

North American **CleanEnergy**

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How the COVID-19 global quarantine has impacted air quality Pg. 8

After the Storm

The electric utilities sector long-term implications of COVID-19 Pg. 62

The Height of Safety

Pg. 10

Keeping out of Harm's Way

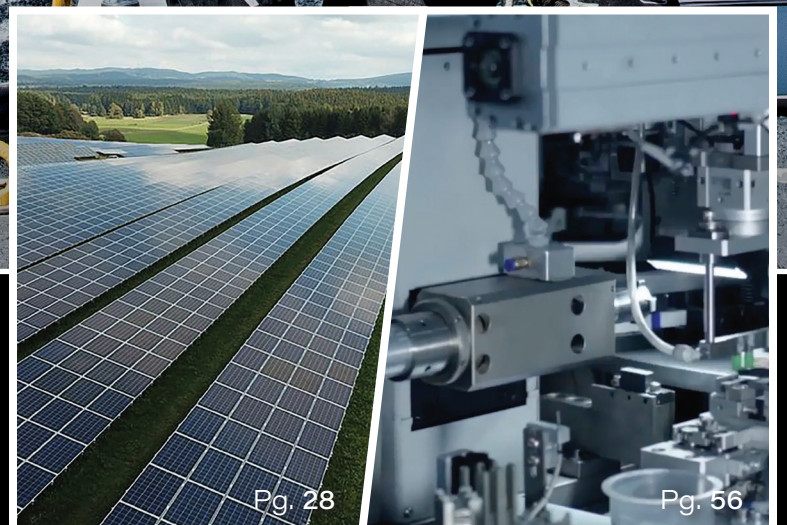
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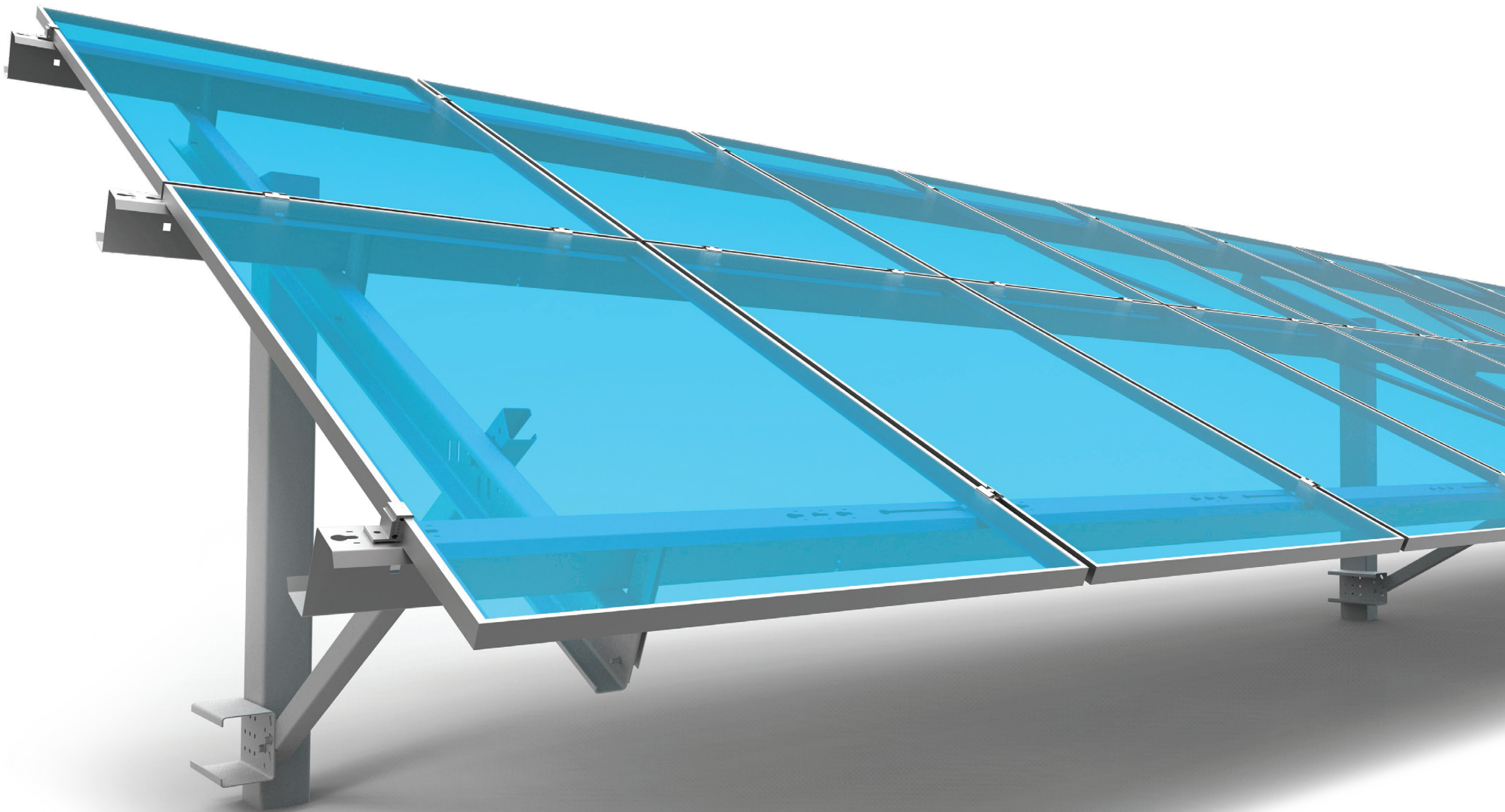
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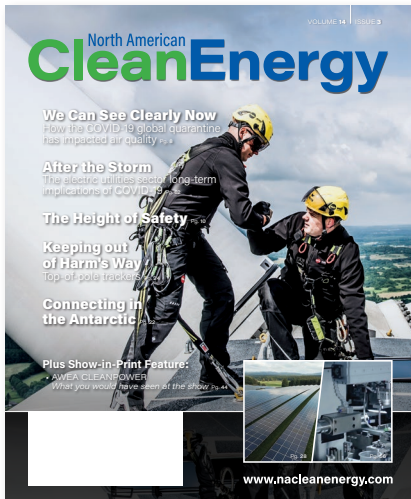


