanized steel with anodized aluminum panel clamps

Pre- or Post-assembly: Pre-assembled torque tubes, post-assembled bearing heads and panels

Certifications/Approvals: UL 3707, IBC 2012, ASCE-10, B&V due diligence

Warranty: 20-year warranty on structure, 5-year warranty on controller, motors, and gears

Key Features:

- 105mph wind load, custom wind load up to 160mph;
- Single linear actuator, PLC technology backtracking;
- Motor drive, Brown power (or) Shoals wireless parasitic;
- Tracking accuracy of 0.5°.

www.shoals.com



Mounting Systems

Product: Tau+

Application: Trapezoidal metal roof-mount

Type: Fixed

Angle: up to 60°

Material: Aluminum with stainless steel hardware, EPDM backing

Pre- or Post-assembly: Pre-assembled, some on-site assembly required

Certifications/Approvals: Meets IBC and ASCE codes

Warranty: 10-year warranty

www.mounting-systems.us



Everest Solar Systems, LLC

Product: D Dome Railless Version

Application: Commercial flat roof

Type: Fixed, double-sided east/west

Angle: 10°

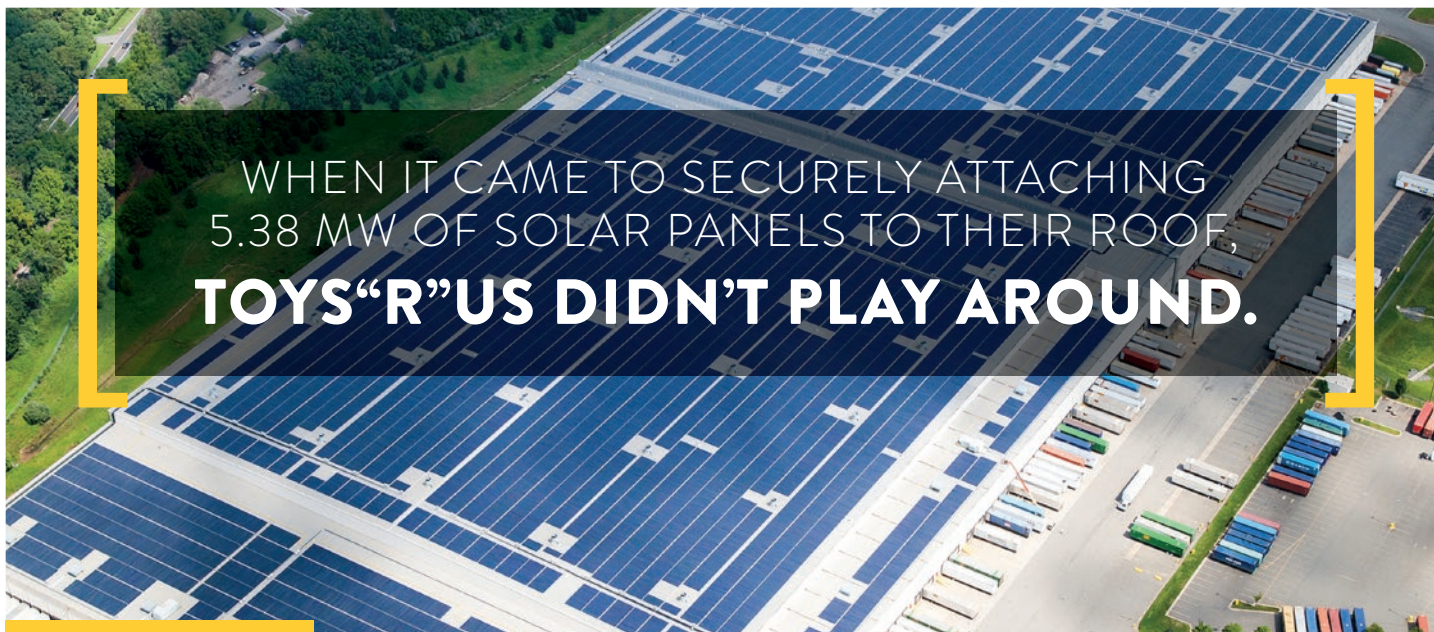
Material: Aluminum and stainless steel

Pre- or Post-assembly: Pre- and post-assembly

Certifications/Approvals: UL 2703, SEAOC

Warranty: 12-year standard warranty

www.everest-solarsystems.com



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SEE AD ON PAGE 12



TRA Snow and Sun

Product: Flush Mount System
Application: Flush-mount, roof-mounted application accommodating asphalt shingles, tiles, standing seam, and metal panels
Type: Fixed
Angle: Parallel to roof

Material: Aluminum
Pre- or Post-assembly: Post-assembly
Certifications/Approvals: UL 2703
Warranty: 25-year manufacturer's warranty

Key Features:

- Greater rail spans;
- Integrated grounding;
- Accommodates all roof types.

www.trasnowandsun.com




SunLink Corporation

Product: SunLink ViaSol Tracker
Application: Commercial and utility-scale ground-mount
Type: Tracking
Angle: +/- 52.5°
Material: Galvanized steel
Pre- or Post-assembly: Post-assembly on-site with no cutting, drilling, or welding. Commissioning provided by SunLink
Certifications/Approvals: UL 2703
Warranty: 10-year warranty on mechanical and structural components, 5-year warranty on controls and actuators
www.sunlink.com/tracker



SolarDock


Product: SolarDock
Application: Flat-roof and ground-mount installations
Type: Fixed
Angle: Up to 35°
Material: Aluminum with stainless steel hardware
Pre- or Post-assembly: Post-assembly
Certifications/Approvals: TUV Rheinland Certified; tested and passed proposed UL2703 standard; wind tunnel tested up to 150 mph
Warranty: 25-year warranty
www.solardock.com



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SEE AD ON PAGE 26



Ecolibrium Solar



Ecolibrium Solar

Product: EcoX

Application: Roof-mount

Type: Fixed

Angle: 0° to 90°, flush mount (parallel to roof)

Material: Aluminum

Pre- or Post-assembly: Pre-assembled

Certifications/Approvals: UL 2703 (grounding and bonding, mechanical loading, fire for Type I and II modules), ICC waterproofing

Warranty: 15-year warranty

Key Features:

- Up to 30% fewer roof penetrations than traditional rail-based systems;
- Skirt or skirt-free options offering a clean, finished, aesthetic look;
- Compatible with range of attachment solutions for many roof types including, composition shingle, tile, metal, and flat roofs.

www.ecolibriumsolar.com/ecox

SEE AD ON PAGE 40



Magerack Corporation

Product: Magerack Solar Mounting System

Application: Roof-mount

Type: Fixed

Material: Aluminum alloy 6061-T6 and 304 stainless steel

Pre- or Post-assembly: Post-assembly

Certifications/Approvals: UL 2703 Listed, Class 'A' Fire Rating, PE Certified

Warranty: 20-year warranty

Key Features:

- A complete turnkey solar mounting system, including roof attachments for composition, Spanish tile, flat tile, and stone-coated steel roofs;
- All components have integrated bonding capabilities, and are fully bonded to the ground (including the mid-clamp, end-clamp, rail-splice, and the micro inverter mounting kit);
- The ground lug doesn't require drilling;
- The patented L-foot with flashing is easy to install, at a low cost, with absolute waterproofing.

www.magerack.com



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- JOB-Site training available

**Challenge is based on cost of overall system, component functionality, overall features, and speed of install and removal. Purchase of system is required for JOB-Site training.*



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O Clam-P's

Optimizer & microinverter mount

- Comes fully pre-assembled
- Work smarter. Install Optimizers on the ground, less time spent on the roof.
- The **ONLY** solution when using Optimizers or microinverters for any job application.

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AceClamp

Product: AceClamp A2 Solar Kit

Application: Roof, SSMR

Type: Fixed

Angle: Various

Material: Stainless steel, aluminum, brass

Pre- or Post-assembly: Pre-assembled

Certifications/Approvals: FM approved, UL listed

Warranty: 20-year warranty on manufacturer's defects

www.aceclamp.com



Silverback Solar

Product: 60 Series

Application: Roof-mount

Type: Fixed

Angle: 3° to 75°

Material: Galvanized and stainless steel

Pre- or Post-assembly: Post-assembly

Certifications/Approvals: UL 1703

Warranty: 20-year warranty

www.silverbacksolar.com



SunModo Corp.

Product: EZ SunBean System

Application: Roof-mount, ground-mount

Type: Fixed

Material: Aluminum (roof-mount) aluminum and steel (ground-mount)

Pre- or Post-assembly: Post-assembly

Certifications/Approvals: ETL listing, UL 2703

Warranty: 20-year warranty

www.sunmodo.com



AP Alternatives

Product: APA Modular Racking

Application: Ground-mount, utility-scale

Type: Fixed

Angle: 0° to 30°

Material: Galvanized steel

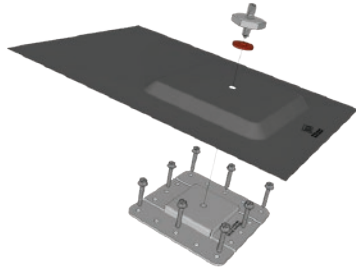
Pre- or Post-assembly: Pre-assembled

Certifications/Approvals: UL 2703, PE stamped in every state

Warranty: 20-year warranty

www.apalternatives.com

SEE AD ON PAGE 38



Zilla Corporation

Product: Zilla Double Stud XL Flashing

Application: Roof-mount

Type: Fixed attachment directly to sheathing or structure

Angle: Flush mount on composition/asphalt shingle roofs

Material: Galvanized steel base plate and aluminum flashing

Pre- or Post-assembly: Post-assembly using standard tools and hardware

Certifications/Approvals: Passed AC 286 evaluation standards using the methodology of UL 441

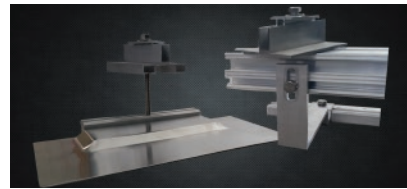
Warranty: 10-year limited product warranty

Key Features:

- Attaches directly to sheathing or structure;
- Patented base plate design increases speed, strength and flexibility in the field;
- Low profile patented design includes a metal-to-metal compression zone that creates a complete water tight seal while ensuring the integrity of the structure during expansion and contraction;
- Compatible with Zilla flush mount system or any solar mounting system;
- One or more patents apply to this product including without limitation: US Pat. 8,448,405; 8,479,455; 8,707,654; 8,689,517; 8,707,655; 8,833,032; 8,833,033; and/or 8,752,338.

www.zillarac.com

SEE AD ON PAGE 36



Spider-Rax

Product: Black/Red Widow

Application: Roof

Type: Fixed

Material: Aluminum

Pre- or Post-assembly: Post-assembly

Certifications/Approvals: UL testing, fire Class A

Warranty: 25-year warranty

Key Features:

- Fast install without losing reliability;
- Laboratory tested for up to 1,710lbs (775 kg) of pull force and 180mph winds;
- Rail-less stud attachment option for composite shingle and all tile roofs;
- Features a new two-course composite shingle flashing;
- Integrated grounding;

www.spiderrax.com



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SEE AD ON PAGE 41



KINETIC Solar Racking and Mounting

Product: K-Flash

Application: Pitched-roof, ground-mount, and flat roof

Type: Fixed

Angle: Flush-mount up to 40°

Material: Anodized, extruded aluminum

Pre- or Post-assembly: Some pre-assembly required

Certifications/Approvals: Fully engineered, LCAB, UL 467, CSA-C22.2 No.41

Warranty: 20-year warranty

Key Features:

- Easy-to-use, quick-to-install;
- Knowledgeable staff;
- 100% watertight flashing;
- Low per-watt price;
- Widely available.

www.kineticsolar.com

SEE AD ON PAGE 35



Applied Energy Technologies (AET)

Product: Rayport - G ECO Utility-Scale Ground-Mount System

Application: Utility-scale, ground-mount

Type: Fixed

Angle: 10° to 40°

Material: G90-G140 steel beams, hot dipped galvanized posts

Pre- or Post-assembly: Post-assembly

Certifications/Approvals: UL 2703

Warranty: 25-year warranty

Key Features:

- Fits all panels currently available;
- High shipping density which lowers freight bills;
- Single point to connect to system ground, UL 2703 listed;
- Lightweight for easy handling on the job site and quick installation time.

www.aetenergy.com



Opsun Systems Inc.

Product: Sunrail Structure

Application: Roof (large commercial)

Type: Fixed

Angle: Any fixed angle

Material: Structural aluminum and stainless steel components

Pre- or Post-assembly: Pre-assembly available

Certifications/Approvals: UL 467, UL 2703 (pending)

Warranty: 10-year warranty (20-year warranty available)

www.opsun.com



AllEarth Renewables

Product: AllEarth L20 Solar Tracker

Application: Ground-mount

Type: Dual-axis tracking

Angle: 30° to 60°

Material: Galvanized steel

Pre- or Post-assembly: Post-assembly

Certifications/Approvals: 120mph wind tunnel tested

Warranty: 10-year warranty

www.allearthrenewables.com



PCM Solar

Product: Solar Racking

Application: High-wind load roof-mounts (commercial and residential)

Type: Fixed

Angle: Any angle

Material: Aluminum, stainless steel and other upon request

Pre- or Post-assembly: Pre-assembled

Warranty: 10-year limited warranty

www.pcmsolar.us



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SEE AD ON PAGE 27



SolarRoofHook.com

Product: QuickBOLT Mounting Kit

Application: Roof-mount

Type: Fixed

Material: Aluminum

Pre- or Post-assembly: No assembly required

Certifications/Approvals:

Tensile, lateral, and water testing performed by Terrapin Test Labs

Warranty: 20-year warranty

Key Features:

- An affordable mounting solution;
- The QuickBOLT uses a patented, custom bolt with an EPDM stainless steel backed compression washer, which is guaranteed 100% waterproof;
- The QuickBOLT is comprised of only 5 pieces of hardware and can be installed in under one minute.

www.solarroofhook.com

SEE AD ON PAGE 28



Solar FlexRack

Product: FlexRack Series G3-X

Application: Ground-mount, commercial, and utility-scale. Can accommodate any foundation type

Type: Fixed

Angle: Any

Material: Galvanized steel

Pre- or Post-assembly: Post-assembly onsite. Components are pre-fabricated so no field welding or drilling is necessary

Certifications/Approvals: UL 2703 (Issue 2), wind tunnel tested, structural load testing, industrial time study verification



Warranty: 20-year warranty

Key Features:

- Easily staged and quickly assembled at job site (third party time study verified);
- Economical use of materials and minimal components for cost-effective solution;
- Integrated bonding and wire management;
- Pre-assembled components;
- Built-in tolerances for maximum field adjustability (up to 20% slope in E/W direction).

www.solarflexrack.com

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We’ve been experimenting with rail-free solar mounting for a while, but systems before Quick Rack limited our selection of panels and were extremely difficult to service.

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I consider Quick Rack a must-have solution for installers who want their systems to last. ”

Quick Mount PV[®]
quickmountpv.com



Glen Koedding
President, Green Sun
Energy Services, LLC

SEE AD ON PAGE 25



OMG Roofing Products

Product: OMG PowerGrip and PowerGrip Plus

Application: Roof-mount

Type: Fixed

Material: Galvalume plate with TPO or PVC membrane specific to the existing roof cover

Pre- or Post-assembly: Pre-assembled

Warranty: Through roof system manufacturer where applicable

Key Features:

- Protects commercial roofs (PVC and TPO) from damage due to ballast rack movement;
- Simple installation process saves time and labor;
- Brand specific material ensures that each PowerGrip is 100% compatible with the PVC or TPO roof system on the facility, and accepted by many roofing manufacturers;
- Properly installed PowerGrips provide a secure anchor to the roof deck and remain watertight;

www.omgpowergrip.com

SEE AD ON PAGE 29



Sun Action Trackers

Product: PST-1AX6 Single Axis Tracker

Application: Ground-mount, utility-scale commercial

Type: Tracking

Angle: +45° to -45°

Material: Magnesium alloy coated steel, hot dipped galvanized steel

Warranty: 5-year critical parts warranty with 20-year structural warranty

Key Features:

- Real time sensing technology developed to capture maximum energy production by the use of a patented real-time sensor;
- Low voltage DC motors require low maintenance and minimum downtime;
- magnesium alloy coated steel (self-healing) design with long life reliability;
- Simple link with Self-Power Controller (SPC);
- 6.75 modules per post.

www.sat-energy.com



Solar Speed Rack

Product: Solar GroundMount

Application: Ground-mount, utility-scale, commercial, and residential

Type: Fixed

Angle: 0° to 35°

Material: High strength steel, stainless steel, and anodized aluminum

Pre- or Post-assembly: Nearly all components are pre-assembled, and/or kitted for rapid install

Certifications/Approvals: UL 467, PE Certified

Warranty: 10-year warranty

www.solarspeedrack.com



Zomeworks

Product: FXL-260 (up to 4kW)

Application: Pole-mount rack

Type: Fixed

Angle: 0° to 45°

Material: Welded steel, aluminum

Pre- or Post-assembly: Post-assembly

Warranty: 10-year warranty, materials and workmanship

www.zomeworks.com



hb solar canada

Product: BLOCKMOUNT2

Application: Roof-mount

Type: Fixed

Angle: 3° to 7°

Material: Aluminum, stainless steel, or galvanized option

Pre- or Post-assembly: High degree of pre-assembly

Certifications/Approvals: UL2703

Warranty: 10-year warranty with 20-year warranty available

www.hbsolar.ca

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SEE AD ON PAGE 33



RBI Solar

Product: Ground-mount solutions

Application: Ground-mount, commercial, utility-scale

Type: Fixed

Angle: 5° to 40°

Material: Galvanized steel

Certifications/Approvals: UL 2703

Warranty: 20-year warranty

Key Features:

- Custom engineered to specific site conditions;
- High strength steel with corrosion protection;
- Fast and hassle-free installation services available nationwide;
- Reduced number of posts;
- Stamped drawings include foundation;
- Optional pre-assembly for ground-mount solar;
- Follow contours to mitigate civil/site work.

www.rbisolar.com

SEE AD ON PAGE 9



GameChange Solar

Product: Genius Tracker

Application: Utility-scale

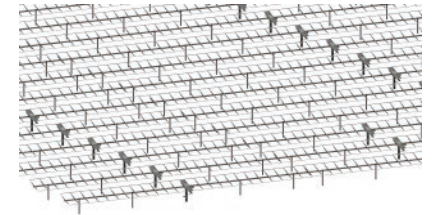
Type: Single axis tracker

Material: Galvanized steel, aluminum, stainless steel

Pre- or Post-assembly: Post-assembly

Certifications/Approvals: CPP Wind tunnel, UL 2703, Black & Veatch

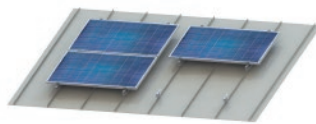
Warranty: 20-year structural components warranty, 5-year control and drive systems warranty is ex-extendable to 20-year



Key Features:

- A highly reliable tracker with fast install and low O&M cost;
- Single axis tracker with a high 99.3% panel density on rows;
- Tru3D-Gimbal bearings account for pile installation being out of plumb, out of azimuth, and out of vertical and E-W alignment;
- Every drive actuator has its own battery backup and wirelessly linked controller, eliminating all trenching;
- Self powered rows eliminate central drive to allow for uninterrupted grass cutting and panel washing.

www.gamechangesolar.com



KB Racking

Product: SeamRack RL

Application: Standing seam metal roof

Type: Fixed, non-penetrating

Angle: 0° to 80° (parallel to roof pitch)

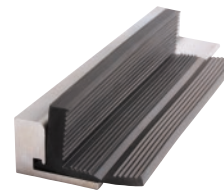
Material: Aluminum and stainless steel

Pre- or Post-assembly: On-site assembly of pre-cut parts

Certifications/Approvals: UL 467 (KB Connect), UL 2703 pending

Warranty: 10-year standard product warranty, extended available

www.kbracking.com



Lauren Manufacturing

Product: Custom isolators

Application: Roof-mount, ground-mount

Type: Both fixed and tracking

Material: Rubber and plastic

Pre- or Post-assembly: Pre-assembled

Certifications/Approvals: TS 16949, ISO 9001 w/design, ISO 14001

www.lauren.com

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SEE AD ON PAGE 33



Renusol

Product: Renusol EW

Application: Roof-mount (ballasted flat-roof system)

Type: Fixed

Angle: 10°

Material: Aluminum

Certifications/Approvals: UL 1703, Type 1 and Type 2, with UL pending

Warranty: 10-year warranty

Key Features:

- Up to 20% more module density on the roof;
- More hours of PV generation with better utilization of the inverters;
- Streamlined design lowers ballast weight; integrated ballast blocks;
- Wind tunnel tested, no air deflectors required;
- No long rails to manage, universal clamps.

www.renusolamerica.com

SEE AD ON PAGE 3



Sol Components

Product: PVCobra Fixed Tilt

Application: Utility-scale ground-mount

Type: Fixed

Angle: 5° to 35° (configurable)

Material: Light gauge structural steel

Pre- or Post-assembly: Components require no field welding

Certifications/Approvals: UL2703 and meets IBC 2012, CBC 2013

Warranty: 5-, 10- and 20-year structural warranties available; Surety: Bid Bond, Supply Bond and Warranty Bonds available thru Wells Fargo

Key Features:

- 100% domestic products;
- Designed for durability and simplicity;
- In-house engineering team ensures customized designs.

www.solcomponents.com

SEE AD ON PAGE 39



Cosma Renewable Systems

Product: Fixed tilt racking, single axis tracker

Application: Utility-scale ground-mount

Type: Fixed, tracking

Angle: Fully customizable

Material: Galvanized HSLA steel

Pre- or Post-assembly: Post-assembly

Certifications/Approvals: ASCE 7-10, OBC 12, UL 2703 compliant (grounding and bonding), ISO compliant

Warranty: 25-year warranty

Key Features:

- CPP wind tested, snow tested to 70psf;
- Full-scale physical validation, durability, and lifecycle testing;
- Patent pending stow strategy, programmable snow shedding strategy;
- Tested to withstand corrosion.

www.cosma-solar.com

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Brittmore Group

Product: SolWay GM2 with automated installation

Application: Ground-mount, utility-scale, distributed solar, commercial

Type: Fixed

Angle: 5° to 35°

Material: High-strength galvanized steel

Pre- or Post-assembly: Nearly all components are pre-assembled, with only 8 fasteners to assemble rack in field

Certifications/Approvals: UL 2703

Warranty: 20-year limited warranty

www.brittmore.com



SunRise Solar America, Inc.