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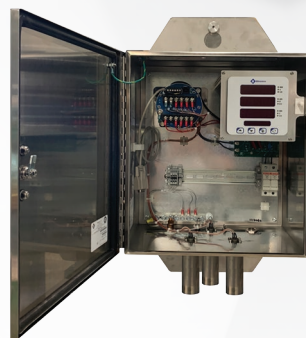
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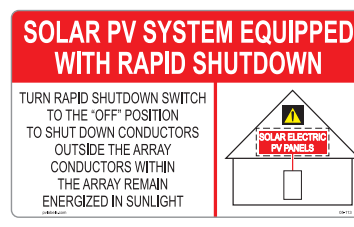
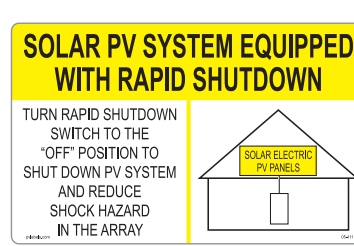
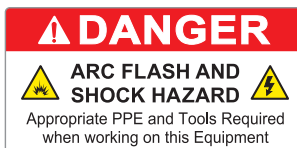
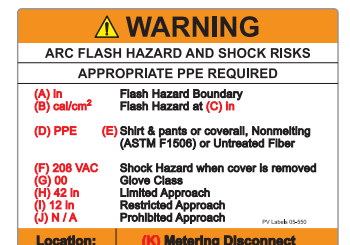
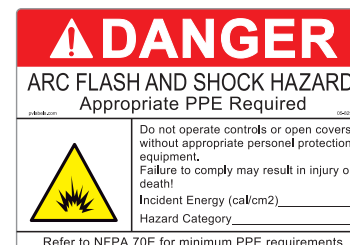
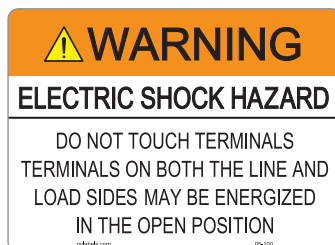
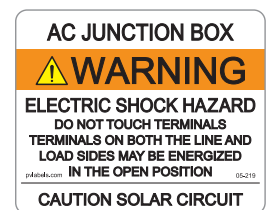
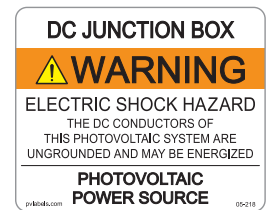
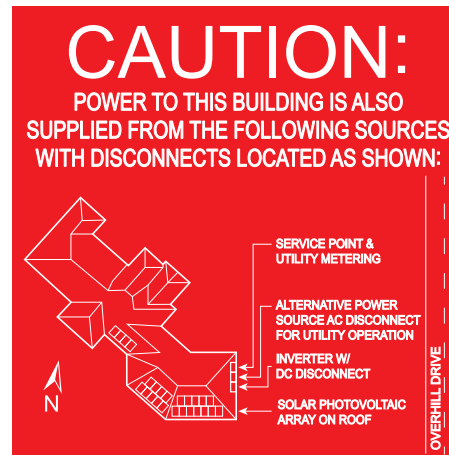
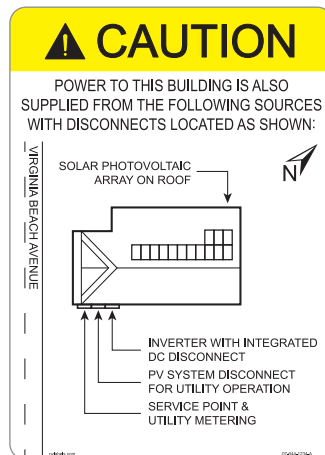
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SO. HOW'S YOUR WEEK GOING?

Mine's pretty much the same as last week...and the week before that. I am lucky enough to work from home most of the time. Initially, the only real change these stay-at-home orders made for me was having my husband and kids at home all day, distracting me from my work. The first week was almost like a vacation: we played games, we watched movies, we tried to make it fun. The second week, I started noticing all the extra dirty dishes. The third week, when our governor announced the schools would be closed for the rest of the year, I had to remind myself to take a few deep breaths. By the time we rolled into the fourth week, I decided there was no real point in trying to keep the house clean. The fifth week was a blur. Now, here I am, entering week six of the quarantine. I have learned so many new phrases recently: social distancing (I prefer to call it physical distancing, because we are still being social), contact-less delivery/payment, N95, new normal, flatten the curve, apex, community spread, contact tracing, it goes on and on... I just read an article that listed 8 warning signs of being mentally and emotionally exhausted.¹ I recognized myself in all 8 of them! But being, for the most part, a positive person, it is in my nature to try and see the positives of this COVID -19 lockdown.

On the bright side, things seem a bit slower these days. The streets are more quiet with less traffic. Less time is spent commuting to and from work which allows more time with family. There's an increased awareness of personal space and hygiene. There's an early evening parade of golf carts around our neighborhood, families getting out and waving to each other. Happy Hour is getting earlier - even if we have to stand six feet apart, we still get together outside with our next door neighbors. Animal shelters are finding their kennels empty as people are using this time to adopt the pet they've always wanted. People are kinder, offering to help, saying, "thank you" to those essential workers who are still doing their jobs with a smile. People are patronizing local businesses, cooking and eating at home more, volunteering their services however they can. There's a new kind of generosity, businesses waiving service or delivery fees, offering free online courses or fitness classes, insurance companies giving their clients a 20% discount on auto insurance for the next two months. Artists are streaming live performances from their living rooms. Museums, art galleries, and libraries have put their collections online for people to view free of charge.

For most of us, working from home has decreased the daily commute from an hour trip into downtown to a 3-minute walk to the kitchen table. Driving is way down and I haven't had to fill up my gas tank in weeks. Fewer vehicles on the road and fewer airplanes in the sky all amount to fewer emissions. This pandemic has resulted in the reduction of carbon emission levels around the world. In India, people are posting the smog is lifting and they can see the top of the Himalayas for the first time in decades. NASA recently published satellite images of China² showing a dramatic decrease in airborne NO₂. "This is the first time I have seen such a dramatic drop-off over such a wide area



for a specific event," said Fei Liu, an air quality researcher at NASA's Goddard Space Flight Center. (Read our top story on page 8 for more on this.) Having celebrated the 50th Anniversary of Earth Day on April 22, this may be the silver lining in a really dark cloud.

Of course the renewable energy industry has been affected in more ways than one. According to LevelTen Energy, while solar and wind prices remained steady, about 56% of developers surveyed expect prices to be impacted because of COVID-19³. Without regular commuters, offices and businesses being shuttered, and industries closing down, energy consumption has shifted to atypical times. With a portion of the working population staying at home, energy use is more evenly distributed throughout the day, diminishing demand peak and causing wholesale electricity prices to drop more than usual for this time of year.³

I wonder what kind of long term effects will result from this worldwide experiment. Will life stay slow? Will companies change their business models, recognizing their employees can get the work done remotely? This shift may allow companies to lower operating expenses in the form of less rent, utilities, etc, and at the same time having a positive effect towards combatting climate change by reducing daily commuters. Will some employees demand the option to work from home, enjoying more time with the family, and less time dealing with long commutes in traffic, crowded elevators, and subways? Will we keep washing our hands, sneezing into our elbow, and standing 6 feet away from others in lineups? Will we greet each other with a hand shake again? Will families continue to eat dinner together on a more regular basis, go for walks outside together, draw chalk artwork on their sidewalks for the enjoyment of passersby? Will we recognize that, even though it may be cheaper to do it elsewhere, it may be more important for us to bring the manufacturing of certain items from

overseas back to the United States, Canada, and Mexico? And while we're at it, will we stop caring so much about keeping up with the Kardashians, filling our lives with stuff rather than spending time with family and friends, and focus on what is really essential? Antoine Saint Exupéry wrote, "On ne voit qu'avec le coeur, l'essentiel est invisible pour les yeux." "It is only with the heart one can see rightly. The essential is invisible to the eyes." Maybe if we continue to focus on simplifying our inner environments, the outer environment will reap some of the benefits.

Stay safe,

Jill

¹ www.thepowerofsilence.co

² <https://www.earthobservatory.nasa.gov/images/146362/airborne-nitrogen-dioxide-plummets-over-china>

³ <https://leveltenenergy.com/blog/clean-energy-experts/covid-renewable-energy-industry/>



Donations of PPE in Boston

Boston-headquartered Vicinity Energy has donated 2000 gloves and 1000 protective masks to Boston Medical Center in an effort to support the region's health care workers with the protection they need to treat patients with the coronavirus. Through conversations with the City of Boston Mayor Martin J. Walsh and at the direction of the Boston Public Health Department, Vicinity recently dropped off the gloves and masks at BMC's main campus in downtown Boston's South End. "Given the growing shortage of masks and other protective gear faced by medical facilities across Greater Boston, we have both an opportunity and an obligation to help," said Bill DiCrocce, president and CEO of Vicinity Energy. "Our district energy system provides heat, hot water and the ability to sterilize the surgical equipment at all the city's downtown hospitals and as a result we have been partners with BMC for many years. We have a responsibility to support their unique and essential role on the front lines in fighting the COVID-19 pandemic during this pivotal time."

Vicinity Energy /// www.vicinityenergy.us

COVID-19 has hit us hard, but businesses are stepping up to do their part to help in this crisis.