Product: Drop On Solar Arrays

Application: Residential rooftop

Type: Fixed

Angle: Any roof angle

Material: Aluminum

Pre- or Post-assembly: Post-assembly

Certifications/Approvals: Patented

Warranty: 20-year standard warranty

www.droponsolar.com



Grupo Clavijo

Product: SP-1000

Application: Ground-mount, utility-scale, commercial

Type: Single axis tracking system

Angle: 50°

Material: Galvanized steel

Pre- or Post-assembly: Post-assembly

Certifications/Approvals: TUV Nord, Black & Veatch, AWS, IQnet, AENOR ER

Warranty: 10-, 20-year warranty

www.grupoclavijo.net

SEE AD ON PAGE 34



Solar Clam-P

Product: O Clam-P

Application: All applications

Material: Aluminum

Pre- or Post-assembly: Pre-assembled

Certifications/Approvals: UL 2703

Warranty: 25-year warranty

Key Features:

- Any microinverter, any optimizer, and panel;
- 4MW of installed capacity since 2011, O Clam-P is field tested and proven;
- O Clam-P's come pre-assembled to provide fast installation;
- Microinverters and optimizers can be installed in a controlled environment, reducing labor costs and improving logistics;
- Custom colors are available to personalize each system.

www.solarclam-p.com

SEE AD ON PAGE 31



Structural Solar LLC

Product: Canopy and Ground Mount Structures

Application: All parking areas and ground mounts

Type: Fixed

Angle: up to 45°

Material: Galvanized and Aluminum Structures

Pre- or Post-assembly: From supply only to fully installed

Certifications/Approvals: AISC

Warranty: Structures durable for 40-years

Key Features:

- Structural Design;
- Manufacturing;
- Construction.

www.structuralsolar.com



Soltec America, LLC

Product: SF Utility Single-Axis Tracker

Application: Ground-mount, utility-scale, distributed solar, commercial

Type: Tracking

Angle: +/- 60°

Material: Galvanized steel

Pre- or Post-assembly: Post-assembly

Certifications/Approvals: UL 3703

Warranty: 10-year structural warranty, 5-year extendable warranty for motor and electronics

www.soltec.com





www.obous.com



Polar Racking

Product: Utility ground-mount system

Application: Ground-mount, utility-scale, distributed solar, community solar

Type: Fixed

Angle: 15°, 20°, 25°, 30°, and 35°

Material: Galvanized steel

Pre- or Post-assembly: Pre-assembled, minimal components for easy installation

Certifications/Approvals: UL 2703 bonding hardware

Warranty: 20-year warranty

www.polarracking.com




• Commercial and residential solutions

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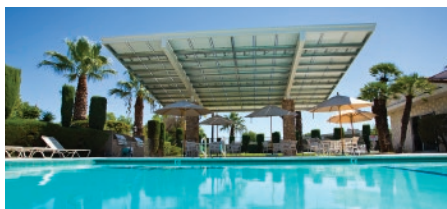
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www.kineticsolar.com

Solar Structures & Carports

Solar power carports and structures take full advantage of large areas, such as parking lots, for the purpose of producing electricity while, at the same time, providing shade and a covered area for users. Gaining popularity over recent years, these solar structures are ideal for generating renewable power without sacrificing valuable real estate. The following listing offers details about some of the more popular options available on the market today.

SEE ADS ON PAGES 5 & 45



Baja Construction Co., Ltd.

Product: Custom designed and engineered solar support structures

Roof inclination: 0° to 15°

Height Clearance: 7' to 14'

Depth: 10' to unlimited (20' to 40' is typical)

Space-to-Column Ratio: 2:1 typical, with 4:1 max

Configuration: More than 3,000, standard solutions to accommodate any financial model. Most popular: full cantilever boxed

Options: Direct solar panel attachment to purlins, solar thermal panel option, thin-film or crystalline, as well as concrete bollards, field painting, fascia, standard and custom, and racking

EV Charging: Available

Panel Type: Neutral, can design/engineer to any model

Power Generated (per kilowatt-hour): Based on module selection, orientation, layout, and location. Baja can accommodate proposed PV layout, improving integration and implementation of solar to canopy structures

Certifications: NABCEP Technical sales/installation, certified fabricators, general contractor, licensed engineers, and certified welders. Baja is licensed in more than 27 States, plus Puerto Rico

Key Features:

- Fully designed, supplied, and installed by Baja;
- Pre-fabricated, pre-engineered, all-galvanized, and custom engineered to site, soils, local codes, and solar panels;
- Turnkey solutions with industry partnerships facilitate and improve project schedule timelines;
- Engineering includes footing design.

www.bajacarports.com

SEE AD ON PAGE 41



Kinetic Solar

Product: Solar Carport

Roof inclination: 10°

Height Clearance: 7.2'

Depth: 20'

Space-to-Column Ratio: Single carport occupies 2 parking spots (min 8.8' parking spot width)

Configuration: 24 Panels, landscape

Options: Off-grid with battery, grid-tied with FIT (non-rooftop), and net-metering

EV Charging: Level I or II EV chargers to charge up to 2 vehicles

Panel Type: Can accommodate any panel

Power Generated (per kilowatt-hour): 6.85kW system size. The installation is an off-grid setup with batteries from Canadian Energy.

Key Features:

- Level III fast DC chargers with battery option can be integrated with larger carports;
- Durable, modular, easy installation;
- Engineered to withstand over 150mph winds;
- No loss of parking spots;
- Innovative foundation solution with no excavation

kineticsolar.com



Inovateus Solar

Product: Carport

Roof inclination: 5° and 15°

Height Clearance: 13'

Depth: 40'

Space-to-Column Ratio: 27'

Configuration: Landscape

Options: Module direct attachment; underside decking; concrete bollards; paint; and hot dipped galvanized

EV Charging: GE Charging Station

Panel Type: Schott 235W

Power Generated (per kilowatt-hour): 100kW

www.inovateus.com



Solar Structure Systems, LLC

Product: Steel solar carports and custom solar shade structures

Roof inclination: 5° to 20°

Height Clearance: 7' to 20', design build per solar designer's needs

Depth: per solar designers needs

Space-to-Column Ratio: 2:1, 3:1, and custom per solar designer's needs

Configuration: Full and semi-cantilever, double-cantilever tee, custom per solar designer's needs

Options: direct mount to pre-punched purlins, tube steel

www.solarstructuresystems.com

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SEE AD ON PAGE 31



Structural Solar LLC

Product: Solar Carports, canopies, pavilions, ground-mounts

Roof inclination: 0° to 25°

Height Clearance: Unlimited

Depth: up to 60'

Space-to-Column Ratio: Columns typically on 27' centers

Configuration: All types

Options: Architectural options, roofing, lighting, charging stations

EV Charging: Yes

Panel Type: All types of modules including bi-facial frameless modules in water management system

Power Generated (per kilowatt-hour): no limit

Certifications: AISC certified fabrication and coating

Key Features:

- Licensed across the USA;
- Module-ready structures
- Durable for 40 years

www.structuralsolar.com



M Bar C Construction

Product: Custom-designed "T" and "OT" structures

Roof inclination: 0° to 15°

Height Clearance: 9' to 15'

Depth: 10' to 40'

Space-to-Column Ratio: 2:1 or 3:1

Configuration: Any

Options: Module direct attachment; underside decking; concrete bollards; paint; and hot dipped galvanized

EV Charging: Optional

Panel Type: Any

Power Generated (per kilowatt-hour): Based on project size

Certifications: General contractor; structural steel contractor; certified welders

www.mbarconline.com



S:FLEX Inc.

Product: S:FLEX PV Carports

Roof inclination: 0° to 15°

Height Clearance: 8' to 15'

Depth: 20' to 50'

Space-to-Column Ratio: 27' span between columns

Configuration: Standard portrait settings are from 3-high to 7-high including a 3x3-Y. Landscape options are also available.

Options: Supply-only with various options

EV Charging: Available by third-party

Panel Type: Any framed modules, however 72-cell modules are preferred

Power Generated (per kilowatt-hour): Various, dependent on size and tilt

Certifications: DSA Approved, grounding certificates, meets all current code requirements

www.pvcarports.com

Specialists in Solar Support Structures

We Have Your Solution Covered!



There are no barriers to the scope of work Skyline Solar of AZ can facilitate from small to utility scale installations.

- Over 100MW of Structures installed across US and now in Hawaii
- Design/Build Standard and Custom Steel Support Structures
- 2013 UBC – DSA PC Standard Carport Designs as low as \$0.9/W

Our Services Include Project Management, Engineering, Fabrication, Site Mobilization, Construction and Installation of Solar Carports, Canopies for Parking Garages & Bus Parking, Ground Mounts & Ballasted Flat Roof. P.E. stamped plan sets in all 50 states

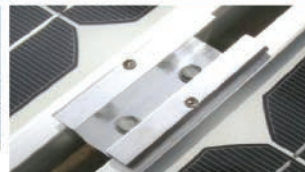


Why is Skyline Solar of AZ Chosen Time and Time Again? QUALITY, CUSTOMER SERVICE AND DEDICATION

With over 30 years experience of steel fabrication and erection, our one-stop shop, knowledgeable team and highly trained field crews have worked together with an array of clients in commercial, industrial, civil, municipal, medical, educational and government construction. Our reputation for safety, on time installation and low cost keeps our customers returning



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NEW SkyGrip™ top grounding middle clamp eliminates lay-in ground lugs and copper wire on solar modules. Listed to UL467 self drilling screws or bolted connections to metal rails, available now at competitive pricing.



NEW SkyBite™ stainless steel solar module mounting and grounding attachment developed for carports, Listed to UL467, installs from below - reduces safety risk and damage from crawling or walking on PV modules. Coming soon at great pricing!

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480-926-0122

info@solarcarportsaz.com www.skylinesolaraz.com

SEE AD ON PAGE 43



Skyline Solar of AZ

Product: Solar Carport Structures

Roof inclination: 0° to 15°

Height Clearance: 7' to 25'

Depth: 10' to 50'

Space-to-Column Ratio: 2:1 to 6:1

Configuration: Landscape or portrait

Options: Single or double cantilevered, double post and beam, straight or tapered beams, exposed piers, deck, painted, or galvanized

EV Charging: Charging station can be attached to the columns

Panel Type: Specified by integrator



Certifications: AISC Certified fabrication shop, OSHA Certified / CPR trained crews, Certified field welders

Key Features:

- Using Skyline Solar's employees and equipment ensure on-time schedule;
- All structures are designed to fit location by a licensed engineer, includes all local codes and seismic requirements, and footing designs;
- Panels can be installed with Skyline Solar's self grounding clamps, saving time and money.

www.skylinesteelinc.com

SEE AD ON PAGE 33



RBI Solar

Product: CP-T, CP-K, CP-P, RBI Long Span

Roof inclination: 7° standard

Height Clearance: 10' and 14' standard

Depth: 39' standard

Space-to-Column Ratio: 4:1

Configuration: Portrait

Options: Truss for higher loading conditions, multiple coating types

EV Charging: Mounting options available

Panel Type: Works with all commercially available solar modules

Certifications: In-house stamp for all 50 states

Key Features:

- No field welding, drilling, or other on-site fabrication;
- Pre-engineered solution for custom situations;
- Installation services available;
- Increased bay size to minimize parking lot interference.

www.rbisolar.com



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Media Sponsors



SEE AD ON PAGE 42



Park n' Shade Inc.

Product: Custom designed and engineered solar carports and shade structures

Roof inclination: 0° to 20°

Height Clearance: 7' to 25'

Depth: 10' to desired depth (36' to 40' is typical)

Space-to-Column Ratio: 1:1 to 3:1

Configuration: Semi-cantilever, full-cantilever, TEE- cantilever, double post, super-structure

Options: Galvanized, wide flange I-beam, tube steel, weld or bolt-together frames, painted to match client's request, slide-in solar purlin with UL 2703 compliant mounting clips, underside decking

EV Charging: Can be designed and built into the carports

Panel Type: System is designed to the client's chosen module

Power Generated (per kilowatt-hour):

Dependent on the client's layout and chosen design. Park n' Shade will design-build their carports to fit each individual project.

Certifications: Licensed contractor, certified welders, DSA PC designs, engineering licensed in all 50 States and Territories, installation crews are OSHA certified

Key Features:

- A one-stop shop for design, engineering, fabrication, and complete structural installations (footings included) with optional module installation;
- Solar purlin racking system with gator clip reduces install times and decreases the overall purlin count by up to 40%;
- Individual attention given to design and build the carport that will fit a client's project;
- Onsite construction consultation in all 50 States and Territories

www.parknshade.com



Quality Solutions Optimized by Experienced Industry Professionals

AFTER 31 YEARS IN BUSINESS, Baja Construction has perfected the craft of optimizing the process of “Design to Implementation”. Baja’s “All-In” or “Turnkey” Approach to implementing Solar Carport, standard carport, as well as Solar RV, standard RV, and boat facility projects have led the industry for three decades.

Facilitating opportunities with existing customers as well as creating new relationships are the motivating factors in Baja’s continued success.

As the industry strives to create new opportunities and open the door for increased capacity, the demand for experienced implementation is growing. Baja Construction is dedicated to supporting the industry and welcomes the opportunity to lead the way in setting the standard. Baja Construction is focused on the future of the carport and RV industry and will continue to pave the way for success.

As a leader in the industry, Baja Construction is also dedicated to a continued commitment of keeping its customers, as well as the industry as a whole, informed of changes and trends in the marketplace. We are continually educating ourselves for the sole purpose of keeping our customers updated so that they can make informed decisions.

Baja Construction Co. Inc. is a construction company built on reputation, experience, and training with a backbone of honesty and integrity.

We provide construction project related services and proprietary product lines to both public and private sector clients in a timely, cost effective, and innovative manner while providing quality and responsive service by a qualified and experienced staff. Baja’s commitment is to provide exceptional client service in a fair, ethical, and independent manner.

Few owners maintain the necessary staff to pay close, continuing attention to detail throughout every phase of the project – yet, in today’s volatile market, these details can “make or break” a project.

Baja can augment the client’s project with pre-planning, design, and structural engineering, contracting, management, and general construction expertise that can ensure the best possible project outcome no matter the size or type of delivery method used.

The company best serves its clients by being an independent firm focused on providing quality professional construction services and products at a fair rate with no conflicting interests or influences.

We bring expert construction experience as structural sub-contractors and solar support structure supplier along with professional and technical expertise.

BACKGROUND

Baja Construction Co. Inc. is a California corporation established in 1981 and serving the entire United States, Canada, Mexico, as well as Puerto Rico and all of the Caribbean Island region. Our professional staff provides design, engineering and turn-key construction services for solar support structures to a wide range of public and private clients on both engineering and building projects.

The company was created out of the desire to better serve the client by being a “project advocate”, acting in ways which are ultimately in the client’s best interest. We are committed to quality and have incorporated it into our core principles. We are proud of our service

and performance for our clients. Our repeat selections and contract extensions attest to our ability, our commitment to provide quality construction related services and products, our understanding and command of the nature of work to be performed, and our desire to be responsive to all task assignments related to our scope of work.

The Mission of Baja Construction Co. Inc is to provide the highest quality construction services and products to all clients including municipalities, agencies, developers, designers, and contractors. In other words...all project shareholders. We want to help achieve their goals related to the project in an ethical, creative, and cost-efficient manner by applying effective management and sustainable techniques to the planning, design, engineering, and construction of a project from inception to completion for the purposes of controlling time, cost, and quality while enhancing the quality of life and the environment.

Our Philosophy is to be the client’s advocate during the project. We combine knowledge, experience, judgment, and leadership ability with a commitment to excellence and professionalism in providing construction services and quality products. We owe the client a special duty as the owner’s “expert” structural representative. Providing services with intelligence, integrity, and energy and being exclusively responsible to the client, acting in their best interest at every stage of the project to ensure complete satisfaction. To achieve this, we must be the “project advocate” as well. In order to maintain this responsibility to our clients we adhere to a code of ethics as professionals responsible for the successful completion of the project. These services are engaged based on demonstrated competence and qualifications for the types of services to be performed and at fair and reasonable prices to the client. We believe good things tend to happen to companies and individuals that consistently do the right thing. It is the smart thing to do, and it is the Baja Construction Co. Inc. philosophy!

Baja Construction Co. Inc. has performed construction services and provided quality solar support products under several public works and private contracts. Through this experience, our team has gained an excellent understanding of project requirements and a depth of experience in responding to them. Our team is proficient at a multitude of tasks and can effectively plan for flexible workload and scheduling requirements. We have the ability to respond to smaller projects with short project durations, including those that require highly specialized and out of the ordinary services. The depth of our construction and engineering experience will provide a distinct benefit to the client. Projects that represent the depth of our experience include, the construction and development of commercial, residential, public works, DSA, OSHPD and other development projects. We have successfully completed many of these types of projects for developers, agencies, municipalities, and contractors alike.



Ground Screws & Anchors

Ground screws are becoming the choice in foundation methods. They eliminate the need for concrete and allow foundations to be quickly set. The following highlights a variety of available options to suit different applications and soil conditions.

SEE AD ON PAGE 47



Ancora

Product: Solar Foundation Piles

Description: Ancora manufactures project specific driven beam and helical anchor foundation piles. Beams typically are W6x9, or W8x10. Helical anchors range in post sizes of 4.5", 5.0", and 5.563" with wall thicknesses from .250" to .375". Helixes range in size from 12" to 24". Foundation piles are hot dipped galvanized to ASTM A123, post fabrication. Piles are packaged in bundle configurations to minimize shipping costs.

Material: Steel

Surface Treatment: Hot dipped galvanized

Diameter: Project specific

Thickness: Project specific

Length: Project specific

Flange Size: Project specific

Thread Pitch: Project specific

Threads: Project specific

Key Features:

- Manufacturer-direct supplier;
- Project sizes from 500kW to 100MW;
- Site specific;
- Optimized designs;
- High volume manufacturing.

www.ancorapiling.com

SEE AD ON PAGE 47



American Earth Anchors

Product: PE46-Hex

Description: 46" aluminum screw anchor that replaces concrete footings adjustable height for leveling. The PE46-Hex will not rust and weighs only 10lbs (4.54kg)

Material: Heat treated aluminum

Diameter: 3" (7.62cm) flights

Thickness: 1 3/4" (4.45cm) shaft

Length: 46" (116.84cm)

Flange Size: 4" (10.16cm)

Thread Width: 3" (7.62cm)

Thread Pitch: 2.25" (5.72cm)

Threads: 17

Key Features:

- Replaces concrete footing, no digging, forms, pouring, or waiting;
- 14,000 lbs (6350kg) of pull-out and 9,000 lbs (4082kg) down pressure;
- Aircraft-quality 356 alloy, heat-treated, cast aluminum;
- Fast installation with 2" (5.08cm) socket and impact wrench; and
- 3/4" (1.9cm) hole tapped in head for post brackets, threaded rod, etc.

www.americanea.com



TerraSmart

Product: Ground Screw

Description: TerraSmart's patented ground screw offers a versatile and economical solution in all soil and field conditions. Ground screws have an ability to penetrate the toughest soil conditions, including: bed-rock, caliche, permafrost, and coral, with ease in just minutes.

Material: Galvanized steel to ISO 1461 (EQ. ASTM A123)

Diameter: 3" (7.62cm)

Thickness: .165" (8 gauge)

Length: 82" (208.28cm)

www.terrasmart.com



Cantsink Manufacturing

Product: Helical Pile Foundation

Description: A helical pile is a steel pipe with a helix plate at the bottom. They are screwed into the ground with a bobcat or similar machinery. The helical piles perform extremely well in very poor, sandy or other non-cohesive soils, and they are used for foundation support.