Reusable mouth and nose protection

To counteract protective clothing supply bottlenecks in the course of COVID-19, SKYLOTEC has converted parts of its production. Effective immediately, the globally active brand for fall protection systems is producing simple oronasal protective masks. These are designed to help prevent the spread of potential pathogens that are present in the exhaled air in the form of droplets, thus reducing the risk of COVID-19 transmission. SKYLOTEC will manually manufacture simple surgical masks made of cotton at the company headquarters in Neuwied, Germany, using existing machines. SKYLOTEC wants to contribute to reducing the spread of the virus. Oronasal protectors can be worn by people who go out in public and do not know whether they are infectious and can also be used by hospital or nursing staff who want to protect patients from their own respiratory emissions. Furthermore, the mask is washable and therefore reusable. Production is in accordance with the guidelines for the manufacture of medical equipment recently published by the EU Commission. It will initially be produced at the German site, but will be expanded to the production site in Hungary if necessary. The oronasal masks will not be available for sale for the time being, but will be offered to health and district offices as support where there is a need for masks. In addition, SKYLOTEC could soon start production of FFP2 standard respiratory protection masks. For such masks, instruction is required to ensure that the protective effect is achieved. Wearers can work with infected patients without infecting themselves. With ultraMEDIC, the SKYLOTEC Group has a certified manufacturer of medical products that has the necessary know-how. However, the procurement of materials is becoming a challenge. The necessary raw materials are mainly produced in Asia. Therefore, SKYLOTEC is currently examining the use of alternative materials that also offer the best possible protection.

SKYLOTEC GmbH
/// www.skylootec.com

3D printed shield for N95 face masks

As COVID-19 started cropping up across the United States in March, a team of workers at GE Renewable Energy's wind turbine factory in Pensacola, Florida was assigned to screen employees for fevers or other signs of infection. Caroline Shaw, the sourcing manager, was responsible for keeping the team supplied with proper personal protective equipment, especially N95 face masks that limit the spread of the disease. Not wanting to tap into the supply needed by the medical community, Shaw got moving. She knew a lot about additive manufacturing, as 3D-printing is more formally known. Her plant uses an industrial-grade 3D printer to make tooling and custom-made gauges and prototype wind turbine components. She printed a plastic prototype of the N95 protective shield on a simple 3D printer and gave it to the on-site nurse to try out that afternoon. While the initial version worked well enough, the testers reported back several flaws that were quickly remedied. While additive manufacturing excels at rapid prototyping, it took about 40 minutes to make each shield. The next and faster iteration of the manufacturing process could involve water jetting, which uses streams of water laced with tiny pieces of garnet to carve the masks out of sheets of plastic. This method has the additional advantage of being able to form the shield from plastics that are less porous than the ones 3D-printed. This could make them easier to clean by lowering the chance of a virus being able to cling to the shields. That advance should allow shields to be produced every 5 minutes. After that, the team is looking to move to laser or die cutting, with the goal of being able to produce a shield in just 5 seconds.

GE Renewable Energy /// www.ge.com

Partnering to support community-based responses to COVID-19

The Enel Group's US-based company, Enel North America, which operates through renewable energy company Enel Green Power North America and the advanced energy services company Enel X North America will provide 1.3 million USD to support more than 75 local organizations across 17 US states, Washington D.C., and Alberta, Canada, as they respond to COVID-19. Enel North America has over 100 plants, offices, and projects in the US and Canada. This support will help organizations and frontline workers, primarily in rural communities where the business operates, who are experiencing a critical shortage of essential resources. "At Enel North America we have always felt a deep responsibility to support the health and well-being of the communities where we live and work, and even more so during this crisis," said Enrico Viale, Head of Enel North America. "COVID-19 has caused unprecedented economic challenges for critical service organizations in many communities and we hope our support can provide some sense of relief. From rural hospitals to first responders, local schools and foodbanks, these organizations and their workers are on the frontlines and we thank essential workers everywhere for their extraordinary and unwavering response to this crisis." Enel North America is committed to a multi-phase, community-based response to address both immediate health and social services needs, plus long-term socioeconomic impacts from this crisis.

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We Can See Clearly Now

How the COVID-19 global quarantine has impacted air quality

by Shaina Shay

The COVID-19 pandemic has impacted nearly every person on the planet. Working remotely, living under quarantine, caring for someone infected - everyday life has fundamentally changed. But how has this global quarantine behavior impacted the world as a whole?

The environment has quickly adjusted to its humans moving indoors, reducing travel, and slowing production of non-critical consumer goods, and the results have been nothing short of astonishing. Waters have cleared, animals have returned, and air quality has improved.

It comes as no surprise that much of the improvement in air quality can be attributed to an extreme reduction in fossil fuel emissions. Levels of both nitrogen dioxide (NO₂) and particulate matter declined during the early months of the pandemic. Of these two pollutants, however, it's NO₂ that experienced the most significant change. To better understand the impacts, let's take a look at the facts.

Nitrogen Dioxide

NO₂ is a closely-monitored pollutant that can irritate respiratory systems, aggravate existing health conditions (like asthma and COPD), and has been shown to contribute to the development of lung diseases from long term exposure. The primary source of this pollutant is combustion of fossil fuels (e.g. emissions from coal smokestacks and automobiles). NO₂ concentration has a significant impact on general air quality because it, along with other oxides of nitrogen (NO_x), can interact with chemicals in the atmosphere to create new respiratory irritants like particulate matter (PM₁₀ and PM_{2.5}) and ozone.

Due to their adverse effect on the environment, NO₂ levels have been closely monitored by a team of government agencies. One agency tasked with this assignment, the US EPA, created an air quality guide for NO₂ that includes a rating system with public recommendations. The EPA determined these critical thresholds:

- 1-hour NO₂ standard at the level of 100ppb and;
- Annual average NO₂ standard of 53 ppb.

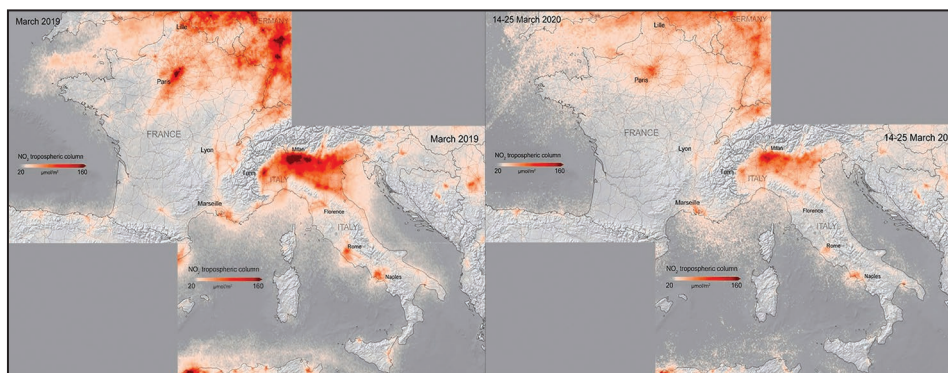
To maintain regulatory compliance, state and local agencies are responsible for monitoring and reporting NO₂ levels to the EPA throughout the year. In addition to on-the-ground monitoring, NASA and other international agencies, like the European Space Agency (ESA), monitor concentrations of NO₂ from space. The Sentinel-5 Precursor (Sentinel-5P) is an ESA satellite dedicated to monitoring a wide variety of air pollutants. The troposphere is the layer of air closest to the earth, where we breathe our oxygen and experience our weather. Preliminary analyses of tropospheric NO₂ data from Sentinel-5P show a drastic decrease of the amount of NO₂ between January and March 2020, when compared to previous years. The decrease corresponds with the COVID-19 quarantine measures across the globe, and the subsequent "powering down" of our daily activities. Given the extraordinarily high levels of pollution its citizens have endured over the past several years, it comes as no surprise that the region with the biggest change in NO₂ levels has been China, where the most severe quarantine measures were first imposed. As parts of Europe adopted quarantine measures, the NO₂ levels over that area followed a similar decline.