Material: Steel

Surface Treatment: Hot dipped galvanized

Diameter: 2" to 8" (5.08cm to 20.32cm)

Thickness: Varies

Length: Standard lengths range from 5ft (1.52m) to 10.5 ft (3.2m)

Flange Size: Helix ranges from 11" (27.94cm) to (35.56cm) standard

www.cantsink.com



- Helical Pier Foundation and Pat. Pending Pier Stabilizers for controlling lateral loads
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- Extremely high load bearing and pull-out resistance to tens of thousands of lbs
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- Customizable to connect to almost any design or configuration
- The ability to provide additional anchoring for existing preinstalled solar foundations



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sales@milspecanchors.com [web: milspecanchors.com](http://web:milspecanchors.com)

SEE AD ON PAGE 46



Milspec Earth Anchors

Product: Solar Helical Pier

Description: Solar pier with helical plate is a foundation alternative to cement or driven H-beam. Milspec's solar helical pier allows for greater loads and has an extremely high pullout resistance. With a 50-year minimum lifespan, they are easily removed and can be reused.

Material: API pipe

Surface Treatment: Hot-dipped galvanized

Diameter: 2 3/8" (6.03cm), 2 7/8" (7.3cm), 3 1/2" (8.89cm), or larger if needed

Thickness: .190w to .337w

Length: 5ft to 10ft (1.5m to 3m) as needed

Flange Size: As required

Thread Pitch: 3" (7.62cm)

Threads: 1 to 3 helices

Key Features:

- Start loading immediately after installation;
- Reusable;
- Custom pier stabilizers control lateral loads;
- Milspec Earth Anchors manufactures their piers and can perform installations upon request.

www.milspecanchors.com



Ground Connection, LLC

Product: Foundation ground screw

Description: Ground Connection's ground screws are used in lieu of concrete foundations in many applications including highway signs, solar LED lighting and solar installations. Ground screws use the natural compression of the earth for strength and stability. They can be installed in minutes and do not disturb the site or require extensive clean up. They are the environmentally conscious solution.

Material: Cold rolled steel

Surface Treatment: Double hot-dipped galvanized

Diameter: 2" to 5" (5.08cm to 12.7cm)

Thickness: Varies, depending on size

Length: 22ft to 200ft (6.7m to 61m)

Flange Size: Various flanges available

www.groundconnection.us.com



Earth Contact Products

Product: ECP Ground-Mount Solar Foundations

Description: ECP Solar Foundations are designed and engineered to provide a strong foundation element for ground-mount solar systems. Multiple solar foundation systems are available for post-type, ballasted, or arrays.

Material: Steel

Surface Treatment: Hot dipped galvanized

Diameter: 2.88" (7.32cm)

Thickness: .203" (.515cm)

Length: 7ft to 10ft (2.13m to 3.05m)

Flange Size: Variable

www.earthcontactproducts.com

Bayo-S, Ltd.

Product: Extendable ground screws

Description: Extendable ground screw foundation system for quick, easy, and environmentally friendly foundation construction for all available solar arrays. The ground screws work in all terrains, including rock. The unique, extendable system allows a response to changing soil conditions on site without slowing down production.

Material: Steel

Surface Treatment: Galvanized

Diameter: 3" (76mm)

Thickness: 3.8mm

Length: 3ft to 11ft (90cm to 350cm)

Flange Size: Adjustable

Thread Width: Depending on load requirements

Thread Pitch: Depending on load requirements

Threads: Galvanized steel

www.bayo-s.com



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Driven Piles

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- ASTM A992 / A572 Gr50

- High Volume Production
- Project Specific

Helical Anchors

- 4.500", 5.000" or 5.563" OD
- ASTM A500-C
- True Pitch Helices: 3", 4" or 6"

- Northern climates with soil susceptible to frost heave
- Expansive soils with high clay contents

www.ancorapiling.com



American Earth Anchors

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Metal Fabrication for Solar Structures

Customized shapes and formed structures designed to mount, secure, and support solar panels are a significant component to any reliable solar power project. This is where processes such as roll forming and extrusion come into play. The following highlights some of the main companies involved in metal fabrication processes for solar components and related support structures.



SALES OFFICE

Kipp & Zonen USA Inc.
125 Wilbur Place
Bohemia NY 11716
USA

Rodney Esposito
T: +1 (0) 631 589 2065 ext. 338
F: +1 (0) 631 589 2068
M: +1 (0) 631 786 1558
rodney.esposito@kippzonen.com
www.kippzonen.com

Passion for Precision

Accurately Monitoring the Performance of your Solar Energy System



To maximize the effectiveness of your solar energy system, you need to know how it is performing. A Kipp & Zonen pyranometer accurately measures the solar radiation available to your system in real time. Comparing this with the power generated allows you to calculate the efficiency of the system. A drop in efficiency indicates the need for cleaning, ageing or a fault, allowing you to schedule preventive maintenance and to monitor your return on investment.

Make that difference and contact Kipp & Zonen for the solutions available.



voestalpine Roll Forming Corporation

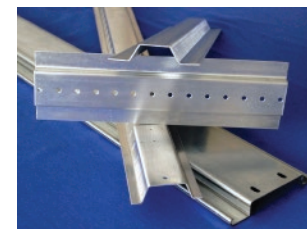
Product/Technology: 42 roll forming lines; laser and dual laser welding; high-frequency welding; laser cutting; bending; post-dip galvanizing; TOX and Tog-L-Lok; rotary stitch; pre-, mid-, and post-punching; and variable thickness materials

Materials: TCRS; HR; HRPO; pre-paint; pre-galvanized aluminum; Titanium, Inconel, and Hastelloy alloys; stainless steel; HSLA; as well as brass, bronze, and copper

Sizing: 0.005" to 0.150" thickness, and coil widths up to 20" wide before forming; maximum height of profiles 5.25" in the vertical axis

Shapes/Structures: Cee's, Zee's, Purlins, Struts, Sigma's, and many other complex shapes

www.rfcorp.com



Johnson Bros. Metal Forming Co.

Product/Technology: Modernized equipment and tooling designed to offer roll forming services with the latest automated technology, including: pre-notching; pre-punching; cut-to-length; and post-fabricating, combined with the cut-length operations

Materials: All metals, including: ferrous and non-ferrous in either plain or pre-anodized; pre-painted; pre-laminated; pre-embossed; perforated; duplex; special alloy; pre-hard tempers; and more

Sizing: 0.005" to 0.150" thickness, and coil widths up to 20" wide before forming; maximum height of profiles 5.25" in the vertical axis

Shapes/Structures: Profiles; panel frames; reflectors; trim; support structure framing; Hat shapes; C-channels; U-channels; Zees; rings; and many other custom shapes for solar components

www.johnsonrollforming.com



RPM Rollformed Metal Products Ltd.

Product/Technology: Rollformed steel

Materials: Steel: Galvanized CRS, HRPO, galvalume, galvaneal and stainless, aluminum, brass, zinc, and copper

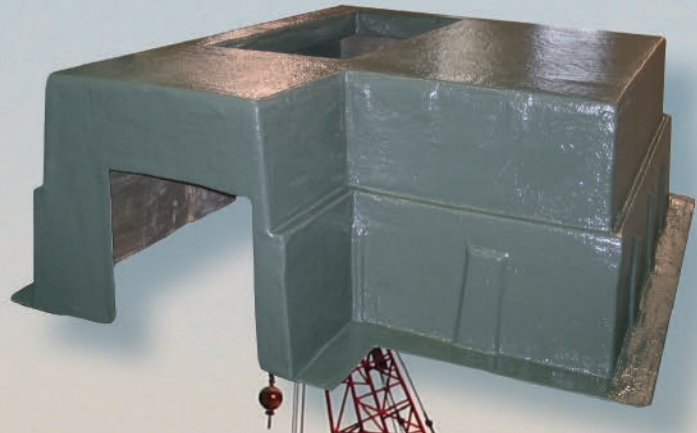
Sizing: Material 0.008" min, 0.168" max (future expansion: 0.250"); strip width 24"; length capabilities 12" min, 60' max

Shapes/Structures: Custom shapes, Z purlins, C channels, U channels, punching, notching, cut-to-length, pre-galvanized steel up to 7 gauge

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The Good News for Renewables

by Chris Brown

Last year proved to be a turning point for renewable energy and the world. In December alone, 196 countries attending COP21 committed to the Paris Agreement, a historic deal to limit carbon pollution to 2°C or less.



And, after two decades of failed attempts, largely due to outright refusals or half-hearted attempts by the biggest pollution contributors to address the challenges of climate change, not only did countries reach an accord, but policy and business leaders attending the climate talks and around the world recognized the centrality of renewable energy sources in arriving to a clean energy future.

Public and private entities made a number of key announcements leading up to the climate accords.

Bill Gates formed the “Breakthrough Energy Initiative,” a private and public partnership dedicated to advancing clean energy technologies. In a related announcement, President Obama and Mr. Gates launched the Mission Innovation program, in which 19 countries, including the U.S., committed to doubling research and funding for clean energy reaching \$20 billion within the next five years. Through the group’s efforts, funding for research will total \$20 billion.

The good news for renewables did not stop at Paris

Less than a week later, the U.S. renewables sector and its supporters were buoyed by Congress’ passage of a five-year extension of both the wind Production Tax Credit, and the solar Investment Tax Credit. After years of roadblocks, both sectors now have the level playing field and predictable policy environment necessary to drive investments up even further.

After all, despite roadblocks on the policy front and fossil fuels’ ongoing efforts to disrupt wind and solar industries’ momentum, renewables were already winning. The economics and independence they provide make sense to a lot of major companies like Google, Walmart, and Amazon.



Over the last twenty years, the cost of wind dropped 80 percent globally and rose to almost 400 gigawatts, with Lazard research demonstrating a 61 percent decrease in real wind energy’s cost since 2009 in the U.S.

Bloomberg New Energy Finance (BNEF) found the costs for newly installed wind power in the U.S. and Europe fell below \$100 per megawatt-hour to levels almost equal to coal.

In addition, wind’s low cost has made it the number one new source of energy in a good number of major markets around the world.

And, in 2014, wind accounted for 20 percent of all newly installed energy capacity around the world.

Wall Street has noticed and is seeing the capital potential of renewable energy

Blackrock Alternative Investors, which manages \$110 billion in investments, recently created a renewable power investment group which forecasts spending in renewable energy to reach \$1 trillion by 2035 in the U.S. and European Union.

Goldman Sachs increased its renewable financing targets to \$150 billion and announced renewable energy had bested fossil fuels in newly installed power.

Bloomberg New Energy Finance reported green bonds to support climate-friendly projects attracted \$40 billion in investments in 2014, an eight-fold increase from 2012.

Between the beginning of 2013 through April 2015, the WilderHill New Energy Global Innovation Index, which follows companies “whose innovative technologies and services focus on generation and use of cleaner energy, conservation and efficiency, and advancing renewable energy generally” has shown a 50 percent return.

Conversely, the outlook for fossil fuels, despite \$500 billion in subsidies annually, is less optimistic.

The S&P 500 Oil and Gas index has been mostly static, while the Stowe Global Coal index has dropped more than 50 percent, according to BNEF.

The increased predictability of both wind and solar technologies has made renewable energy even more attractive to investors.

The wind industry’s ability to forecast from wind turbines globally has enabled the elimination of unpredictable energy spikes. Especially for countries hard hit by drought, wind, unlike fossil fuel sources, offers a virtually water-free solution.

Wind is advancing in other ways as well. The industry now employs 70,000 American workers. That number is projected to rise to 375,000 by 2030.

The success of the Paris Agreement, passage of equalizing federal policy, advances in technology, and decreases in costs have demonstrated to world leaders, private and public investors, utilities, and the general public that wind makes sense on so many levels.

For anyone who still asks, “Why renewables?” the answer is, “How can you afford not to?”



Chris Brown is president of Vestas North America.

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Wind Plant Modeling Data Essential to Interconnections

by Jim Smith

WIND POWER DEVELOPERS OFTEN ARE NOT AWARE UNTIL THE LAST MINUTE before submitting an interconnection application that they are required to provide computer modeling data. Ignorance, in this case, certainly isn't bliss, but a little awareness can make the process a lot less painful.

The North American Electric Reliability Corporation (NERC) requires generation operators to provide computer models when they apply to connect to a transmission grid in the United States or Canada. NERC requires verified modeling data whether the generation is conventional or renewable above a certain MVA threshold, which varies between interconnections.

The purpose of this modeling data is to study how the proposed generation will impact the grid now and in the future. The data also is used to compile detailed models of the grid to study how the system, as a whole, will perform for various disturbances that may arise.

The modeling discussed here refers to positive sequence models of the power system, which assumes that each of the three phases are balanced so only the positive sequence representation of the system is needed.

Positive sequence computer models for generators have two parts. This is true for conventional, wind, or solar photovoltaic plants. The first part is the load-flow or power-flow model. This is a steady-state or static model and represents the real power (MW) and reactive power (MVAR) capability of the generator.

In most cases, the load-flow model of a wind plant is fairly similar to the load-flow model of a conventional generator, except in the area of reactive power control. Most conventional generators generate reactive power (vars) to control the voltage of its terminal bus or some nearby local bus. Another difference with wind plants is the collector system for the plant is generally replaced with a calculated equivalent in the model so the model resembles a single generator with a step up transformer and equivalent tie line connecting to the utility point of interconnection.

Wind plants most often do not control voltage. Instead, they generate vars based on a constant var output control or a constant power factor control. Some larger wind plants, or solar plants, may be required to control voltage. In such cases, they are required to operate more like a conventional generator. Generally, this is only required when the interconnection point of the wind plant has poor voltage characteristics and the voltage control is needed to correct it.

The second part of a generator model, whether conventional or renewable, is the dynamic portion of the model, sometimes referred to as the stability model. Software packages simulating the positive sequence dynamic behavior of power systems will also include a load-flow module.

The load flow is used as the starting point for dynamic simulations. The load-flow program calculates how the power injected by the new generation will flow through transformers and transmission system, and eventually make its way to customer loads.

The dynamics simulation looks at how the generation responds to disturbances in the system such as faults and loss of a transmission line or transformer. System disturbances can cause generators to lose synchronism and can be very damaging to equipment.

System disturbances also can cause voltage fluctuations on the system. This can interfere with proper power delivery to loads, so determining how the new generation will affect the voltage profile before and after a disturbance is another important consideration in the evaluation of newly proposed generation. With wind turbines, the voltage and frequency ride-through characteristics of the plant are an important part of the dynamic model.

When modeling wind turbine dynamics, one of the biggest differences compared to conventional generators is the inertia of the machine. A conventional generator is electro-mechanically coupled to the grid through its inertia, and the mass of the generator is accelerated and decelerated with even the slightest change in frequency.

Wind turbines are generally classified into one of four types:

- **Type 1:** fixed speed induction machine
- **Type 2:** variable slip induction machine
- **Type 3:** doubly fed induction generator or DFIG
- **Type 4:** inverter-based generator, which injects power into the AC grid electronically

Types 1 to 3 all have significant inertia, although less than a conventional generator. Type 4 wind turbines, the most common generator currently being installed, has no inertia. Having no inertia, these are electronically coupled to the AC grid and not electro-mechanically coupled.

Having no inertia has some benefits, but also some disadvantages. One main benefit is inverter-based generation is much less susceptible to stability problems where the generator loses synchronism with the grid. Inverter-based generation only has to change its firing angle electronically to remain synchronized. Unlike a conventional generator, there is no accelerating or decelerating a rotating mass. A disadvantage in a system containing low inertia is frequency deviations caused by disturbances can be more severe.

Whenever new generation is being proposed, the interconnecting utility is required to do some simulation studies to make sure the proposed generation will operate as expected under normal conditions and will also operate acceptably under abnormal conditions.



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Power systems are very complex and expensive, and simulations are the easiest way to evaluate how these systems are going to interact. After things are built, it is too late to find out they are not going to play well together.

Sometimes wind developers will want to run their own simulation analysis of a planned interconnection to see if their plans have any obvious issues before submitting the interconnection application. This can be useful for determining a suitable generation size and interconnection voltage level prior to the application process. This can help speed up the application process by avoiding a proposed interconnection that will run into complications in the utility system impact study.

Recently, most utilities have spent considerable effort to improve their data and validate their generator models. This includes testing of generators or recording of system disturbance events to obtain field validation of the model parameters. NERC MOD-025-2, which requires verification and reporting of generator real and reactive power capability, applies to wind turbines and is phased-in over five years with at least 40 percent of each generator owner's units due by July 2016.

Field validation of generator excitation dynamics or equivalent controls, and turbine-governor dynamics or equivalent became effective in July 2014 for new or changed plants or controls. For existing plants, the compliance is phased-in over 10 years with at least 30 percent of each generator owner's MVA due by July 2018.

The most common software packages used in the United States for simulating large scale positive sequence models of power systems are PSSE by Siemens-PTI, PSLF by General Electric and PowerWorld by PowerWorld Corporation.

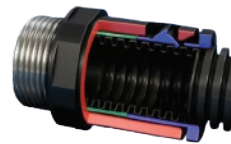
All of these packages contain many of the same standard models for different types of equipment including generators, transmission lines, transformers, shunt reactive devices, loads, and relays.

A typical power system model of the western United States is going to contain many thousands of each of these components, so there is a substantial effort that goes into developing a database to represent the system for different numbers of years projected into the future and different seasons of the year.



James R. Smith, Ph.D., PE, senior project engineer, specializes in power system modeling and dynamic studies services for POWER Engineers, Inc.

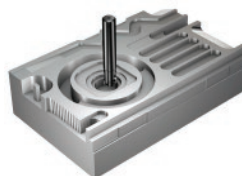
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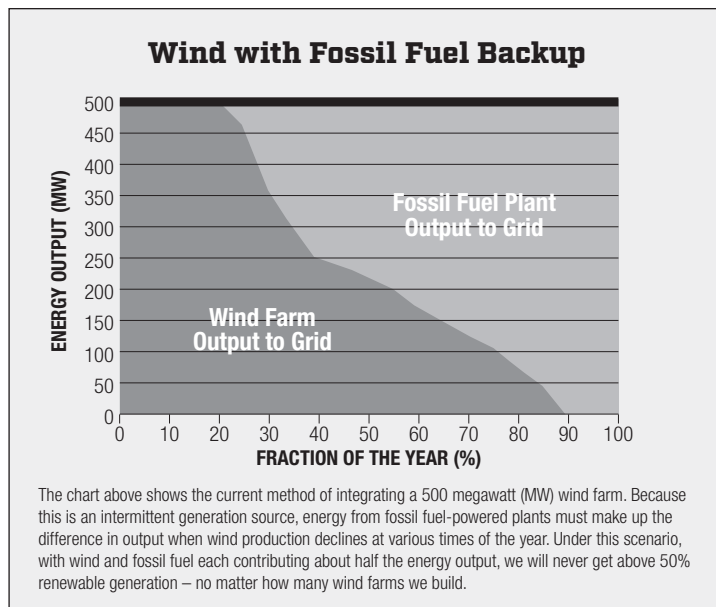


figure 1.

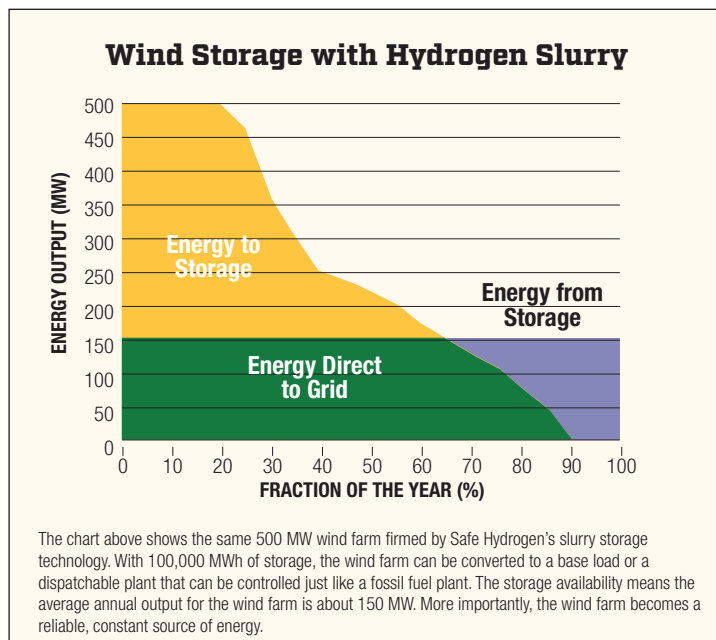


figure 2.

Hydrogen and a New Paradigm for Electricity Storage

by Ken Brown

A NEW PARADIGM IS NEEDED FOR ELECTRICITY STORAGE IN THE WIND ENERGY MARKET.

Today, what passes for “grid storage” are technologies providing, at most, eight to 12 hours of discharge time. If electricity generation is to be successfully weaned from fossil fuels, storage must have more than 1,000 hours of discharge time to back up renewables when they are intermittent. Sometimes the wind does not blow and the sun does not shine for long periods of time. Long discharge time provides reliability.

The good news is the low-cost storage technologies required to accomplish this transformation are being developed.

Strong need for storage

It's clear that renewable energy from wind farms, as well as solar energy installations, remains intermittent and frustratingly dependent on fossil fuels. Because of the variable nature of the energy output, a generation plant must be available to be turned up or down. In general, natural gas-fired turbine generator plants accomplish this task for wind farms.

The renewable energy industry faces a dirty dilemma: behind every wind farm sits a fossil fuel plant to provide backup power when the skies are still. More wind farms mean more fossil fuel plants with more carbon emissions. Building more wind farms will not lead to full energy generation from wind.

To integrate this intermittent energy source, dispatchable plants of the same output must be ready to take over whenever wind production falls, as it does some 80 percent of the time, to keep the amount of generation constant. Some of the energy harvested by spinning wind turbines must be stored so it can be used when the wind isn't blowing. That way, a wind farm becomes a dispatchable plant controlled just like a fossil fuel plant.

State of storage technology

To understand where we need to go, it's important to look at how far we've come. What types of storage technologies are available or under consideration today and what are some of their attributes?

Batteries

Lead acid is a tried and true technology, and there have been developments to improve the cycle life. Lithium-ion, a newer technology, provides higher power density and the cycle life is longer compared to lead acid. These technologies would need a cost reduction of 98 percent to economically store 1,000 hours of output.

Flow batteries have a different construction. An electrolyte liquid flows from tanks through a casing containing the electrodes. Because the electrolyte is separate from the electrode case, flow batteries can be significantly cheaper in cost. The cost still must be reduced by 95 percent to economically store 1,000 hours.

Metal air batteries involve the oxidation of metals with the oxygen from air. Using inexpensive metals, they can be cheaper as well but have limitations in their cycle life. The cost must come down 80 percent to economically store 1,000 hours.

Beyond batteries

Some other storage technologies are in the mix. First, flywheels are very quick to respond and are good for frequency and voltage control. Although high in power, they are low in energy and not suitable for long duration discharge.

Pumped storage is the only significant storage technology in use today. The idea is to pump water uphill when electricity is inexpensive and to harness gravitational energy by releasing the water back down through a hydroelectric turbine when power is needed. New pumped storage facilities are expensive to build and difficult to permit.

Another technology, Compressed Air Energy Storage, or CAES, consists of a compressor that pumps air into a pressure chamber. When electricity is needed, the air is heated and expanded via an air turbine generator. The lowest-cost CAES utilizes underground caverns. However, good caverns are in short supply.

Hydrogen on the horizon

In addition to the aforementioned storage solutions, a patented slurry technology is emerging as a contender to prevent wind farms from having a carbon footprint of their own. The projected costs make this technology economically viable.

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Detachable self-rescue device

3M Personal Safety Division and 3M's Capital Safety business have introduced the DBI-SALA Self-Rescue, a detachable self-rescue device. The device easily connects to a worker's current safety harness, providing a fast, effective method of escape from suspension, while minimizing risk for the wearer, coworkers, and rescue personnel.

Self-Rescue features a patent-pending EZ-Link D-ring to simplify connection, a secondary rescue ring for assisted rescue, and a sealed, padded package to protect the descent device from damage during use. In an effort to ensure reliable performance in the field, Self-Rescue has gone through rigorous testing. The sealed design allows the product to perform as expected after it has been soaked in water for two hours and frozen in temperatures of negative 40°C. With 50- or 100-ft versions available, the self-rescue device is among the most flexible and adaptable ever created.

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The process uses electricity from a wind farm to split water into hydrogen and oxygen, through electrolysis. The hydrogen is stored in a magnesium slurry that can be safely stored on site or transported to where it is needed. The slurry is heated to release the hydrogen to fuel gas turbines, which drive generators. Discharged slurry is "recharged" at wind farms.

Figures 1 and 2 show the difference between a wind farm backed by a fossil fuel plant, which limits the actual renewable energy output to around 50 percent, compared to a similar scenario with hydrogen slurry storage technology in place.

This technology has significant cost advantages over current battery storage technologies, as well as the potential to transform a wind farm into a dispatchable plant without need for a fossil fuel backup. When the wind blows hard, part of the energy streams directly to the grid, while the rest goes to storage. When the wind dies down, energy flows from the storage system to the grid.

Breakthrough energy storage

Last fall, technology titan Bill Gates gave the clean energy industry a shot in the arm, or perhaps a breath of fresh air, when he led a group of billionaires in launching the Breakthrough Energy Coalition.

"We will look for novel technologies as well as ways to make existing technologies dramatically cheaper, more efficient, or more scalable," Gates stated in his five principals guiding the coalition's effort. He also singled out storage as a key factor "on the path to a zero-carbon future," while lamenting renewables' intermittency, persistent dependence on fossil fuels, and the high cost of storage.

Aggressive innovation and investment is necessary to making meaningful advances in storage technology which will help clean energy reach its true potential.



Ken Brown is the CEO and Managing Partner of Safe Hydrogen, LLC, a storage technology company based in Massachusetts.

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Enabling the Wind Power Market in 2016

by Dr. Kimberly McGrath

Driven by cost reduction and regulatory incentives, interest in wind power is at an all-time high, with more than 50GW of incremental capacity added globally in both 2014 and 2015, according to the Global Wind Energy Council. In the United States, wind comprised 47 percent of new generation capacity, and China added approximately 23GW of new capacity, the GWEC found. Likewise in Europe, offshore capacity grew 200 percent within the first half of 2015.

Combined with an overall reduction in wind power purchase price, worldwide political and legislative calls for reduced carbon emissions, and increased efficiency will drive growth in generation and capacity. For example, the Environmental Protection Agency's Clean Power Plan and recent passage of the U.S. House of Representatives \$1.1 trillion omnibus spending bill encompassing extensions for wind production tax credits will continue to promote North American capacity growth in renewable generation. Likewise, Beijing plans to increase China's wind capacity to 200GW by 2020, according to the Earth Policy Institute. 2016 will be a growth year in wind generation worldwide providing appropriate governmental drivers remain in place and new innovative technologies bring increasing positive economic justification over traditional generation.

Demand for power quality

As more wind power is added to the grid, improved power quality, reliability, and transmission and distribution (T&D) infrastructure improvements are required to meet Federal and State renewable energy goals. Advances in fast-responding storage, such as ultracapacitors, will further enhance wind energy production reliability indices by substantially reducing and, in many cases, eliminating the intermittencies associated with wind generation.

The goal of wind energy generators is to deliver clean power at levels of quality and reliability acceptable to the regional grid operators and served utilities while maximizing their returns by minimizing operating costs. Integration of fast-responding energy storage (at the generation site) into operations along with advanced scheduling and management will facilitate this goal in several ways.

Frequency response

Grid frequency continuously fluctuates due to changing loads, and balance must be maintained on a second-to-second basis between electricity demand and generation to maintain grid stability and generation norms. The tight frequency envelope, typically specified in tenths of a hertz, must be managed in second-to-subsecond timeframes to prevent system collapse. This is an important factor to be considered by wind generators because energy storage assets can be leveraged to provide frequency

response. There is growing demand from grid operators, particularly those with a high penetration of wind and solar, such as National Grid, for faster frequency response service. This service can be sold to the independent system operators (such as PJM, MISO, or ERCOT) as one of several stacked services provided by "fast-responding energy storage," thus improving the overall value of storage.

Wind power smoothing

As an increased amount of intermittent renewable generation penetrates the grid, variations in wind power output can become significant and create faults on local transmission lines and poor quality of delivered power to utilities and their customer loads. Energy storage technologies that can respond in the milliseconds to power output fluctuations can be deployed to prevent these problems. Ultracapacitors are the ideal technology to address these reactive and active power fluctuations given they have fast response times and can "ride through" milliseconds-to-minute-level fluctuations. Economically, the addition of ultracapacitors to rapidly deliver quality power mitigates the risk of curtailment (revenue loss) and can defer transmission line upgrades (cost savings).

Reducing operating expenses

The growing demand for power quality as part of government goals must be met without putting suppliers over budget. This has led suppliers to seek new options for deploying pitch technologies in their turbines. Ultracapacitors have emerged as a viable option for producing high-quality, reliable power without driving operating costs up significantly. According to Navigant's 2015 report, the top 10 wind power suppliers globally produced 36,301MWs out of the 51,026MWs produced globally. Forty-one percent of new turbines contained ultracapacitors, compared to 38 percent using hydraulic and 21 percent relying on batteries. Speedier charge and discharge cycles, along with a longer lifetime, more reliable performance in colder temperatures and decreased intermittencies, make ultracapacitors the best option for suppliers. Increased durability, paired with guaranteed operation even in the face of extreme weather, eliminates some costs related to maintenance and replacing components.

A combination of governmental incentives and cost reduction will keep wind generation on a growth trajectory through 2016. Energy storage utilizing fast-responding ultracapacitors is a key enabling technology to both improve generation quality and reliability while offering potential new revenue streams. MW scale projects are now commissioning and will define the financial benefits of fast responding energy storage to generators, operators, and utilities. Likewise, incorporation of next-generation wind pitch control technologies reduces operator ongoing costs.

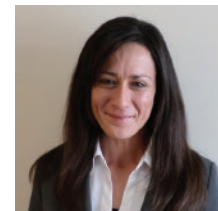


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Dr. Kimberly McGrath is director of business development for Maxwell Technologies and has spent her career in the field of energy storage applications and technology development. Dr. McGrath received her doctorate in chemistry from the University of Southern California and an MBA from The Paul Merage School of Business at the University of California, Irvine.

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3D inspection tags

Etiflex Corp, a manufacturer of industrial labels and inspection tags, received its second patent in relation to its molded tags. Etiflex already holds a patent for its unique RFID tags. The newest patent for their line of Data Matrix tags is based on the unique three dimensional construction resulting in tags that are extremely durable - making them ideal for outdoor and harsh environments. The new tags allow the user to record information on the tag even while it is installed - so it can be used to permanently display and record inspections over a multi-year period. They can also be configured for product identification, serial numbers, and any specific data that needs to be recorded. The 3-D construction and UV resistant formulation is designed to last in abrasive environments like construction equipment, marine use, utility companies, and lifting slings. The two patents can be combined to make the tag RFID enabled which allows the tag to electronically record the information utilizing RFID software, while also visually displaying the information so anyone can also see and record information as well.

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High performance end mills

Sandvik Coromant launches a new series of end mills delivering high performance and security in side and pocket milling operations. The CoroMill Plura HFS (high feed side milling) end mills are developed for steel and stainless steel applications, but they can also enhance productivity in difficult-to-machine materials such as heat-resistant super alloys (HRSAs) and titanium. The CoroMill Plura HFS utilizes the complete cutting length of the end mill and achieves a high metal removal rate with smaller diameters. The result is lower tools costs and improved overall productivity. CoroMill Plura HFS features include: an unequal helix flute design that assures a variable angular pitch in every axial section to increase the chatter-free material removal rate; an asymmetrical chip-breaker profile that improves chip evacuation and minimizes the risk of edge chipping and tool breakage; and a conical core shape with a smaller core diameter at the face to improve chip evacuation capabilities, with a larger core diameter at depth of cut maximum (APMX) for maximum stability. The grade for the CoroMill Plura HFS is GC1740 which was developed to resist bending forces generated when using a 4xDC length of cut. This is needed when the component has a large depth of cut and cutting width. Furthermore, Sandvik Coromant's Tailor Made offer includes CoroMill Plura end mills for manufacturers or machine shops needing a 5xDC length of cut.

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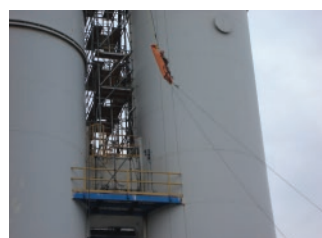


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Working at Heights

Required training and equipment

by Scott Connor

WORKING AT HEIGHTS TRAINING PROGRAMS FOR COMPANIES, fire departments, and individuals have seen many improvements to historical rescue gear and the welcomed invention of many new pieces of equipment in the past 25 years.

Much of the equipment now available has additional safeties built in, allowing it to pass “the whistle test.” Should something happen to the rescuer manning the system while the victim is hanging on a lifeline, or when a whistle is hypothetically blown at any time during testing, the equipment should either lock-up, or offer automatic controlled descent. The alternative would have the victim free-falling to earth in the event the rescuer becomes distracted or incapacitated.

Most regulations pertaining to Working at Heights will reference the standard to which the equipment has meet. Europe has CE/EN, the United States have OSHA/ANSI, AS/NZS for Australia and New Zealand, and CSA for Canada.

The four main types and purposes of equipment for people who work at heights are Sport, Rope Access, Emergency Services, and Industrial.

Since there is no aspect to working on wind turbines that is Sport (rock climbing/mountaineering) it is not recommended any Sport equipment be used in this field. It often does not have the strength to handle the rigors of industrial situations, and in many cases does not incorporate the whistle test safeties.

The equipment used in Rope Access is not very expensive but requires at least 40 hours of training, as well as continued training to maintain the skills to be efficient and hopefully, by default, safe. Not only can the failure rate be quite high, but even after attending training, workers still require supervision by a person with a higher level of Rope Access training when they go to work. It is very also physically demanding, so worker injury due to strained and pulled muscles is not uncommon.

The gear used in Rope Access is specific to a certain diameter of rope, therefore compatibility becomes an issue should the user attempt to use gear intended for something else, such as Emergency Services. Some feel, while Rope Access follows a method for using their equipment which meets an equivalent level of safety for working at height, most of the gear is not CSA approved which may become an issue with a labour inspector or during an accident investigation.

Emergency Services, such as fire departments, generally require a National Fire Protection Association (NFPA) rating on the gear they use. NFPA is the body which prepares the standards for Emergency Services and what they use for training operating protocols and guidelines in addition to fire code standards. The equipment, for the most part, is not very expensive but requires a fair amount of initial and regular recurrent training to maintain the skill set and

efficiency. Most of the time, rescues are taught with a full complement of trained responders, therefore the skills learned don't carry over well when one person is trying to conduct the rescue alone in a remote location. Most of the gear used by Fire Departments are not CSA approved so again, this may become an issue with enforcement if you are a business and not a Fire Department.

The majority of all work erecting and maintaining wind turbines is Industry. The industrial regulations in each region state the standard in which the equipment must be tested to. In Canada, most provinces require the fall protection equipment to meet CSA standards. This makes life easy for businesses, managers, and supervisors to enforce since it will either be stamped with the CSA logo or have associated paperwork stating such.

Most CSA approved Fall Protection equipment and rescue gear is what some refer to as “clip-and-go/pre-rigged” equipment, and is very user friendly and intuitive. Even though the initial outlay for the cost of equipment is a bit more, it is safer, and the time commitment in training is much less than Rope Access or Emergency Services techniques, due to the ease of use of the equipment. It also requires less ongoing training to maintain the skills and techniques, which is beneficial to businesses which may only train their workers in Working at Heights and Rescue every one to three years.

Training should be specific to the equipment in use and situations which may be encountered. Using CSA approved clip-and-go systems ensures the equipment will not be an issue during an inspection or investigation, and a much greater chance it will be used correctly during an actual emergency.

Scott Connor is the chief training officer for TEAM-1 Academy, Inc.

TEAM-1 Academy, Inc
www.team1academy.com



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Tensioners & Torque Systems

The proper alignment of a bolted joint can be achieved by using either torque or tension methods of bolting. Proper bolt loads must be realized during installation or the integrity of the joint will be compromised, leading to misalignment and, if left unchecked, the ultimate failure of the joint. In this issue, we look at some of the tensioners and torque systems available today.

SEE AD ON PAGE 59



TorkWorx

Product: Multi Schedule Base Bolt Tensioner

Description: The new TorkWorx Aero WTF is a purpose designed range of hydraulic bolt tensioning tools developed by Tentec and designed to suit most wind turbine foundation bolting applications. The Aero WTF tensioning tools can be supplied to suit many different bar types.

Bolt Diameter: #10, #11, 1-3/8", and 1-1/4" in 75KSI and 150KSI

Stud Protrusion: 10" (223mm)

Max Stroke: 1" (25mm)

Max Load: 171,404 lbf, 762Kn

Stud Protrusion: 10" (223mm)

Hydraulic Pressure Area (in²) & (mm²): 8.74" (5647.79mm)

Outside Tool Diameter: 4.84" (122.94mm)

Overall Height: 6.88" (174.75mm)

Overall Distance Between Stud CLs: 6" (152.4mm)

Weight: 21.42lbs (9.72kg)

Key Features:

- Multi-schedule design allows for tensioning of multiple sizes;
- Manual and gear-driven models available;
- Long 25mm stroke available;
- Spring assisted piston return;
- Easy onsite maintenance.

www.torkworx.com

Pro Torque Tools

Product: Williams Planetary Gear Torque Multipliers

Description: Williams Planetary Gear Torque Multipliers provide the operator with nut-turning power requiring only a fraction of the force required when using conventional tool.

Power System: Hand held

Drive Size: 3/4" to 1"

RPM: 750 to 3200 RPM

Weight: 25lbs to 40lbs (11.3kg to 18kg)

www.protorquetools.com



Norwolf Tool Works

Product: Norwolf TCon K92

Description: Base bolt tensioner, single line action permits use with any 10k psi pump.

Bolt Diameter: #10 or #11 Williams rod

Stud Protrusion: 4.5" (114.3mm)

Max Stroke: 3/8" (9.525mm)

Max Load: 92lbs

Stud Protrusion: 10" (223mm)

Hydraulic Pressure Area (in²) & (mm²): 9.2" (233.68mm)

Outside Tool Diameter: 4.125" (104.775mm)

Overall Height: 6" (152.4mm)

Overall Distance Between Stud CLs: 4.25" (107.95mm)

Weight: 18lbs (8.16kg)

www.norwolf.com

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SEE AD ON PAGE 60



AIMCO

Product: High Torque DC Tools

Description: AcraDyne's transducer torque control system provides consistent, reliable torque values as well as the ability to monitor rotational angle during the tightening process. When combined with AcraDyne's Controllers, customers have a high torque critical bolting system that can quickly handle the toughest and most important bolting jobs.

Drive Size: 3/4" to 1.5"

Torque: 185 to 6000ft/lbs (250 to 8100Nm)

RPM: 315 to 5

Weight: 12lbs to 36lbs (5.3kg to 16.4kg)

Noise Level: 66db

Key Features:

- Transducerized closed-loop control;
- Transducer at the output;
- Interchangeable tools, cables, and controllers;
- On-tool LEDs for accept/reject signals;
- Designed and made in the USA.

www.aimco-global.com

SEE AD ON PAGE 63



RAD Torque Systems

Product: E-RAD Blu Torque Wrenches

Description: The E-RAD Blu precision torque wrenches are designed to provide a high degree of accuracy (+/- 2.8%) and repeatability (+/- 2%). These advanced electronic pistol grip torque wrenches combine the legendary RAD gearbox design and AC Servo motor technology to reduce bolting time up to 300%, as compared to conventional hydraulic wrenches.

Power System: Electric 120V or 230V

Drive Size: 3/4" to 1.5"

Torque: 100 to 7500ft/lbs (135 to 10,000Nm)

RPM: up to 30 RPM

Weight: 11.9lbs to 33lbs (5.4kg to 15kg)

Noise Level: 75db

Key Features:

- High accuracy +/- 2.8%;
- Data collection;
- Interchangeable handles per controller;
- Password protection;
- Bluetooth connectivity with RAD Smart Socket.

www.radtorque.com

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ON INDUSTRIAL BOLTING JOBS

For more information, please email info@hytorc.com or visit www.hytorc.com

SEE AD ON PAGE 61



HYTORC®

Since 1968

Hytorc

Product: Lithium Series Battery Gun

RPM: up to 180 RPM

Description: Powerful and portable, these 36V battery-powered torque guns can average approximately 100 nuts per charge with up to 3000ft/lbs of torque. They are available in various sizes and configurations for use on all bolted joints.

Weight: 9.5lbs to 15.5lbs (4.3kg to 7kg)

Noise Level: 85db

Key Features:

- Long lasting 36V battery;
- Up to 3000ft/lbs power;
- Quiet operation and no vibration;
- Compatible with the HYTORC washer.

Power System: 36V battery

Drive Size: 1/2" to 1"

Torque: 35 to 3000ft/lbs (47 to 4067Nm)

www.hytorc.com

SEE AD ON PAGE 59



TorkWorx

Product: RAD SMART SOCKET

Description: The RAD SMART SOCKET is designed to fulfill torque cycle validation and data collection requirements on controlled bolting applications. Designed for use on any square drive type torque wrench. The SMART SOCKET includes RAD quality torque transducer technology with LED and push button interface.

Power System: Battery

Drive Size: 3/4" to 1.5"

Torque: 150 to 8000ft/lbs (205 to 10850Nm)

RPM: up to 30 RPM

Weight: 3lbs to 8lbs (5.6kg to 15kg)

Key Features:

- Easily calibrate torque systems on the actual application;
- Measures and displays the peak torque of the cycle;
- Data Logging Function – Downloads through mini HDMI;
- LED shows "PASS" or "FAIL" cycle indication;
- Delivers "REAL TIME" Torque Read Outs;
- Bluetooth Technology interfaces with ERAD-BLU Systems.

www.torkworx.com



Chicago Pneumatic Tool Co.