According to ESA, a more detailed quantitative analysis of the impact of quarantine measures is underway (using ground data, weather data and inverse modelling), but will likely take some time to complete.

Europe

Figure 1 shows data from France and Italy comparing NO₂ levels for March 2019 to March 2020.

Figure 1. SA Imagery of Italy and France



China

Figure 2 shows the short-term changes in NO₂ levels across China before quarantine (January), during strict quarantine (February), and after quarantine restrictions were lessened (March). It is common for NO₂ levels in China and much of Asia to decrease during the Lunar New Year celebrations (January 28th - February 9th) due to reduced human inactivity. This year however, the levels have decreased more significantly and stayed lowered for longer compared to previous years. In the major Chinese cities the ESA estimated that NO₂ levels were reduced by nearly 40 percent.

A Breath of Fresh Air

We've witnessed impressive reductions in air pollution levels in the first few months of 2020. But these short-term air quality improvements are unlikely to be maintained if our behaviors do not change as the global economy reboots. Even now, as quarantine measures lessen in China, NO₂ levels are beginning to rebound.

Policy decisions in the near future can push our air quality in either direction. On March 26th 2020, the US EPA announced an unprecedented temporary policy that halts enforcement of environmental regulatory compliance, citing COVID-19 as the catalyst for this decision. While there are built in safeguards (e.g. continued documentation requirements and discretionary enforcement clauses), the long-term consequences are unknown.

This is a pivotal moment. Governments, industry, and individuals have a unique opportunity to choose how we react to our new and changing world. If there is one thing we have learned from global quarantine, it's that large-scale changes can happen, and they can happen fast. Imagine if air quality and environmental health were integral in the development of government relief packages. Let's realize the combined power of our individual travel and purchase choices. Let's take in this global breath of fresh air, and help the future breathe a little easier.

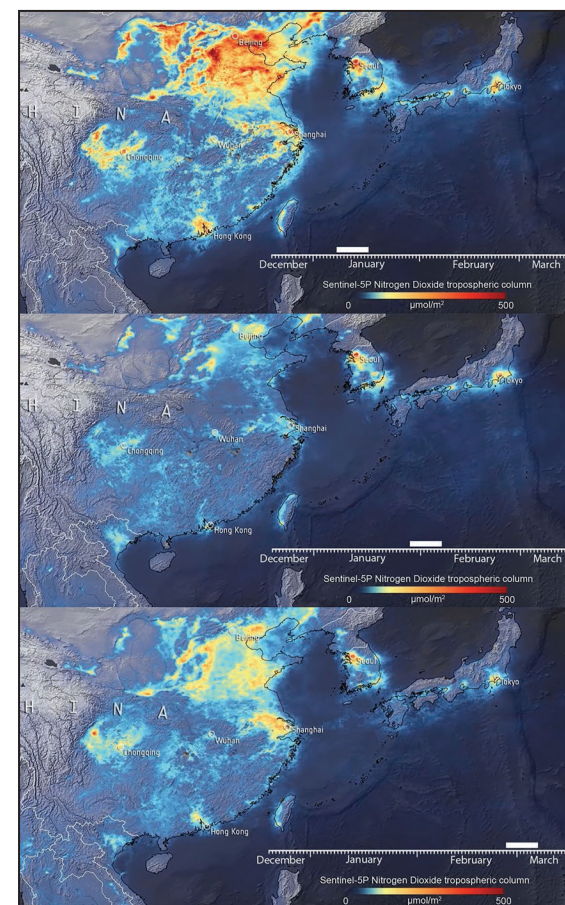


Figure 2. January-February-March NO₂ Levels - China

Shaina Shay is the Environmental Market Manager at Alicat Scientific. Shaina is a policy development and research expert, specializing in environmental resource management. She has led campaigns resulting in smart, sustainable policies around the world.

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The Height of Safety

by John Salentine



BEING STRUCK BY FALLING OBJECTS

is the fifth leading cause of industrial accidents, costing billions every year. The International Safety Equipment Association (ISEA) and American National Safety Institute (ANSI) worked with major tether manufacturers to develop the new ANSI/ISEA 121 manufacturing and performance standard for tethering tools and equipment used at heights.

It's common for companies to have a knee-jerk reaction to drop incidents. Unfortunately, this usually results in potentially unsafe policies for at-heights work.

In order for a company-wide dropped object program to be successful, worker safety, productivity, and convenience must be part of the solution.

The comprehensive ANSI/ISEA 121 Dropped Tool Standard is the result of the first major study to delve into this at-heights issue. Tool dropping was initially noted as a safety issue over 100 years ago. A New York Times article on August 2, 1903, described the ongoing construction of the Williamsburg Bridge: "Dozens of placards posted at various places on the bridge caution the iron workers to use great care in the handling of tools." Ironically, the story cast more emphasis on losing valuable tools rather than injuring passengers on the boats passing beneath the bridge.

In the early stages of corporate tool tethering policies, dropped object practices were often an impulsive reaction to a specific fallen tool (i.e. a hammer is dropped and the project is shut down until all hammers are tethered). The subcontractors would then base their own dropped object policy on the principal company's requirements (i.e. tether all hammers). As a result, many dropped objects programs targeted only one or two tools. The subcontractors and other short-term employees would purchase cheap tethers for a specific project and tool. These tethers were usually considered one-time-use, throwaway items - a behavior that persists today, adversely impacting safety and productivity.

Additionally, budgets for tethers remained tied to specific projects. Solutions consisted of giving every worker one or two tethers, with the suggestion that they connect their tools when they are by the leading edge. Or too many tethers were issued, which created confusion, frustration, entanglement problems and, eventually, lack of compliance. Either way, productivity and safety issues were not properly addressed.

Instead of solely relying on the principal company's at-heights program, subcontractors should consider developing their own adjunct company-wide programs. Just like hammers and drills, tool-tethering systems are tools. Like all quality tools, their purchase should be based on the same criteria: quality, durability, ease of use, and increased convenience. Instead of buying disposable, low-cost tethering products that are thrown away after every job, choose well-designed, ergonomic tethers and lanyards that will increase productivity and last longer. Make them a permanent part of the company tool kit.

As well as being safer than disposable tethers, the new ANSI/ISEA-121 compatible tool tethers feature several convenience and productivity improvements. These include: quick-release tool interchangeability (so one tether can accommodate many tools); locking carabiners (to prevent accidental release); tethers that offer maximum but gentle retraction and extension length; a wide range of retractable tethers that increase safety by keeping tools close to the body (to avoid dangling tether accidents); and tethers that can be easily inspected for wear (for continued safe use).

Definition of "tool"

While safety conscious companies have taken more aggressive steps to reduce their dropped object incidents, their guidelines were often too broad. A hammer is a tool, but so are hardhats and tape measures, both of which can be dropped and cause injury and death (in one recent incident, a tape measure dropped from an upper story of a construction site, killing a worker below).

Principal companies are now saying they require 100 percent tool tethering. But what exactly does that mean? Does it mean just tethering heavier tools like hammers and drills? Or does it include ALL items like hardhats, tape measures, phones, tablets, and radios? The next question should be, "Is productivity a concern?" If not done properly, adding more tethers can negatively impact productivity and safety.

Another compliance challenge is when technicians believe they are tethering all of their tools, when they're just tethering the heavier ones, or tools they may have dropped in the past, like hammers or spud wrenches. When smaller tools like screwdrivers or cell phones are not tethered, technicians risk dropping them from working heights, which can cause injury or death.

It doesn't have to be a choice between productivity and safety.

The bottom line is that principal companies often have no real road map regarding dropped objects. Too many subcontractors, when asked if they are adhering to the principal company's 100 percent at-heights tethering policy, just roll their eyes.