Product: Titan Hydraulic Torque Wrenches

Description: Titan's hydraulic torque wrenches are powerful, accurate, durable, robust, and efficient. They are cycle tested under load and then calibrated and certified with traceability to N.I.S.T.

Power System: Hydraulic (powered by electric or pneumatic)

Drive Size: 1/2" to 3 1/2" square drive, 7/8" to 6 1/8" hex drive

Torque: 197 to 43,000ft/lbs (267 to 59,308Nm)

Weight: 5.65lbs to 120lbs (2.56kg to 64.3kg)

www.titanti.com



TorcUP Industrial Bolting Tools

Product: TU Square Drive Hydraulic Torque Wrench

Description: The Torcup TU Series utilizes high strength aerospace alloys and machines them into a finely engineered tool, providing +/-3% torque accuracy. The TU Series is durable, reliable, and field maintainable.

Power System: Hydraulic

Drive Size: 3/4" to 2 1/2"

Torque: 127ft/lbs to 58,000ft/lbs (172Nm to 78625Nm)

Weight: 4lbs to 130lbs (2kg to 58kg)

Noise Level: 75 to 80db

www.torcup.com



Stahlwille Germany

Product: Electronic torque tester for torque wrenches Sensotork 7707W

Description: Compact workshop-based torque tester manufactured in Germany for easy adaptation by replacement of transducers. Tester can be used for both horizontal and vertical testing positions for CW and CCW uses. High degree of accuracy thanks to flat transducer and conversion/digitalization of readings within the transducer.

Power System: Electric

Drive Size: 1/4", 3/8", 1/2", 3/4"

Torque: 0.15 to 812ft/lbs (0.2 to 1100Nm)

Weight: 21lbs to 24lbs (9.5kg to 11kg)

Noise Level: 75db when click of torque wrench is triggered

www.stahlwille.de



SPX

Product: TWHC High Cycle Torque Wrench

Description: SPX's TWHC torque wrench is designed with a long-stroke mechanism for a minimum 30° nut rotation per stroke while maintaining a tight and compact nose radius. Made of corrosion resistant material, this torque wrench can be used in harsh environments.

Power System: Electric/hydraulic, air/hydraulic

Drive Size: 3/4" to 2.5"

Torque: 1,413 to 53,000ft/lbs (1,915 to 71,816Nm)

Weight: 6.2lbs - 152lbs (2.8kg - 69kg)

www.spx.com



Snap-on Industrial

Product: Hydraulic Torque Wrench

Description: Lightweight, heavy duty, ergonomic, +/- 3% accurate, uni-body hydraulic wrench with 360° adjustable, push-button reaction arm and uni-swivel hose couplings. The dual pawl, anti-backlash mechanism provides smooth, equal load operation and a quick release square drive allows for simple change of direction.

Power System: Electric or pneumatic over hydraulic

Drive Size: 3/4", 1", 1 1/2", 2 1/2"

Torque: 120ft/lb to 37,000ft/lb (1100Nm to 50,000Nm)

Weight: 2.7lbs to 77.5lbs (1.22kg to 35.15kg)

Noise Level: 75 to 80db

www.snapon.com/industrial



Proto Industrial Tools

Product: Proto Micrometer Torque Wrench

Description: Proto Torque Wrenches are manufactured to meet precision and highly accurate standards in common industrial torque environments, general industries, heavy equipment, and maintenance. These industrial grade torque wrenches are calibrated to +/-4% clockwise direction and +/-6% and counter clockwise direction at 20% to 100% of full scale.

Drive Size: 1/4" to 1"

Torque: 40 to 100in/lbs and 16 to 2,000ft/lbs

Weight: 1.2lbs to 53.10lbs (.54kg to 24.09kg)

www.protoindustrial.com



Enerpac

Product: PTW-Series Pneumatic Torque Wrench

Description: Enerpac's PTW-Series Pneumatic Torque Wrenches are designed to provide fast, safe, and simple fastening for applications that require controlled bolting solutions. They are robust enough to withstand tough job site conditions.

Power System: Pneumatic

Drive Size: 1" to 1 1/2"

Torque: 300ft/lbs to 6,000ft/lbs (407Nm to 8135Nm)

RPM: 2.5 to 12.6

Weight: 18lbs to 39lbs (8.16kg to 17.69kg)

www.enerpac.com



ITH Engineering

Product: ITH Bolt Tensioning Cylinder

Description: ITH bolt tensioning cylinders are designed for tightening large diameter bolts of all major OEM wind turbine applications including: foundation rods, tower bolts, bearing bolts, and other applications. Combine ITH tensioners with the standard-duty ITH Eco-MAX pump for construction jobs or the lightweight and compact Micro-MAX pump for maintenance jobs.

Bolt Diameter: M16 and larger

www.itheng.com



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WWW.RADTORQUE.COM



Bolts, Fasteners & Adhesives

Reliable tools and components are important in any industry, but particularly in wind power, where efficient turbine and blade construction and operation are essential to safety and project success. This issue, we're highlighting the latest in bolts, fasteners, and adhesives, from various companies in the industry.

SEE AD ON PAGE 65



Heico

Product: HEICO-Lock Wedge-Lock Washers

Description: Heico's certified bolt-fastening system works safely in dry and lubricated conditions, can be reused consistently without loss of function or quality, and costs up to 50% less than identical fasteners. Wedge-Lock Washers are suitable for use as high-tensile bolts of 8.8, 10.9, and 12.9, with their respective nuts, and are available in standard or enlarged outside diameters of M3 to M130.

Application: A wedge-locking system that delivers high-quality, anti-vibration security, for demanding bolted joint applications, such as for wind turbines.

Key Features:

- HEICO-LOCK Wedge-Lock Washers lock bolts tight without any loosening;
- Supplied as a pre-assembled pair that is easy to install and remove;
- Washers will not rust, break, or vibrate - ever;
- Available in steel or stainless steel, with narrow or wide bearing surfaces;

www.heicofasteners.com

SEE AD ON PAGE 61



HYTORC[®]
Since 1968

HYTORC

Product: The HYTORC Washer

Description: The HYTORC Washer is a simple way to add efficiency on all bolting jobs while increasing the lifespan of tools. This economical system eliminates dangerous pinch points and simplifies complex bolting jobs. Additionally, the washer prevents unintentional nut loosening and ensures even and accurate bolt load every time. Using the HYTORC Washer also removes internal pressure from hydraulic torque wrenches, which increases the lifetime of the tooling.

Application: All bolted joints.

Key Features:

- Hands-free safety;
- Reduced bolting time;
- Increased bolt load accuracy;
- Intuitive operation.

www.hytorc.com/washer



Lightning Bolt & Supply, a division of Thunder Threads

Product: Custom nacelle fasteners

Description: Lightning Bolt's custom, per-print nacelle fasteners for the wind industry are manufactured using specialty platings and exotic alloys. Also available are tower bolts, blade bolts, and many different types of metric fasteners including stainless steel metric bolts.

www.thunderthreads.com



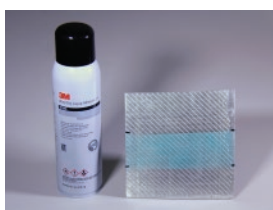
Cooper & Turner Industries, Inc.

Product: Foundation Studs

Description: Cooper & Turner's foundation studs are manufactured from high tensile steel ranging in diameter from M24 to M64 and grades up to 10.9. Various sacrificial coatings are available including, hot-dipped galvanized, sheradized, nylon, and delta.

Application: Tower foundations

www.cooperandturner.com



3M

Product: 3M Dry Layup Adhesive 2.0 W7900

Description: Dry Layup Adhesive 2.0 provides required shear and peel properties to hold the reinforcement in place, eliminating waves and wrinkles. A fast tacking composite spray adhesive with innovative color changing technology.

Application: Dry Layup Adhesive 2.0 is designed for bonding/holding glass fabrics and roving, other reinforcements and materials (i.e., flow media) in place during the composite manufacturing process.

3M.com/Wind



Henkel

Product: Loctite 4090 Hybrid Adhesive

Description: Loctite 4090 hybrid adhesive helps LED streetlights withstand the most severe environments. This versatile, patented technology from Henkel is the first of its kind to combine the strength of a structural adhesive with the speed of an instant adhesive. Loctite 4090 meets Cree LED-compatibility requirements for indirect lighting applications and withstands temperatures up to 300°F. It provides powerful impact and vibration resistance and bonds multiple substrates including metals, most plastics, and rubbers. Now available in a new 400ml size.

Application: Bonding and sealing LED assemblies

www.henkelna.com/4090



NTC Wind Energy

Product: IronClad Grout Sleeves

Description: IronClad Grout Sleeves protect foundation anchor bolts from exposure to grout and increase grout weight-bearing surface.

Application: Foundation anchor bolts

www.ntcwind.com



Sika Corporation

Product: SikaForce-7800 RED and BLUE

Description: A 2-component, high performance, non-sagging polyurethane, structural adhesive for windmill blade repair.

Application: SikaForce-7800 RED and BLUE is used for profile shaping, surface filling, and finishing of damaged rotor blades in the wind turbine industry with available packaging specifically for onsite wind blade repair applications.

www.sikausa.com





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



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Blattner Energy is a diversified power generation contractor providing complete engineering, procurement, and construction (EPC) services for utility-scale HV and EHV transmission and substation projects throughout the United States. Blattner has served the power industry for more than 30 years with over a century of experience building large, complex projects across North America. As a power delivery contractor, Blattner's project management skill set and self-performance capabilities allow them to control the safety, quality, schedule, and productivity of every project.

Blattner Energy | www.blattnerenergy.com



Smart oil containment

Albarrie introduces its newest generation of smart oil immobilizing fabrics. SorbWebPlus is an innovative green technology used to meet SPCC regulations for secondary containment. These permeable oil immobilizing smart fabrics eliminate the occurrence of standing water occupying the space that was reserved for an accidental spill and makes them the perfect option for a diverse range of applications. Albarrie's innovative SorbWebPlus, is a passive engineered oil containment system, significantly reducing capital outlays, providing environmental protection, and drastically lessening the economic consequences of an oil spill.

Albarrie | www.albarrie.com



Metal oxide varistor (MOV) surge arresters

Thomas & Betts' Elastimold MOV Surge Arresters provide high-voltage lightning and switching surge protection of transformers, cable, equipment, and other components typically located on underground power distribution systems. IEEE 386 interfaces provide convenient energized connection with other 200A loadbreak or deadbreak components. The EPDM molded rubber construction is fully shielded and fully submersible for a variety of applications and the compact size enables installation in existing cabinetry, saving money. Thomas & Betts offers three styles of arresters to fit any application and they are all easy to install: Elbow (ESATM), Parking Stand (PSATM) and Bushing (BSATM).

Thomas & Betts | www.tnb.com



Meter pedestal/box pad combination

Nordic Fiberglass's GS-37-39-15-MP-MG-22x22 meter pedestal/box pad combination brings together a transformer and meters into one convenient electrical system. A fiberglass box pad accommodates single phase transformers from 25kVA to 167kVA. The box pad cavity provides a raceway for electrical cables to run from the transformer to the meter(s). Customers can install up to three meter enclosures on Nordic's plastic meter pedestal. Large interior meter pedestal makes installing meters easy. Meter pedestal has penta-head locking and is pad-lockable.

Nordic Fiberglass, Inc.
www.nordicfiberglass.com

SIBA FUSES is proud to be the world leader in Energy Storage protection. We have a long-standing record for being first to lead the world in introducing & innovating new generations of PV fuses. SIBA Fuses was also the first to develop special wind farm SSK fuses for Switch-Fuse combination with low minimum breaking current at lower power dissipation, which can be used on transformers rated up to 3150KVA. Our Energy Storage fuses feature a high breaking capacity, specifically designed to meet the stringent requirements for energy storage applications, which we have perfected for the world's largest OEM's.

When you need true solutions, you will find that SIBA Fuses is the one stop you need to make to resolve all your Energy Storage protection requirements. Our product line includes, but is not limited to, the following fuses: capacitor, motor, transformers, PT, under-oil, traction, miniature and AC/DC semi-conductor fuses from 32VDC-5KVDC and 32VAC-40.5KVAC. Give us the opportunity to serve you. We're very confident you will appreciate our efficiency, product knowledge, and the superior technology and imaginative solutions that we can offer. We'd love to have you as one of our many satisfied SIBA FUSES customers.



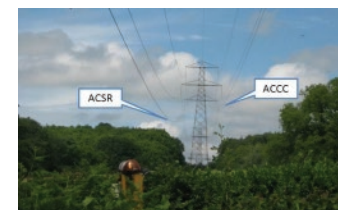
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Combined vacuum circuit breaker & grounding switch

EMA Electromechanics, LLC is the designer and manufacturer of the VDH/GSMI combined 34.5 kV outdoor vacuum circuit breaker and high-speed mechanically interlocked grounding switch. This is a patented system for switching and grounding of wind and solar power collection circuits with noticeable technical and economic advantages in comparison with traditional grounding systems. EMA also offers conventional 34.5 kV outdoor substation vacuum circuit breakers.

EMA Electromechanics, LLC
www.emaelectromechanics.com



Advanced technology delivers advanced benefits

CTC Global produces a technologically sophisticated line of high-efficiency, high-performance transmission conductors and related fittings. Their products leverage their proprietary research effort, begun in 2002, to develop a conductor that can be used to upgrade existing transmission corridors without needing structural modifications. The result is a high-strength, light-weight hybrid carbon and glass fiber core that can incorporate additional conductive aluminum without a weight or diameter penalty. ACCC conductor based on this technology reduces thermal sag, carries more current, reduces line loss by 30-40%, and enables longer spans between fewer and/or shorter (less expensive) structures.

CTC Global | www.ctcglobal.com



Tool operation, maintenance, and repair center

BURNDY tooling installs a wide range of connectors, is reliable, cost effective, and precision engineered for durable, long-lasting service, and insures a quality, fully inspectable connection. BURNDY designed and produced the first self contained hydraulic compression electrical connector installation tool in 1924. An important element of the BURNDY tooling program is the Tool Center located in Littleton, NH. This center provides advice and information on the operation, maintenance, and repair of BURNDY tools. The repair center is staffed with specialized technicians who provide the best possible tool repair service, for all BURNDY tools, pumps, and accessories. It is BURNDY's continuing mission to provide the highest quality and highest value connection systems to all their customers in all areas of the marketplace.

BURNDY | www.burndy.com



Finger-actuation knife disconnects

Phoenix Contact's newest knife disconnect terminal blocks feature a quick and safe finger-actuation mechanism for test and measurement applications. The UT 4-MTL and UT 6-MTL's finger levers enable technicians to safely perform circuit-polarity checks and troubleshooting without disrupting service. The MTL lever does not require a tool to actuate. It extends above and beyond the recessed version found in standard UT 4-MT and UT 6-MT disconnects. The UT-MTL blocks accommodate colored knife disconnect levers to differentiate circuits, while conserving space and assisting wire management. This series also helps reduce inventory costs because it accepts CLIPLINE complete accessories and marking products. Phoenix Contact's patented Reakdyn Principle ensures reliable, maintenance-free screw-clamp connection.

Phoenix Contact | www.phoenixcontact.com



Substations protection solutions

The Southern States ballistic resistant solutions, Ballisti-Wall and Ballisti-Cover, offer military grade protection for utility critical infrastructure facilities and equipment. They are constructed from multiple layers of woven fiberglass encapsulated with a proprietary resin system that produces a rigid panel with exceptional ballistic resistance. These protection products offer ballistic resistant security with the additional performance advantages of durability, corrosion resistance, electrical non-conductivity, low thermal conductivity, and light weight.

Southern States, LLC
www.southernstatesllc.com



Swaging, not welding

AFL's Swage Substation product line consists of one to six-inch bus accessories, cable accessories, and a Swage 45-ton press assembly. The assembly produces 360° of compression on Swage accessories ensuring that the connection is electrically and mechanically sound. The entire Swage product line complements AFL's substation family with voltage up to 765 kV that involve cable, pipe, flat or tubular bus, and integral connections.

AFL Global | www.aflglobal.com



High power fuses

SIBA Fuses new "SSK" Technology reduces short circuit energy. The increased demand of generation and power distribution for all types of transformer applications requires proper protection of transformers. For the increased levels of power used, such as in wind applications, SIBA developed "SSK" fusing with the following criteria: higher interrupting current ratings compared to circuit breakers; limits Arc Energy; fast acting "striker initiated" opening time reduces higher fault-current impact on switchgear; combines low power losses with low minimum breaking currents, providing effective installation in tight enclosures; integrated temperature limiter, independent of striker pin operation. SIBA Micro Switch initiates certain functions when temperature reaches 220°C; applications include switch-fuse combination circuits, transformer circuits and load circuits; cost saving, simple mounting; Siba Fuses Patented Design: specific melting-element system.

SIBA Fuses | www.siba-fuses.us



Power system design

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Measuring the True Costs and Benefits of Energy Storage

Part Two - How cycle life and environmental factors impact LCOE

by Catherine Von Burg

In last month's issue, Part One of this series began covering how checking a few simple performance metrics can help calculate the true costs and benefits of competing energy storage systems. Additionally calculating this leveled cost of energy (LCOE) can help distinguish between what might look like a good price up front from what's actually a better buy in the long run.

How to Calculate the Levelized Cost of Energy (LCOE)

To calculate the Cost of Electricity in Kilowatt Hours (kWh) over time:

Step One: Gather the Facts

- Size of Battery in Rated Amp Hours – Ah
- Voltage of Battery – V
- Depth of Discharge – %
- Number of Batteries – Qty

The battery rating is based on the manufacturer's stated capacity in watt hours at specific discharge rates.

Step Two: Calculate Watt Hours (Wh)

$Wh = Qty \times Ah \times V \times \%$

Step Three: Calculate Lifetime Watt Hours (LW)

$LW = Wh \times \text{Cycle Life}$

Cycle Life is the number of full (not partial) charge and discharge cycles expected over a battery's lifetime while it has at least 80% of its original published capacity. It is based on manufacturer's estimate using specific depth and rates of discharge and operating temperatures.

Step Four: Factor in Costs

- Price (per battery)
- Calculate Total Battery Cost (Qty x Price)
- Add Ancillary Costs including Cabling, Racking, Containment, Venting, Cooling, Installation, Transportation, Maintenance, etc.
- Calculate Actual System Cost = Total Battery Cost + Ancillary Costs

Step Five: Calculate Cost per Wh

$\text{Cost per Wh} = \text{System Cost} / LW$

Step Six: Calculate LCOE in kWh

$LCOE = LW \times 1000$

The various components of the LCOE equation were covered in last month's issue. These include, but are not limited to, whether a battery system needs HVAC equipment and extra space to regulate temperature regulation, maintenance and the manpower required to conduct it, use of other chemicals or resources, limitations on usages, operation locations or transport methods because of temperature issues, or thermal runaway risks posed by using cobalt oxide.

Battery chemistries containing cobalt include Lithium Cobalt Oxide (LiCoO₂ or LCO), Lithium Nickel Manganese Cobalt Oxide (LiNiMnCoO₂ or NMC), and Lithium Nickel Cobalt Aluminum Oxide (LiNiCoAlO₂ or NCA). This grouping of LI batteries can be referred to as LI with cobalt. Chemistries without cobalt oxide include Lithium Ferrous Phosphate (LiFePO₄ or LFP), and Lithium Titanate (Li₄Ti₅O₁₂ or LTO), although LTO is rarely used in large format energy storage. For more on this topic, please see Part One in the January/February issue.

Cycle Life

The LFP chemistry offers a significantly longer cycle life, meaning the number of times the battery can be fully charged and discharged, than LI with cobalt. It also allows a deeper discharge depth and a faster charge/discharge rate.

Based on published studies, utilizing an 80 percent depth of discharge (DOD), Li batteries with cobalt offer a cycle life of 500 to 700 cycles, whereas the LFP batteries offer 2,500 to 4,000+ cycles. Therefore, if an Li battery with cobalt is discharged by 80 percent, once a day for a year, it would offer a cycle life of about two years (700/365 = 1.9 years). If the individual battery is discharged at a shallower depth, it could last longer. But that would result in less useable kWh per pound, square foot, and human or mechanical resources required to install, house, and maintain the system. A shallower depth of discharge per battery (to extend cycle life) would also require more batteries, installation costs, space, and maintenance to provide the same amount of power; raising the cost of energy over time.

By contrast, an LFP battery that is discharged by 80 percent once a day for a year will provide the same amount of power for 6.8 years to 10.9 years (2,500/365 = 6.8 and 4,000/365 = 10.9). That's more than three to five times as long. Therefore, the true cost of LFP battery storage over time is far lower given its longer cycle life, compact footprint and more efficient utilization of resources, even though its up-front price-point might be higher than batteries with other chemistries such as Li with cobalt, lead acid, Lithium Nickel Manganese Cobalt, flow, zinc bromide, or salt-water-based batteries.

Additionally, independent tests reported in scientific papers (Journal of Power Sources Vol. 257, 2014) studying the cycle life of LFP battery cell chemistry demonstrate cycle life in excess of 8,000 cycles is practical and can be maintained when the depth of discharge is limited to a range of 60 percent. Therefore, if LFP batteries are integrated into a small or large power storage format in which the monitoring and control software platform maintains a recommended depth of discharge, the batteries could provide as many as 21 years of useful life (8,000/365 days = 21.9 years). This extended cycle life for the LFP chemistry can also be enhanced by a conservative rate of charge and discharge.