Matching the correct tether with a specific tool or object starts with the item's weight, then choosing a tether of the appropriate length for the item. The new ANSI/ISEA 121 Standard establishes minimum design, performance, and labeling requirements to use as a guide. This gives companies a more defined path for selecting the best and most appropriate tethers to mitigate drop hazards, while improving the productivity and convenience of their employees.

John Salentine is the co-founder and Vice President of Hammerhead Industries, which manufactures Gear Keeper. Gear Keeper is patented personal safety tethering equipment that includes retractable tethers and lanyards for tools, gear, and instruments. All of the company's products are built in the USA.

THINGS TO CONSIDER

100% tie-off is a dropped object policy. Tool tethering is just one aspect of solving dropped object danger. Tethering includes lighter tools including cell phones, radios, and tablets.

Scale down the number of tools being used at-heights. Pick only the tools that are required to complete the assignment and then provide tethering solutions for just those tools.

Consider convenience. "Smart" tethering products that keep tools close to the body will minimize entanglement issues and enhance productivity

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Repowering a Fleet

by Jeffrey Fuchs

46GW OF THE U.S. WIND FLEET IS TURNING TEN YEARS

or older this year. Wind technology has developed so rapidly in the last decade that new solutions can deliver major benefits to these decade(s)-old plants. When an existing plant is modified with new equipment, the industry calls it a repower. Repowers can grow the value of existing assets by increasing annual energy production (AEP), decreasing operations and maintenance (O&M) costs, and capitalizing on the recently extended federal Production Tax Credit (PTC).

The recent PTC extension allows repower projects to qualify for 60 percent of the PTC value if they commence construction or safe harbor equipment in 2020, and then complete the project by 2024. Repowers must pass the 80/20 test in order to qualify, which means owners must invest four times the fair market value (FMV) of the remaining turbine components on a per turbine basis. In other words, thanks to the PTC extension, repowers just went on sale.

The wind industry defines repowers in three categories: partial repower, or the installation of a new nacelle and rotor on an existing tower and foundation; refurbishment, meaning the replacement of a turbine component and/or installation of upgrades; and full repower, or the full replacement of an existing turbine including tower and foundation. The benefits of these repower approaches fall into three categories: increased revenue, lower costs, and speed to market.

Increased Revenue

A proven benefit of repowering a project is increased AEP and extended project life. Installing newer technology allows for greater capture of wind energy, equating to increased revenues. In general, AEP can increase 8-10 percent for refurbishments, 20-30 percent for partial repowers, and as much as 50 percent for full repowers.

Lower Costs

In many cases, repowering an existing project is cheaper than siting, building, and operating a new asset. Also, because failure rates typically increase with the age of a turbine, repowers can achieve operational expenditure reductions from around 10 percent with refurbishments, and up to 40 percent with full repowers. Cost reductions come from the assets' improved reliability, lower repair costs, and improvements in data-driven predictive maintenance capabilities.

Speed to Market

With a typical wind project, it takes several years to acquire the necessary permits and regulatory approvals, and then complete construction—especially in markets with long interconnection study processes. Repower projects already have many siting approvals and existing infrastructure, making it easy to comply with the 60 percent PTC 2024 in-service window.

With increased project revenue, lower costs, and faster speed to market, the repower value case is clear. The next question becomes what type of repower is most suitable for what type of project.

Partial Repower: ~10-15+ years

The technology options available to projects in the ten to fifteen-year range are similar to shopping at a large, full-service super store. The relative youth of these projects means that their concrete foundations and towers can support the replacement of newer blades and/or nacelles. The customer has their pick of the latest and greatest products.

Since about 70 percent of the turbine's cost is concentrated in the nacelle and rotor, partial repowers are relatively straightforward when it comes to satisfying the 80/20 rule. Replacing the nacelle and rotor allows the project owner to subtract 70 percent of the turbine's value when calculating the remaining FMV (the portion that determines the required investment for PTC qualification).

The investment for partial repowers typically remains below the purchase price of a new turbine. Investing more in the best technology also increases O&M savings and energy output—a major financial benefit at unconstrained sites. Likely for this reason, partial repowers make up the vast majority of past and pending repower projects.

Refurbishment or Component Repower: 12+ years

If partial repowers are like customers shopping at a superstore, then refurbishment is like shopping at a corner drug store—a less diverse selection of products, but lots of available savings. These older projects likely have foundations and towers that are compatible with fewer new technologies.

For these older projects, the FMV of remaining components can be quite low due to dated technology, declining availability and performance, or depreciation. Therefore, the total amount a project must purchase in repower equipment to qualify for the PTC is quite low. Refurbishment projects often represent the lowest capital expenditure of all repower types, allowing the project to spin for years to come while receiving PTCs.

Refurbishment can make sense for owners most interested in reinstating project PTCs, and re-investing in existing assets over new development.

Full Repower: 16+ years

Finally, full repowers are most like driving to the grocery store but realizing you left your wallet at home—you have no more options unless you go home and start all over. In these cases, refurbishing a turbine component is not possible because the original technology is obsolete. A full repower may be necessary if the existing turbine is not projected to run another ten years and cannot take advantage of PTCs.

The remaining components would have little to no FMV. A full decommission must take place: all components must be removed and the land must be returned to a similar state as it was before the project. However, the owner can leverage existing land agreements and infrastructure, such as access roads.

Although full repowers sound expensive and time-intensive, they can provide benefit to sites in high-barrier to entry markets with a great wind resource. For example, a site nearing its end of life in the heart of the wind belt can use the same location and a much larger turbine, capturing far more revenue with decreased O&M expenses, and potentially offsetting full tear-down costs. In other words, just when you thought you were out of options, it turns out the wallet was in your car all along.

Repower opportunities are available to fit almost any project need. Repower technology innovations allow the industry to breathe life into the existing fleet, while increasing revenues from increased annual energy production and lowering O&M costs. With the 60 percent PTC extension opening the door for four years of qualifying projects, repowers are on sale—doors open at 8:00 am.

Jeffrey Fuchs is Vice President of Sales Operations and Market Intelligence for Vestas Americas. Vestas designs, manufactures, installs, and services wind turbines around the world.

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Protecting from a Wind Fall

by Baxter Byrd



If there is one constant in energy production over the past several decades, it has to be change. The energy landscape is in constant motion, reacting to changes in demand, regulations, or the shift from carbon-based energy to renewable energy sources like solar and wind. If there is a second constant, it's the need to keep workers at height safe while building, running, and maintaining the machines that produce the energy that runs the country (and the world).

In many ways, height safety in the clean energy sector resembles that of any other industry. Workers still rely on the same basic A-B-C model of building a personal fall arrest system: an appropriate Anchorage connector, which attaches to a sound structure; Bodywear that the worker dons whenever exposed to a fall hazards; and a Connector to connect the two. There are, however, a few considerations that seem to crop up in wind and solar more frequently than most other jobsites.

Harness D-ring Configuration and Design

More so than their counterparts working on residential or commercial buildings, workers climbing wind turbines often rely on fixed ladder-systems, in which a worker connects a cable grab device to a tensioned steel cable that runs the height of a permanently installed steel ladder. Also, while ascending or descending the ladder, they may be required to stop and perform work at a specific location for an extended period of time – also called Work Positioning. To properly address these two fall protection scenarios, a full-body harness must include a sternal D-ring connection point and side D-ring connection points, in addition to the standard dorsal D-ring most commonly used for fall arrest.

A sternal D-ring connection to a fixed-ladder system must be configured to keep total free fall to 3' or less, and may only be used while actively ascending or descending the fixed ladder system. At no time should the worker pull against the steel cable on a fixed ladder system as a form of

fall restraint or work positioning. Although both conditions might look similar, once the worker stops their ascent or descent mid-span, they must transition to a work positioning application, and utilize an appropriate "Y" work positioning lanyard that connects the harnesses side D-rings to a compatible anchor.

Workers climbing fixed ladder systems also require greater flexibility and harness ergonomics than those who remain primarily on a single level throughout the workday. Manufacturers attend to these needs by altering vertical torso straps from the more parallel style, to a Y configuration (which centralizes webbing for greater range of arm motion), or reconfiguring waist belt webbing (which permits freer leg movement while climbing).

SRL Lifeline and Lanyard Materials

Green energy solutions frequently rely on lightweight or specialized materials such as carbon-fiber, structural foams, or specialized glass (in the case of solar panels). Each of which is susceptible to damage, especially during handling or installation. To prevent damage from incidental lifeline/material contact where leading-edge work is required, look for nylon-coated galvanized steel lifelines. For fall restraint applications, pay attention to webbing lifelines.

Rescue at Height

Although there is really no such thing as a 'routine' rescue in any industry, wind turbine

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rescues have two additional complicating factors not found in the majority of rescues: extreme heights and extreme remoteness. Nowhere is a total fall rescue plan more important than hundreds of feet in the air or hundreds of miles from the nearest emergency services. Of course, relying solely on local emergency services is never a suitable alternative for a rescue plan, but having those services close is a decided benefit to assist a stricken worker once back on the ground.

In the event of a fall or other incapacitating incident, the rescue must be initiated immediately, meaning that the rescue equipment must already be in the turbine nacelle - not in a truck 240 feet below. Also, the rescuer must be prepared for many potential types of rescues, including self-rescue with the use of a constant-rate descender (CRD) device, or an assisted rescue (whereby the fallen worker is transferred from their own fall arrest system to that of the rescuer's, then lowered).

Rescuers must also be prepared for events within the tower itself. A worker may be injured at any height, from just above ground level up to the very top. Given the ready access to the worker from above or below via the fixed ladder, rescuers can utilize a belay-style or CRD device, depending on the situation and condition of the worker.

Just as engineers continually move energy production forward by creating new forms of clean energy, fall protection professionals must also constantly adapt to meet the challenges of keeping workers at height safe during installation. In both cases, out-of-the-box thinking will serve them well, now and in the future.

Baxter Byrd is a technical writer with Pure Safety Group, an independent provider of fall protection equipment and training worldwide. His primary mission is translating dense regulatory standards to increase understanding and practical applicability. Byrd holds a B.A. in Communication from the University of Washington.

Pure Safety Group

/// www.puresafetygroup.com



Next level predictive maintenance

The technology group Wartsilä announced the launch of its Expert Insight predictive maintenance product. This digital product enables customer support to be delivered proactively by Wartsilä Expertise Centres to ensure long-term accurate insight for their predictive maintenance strategies. The product is available in combination with a Wartsilä Lifecycle Solutions agreement. Wartsilä Expert Insight leverages artificial intelligence (AI) and advanced diagnostics to monitor equipment and systems in real-time. When anomalous behaviour is detected, it is flagged to specialists at Wartsilä Expertise Centres, allowing them to support the customer proactively with an appropriate resolution to the issue. The combination of AI, advanced diagnostics, and Wartsilä's deep equipment expertise greatly enhances the safety, reliability, and efficiency of the equipment and/or systems installed. Wartsilä Expert Insight represents an important next step within the company's ongoing development work in honing its predictive maintenance capabilities. Wartsilä Expert Insight promotes closer collaboration between Wartsilä's Expertise Centres and the customers' technical personnel, which in turn forms the basis for better asset management decisions, thereby taking predictive maintenance to a new level. By identifying and highlighting potential issues proactively, asset availability is greatly enhanced, as is the reliability and safety of the equipment or system.

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Coming Out Ahead

How to benefit from the loss of an OEM

by Brian Hill

ANY TIME A MAJOR MANUFACTURER

exits an industry, that absence creates a market disruption for its customers. This is especially true when customers develop such a symbiotic relationship with their OEM that it leaves them in a uniquely vulnerable position when that provider walks away. With everyone looking to trim budgets while boosting production and revenue, being left in the lurch can crash your operations, no matter what business you're in. Case in point: a sizable group of wind farm owners recently found themselves unable to maintain

operations when their OEM decided to cut them loose, essentially leaving them high and dry. It's not the first time or the last time this situation will rear its ugly head, where limited viable options leave operators in a very precarious position. Fortunately, our rapidly changing industry tends to favor innovators that can adapt just as quickly, and the OEM's swift exit provided a unique opportunity for many of the wind farms to rethink their operating strategies, and rework their plan of action.

For these owners, the operation and maintenance of their entire wind farms had been so deeply interwoven with their original OEM that it had led to a complete dependency on that OEM, for even the most basic turbine operations; they had to use time-limited passwords for access to local turbines at the HMI level, and SCADA servers were hosted overseas. The rapid deterioration post-OEM revealed that these wind farm owners had such a tenuous hold over their operations, they actually ended up locked out of their own turbines. No business owner wants to be in this position. On the contrary, feeling trapped and beholden to an absent OEM is in stark contrast to the preferred operating strategy of control and autonomy.

Starting in September of last year, these owners began receiving notices of discontinuation of service, giving them only weeks to implement a new strategy. Barring a complete hardware or software retrofit - which had not been part of their budget forecasts - the only available option involved signing with the new OEM, using the same IP, and burdened with the same restrictive conditions under which they had previously operated.

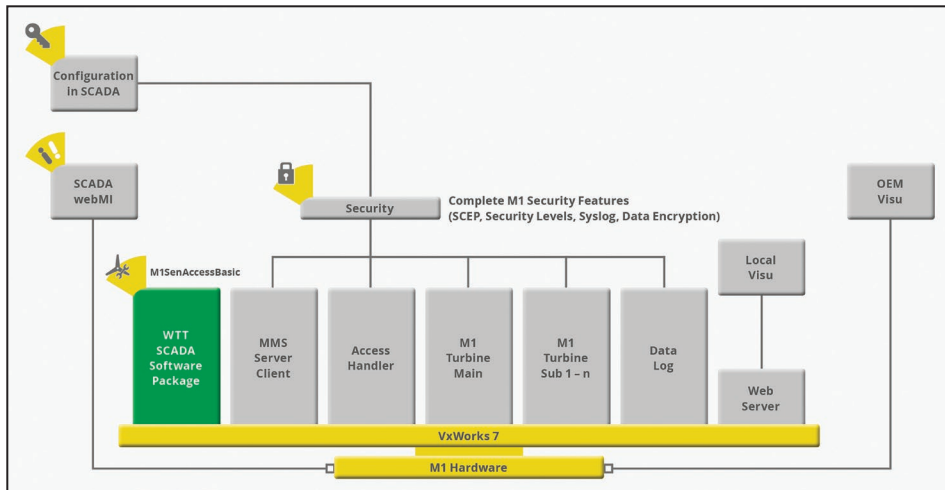
While a complete control software retrofit could have provided the operators with some level of independence, upon closer inspection, that solution was not quite so appealing. Replacing existing turbine control software with entirely new control software could require new type certification to guarantee proper functionality and fulfill insurance requirements (with certification often costing in excess of \$1 million). Furthermore, when existing control software is replaced with brand new, untested software, the cumulative experience and built-in know-how from the original software is effectively erased, which presents a real risk for the continued operation of the turbine.

The wind farm operators reached out to the supplier of the OEM's original operating software to explore possible solutions. Taking advantage of the market gap left for an independent access solution, the supplier developed a software package that would

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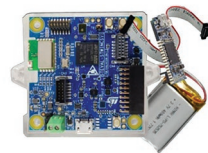
fully utilize the farm's existing hardware and software, while also offering unfettered access to all turbines and grid stations. An operator specific access handler meant continued turbine access with zero OEM passwords. Even better, this new approach was installed and deployed in under 30 minutes per turbine, granting access without new hardware or type certification. User access rights management were directly in the owner's hands, guaranteeing independence and security.