One other point to consider is that so-called "long duration, large format" batteries, such as aqueous salt water and some flow batteries, require an unusually slow optimal discharge rate. These battery chemistries can require discharge rates, as long as up to 20 hours, to protect capacity (useable kWhs) and cycle life. This significantly adds to the size, weight, and LCOE per kWh. Meanwhile, the rate of charge and discharge for Li with cobalt batteries must be heavily regulated to control the buildup of heat and to prevent thermal runaway.

When considering an energy storage solution, be sure to calculate the LCOE and any other impact in order to assess the true costs and benefits of the system.



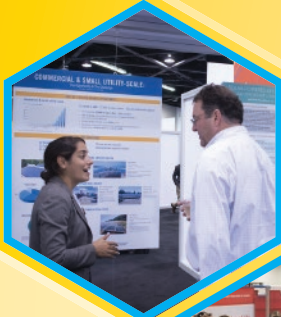
Catherine Von Burg has been the CEO of SimpliPhi Power since 2010. Before her work in energy storage, she spearheaded national program, policy and business-driven initiatives with organizations such as

Pew Charitable Trusts, Rockefeller Institute, Columbia University, NY March of Dimes Foundation, John's Hopkins School of Biomedical Engineering, Wilderness Education Association and First 5 Commission of California. She graduated from Columbia University in New York and holds a Master's degree from University of Pennsylvania, School of Social Policy.

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Energy Storage

New technologies address obstacles to system deployment

by John Merritt

The energy storage industry is growing rapidly as new technologies develop, markets expand, and new applications have the potential to provide greater benefits to end users. As this dynamic corner of the energy industry comes into its own, new obstacles to deployment continue to arise. A number of considerations must be taken into account, like broadly varying regulations and standards, as well as overall system design affecting cost, logistics, interconnection, and the ease of energy storage system deployment. Considering these factors when designing or integrating a battery energy storage system can potentially save energy storage system companies, installers, integrators, facility owners, and other end users headaches in the long run.

System design

Reduced footprint

A key part of the cost puzzle for energy storage is the size and weight of the overall system. Currently, lithium-ion batteries are the incumbent technology because they have a high power density and a small footprint. While there are alternative battery chemistries, lithium-ion remains the most viable for behind-the-meter Commercial and Industrial (C&I) applications where size is an important equipment siting consideration. What remains, then, is the power converter. Advanced power conversion systems are not only more efficient, but dramatically smaller and lighter as well, providing significant logistical and cost advantages.

High efficiency

Energy storage presents a unique challenge in that its applications are inherently bi-directional, AC to DC and DC to AC, making an energy storage system more complicated than its PV inverter counterpart which operates in only one direction, DC to AC. In systems designed with conventional power electronics, magnetic components contribute to significant power losses. For example, average round-trip losses created by transformers and line reactors are roughly 5 percent, resulting in typical system round-trip efficiencies of 90 percent or less.

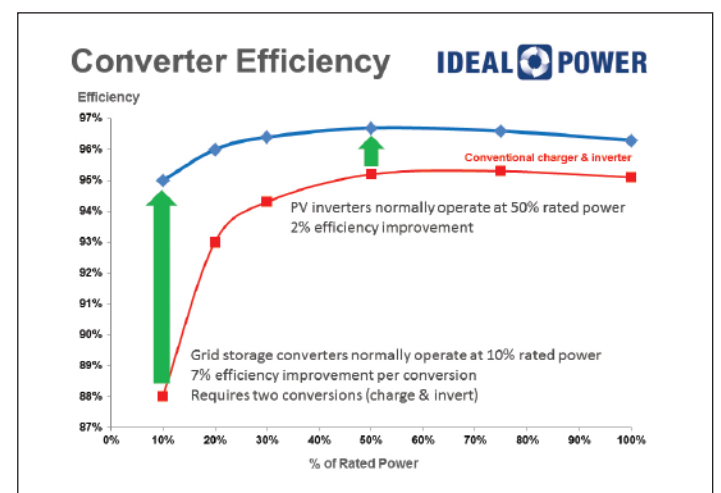
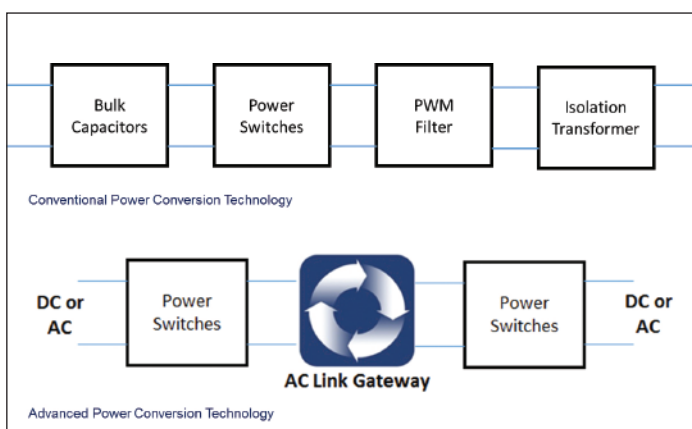
Advanced power conversion technologies, particularly those with high nameplate efficiency ratings, greatly reduce round-trip power losses for energy storage systems. Due to lower conversion losses, energy storage systems based on transformerless power converters require about 10 percent less electrical power input and 5 percent less battery capacity to generate the same energy output. Over time, this increase in efficiency results in accelerated energy storage system payback.

Differentiators

Multiple value streams

The ability to incorporate multiple value streams can dramatically accelerate storage system payback, compared to equipment supporting a single application, such as peak shaving/demand management. Those value streams can benefit both the commercial customer and the local utility. Hundreds of commercial-sited storage systems were deployed in California in 2015, and the vast majority of those

targeted a single value stream: demand management. Going forward, the industry is expected to embrace a broader set of storage applications, including backup power/critical load support, improved facility power quality, and self-consumption which directly benefit the building owner/operator. Volt/Var features will also be added, benefitting the utility. Monetizing just two or three of these emerging value-streams can dramatically impact return on investment (ROI).



PV + storage

Integrating PV with energy storage utilizing an advanced multiport power converter, compared to the incumbent approach of using separate stand-alone converters for PV and the battery, provides additional value. These multiport converters can support critical loads in a building using solar as the primary energy resource during grid outages and natural disasters, a capability PV inverters and most energy storage converters installed to date cannot deliver, as demonstrated by superstorm Sandy. Managing separate power converters is a daunting real-time backup power control and management challenge which is eliminated by the use of an advanced multiport (AC/DC/DC) converter architecture. The costs of these multiport systems are rapidly declining and are already competitive with the 2-converter solution noted above.

Smart inverter features

Advanced power converters must support a broad range of new capabilities to support emerging smart grid requirements. Both California and Hawaii are on the forefront of this effort, and industry groups such as the SunSpec Alliance and Modular Energy Storage Architecture (MESA) have published open control and monitoring standards to further accelerate the adoption of energy storage.

Logistics

Shipping, siting, and installation

The first benefit to the form factor reduction in power conversion systems is dramatically lower costs associated with shipping and installation. Conventional power conversion systems can easily weigh six times that of the newest transformerless technology. Compared to a 30kW system weighing less than 100 pounds, a 650-pound piece of hardware is at a great logistical disadvantage. Conventional systems incur high shipping costs due solely to size and weight. A system of this size requires more dedicated space, limiting siting flexibility, and possible floor re-enforcement, whereas a sub 100-pound system is wall-mountable, and easier to ship, install, and integrate into the rest of the energy storage equipment package.

Interconnection

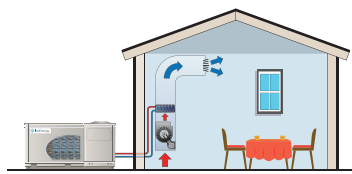
Getting timely interconnection approval from local authorities remains an impediment to energy storage system deployment. Batteries and power converters often receive critical reviews by local inspectors from both fire and grid safety standpoints. Converters must meet all appropriate safety standards including UL 1741 and IEEE 1547a to ensure they remain isolated and will not backfeed the grid during outages and, when connected, do no harm to the grid such as surges or current harmonics when exporting or importing power. Note these standards currently vary by utility and/or region which requires all newly installed converters be field programmable and configured to meet local interconnect requirements. Without this flexibility, certain brands of converters may be denied interconnection, dictating the use of different equipment packages based on geography.

The interconnection challenges outside of North America are also significant. The European Union and vast parts of Asia and South America operate on a 50Hz grid standard, requiring a completely different safety test and certification regimen than that of 60Hz environments. Japan is an extreme example, where both 50Hz and 60Hz grids coexist but operate at different voltages than found in either the E.U. or North America. Supporting both 60Hz and 50Hz standards in a single unified power converter platform vastly simplifies the deployment of energy storage solutions beyond North America, and should be a key consideration for systems integrators desiring expansion into new markets.

While interconnection standards and regulations will continue to evolve over time, many of the solutions to these issues can be built into the design of energy storage systems. Flexibility will be a key factor in navigating the challenges associated with deploying energy storage for various applications. The other factor, cost, can be mitigated by increasing energy storage system efficiencies and decreasing the size and weight of the necessary components which make up these systems. As the market for energy storage grows, the technologies will advance. That is why the ground work currently being laid by pioneers in this field is crucial for the future development of the industry.

John Merritt is the director of applications engineering for Ideal Power

Ideal Power, Inc. | www.idealpower.com



Thermal energy storage solution

Ice Energy has introduced the Ice Bear 20, a smaller-capacity version of its flagship Ice Bear system. The new system combines Ice Energy's patented thermal storage and smart-grid technology with integrated cooling, enabling utilities to control residential cooling load and reduce peak demand by up to 95% for up to four hours. It also allows increased load during periods of solar over-generation, while providing homeowners the cooling they desire.

The Ice Bear 20 is suited for residential and small commercial applications. In residential applications, it seamlessly integrates with the HVAC systems of new or existing homes.

Ice Energy | www.ice-energy.com



Low inductance impulse winding tester

Chroma Systems Solutions, Inc., a provider of power conversion and safety testing equipment and automated test systems, announces the release of their new 19031A Impulse Winding Tester designed for low inductance applications including transformers, power chokes, and other wound components. Combined with high/low inductance applied technology, the 19031A Impulse Winding Tester has 1000V impulse voltage, 0.25V resolution, and a 200MHz high speed sampling rate to satisfy test requirements for a wide range of power inductance products from 0.1uH to 100uH. The function of the 19031A Impulse Winding Tester is to discover potential defects as early as possible. Defects can be winding layer short, poor electrode welding, and poor internal coil or core insulation. The built-in Area Size and Differential Area Comparisons, Flutter Value, and Laplacian Value functions make it an effective way to inspect the coils for poor insulation. Even when applied to low inductance winding components, Chroma also includes 4-wire test, contact check, inductance check and a voltage compensation that avoids voltage errors resulting from the variance of DUT inductance or equivalent wiring inductance. The colorful display and screen capture function enables the user to save waveforms through the USB port on the front panel. The 19031A is well suited for on-site production as well as R&D and quality assurance.

Chroma Systems Solutions | www.chromausa.com



Next-generation energy storage system

Sunverge Energy announced the next generation of its Solar Integration System (SIS), offering customers a cost-effective package of more battery options and a streamlined design with even more system intelligence than the original SIS. The new Solar Integration System, available this summer, supports multiple lithium-ion battery chemistries and a wide range of storage capacities. Lighter, more modular, and easier to install than its predecessor, the new SIS maintains standards for performance, reliability, and safety and is suitable both for installation into existing home solar systems and for packaging with new solar panels. All of these features give utilities, retailers, solar providers, and developers the flexibility and choice they need to integrate storage into their customer offers.

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Image 1. Connection diagram of a power plant combining PV and storage inverters

Energy Storage Systems for Utility-Scale PV Plants

by Carlos Lezana

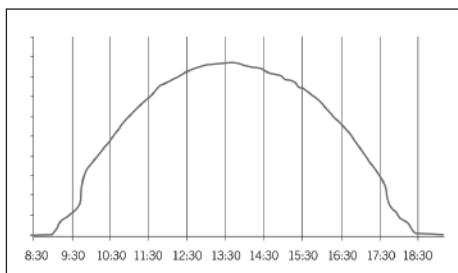


figure 1. Power delivered by a PV plant on a sunny day

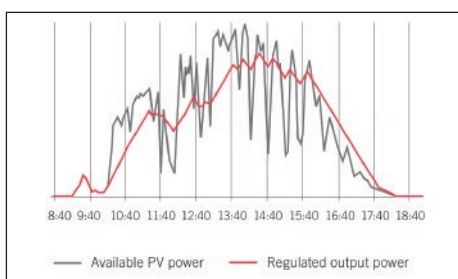


figure 2. Power output regulation thanks to an ESS at a PV plant on a day with scattered clouds

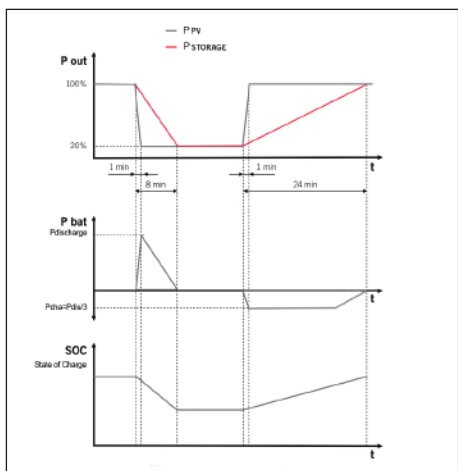


figure 3. Example of storage inverters performance

ALMOST EVERY REGION IN THE WORLD has deployed renewable energy generation. In the United States, for example, most states have a renewables portfolio standard which requires a specific portion of all generation to be produced from renewable energy. In part, this has propelled the US to become one of the biggest markets in the world for solar energy and for energy storage projects.

Although energy storage is just now gaining significant momentum, some studies predict that this market will surpass \$50 billion by 2020¹. During this time, numerous storage technologies will be fighting for their predominant position in the market. What is clear is that batteries will play a key role inside the storage sector as the main electrical energy storage technology. Additionally, US policy is now leading the way with some important Federal decisions. For instance, the US Department of Energy declared that energy storage will play a key role for the country's search of energy security and independence. Also, the Department of Defense has invested more than \$800 million in energy storage programs since 2009². California and Puerto Rico are paving the way and more states are shortly behind, like Texas, New York, and those connected to PJM transmission.

Energy storage projects are being deployed with photovoltaic (PV) systems anywhere from smaller residential systems to the largest utility-scale projects. And although all sectors are increasing, utility-scale grid-tied photovoltaic systems have experienced a considerable increase in market share worldwide. With a global installed capacity close to 200 GW³, photovoltaics have risen to occupy a prominent position within the power generation technologies. It is also important to note, that in order to achieve a higher penetration rate, it is imperative to integrate photovoltaics into the grid seamlessly, and this can be done using Energy Storage Systems (ESS).

Conventional electricity generating plants (thermal, nuclear, etc) implement a number of regulation mechanisms to ensure energy production is equal to consumption at all times. This is done to guarantee grid stability. However, this regulation requires specific response times. The integration of renewable energies (solar and wind power) may compromise this stability, due to the fact that the variability of this energy resource is far higher than that of conventional plants.

Figures 1 and 2 show two actual cases in which PV energy is produced at a 1MW power plant on a sunny day and on a day with scattered clouds, in addition to the output power when ESS are included in the plant.

In this way, for example, conventional power plants have an output power variability of 3-10%/min, but PV plants can reach values of up to 80%/min, depending on their size. This fact takes particular importance in weak grids such as those in islands or small grids based on diesel generators, where high penetration levels could endanger the stability of the system.

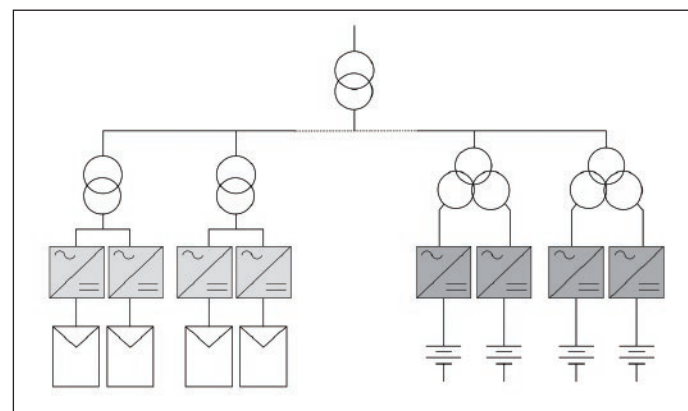


figure 4. Connection diagram of a power plant combining PV and storage inverters

To counteract a sudden increase in irradiance, PV inverters can limit their production by moving away from their maximum power point range and operating like a conventional power plant. However, when there is a drop in irradiance, the PV inverter is unable to control the energy produced, therefore requiring the use of ESS to provide power and to limit variations.

The integration of an ESS makes it possible to control the power ramps generated at the PV plant. Whenever a cloud passes over, with the subsequent loss of irradiance, the ESS provides the energy required to offset the energy shortfall. Once the cloud has gone, the available power increases sharply and this is used to charge the batteries whilst smoothly increasing the power output at the same time. Figure 3 shows an example of the system performance in the face of an 80%/min fluctuation in irradiance (up and down), in accordance with the 10%/min output power variation currently imposed by some grid operators, such as PREPA in Puerto Rico.

In order to address this issue and to facilitate the greater integration of PV energy into the grid, a family of storage central inverters have been developed with an output power ranging from 375 to 1,110 kVA, and are designed to integrate battery-based storage systems in PV plants. Moreover, it is possible to integrate the inverters and all the other electrical elements into a power station which can be supplied fully furnished on site, reducing capital expenditures (CapEx) and gaining cost-effectiveness. Thus, this storage (or photovoltaic) power station can achieve up to 3,500 kVA power output.

This kind of utility-scale solution has been developed by using the same technology applied to the medium-voltage photovoltaic power stations. The main reference is a 9,000 kWh storage system (with Li-ion batteries) coupled to a 9,000 kW PV plant.

Although there are several ways of integrating storage systems in PV plants, the engineers on this project believe the best one is to keep the ESS completely centralized, as if it was an independent installation coupled to the PV plant immediately before the point of connection with the medium voltage substation.

Figure 4 shows a typical connection diagram, with conventional grid-connected inverters for PV generation and dedicated storage inverters to connect the batteries to the electricity grid.

This option can be installed in PV plants that are already operating. With this system it is also possible to provide reactive energy with the battery inverters, thereby avoiding the need to over-size the PV inverters, should there be strict reactive power delivery requirements. The power plant controller will manage the energy flow between the grid and the batteries, adjusting the plant generation to a preestablished pattern.

In its annual 'World Energy Outlook' report, the International Energy Agency revealed that in 2014, renewables accounted for almost half of the new power generation capacity built worldwide and have now collectively become the second-largest generator of electricity after coal⁴. This clearly shows that we are now facing a global shift to low carbon energy sources.

Carlos Lezana is the marketing and communications director for Ingeteam's Solar PV Energy Division.

Ingeteam Inc. | www.ingeteam.com

¹ Lux Research, 2014.

² US Department of Energy. Grid energy storage.

³ According to BSW-Solar (German Solar Industry Association).

⁴ World Energy Outlook, November 2015. International Energy Agency.

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Is Your Battery Bank Ready for Spring?

by Ganesh Balasubramanian

In North America, the days are finally getting longer and the promise of spring seems just around the corner. More sunshine and better battery charging are good news for the battery-based, off-grid photovoltaic system owner, but it's important to do some spring cleaning to ensure the system will perform as expected for the remainder of the year.

For residential off-grid systems, winter can be hard on batteries. The shorter days of winter may have left batteries undercharged from time to time, and lower ambient temperatures will reduce overall capacity at a time of year when energy consumption may be at its highest. Remember the last big winter storm? How many days went by without proper charging because of lack of sunshine, or snow and ice covering the solar array? Was it just too cold to get out and fire up the backup generator to give the batteries a boost?

Our energy use also tends to increase during the winter months, creating the perfect storm for undercharged batteries as springtime arrives. So, as we come out of hibernation, it's time to give our batteries a little extra TLC, and take this opportunity to perform basic battery maintenance. Be sure to do the following tasks:

Check connections

Ensure that all connections are free of corrosion and properly tightened per manufacturers' recommendations. If corrosion is observed, clean the terminals with a mixture of baking soda and water using a wire brush. When finished cleaning, apply a thin coat of petroleum jelly or terminal protector spray.

Check set points

Check that the photovoltaic charge controllers and inverterchargers in a renewable energy system have been programmed according to the voltage set points recommended by the battery manufacturer.

The three stages of charging typically associated with daily charging cycles in a battery bank are bulk, absorption, and float charging. Since temperature variations affect batteries, using a charging system with temperature compensation, the ability to measure battery temperature and compensate charge rates accordingly, will ensure batteries receive a proper charge. Always consult the battery manufacturer for recommended set-points to be sure the settings provide optimum charging efficiency. Some devices are programmable while others may have pre-programmed options. In either case, incorrect settings can potentially reduce the life of a battery over time. After a long hard winter, double check all set points so the better charging days ahead will be optimized.