Part of the access solution package included a new SCADA platform, Wind Power SCADA (WPS). Utilizing the open communication standard IEC 61400-25, WPS provides communication via OPC UA, standardizing nomenclature for mixed-fleet sites and facilitating migration to a common, flexible SCADA platform. An additional feature designed to boost energy production unlocked complete access to all turbine parameters. This helped the sites realize significant AEP gains. By hosting SCADA turbine data locally (via localized servers) the customers were able to achieve faster data transmission speeds – and further independence from the OEM.

By unlocking complete access to all turbine parameters, the access solution allowed owners to quickly reestablish the connection to their plant and turbines, minimize the potential for extended downtime, and keep future maintenance in-house. In the end, they were able to reevaluate, reinvent, and ultimately come out on top.

Brian Hill is General Manager - North America for Bachmann electronic GmbH, an Austria based controls manufacturer that provides solutions for wind and renewable energy, industrial, and maritime automation. Brian has 30 years of experience in the energy industry, including the following positions: Co-founder of Superna Energy, LLC, a full-service management consulting & energy development; Senior Associate at AGEISS Inc, consulting to the U.S. Air Force; and Chief Development/Operations Officer, Board of Directors, - Wind Energy America, Inc. a publicly traded developer, owner and operator of wind energy generation projects.

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Hardcore Solar

Smart PV design for tough terrains and wicked weather

by Michael Faraone Ph.D., P.E.

Tough climates and ground conditions should never hinder your ultimate solar success. Deploying durable, economical solar plants in extreme conditions means knowing the environmental and geotechnical challenges presented by strong winds, extreme frost, and steeply-sloped topography. Developers and EPCs can harness versatile racking products to ensure project reliability through the most arduous environments, be it a blizzard or a rock-strewn hillside.

EXTREME WEATHER

Standing Up to Snow

Dense mounds of snow can pile up and place potentially damaging stress on solar racking structures, particularly on hilly or sloped terrain. Snow loads can be determined from snow maps provided by the American Society of Civil Engineers (ASCE), and certain locations may require data from their own case study due to extreme variation in elevation and climate. Projects in northern environments are built with front edge heights of 30 inches or higher to mitigate snow banking on the racking structure.

Withstanding Wind

In certain regions of the country (like the foot of the Rocky Mountains), withstanding “high winds” refers to accounting for wind speeds in excess of 170 MPH. Depending on the tilt angle of the racking structure, significant lateral and uplift force can be imparted on the foundations. Wherever terrain can have a big impact on wind speed, make sure your system is designed in accordance to ASCE guidelines, as well as local design criteria.

Fighting Freeze

Frost heave is another element that wreaks havoc below ground. When freezing temperatures penetrate soil, they cause an upward swelling that warps foundations, which can lead to costly damages. PV plant foundations are subject to adfreeze, in which the frozen soil adheres to the steel surface of the foundation, resulting in an uplift force known as frost jacking.

Foundations

The key to selecting the right solar racking structure starts from the ground up. For sites with high wind speeds, you must ensure that the foundation has adequate uplift and lateral capacity (this can be confirmed through load testing of the project site). When combating against frost heave, embedment below the frost depth line is key. Longer driven piles can be specified with lengths at three times the frost depth to prevent damage from frost heave. Unfortunately, in addition to increasing costs, driving 18- to 30-foot piles is unwieldy, and increases the likelihood of refusal upon striking bedrock and other impediments. Foundations like ground screws are a cost-effective means of resisting frost heave. Ground screws also mobilize more tension with a smaller foundation versus a pile, because the threaded portion is embedded below the frost depth line.



Ground Mount

In the case of high wind and snow loads, be sure to select a racking solution using the latest steel design codes with load testing, to confirm that it can accommodate extensive amounts of snow and wind. Furthermore, consider choosing racking with flexible sizing, which will reduce the number of modules per foundation and decrease loading on the system. If foundation counts become too high, look at increasing the size of the structural support members to provide a rack that is both structurally efficient and cost-effective.

When contending with high load environments, confirm that the module selected has the appropriate capacity to meet the applied downward and upward pressure. Various mounting methods (clamps, bolts, etc.), and mounting locations for PV modules can have their own individual load ratings; these need to be checked to ensure they meet the project’s loading criteria.

Trackers - In terms of tracking solutions, look for products with intelligent controls that secure systems with weather stow functionality. Onsite weather stations monitor severe conditions, automatically stowing the site when certain thresholds are crossed. Find systems integrated with a weather API to proactively stow your sites before a big storm hits. Also, make sure the tracker has undergone extensive Wind Tunnel Analysis to confirm additional loading due to the dynamic stability of the tracker.

TOUGH TERRAIN

Below the Surface

Rock, clay, sand, and other tenuous ground will impact the foundation that should be used. Knowing how to choose the correct solution will help mitigate any subsurface risk. When working with bedrock, caliche, volcanic rock, and glacial till, for example, solutions include pilot hole drilling with a ground screw foundation, or pre-drilling for piles using a concrete encasing. Unlike piles, screws can be embedded without ground modification, and efficiently drill past cobble and buried rocks without refusal -- reducing upfront construction costs and eliminating subsurface risks. For extremely soft soils such as clay, helical piles are a common choice given their large single flight, which helps secure the ground anchor within the soil.



Run for The Hills

Hilly sites require racking structures that are highly adjustable to accommodate undulating ground with relative simplicity. This adjustability can result in huge savings to help minimize civil work and grading on a project.

Most racking vendors are limited to working with slopes up to 20 or 25 percent. Assess your racking to suit every terrain option with an eye toward nimble design, choosing connections for slope adjustability up to 36 percent. Trackers are more limited when it comes to high sloping terrain, but can be configured to work up to 20 percent.



Getting to Work

Uneven solar locations often require civil work to level your site for mounting. Civil work isn't feasible for every project, as operations like grading can raise

costs and/or alter precipitation runoff patterns that may not be acceptable to local code. Make sure to run a geotechnical report to assess rugged ground conditions via in-situ field tests. Worker safety is paramount when installing systems on rugged sites. As large equipment often can't be used on steep slopes, consider smaller or more agile equipment to clamber up bumpy terrain.

Ultimately, careful evaluation of weather and terrain conditions - along with appropriate sourcing of products suitable to those conditions - helps safeguard plant integrity and performance before the first support structure is put in place.

Michael Faraone Ph.D., P.E. is Director of Engineering at TerraSmart, which has built over 3 GW's of ground mounted, utility-scale solar projects across the United States. Dr. Faraone joined TerraSmart in 2016, and has been an instrumental leader of the engineering department to develop, analyze, and test the company's innovative solar-racking solutions. His experience in deep foundations and extended studies in geotechnical engineering has earned him the nickname "Dr. Dirt."

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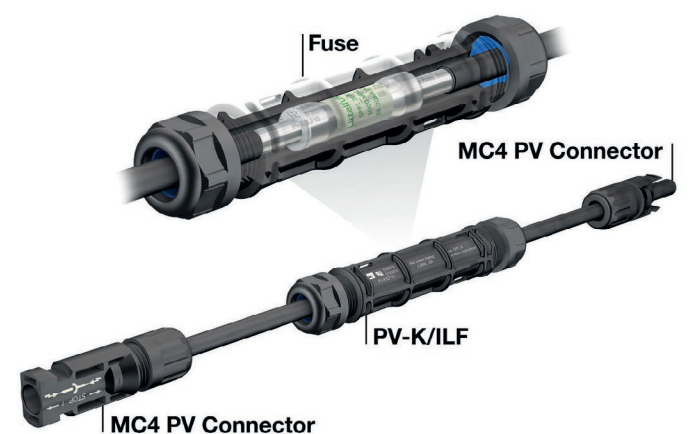
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by Auston Taber and Clifford Myers, PE

FROM SANDSTORMS AND STORM SURGES

to tornadoes and wildfires, natural disasters can wreak havoc on solar power infrastructure — taking out inverters, knocking entire plants offline, and sending owners into a spiral of down time, repair costs, and lost revenue. In those critical first minutes and hours after a disaster, decision-makers must quickly choose a direction based on seemingly conflicting information. Here's what you need to know about plant recovery and restoration to get solar production back online.