Clean and tighten battery terminal connections for optimum performance

Check electrolyte levels

As deep-cycle flooded batteries charge, hydrogen gas is produced and vented. This "off gassing" of hydrogen reduces the battery's electrolyte level, so periodic "watering" of the batteries with distilled water is required to ensure maximum life.

Distilled water should only be added to fully charged batteries in float mode, where the charge current and voltage are reduced to maintain a full battery. While there may be some variation from manufacturer to manufacturer, electrolyte levels should never be allowed to go so low as to expose the battery plates to air.

As flooded batteries age, their gassing rate will increase, which will require more frequent watering. No matter how often a battery bank is watered, it is important that this be done according to a regular schedule.

Equalize it! Don't criticize it!

The process for equalizing flooded deep-cycle batteries involves periodically overcharging the batteries at a higher voltage for a set period of time. This reduces the effects of electrolyte stratification, sulfation, and cell inconsistencies which develop over time. If left unchecked, these conditions will eventually diminish the overall efficiency and performance of the batteries.

If a battery has not been equalized in the last few months, now would be a good time to do it. Contact the battery manufacturer for detailed instructions on equalization.

Remember! Always wear protective clothing, gloves, and goggles when working with batteries. The electrolyte in a flooded battery is a solution of acid and water, so take extra precaution to avoid contact with skin and clothing. To prevent short circuits, use only insulated tools and do not lay objects on top of batteries.

There are also helpful videos available from battery manufacturers which will go step-by-step through these various battery maintenance tasks. When batteries are taken care of, they will continue to do their job well.

Ganesh Balasubramanian is the director of new market development at Trojan Battery

Trojan Battery | www.trojanbattery.com



The ESA 26th Annual Conference & Expo will be held April 25-27, 2016 at the Charlotte Convention Center in Charlotte, NC. Connecting technologies and opportunities, companies, and customers with authoritative speakers and insightful workshops, all coupled with the largest energy storage technology showcase. For three days, the most influential leaders and decision makers will gather with global experts to shape the future of the energy storage industry.

www.energystorage.org

show in print

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



Flow battery products

Through their partner Flextronics, Redflow has become the first flow battery company to commercially outsource the manufacturing of its products. Store and shift renewable energy, manage peak grid load, and support off-grid power systems and telecommunications with Redflow's range of compact ZBM and LSB flow battery energy storage products. Redflow's zinc-bromide flow batteries are well-suited to regular deep-discharging and operation without degradation in high ambient temperature climates in multi-hour applications ranging from kW to MW. Redflow's ZBMs and LSBs are sold, integrated, and maintained through a network of global system integrators.

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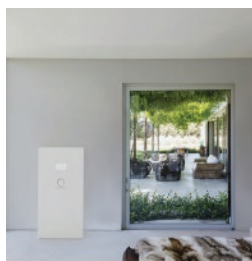


Power converter system

The Northern Power Systems FP2000 power converter system with FlexPhase technology integrates a modular bidirectional inverter, master control system, DC switchgear, and AC switchgear into a single enclosure for containerized or pad-mounted installations. FP2000 power converters are fully four-quadrant capable at any power factor, with response times of less than 1 ms. FP2000 is ideal for Battery Energy Storage Systems (BESS), grid frequency regulation, and hybrid systems. Their power converters are designed for MW-scale applications with a wide DC-voltage operating range for different battery chemistries, can be configured with two independent storage devices in a shared converter enclosure. Both grid-parallel and island modes supported, with ability to transition seamlessly between these modes (EnergyBridge). The FP2000 is microgrid ready, with islanding- and black-start capabilities at your disposal.

Northern Power Systems

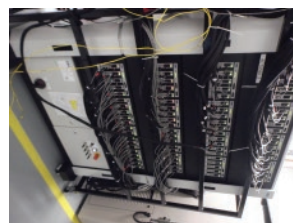
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Renewable energy consultant

DNV GL is the largest, global provider of independent renewable energy advice. A recognized authority in energy storage, DNV GL is also at the forefront of the wind, wave, tidal, and solar sectors, providing independent technical and engineering services, products, and training. Customers include: renewable energy developers; investors; lenders; manufacturers; construction firms; owners; operators; insurers; non-profit/government organizations; and large-scale, utility firms. DNV GL is present in all major and emerging global markets for renewable energy.

DNV GL | www.dnvgl.com/renewables



Megawatt-level energy storage

Intensium Max provides a megawatt-level energy storage solution featuring Saft's efficient and long life Li-ion technology. Featuring 1MWh in a 20-foot container, Intensium Max offers a high energy storage capacity. The system is readily scalable to suit a wide variety of applications, including grid support functions enabling optimized utilization of grid infrastructures, and offers energy storage capacity in a compact format.

Saft Batteries | www.saftbatteries.com



Key Cost Drivers in the Solar Industry

Four things to know

by Jamie Evans

Emerging models

A few years back, the buzz and excitement was around the steep fall in panel prices. Everyone was planning their next deal, dreaming of all the opportunities lower prices would bring the industry. While lower component prices certainly have boosted solar sales and more projects have been completed, the discussion has shifted to other ways developers can make deals more efficient to ensure more organizations go solar.

When it comes to integrating renewable energy, there are so many moving parts and multiple parties (developers, lawyers, builders, suppliers, and bankers) at play. The financial structures are complicated and many companies have limited experience monetizing the tax credits and depreciation benefits. In addition, while Power Purchase Agreements have grown in popularity, the challenges associated with negotiating, structuring, and financing these deals with numerous parties can frustrate potential customers and make transaction costs prohibitive.

A company's decision to convert to solar energy is also effected by the variable cost of service and maintenance that could impact projected savings. They want to ensure they can maximize their return on investment by minimizing operating costs and optimizing asset performance.

Today, the industry is beginning to adopt new financing models which help streamline the process so solar can be implemented smoothly, while maintaining the cost advantages ushered in by lower component and installation costs. Backed by a financially sound and trusted partner, these models can help deliver large systems that can be reliably operated and maintained for over 20 years.

ITC 101

Implemented in 2006 and extended in 2008 and again in 2015, the solar Investment Tax Credit has been a key component to successfully financing solar projects in the U.S. In fact, according to SEIA, since the ITC went into effect it has helped solar installations in the U.S. grow by more than 1,600 percent, a compound annual growth rate of 76 percent.

Why? It provides a 30 percent tax credit for systems and drives tax equity-based funding, an important piece of the capital structure given most projects, and system owners struggle to fully utilize their tax benefits. For project developers, the ITC has brought both stability and a degree of flexibility.

Thanks to the latest extension in December, the ITC will remain at 30 percent through the end of 2019, dropping to 26 percent in 2020 and 22 percent in 2021. After that, it will remain at 10 percent for commercial scale projects. With this support, the solar industry is expected to deploy more than 20 gigawatts of solar capacity annually by 2020.

Legislation that promotes parity

In the renewables business, there are simple things that can be done to ensure continued success. One getting a lot of attention is master limited partnership (MLP) legislation. MLP structures today are only available to companies in the oil and gas industry. A simple legislative change, while perhaps unlikely in the current Congress, would allow the renewables industry to avail itself of tax efficient MLP structure, open up new and broader sources of capital, and lower the cost of financing for renewable energy. As an industry, we're hoping to level the playing field with greater parity and simplicity to more easily deliver benefits to the broader energy market.

Reducing costs through R&D

To further drive clean technologies down the cost curve, the industry is focused on making continued advancements through research and development. Stable policies enduring over election cycles and administrations will play a role here, allowing businesses to make long-term decisions, because fundamentally, R&D is a long term investment. It's as critical as financing innovation, policy innovation, and cost reduction.

What it boils down to is creating an atmosphere at federal, state, and local levels where sustainable technologies can thrive. With the right policies in place, strong partnerships, and adequate investment in R&D, solar will be set up for success, in 2016 and beyond.



Jamie Evans is the managing director at Panasonic Eco Solutions.

Panasonic Eco Solutions

<http://panasonic.net/ecosolutions/>



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The 2016 NABCEP Continuing Education Conference is intended for NABCEP Certified Professionals who need continuing education credits in order to maintain their certification. The content presented is geared toward seasoned PV industry professionals who have several years of installation and/or technical sales experience. This is the ideal opportunity for NABCEP Certified PV Installation Professionals and PV Technical Sales Professionals to obtain all of the continuing education credits needed for recertification and non-certified professionals can earn up to 18 hours toward certification eligibility.

www.nabcep.org

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



Reduced roof penetrations

The CSS Solar Racking System allows fewer penetrations for commercial roof-mounted systems. In addition to reducing roof sealing costs, this simplifies installation since there are fewer attachment points. This system also allows roof access for repairs and re-roofing without removing the solar array. The CSS System anchors into the main girders of the building, providing solid attachment points without the need to attach to the roof sheathing or weaker roof supports. For each project ISA prepares a detailed dimensional layout of the array on the specific roof and delivers a customized CSS Racking kit ready for quick installation.

ISA Corporation
www.isa-corporation.com



Hybrid inverter/charger

Conext XW+ is an adaptable single-phase and three-phase hybrid inverter with grid-tie functionality and dual AC power inputs. Available solar charge controllers, monitoring, and automated generator control modules enable further adaptability. From a single Conext XW+ unit to clusters up to 102 kW, the Conext XW+ is a scalable system that allows for the integration of solar capacity as required. Adaptable and scalable, the Schneider Electric Conext XW+ system is a solution for grid-interactive and off-grid, residential and commercial, solar, and backup power applications.

Schneider Electric
solar.schneider-electric.com



Versatile mounting hardware

SolarRoofHook.com's All Tile Adjustable Roof Hook is mounting hardware for clay and concrete tile roofs. Their hook has been designed to work with a variety of tile sizes and types, including both Flat and Spanish tile roofs. This hook has 3 points of adjustability to suit the majority of solar residential roof designs. The rail attachment slot is compatible with all major racking manufacturers, accepting 5/16" or 3/8" bolts. The mounting screw holes accept either #14 or 5/16" size fasteners.

SolarRoofHook.com
www.solarroofhook.com



Maintenance-free AGM models

Offering a wide range of voltage and Amp-Hour capacity options to meet the requirements of small to large-scale installs, Rolls AGM-S and AGM-R series provide maintenance-free convenience and versatility with the longstanding dependability Rolls customers have relied on. Rolls high-quality AGM models offer ideal power storage solutions for remote, backup off-grid and grid-tied applications.

Rolls Battery Engineering
www.rollsbattery.com



Rail-less PV mounting systems

With high reliability, the all-in-one designed RT-[E] Mount clamps the PV Module to the roofing system. It can be attached directly into the sheathing, saving the solar contractor time up on the roof. This fully waterproof, integrated, flexible flashing is certified by the International Code Council (ICC) and is also UL certified with P.E. Stamped letters ready.

Roof Tech, Inc.
www.roof-tech.us



CSS RACKING THE PROBLEM SOLVER FOR COMMERCIAL ROOFS

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- Tilts up for Re-Roofing
- Anchors to the Strong Building Girders
- Clears Major Roof Equipment
- Maximizes Usable Roof Space



www.isa-corporation.com



Waterproofing for composite/asphalt shingle roofs

E-Mount Lag from Quick Mount PV uses the patented QBlock Elevated Water Seal technology to provide superior waterproofing on composition/asphalt shingle roofs. It is backed by solid engineering and certified for strength and waterproofing by the ICC-ES (ICC-ESR-3744). All-aluminum 9 x 12-inch flashing. All stainless steel hardware included for fast, single bolt installation. Meets or exceeds roofing industry best practices. 20-year limited product warranty.

Quick Mount PV
www.quickmountpv.com



Renewable energy inverter/chargers

Magnum Energy manufactures inverter/chargers for Renewable Energy applications. Shipped worldwide, their products use high quality components to respond to the extreme conditions of variable climates. For reliable power regardless of grid connectivity, Magnum inverter/chargers, interconnection system equipment, and accessories are a solid base to build a battery back-up, AC Coupled, or off-grid power system.

Magnum Energy
www.magnum-dimensions.com



Installer training programs

Fronius is featuring their unique SnapINverter technologies for both residential and commercial solar systems. Fronius also sponsors the NABCEP conference and is offering several NABCEP CEC's for their Fronius Service Provider installer training program. Installers can become exclusively certified with the manufacturer to perform field service work on all their string inverters.

Fronius USA
fronius-usa.com



AKÇA ENERJİ geothermal binary plant
Exergy | www.exergy-orc.com

2016 GEOTHERMAL BUYERS GUIDE

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EDUCATION | R&D

ENGINEERING & EQUIPMENT

ENVIRONMENTAL | ENGINEERING CONSULTANTS

EXPLORATION & SITE ASSESSMENT

GEOTHERMAL EQUIPMENT (SUPPLIERS/MANUFACTURERS)
LARGE-SCALE PROJECTS

GEOTHERMAL EQUIPMENT (SUPPLIERS/MANUFACTURERS)
SMALL-SCALE FOR HOME/BUSINESS

GEOTHERMAL HEATING & COOLING SYSTEMS

POWER PLANTS | POWER PLANT DESIGN & CONSTRUCTION

TOOLS

OTHER

C&I Solutions

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DRILLING



Hammer Rig Rentals USA, LLC

Hammer Rig Rentals USA, LLC offers flexible and convenient drilling rig rentals, used equipment, and tooling sales all over the US. Specializing in micro-piling, limited access, and geothermal drilling equipment rental contracts, they also offer lease-to-own options and used equipment sales. www.hammerrentals.com



Webco, Inc.

Webco Industries manufactures LaserLine seam-welded nickel alloy, duplex, and stainless steel coiled tubing, including capillary strings for scale and corrosion inhibition in geothermal wells. Tube sizes range from: 0.250 to 1.5 OD, wall thickness from 0.035 to 0.125, and lengths can be up to 12,000 meters or longer. Product specifications and process requirements can be met by tailoring material grades and customizing to specification, including limiting orbital welds. www.webcotube.com



WWT International Drilling Tool Services

WWT Non-Rotating Protectors (NRPS) measurably improve drilling and well cleanout operations in geothermal applications by preventing casing wear to preserve casing integrity. Torque and drag are also significantly reduced which improves drilling performance by reducing rotational and sliding friction. WWT NRPS have been run on numerous geothermal wells all around the globe. www.wwtinternational.com

EDUCATION | R&D



The Geothermal Institute

The Geothermal Institute conducts geothermal energy related research, education, consulting, and training programs. It also provides research and development, testing and laboratory services, and commercial services. The Geothermal Institute is one of the premier geothermal training centers in the world and coordinates the post-graduate geothermal programs for the University of Auckland. The Geothermal Institute convenes the annual NZ Geothermal Workshop, NZ's longest running energy conference www.geothermal.auckland.ac.nz

ENGINEERING & EQUIPMENT



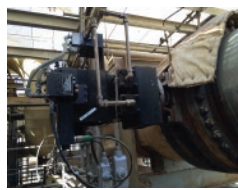
A-T Controls

A-T Controls provides solutions for demanding geothermal applications, providing a variety of durable valves for tough environments. The A-T Controls M Series Metal-seat Ball Valve, for example, is designed for use in more challenging services, such as higher temperature and pressure projects. It can be used in temperatures of up to 1100°F (593°C). Their V-Series Segment Control Valves range in size from 2" to 16", and support temperatures up to 600°F (315.5°C). A-T Controls' Power-seal High-performance Butterfly Valve comes with a pneumatic, spring-return actuator or double-acting actuator. All A-T Control valves are quickly and easily automated. www.atcontrols.com



Nash, by Gardner Denver

Gardner Denver Nash is an international supplier of gas removal systems for geothermal power plants. Nash has over 110 years of experience designing and manufacturing liquid ring pumps and steam jet ejectors. Since every geothermal resource and every plant site is unique, Nash engineers draw on their wealth of application engineering know-how and product development data, to optimize each system to maximize performance and prolong the life of each resource. www.GDNash.com



REXA

REXA Electraulic Actuator's self-contained design increases uptime, reduces maintenance, and improves control for geothermal steam turbines. Maintenance is removed through elimination of the HPU skid, all hydraulic piping, filtration systems, and sampling requirements. REXA's precise positioning and repeatability improves turbine control, and its rugged construction provides maximum durability in extreme conditions. www.rexa.com

ENVIRONMENTAL | ENGINEERING CONSULTANTS



Ecology & Environment, Inc.

A strategic permitting and stakeholder outreach approach is critical to developing successful geothermal energy projects. Ecology and Environment, Inc. (E&E) recognizes that getting new projects approved is as much about building relationships, as it is about building infrastructure. They prepare required federal environmental impact statements, state or provincial-equivalent impact assessments, and local use permits. E&E knows the issues and challenges associated with geothermal development on both public and private lands. They've worked in regions with high potential for utility-scale geothermal energy development and offer clients smart solutions to help them move through the entire project life cycle with a proactive approach and careful planning that saves both time and money. www.ene.com/markets/geothermal

EXPLORATION & SITE ASSESSMENT



Bell Geospace

Bell Geospace acquires, processes, and interprets airborne full tensor gravity gradiometry data for resource exploration. By measuring density changes, FTG data can be used to map geologic structure associated with geothermal deposits. www.bellgeo.com



GeothermEx

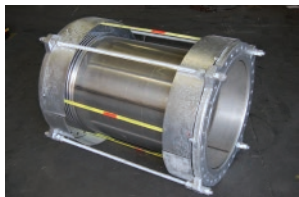
Since 1973, GeothermEx has been working with geothermal developers, investors, regulators, and land owners to explore, assess, and develop geothermal resources. Focusing on the subsurface resource, the riskiest element of all geothermal projects, GeothermEx's team of geoscientists and engineers have participated in hundreds of geothermal projects all around the world, including 70% of all operating projects and many more in earlier stages of development. With its experience in exploration, drilling, well testing, resource analysis, resource quantification, modeling, and risk mitigation, GeothermEx has supported nearly \$13 billion in project financing for more than 7,500MW of geothermal power. Acquired by Schlumberger in 2010, GeothermEx is actively leveraging and adapting Schlumberger technologies for application in geothermal projects. www.geothermex.com



Teranov Geothermal Energy

Teranov, along with KiTerGeo (a Kidova-Teranov Joint Venture) provides project management, engineering, and field services for the development of high and medium temperature geothermal projects over EMEA, Latin America, and the Caribbean. They offer due diligence, capacity building, prefeasibility and feasibility studies involving a broad geoscience approach and innovative tools for resources evaluation and assessment, and reservoir characterization and forecasting all the way up to plant completion and operations. www.terranov.com

**GEOHERMAL EQUIPMENT
(suppliers/manufacturers):
Large-scale projects**



Hyspan Precision Products

Hyspan Precision Products has been supporting geothermal applications world-wide for 50 years. Their offerings include: Well-head, BOP, Thermal, Seismic, Turbine and Pump Connection, Abrasion Service, Universal, Pressure Balanced, Single Ply and Laminated, Heat Exchanger, Metal Bellows, Ball Joints, Slip Joints, Braided Hose, 7000 PSI, Corrosion Resistant Metals, Ball Joint Loops with 80% area reduction, Piping Stress Analysis, and Reverse Engineering. Their accreditations include: EJMA Registered, ASME B31.1-B31.3-Section VIII, CE/PED, NEMA, and they are an ORMAT supplier.
www.hyspan.com



Turboden Srl

Turboden, a Mitsubishi Heavy Industries company, designs, manufactures, and performs after-sales of Organic Rankine Cycle (ORC) turbogenerators. They are also a global supplier of geothermal solutions to generate electric power efficiently from medium-to-low enthalpy geothermal sources. Turboden manufactures fully engineered power plants based on its proprietary ORC turbines ranging up to 40MW per single generator at low RPM speed, with a variety of field proven different working fluids.
www.turboden.com

**GEOHERMAL EQUIPMENT (suppliers/manufacturers):
Small-scale for home/business**



Geothermal Development Associates

Geothermal Development Associates (GDA) is a privately held US company that specializes in geothermal power and direct-use applications worldwide. Their staff of engineers, geologists, and geoscientists have the capability to oversee projects at every stage—from initial resource exploration and well-testing to the design, supply, and commissioning of a new power plant.
www.gdareno.com

BCP™ 5000 SERIES Sulfur Deposit Removal & Control in Cooling Towers



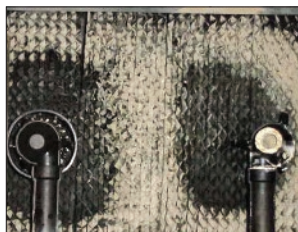
Geothermal energy systems experience a number of unique operational problems. Fluids produced from geothermal reservoirs include steam, brine and a variety of non-condensable gasses (CO₂, H₂S, CH₃, N₂, etc.). In water-cooled systems with direct contact condensers, elemental sulfur fouling in the cooling system can be a significant problem.

H₂S oxidation within the aerobic cooling water environment results in the formation of sulfur deposits in:

Condensers, Flow-lines, Tower fill and Spray nozzles above the fill.



Sulfur deposit accumulation in flow-lines.



Sulfur fouling in the fill diverts water flow to less fouled zones.



Sulfur fouling on and in the spray nozzles results in uneven water distribution over the fill.

End result:

Limited electricity generation by the facility and costly offline clean-up.

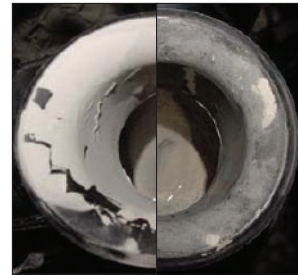
The Solution

BCP™ 5000 products are well-known as organic deposit penetrants and dispersants. In rigorous testing in large geothermal plants in Mexico and the Philippines, BCP™ 5000 products have been shown to be the only chemistry effective in **removing** pre-existing hard elemental sulfur deposits, and in **preventing** the formation of new elemental sulfur deposits.

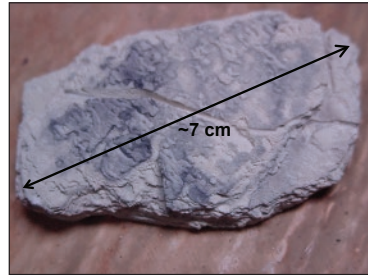
In a system in which elemental sulfur deposits have formed, BCP™ 5000 products* attack the deposits, causing disaggregation and release of the deposits from system surfaces. Shown below are:



Sulfur cylinder from a flow-line, expelled through a nozzle orifice onto the upper surface of the tower fill.



Before/after BCP™ 5000 product treatment comparison of a nozzle orifice



A piece of sulfur deposit detached from the tower structure.

End result:

Improved cooling system efficiency.

For a full case study or more information **contact us at 888-739-0377** or www.amsainc.com

*Patent pending and patents issued



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The Bosch Greensource CDi series stands for Complete Design with Innovation, and is built and tested to be a high efficiency and reliable unit. The Greensource CDi Series Model SM heat pump comes in cooling capacities from 2 to 6 tons and is equipped with quality and innovative technology to cool and heat a home economically and in an environmentally friendly manner. Available in packaged or split system configurations. www.boschheatingandcooling.com



Houghton Chemical

Houghton Chemical Corporation is a fourth generation family business. They are based in Boston with national and international distribution. Their Inhibited Glycols have various applications: geothermal, green, industrial, food, and aluminum. GeoSafe, inhibited ethyl alcohol, is specially utilized in all geothermal applications. Houghton Chemical operates a bulk fleet and internal laboratory with full glycol analysis testing with individualized technical service. www.houghton.com



REHAU

The REHAU RAUGEO ground loop heat exchange system uses crosslinked polyethylene (PEXa) pipe that offers superior flexibility and abrasion resistance compared to HDPE, while prefabricated double U-bends require up to 30% less borehole footage than a single HDPE U-bend. RAUGEO ground loops usually begin and end at a balancing manifold that, unlike the typical reverse-return header, provides easy access and allows each ground loop to be individually controlled for system optimization. www.na.rehau.com/raugeo



WaterFurnace International, Inc.

WaterFurnace's 7 Series is the geothermal industry's first variable capacity unit available to homeowners and surpasses both 41EER and 5.3COP efficiency barriers. This unit features Aurora communicating controls that work in concert with the variable capacity compressor, variable speed loop pump, and variable speed blower motor to offer comfort you have to experience to believe. The 7 Series can ramp down to 20% of normal operation or scale up to 130% output using SuperBoost cooling. www.waterfurnace.com

POWER PLANTS | POWER PLANT DESIGN & CONSTRUCTION



BS&B Safety Systems, LLC

BS&B keeps geothermal power plants and solar power plants safe from the dangers of overpressure with its Sta-Saf line-up of rupture disks. Sta-Saf rupture disks are used as stand-alone devices or combined with relief valves. Rupture disks protect ASME process vessels from static overpressure and runaway reaction. Low pressure disk designs are available to protect systems with design pressures as low as 0.2 psig (6WC). www.bsbsystems.com

Enginomix LLC
IPSEpro is an open-equation modeling software package used to design, analyze and optimize power plants. It can model conventional and renewable technologies, including geothermal (flash & CRC), solar thermal, desalination, heat recovery (ORC & sCO₂), and hybrid plants. With IPSEpro, design virtually any geothermal power plant and predict its off-design performance over a wide range of conditions, accounting for changes in load, ambient, reservoir production, and equipment degradation. www.enginomix.net

Exergy SpA
EXERGY designs and manufactures Organic Rankine Cycle (ORC) systems with the Radial Outflow Turbine for power generation from medium to low enthalpy geothermal heat sources. EXERGY's ORC plants are a cost effective solution offering multiple pressure level plant with single turbine disk with efficiency up to 6% more than axial turbines and extreme flexibility for changing geothermal fluid conditions due to a higher number of stages. EXERGY's solutions are available from small modular unit up to 50MW plants. www.exergy-orc.com

TOOLS



Perma Works, LLC

Perma Works can help decrease logging tool costs by 50% by building project specific pressure housings and running with their calibrated electronics, tested firmware, and easy to use PC software. Perma Works can supply production logging electronics with CCL, running in both memory and surface read out modes. They can even add a company logo to their Windows 10 software. They have reservoir testing tool electronics rated for 530°F (275°C) "continuous" operation. www.permaworks.com

OTHER C&I Solutions

Pfister Energy
Pfister Energy specializes in the design and construction of renewable energy solutions for commercial, industrial, and institutional facilities with an emphasis on building-integrated applications, and energy supply services. Pfister Energy carefully considers all the particulars of a building and provides their client with the necessary information needed to determine if a geothermal heat pump is right for their facility. pfisterenergy.com

Geoinformatics



Arizona Geological Survey

The U.S. National Geothermal Data System's (NGDS) provides free open access to millions of data records, maps, and reports, sharing relevant geoscience and land use data to propel geothermal development and production in the U.S. NGDS serves information from hundreds of the U.S. Department of Energy's sponsored development and research projects and geologic data feeds from 60+ data providers in all 50 states in a federated system. NGDS shortens project development timelines. www.geothermaldata.org

Geothermal Fluid Manufacturer

Greenway Products Inc.

Greenway Products Inc., is a manufacturer of geothermal fluids for commercial and residential closed-loop geothermal systems. Their GlycoChill+ (Propylene Glycol & Bio-Based Glycol) and GeoChill+ (Denatured Ethanol based) fluids include specially formulated inhibitor packages that help prevent unit corrosion and fluid degradation all while providing excellent freeze protection to ensure efficient system operation

www.geothermalfluids.com

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www.geotemps.com

Sulfur Deposit Control



AMSA Inc.

AMSA provides organic deposit and corrosion control products for cooling in industrial applications. They offer DTEA II, which is a safe, water-based, phosphonate-free product that provides sulfur control for geothermal cooling towers. DTEA II also minimizes the use of biocides by reducing the accumulation of organic deposits. It comes with an environmentally friendly profile, due to its quick degradation rate prior to release, when used under common cooling tower treatment conditions. Overall, DTEA II reduces operational costs by diminishing corrosion and improving equipment lifetime. It is sold under the BCP 5000 series label for geothermal applications. Proprietary and custom formulations, as well as private labels, are also produced by AMSA.

www.amsainc.com



Simple solution for radiant heating

WaterFurnace International, Inc., introduces HydroLogic, a turnkey solution for radiant heating that integrates seamlessly into a WaterFurnace geothermal system. The main component of HydroLogic is a pre-piped, pre-wired modular mechanical panel designed to simplify installation. The panel supports cooling, dehumidification, and multiple zones of radiant heating while optimizing heat pump performance by automatically adjusting water temperatures based on indoor feedback and outdoor temperature via the included sensor. HydroLogic's intelligent heat/cool switchover reduces energy waste and maximizes the overall system performance.

WaterFurnace International, Inc. | www.waterfurnace.com

Year	Sales (MW)
2009	0
2011	51
2012	130
2013	219
2014	219
2015	300

In 2009 with the launch of our innovative and pioneering **Radial Outflow Turbine** we changed the ORC industry forever. **We have sold more than 300 MW of clean energy to a diverse range of satisfied clients around the world.**

Today, thanks to our core technology and with 15 years power station design experience we are one of the world's leading supplier of Organic Rankine Cycle (ORC) systems for **geothermal, waste heat recovery, biomass and solar (CSP) applications.**

Based on the Radial Outflow Turbine, Exergy's ORC systems perform with greater efficiency and flexibility than other technologies on the market becoming a valuable choice for the development of binary geothermal power plants.

OUR NEXT GOAL IS TO SERVE YOUR ENERGY NEEDS.

THE RADIAL OUTFLOW TURBINE

OUR GROWTH, YOUR GROWTH.

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WWW.EXERGY-ORC.COM
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Gruppo Industriale Maccaferri



Biomass Waste is a Problem - and a Resource

by Julien Uhlig

Biomass, especially the waste from forestry and agriculture, industry or households, is a clean and cheap energy source. However, biomass power plants are usually expensive, industrial-style, and not applicable for decentralized usage. Therefore, in 2009, a group of German engineers began to develop a small-sized, medium-output combined heat and power plant. Their main goal was to bring electricity, heat, and cooling to even the most remote corners of the earth. They wanted to provide clean energy from waste, where diesel generators are typically used, and help those who still have no access to affordable energy.



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PO BOX 40490 • Eugene, OR 97404



The mountain of waste arising daily in forestry, agriculture, and downstream industries is gigantic. Furthermore, there is food waste and other garbage from service industries and private households. In the US alone, this waste fills more than 3,500 landfills per year. This is as much as 220 million tons of waste, even though plant remains are far too valuable to simply throw away.

Thermally recycled in a biomass power plant, the waste delivers electricity and heat without charging additional carbon dioxide into the atmosphere. Some may argue the combustion of such biomass also produces CO₂, which is true, but only in the same amount it was captured from the atmosphere during plant growth. This represents a clear advantage over fossil fuels, which release longtime stored carbon.

Transform straw into gold

Along with classical steam power plants and OCR systems, biomass gasification plants are a third possibility. The principle behind biomass gasification technology is far from being new. Solid biomass, e.g. wood waste pressed into pellet form, is thermally decomposed at very high temperatures. The escaping syngas is used as fuel in an ordinary gas engine which powers a generator and produces electricity.

Such plants operate on the principle of cogeneration. This means, the generated heat is also used for cooling if it is combined with an adsorption chiller. Biomass power plants are capable of generating base load power, making them ideal renewable energy partners for solar power plants and wind farms. However, the expensive classical steam power plants are often only practical for industrial users and utility-scale power grids.

For the decentralized energy supply, the technical effort required and the size of these plants can become a problem. A new solution is a high temperature reactor, combined with a gas engine and a generator, placed on three square meters, arguably the smallest biomass power plant in the world. One unit supplies 25kW electric and 60kW thermal power. In combination with an adsorption chiller, the heat can be transformed into 30kW cooling power. To increase electric and thermal output, several biomass power plants can be coupled.





Gasification flow meter

Fluid Components International's (FCI) ST75 Series Air/Gas Flow Meter operates in rugged, hot, biomass gasification plant environments to provide measurement of mixed composition gases including hydrogen (H₂), carbon monoxide (CO), and trace methane (CH₄) with highly dependable accuracy to ±2% of reading with ±0.5% repeatability in line sizes from 0.25 to 2 inches (6 to 51 mm).

With its thermal dispersion mass flow sensing element, the ST75 Flow Meter measures mixed composition gases, and is safe for potentially flammable or explosive combustible gas environments. The ST75 Flow Meter operates over a wide flow range in mixed gas environments from 0.01 to 559 SCFM (0.01 to 950 NCMH), depending on line size. For variable process conditions such as those in biomass gasification plants, the ST75 meter is factory preset to a turndown range of 10:1 to 100:1.

The ST75 Flow Meter's fully scalable dual 4-20mA standard outputs are user assignable to flow rate and/or temperature and a 0-1kHz pulse output of total flow. It withstands process temperatures from 0°F to 250°F (-18°C to 121°C). It operates at pressures up to 240 psig [16.5 bar (g)] with a standard t-fitting (NPT female) process connection. With a tube process connection, the meter withstands 600 psig [41 bar (g)].

Offering direct-flow measurement for higher performance at a lower cost with proven thermal dispersion technology, the ST75 Flow Meter eliminates the need for additional pressure and temperature sensors, flow computers, or other devices that are required with orifice plates, Venturis, Vortex shedding, and other volumetric meters. The ST75 meter also requires virtually no maintenance for both a low installed and low life-cycle cost.

FCI | www.fluidcomponents.com

A seemingly insurmountable hurdle to overcome is the substance created while using biomass, tar, and the problems it causes on the engine. Tar is a highly viscous mixture of different organic compounds released during thermal digestion, and is deposited in the engine. The wear is high and frequent maintenance is the only solution. With this new system, however, the power generator can be operated with many different fuel mixtures, and even without additional filtration, the amount of tar residues is less than 0.1 grams per standard cubic meter.

Another important point is the range of usable fuels. Ideally, these should be decomposable, and locally available. In addition, they should not enter into competition for land with food plants. Waste is therefore the ideal solution. A science team at the Technical University of Graz (Austria) is doing ongoing research, identifying new opportunities to convert by-products, agriculture waste, and specific household waste components into a sustainable fuel mixture. At the laboratory, they test various starting materials, verify the tar content, the syngas composition, and the emission values. In the end, many other fuel mixtures will be certified.

Whether its a pellet facility in California, a farm in the Argentine pampas, or a village in the heart of Africa, the demands on power supply are similar. If it can be easily transported to the operation site, simply installed, economically operated, and conveniently maintained, a power plant meets the essential characteristics to be used far away from central electricity grids.



Julien Uhlig is the CEO of ENTRADE Energiesysteme AG, a German cleantech company. ENTRADE is a portfolio company of the LA Cleantech Incubator and one E3 unit in the front of the LA Kretz Innovation Campus is powering the building with electricity and cooling.

ENTRADE Energiesysteme AG

www.entrade.co



Efficient spin loader

Metalfab, Inc. has announced availability of their new Spin Loader. Available in two carbon steel models, the Spin Loader allows utilization of bulk storage facilities to their fullest capacity while eliminating the pyramiding which occurs when flakes and granular materials are loaded into bins, hopper cars, and piles. It also enables loading of up to 15% more product into virtually any storage facility evenly in a 360° arc without costly hand labor or interruption of flow.

Simple to install and easy to operate, the Spin Loader can handle up to 200,000lbs. per hour of 90lbs. per cubic foot material. The entering material flows through the Spin Loader's tube to a motorized, spinning disc which directs it to the outer walls of the bin, allowing each bin or compartment to be filled to its maximum capacity. This method of redirecting the particles greatly reduces the possibility of particle separation while allowing the particles to intermix. And since the entire loading system may be completely enclosed, product waste, and contamination are eliminated.

Metalfab, Inc. | www.metalfabinc.com



Customized thermal solutions

Vulcan Systems specializes in customized thermal solutions for material processing and handling. Their biomass torrefaction systems are able to process biomass to maximize the energy per ton of the product. Torrefying wood by taking the wood to the temperatures nearing combustion in an oxygen deprived thermal processor breaks down the hemicellulose and lignins. Breaking down those compounds and exposing the wood to the high temperatures produces a product with a high BTU value and which is friable.

At Vulcan Systems Thermal Testing Center, clients have the opportunity to bring in materials for thermal processing and feasibility testing, enabling their staff to offer an economical thermal solution for each client's specific material. Their custom-designed thermal treatment and drying equipment helps to cost-effectively meet environmental regulations while also producing a high-quality, high-value product.

Vulcan Systems | www.getvulcan.com



Poultry litter-fueled biomass boiler

Hurst Boiler, an international manufacturer of a complete line of gas, oil, coal, and hybrid biomass fuel fired steam and hot water boilers since 1967, announces the commissioning of its third poultry litter-fueled boiler. Litter has posed a challenge for many boiler systems due to its high ash content and ash characteristics. Litter is significantly different from other biomass fuels. Hurst's new poultry litter-fueled biomass boiler system successfully overcomes the challenges to deliver an energy efficient and environmentally sustainable solution.

Hurst Boiler | www.hurstboiler.com

MARCH

- 14-16 **3rd Annual Wind Farm Data Management & Analysis Forum**
Houston, TX; www.windpowermonthly.com
- 16-17 **2016 ACORE National Renewable Energy Policy Forum**
The W Hotel – Washington, DC; www.acorepolicyforum.com
- 17 **International Geothermal Energy Showcase**
Ronald Regan Building & International Trade Center – Washington, DC; www.geo-energy.org
- 22-23 **AWEA Wind Project Siting and Environmental Compliance Conference**
Francis Marion Hotel – Charleston, SC; www.awea.org/siting
- 23 **12th Canadian German Wind and Solar Energy Conference**
Calgary, AB; www.germanchamber.ca
- 24 **Intersolar Summit USA East**
Brooklyn, NY; www.intersolar-summit.com
- 30-01 **2016 Northeast Biomass Heating Expo**
Burlington, VT; www.nebiomassheat.com

APRIL

- 04-06 **5th Annual NABCEP Continuing Education Conference**
Paradise Point Resort & Spa – San Diego, CA; www.nabcep.org
- 11 **Global Pellet Market Outlook Summit**
Charlotte Convention Center – Charlotte, NC; www.biomassconference.com
- 11-13 **Onsite Energy Conference & Expo**
Charlotte Convention Center – Charlotte, NC; www.onsiteenergyexpo.com
- 11-14 **2016 International Biomass Conference & Expo**
Charlotte Convention Center – Charlotte, NC; www.biomassconference.com
- 11-14 **Utility Solar Conference (USC)**
Grand Hyatt – Denver, CO; www.solarelectricpower.org
- 17-20 **2016 World Congress on Industrial Biotechnology**
San Diego Convention Center – San Diego, CA; www.bio.org/worldcongress
- 18-20 **2016 Adhesive & Sealant Convention**
Hilton New Orleans Riverside – New Orleans, LA; www.ascouncil.org
- 21-22 **Advanced Energy 2016**
Jacob K Javits Convention Center – New York, NY; aertc.org/conference2016/
- 24-28 **LIGHTFAIR International**
San Diego Convention Center – San Diego, CA; www.lightfair.com
- 25-26 **Power Plays: Geothermal Energy in Oil and Gas Fields**
SMU Campus – Dallas, TX; www.smu.edu

MAY

- 04-05 **Renewable & Bio-based Chemicals Summit**
Chicago, IL; www.wplgroup.com
- 15-18 **Strive for Sustainability**
The Sagamore, Bolton Landing – New York, NY; www.nyfederation.org
- 16-17 **Solar Ontario**
Fallsview Casino Resort/Hilton – Niagara Falls, ON; www.solarenergyevent.ca
- 23-26 **WINDPOWER**
New Orleans, LA; www.windpowerexpo.org
- 25-26 **Solar Power Southeast**
Atlanta, GA; www.events.solar/southeast

JUNE

- 08-10 **2016 Modern Solutions Power Systems Conference (MSPSC)**
The Drake Hotel – Chicago, IL; www.selinc.com/mspsc-event
- 14-15 **National Geothermal Summit**
Reno, NV; www.geo-energy.org/events.aspx
- 21-22 **REFF Wall Street Renewable Energy Finance Forum**
The Grand Hyatt – New York, NY; www.reffwallstreet.com
- 26-29 **50th US Rock Mechanics/Geomechanics Symposium**
Houston, TX; armasyposium.org

JULY

- 11-13 **A National Town Meeting on Demand Response and Smart Grid**
Washington, DC; www.demandresponsetownmeeting.com
- 12-14 **SEMICON West**
Moscone Center – San Francisco, CA; www.semiconwest.org
- 12-14 **Intersolar North America 2016**
Moscone Center – San Francisco, CA; www.intersolar.us

SEPTEMBER

- 12-15 **Solar Power International**
Las Vegas, NV;
www.solarpowerinternational.com

OCTOBER

- 04-06 **Energy Storage North America 2016**
San Diego Convention Center – San Diego, CA; www.esnaexpo.com
- 23-26 **GRC Annual Meeting & GEA Geothermal Energy Expo**
Sacramento Convention Center – Sacramento, CA;
www.geothermal.org/meet-new.html

Send us your clean energy show and event listings. Email information to the editor at editor@naceanenergy.com

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47	American Earth Anchors	americanea.com
54	American Polywater Corporation	www.polywater.com/ductseal2.html
81	AMSA	www.amsainc.com
47	Ancora Metalworks Inc	www.ancorapiling.com
35	Applied Energy Technologies	www.aetenergy.com
07	Array Technologies	arraytechinc.com
77	AWEA Windpower	www.windpowerexpo.org
05 & 45	Baja Constructions	www.bajacarpports.com
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16	HT Instruments	www.ht-instruments.com
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78	ISA Corporation	www.isa-corporation.com
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48	Kipp & Zonen	www.kippzonen.com
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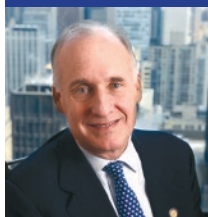
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Plenary: Future of the Electric Utility Industry - Challenges and Opportunities
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Panelists:
Mark Lynch, President and CEO of NYSEG and RG&E
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