Assess the damage

First up is a careful assessment of what's gone wrong. There are four levels of damage to consider:

- Complete destruction: Nothing is operational. There is no way to generate power from any part of the plant without significant remediation.
- Partial destruction: Anywhere from 15 percent to half of the site is offline. The rest may be operational, but balancing repairs elsewhere may require shutting down undamaged sections over time.
- Minor damage: Roughly 10 percent of the site has been affected. There might be one or two central inverters offline and some tracker rows may be damaged, but overall the site can produce power and perform.
- Site intact with some production issues: One or more inverters are offline, but the overall site is generating power.

Get clear with documentation

The key to combating force majeure damage is thorough documentation. Initial impressions can be misleading. Even if damage appears to be minimal, there is value in documenting every aspect of the site that appears to have been affected, even superficially. Take pictures - at least four or five for everything that will require attention. Note components that may no longer be in production, and determine which OEMs will play significant roles moving forward.

For sites with more extensive damage, consider grid-by-grid drone flyover to map the level of destruction. Insurance companies often cover drone inspections because they want to know what they're dealing with just as much as you do.

Secure maximum insurance payouts

Unlike new plant construction, remediation projects require working closely with insurance companies from start to finish. Maximizing insurance pay-outs requires extensive documentation that can cost 15- 25 percent of the entire project's labor costs.

An insurer will have its own vendors tracking the project, such as subrogation and investigations teams. Although asset managers may work directly with an insurance adjuster, contractors are more likely to communicate through a third party hired to assist the adjuster. Here is where having a full-scope general contractor that is responsible for the myriad of subcontractors can be the difference between collecting a full insurance claim, and incurring substantial losses due to unforeseen delays.

Save through salvage

Before beginning restoration work, consider setting standards for testing damaged equipment, and establishing criteria about what warrants repair and what mandates replacement. Here, too, is where substantial restoration experience can prove invaluable. Flexibility is key - be assiduous about maintaining quality, but don't miss an opportunity to continue using viable parts.

In one project, the plant owner and insurance company were prepared to spend about \$4 million to replace inverters flooded by a hurricane. Instead, they took advantage of an alternative plan that was offered to them, which salvaged and refurbished the flooded units, saving them \$1.8 million.

Stagger your work

Minimizing the business interruption insurance claim can help maximize recovery. Unlike new builds, restorations involve balancing current production needs against deconstruction and replacement demands. Look for opportunities to stagger the work to minimize interruption and prioritize production recovery. For example, if one inverter is down simply because of a ground fault, but the rest of the array is in good shape, prioritize restoration at that location to get an entire section of the plant back online.

Set contingency plans

Develop multiple contingency plans so that if one repair must be delayed, other activities can be slotted in immediately to keep the project moving forward. If components delivery is delayed in one area, shift work immediately to a process that doesn't



require new parts. This helps to keep the best personnel active at all times.

Real-world example – Wind damage from 2 hurricanes

After a rogue storm tore through a PV power plant with 60 to 80 mile-per-hour winds, damaging 15 percent of its trackers, it was discovered that more than one-quarter of the site's trackers weren't operational before the winds hit, making it impossible to maneuver them into a protective stow position. As a result, 233 of 1,600 full trackers were damaged and had to be restored.

Initially, the plant owner relied on O&M personnel to assess the damage and submit insurance claims. Four months later, restoration work had yet to begin.

Within four weeks of contracting a restoration and recovery specialist, they had a plan in place for deconstruction of the damaged areas, a testing process to determine viability for salvage, sourced components that needed to be replaced, and a flexible restoration plan to minimize revenue loss and maximize production output.

Ultimately, the original, older technology was successfully married with the new, modern equipment required to repower the site — all without a significant (and costly) redesign.

Perhaps even more importantly, while the asset owner anticipated replacing a large number of the damaged components for roughly \$1.75 million, they were instead able to benefit from a salvage plan for the modules, saving 1.3M and recovering 70 percent more modules than their original budget. Other savings came from reduced business interruption claims and a more efficient timeline, and staggered approach to the execution, which resulted in substantial savings.

- Interruption savings: \$381k in business interruption damages
- Restoration time: 126 days faster than alternative
- Competitive advantage: 40 percent lower cost than alternative
- Total saving: \$3.3M

Recover with the right partner

When the floods recede and the winds die down, you're going to want expert help getting your crucial assets back online. While many O&M providers say they do recovery and restoration work, few have hard-won experience to back them up. Select a partner with expertise in damage assessment, salvage work, insurance claim management, and rapid restoration. The best option is to find a team that you manage through a single touchpoint - with an end-to-end solution that will mitigate your production losses and gets your PV back to peak performance.



Auston Taber is CEO and Founder of Solar Support, a restoration and recovery specialist that also offers equipment repair and component supply for utility-scale systems. Auston has spent nearly 15 years in the solar industry across various technical and service roles, offering deep expertise in PV equipment and site O&M across residential, C&I and utility environments. Auston's experience resolving complex inverter and plant O&M issues spans leadership roles.


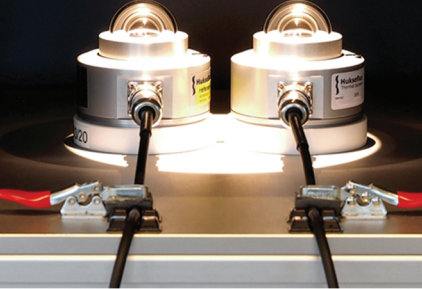
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As Director of DEPCOM Power's Plant Restorations, Repowering, and Recertification business, Clifford Myers, PE drives restoration excellence, bringing his expertise in solar systems fault resolution and performance optimization to DEPCOM Power.

He is a Navy Veteran with over 14 years combined experience in utility PV technology and power conversion systems. He graduated Magna Cum Laude from Arizona State University with a Bachelor of Science in Electrical Engineering.

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Connecting in the Antarctic

by Brian Mills

Picture a solar field. Chances are your mind immediately conjures up a picture of bright sunshine bouncing off of shining panels, reflecting images of blue sky and warm surroundings. Now picture a solar field surrounded by miles of snow and penguins. Few locales on the face of the planet offer a harsher environment than the Antarctic, yet it is on that inhospitable continent that engineers have had to develop and execute innovative solutions to provide life-saving photovoltaic electricity for scientific installations.

Under average conditions (based on what you may have pictured above), modern solar panels are designed to last at least a quarter-century. They are built to withstand extreme variations in temperature, humidity, wind, and UV radiation. In fact, all components used in panel installation - down to the connectors that transfer the electricity - must measure up to demanding standards to guarantee the safe and reliable production of PV electricity.

Average conditions, are not, however, what the Antarctic is known for. The continent is wracked by winter temperatures that plummet as low as -89°C (-129°F) along with punishing winds that can exceed 124 mph, or the equivalent of a Category 3 hurricane. Not only did PV designers have to deal with these extremities, they also had to account for radical swings in available sunlight, which ranged from 16-hour-days in the summers to 22-hour-nights in the bitterly cold winters. This variation meant the entire PV installation had to be constructed quickly - within one summer season - leaving virtually no room for error.

To ensure that critical electrical connections could bear the added stresses of the brutal Antarctic climate, the engineers in charge of the project relied on original MC4 connectors. The MC4 (Multi-Contact 4mm diameter)

connector is the go-to connector for photovoltaic plants currently in operation around the world. It's specifically designed to withstand extreme weather conditions. In order to work properly, PV connectors must be robust, water tight, UV resistant, and able to create and maintain minimal resistance at both low and high voltages — up to 1,500 volts.

While solar panel material and manufacturing technologies are improving on an almost-daily basis, some manufacturers still rely on substandard, poor quality cable connectors in order to save a few extra pennies.

The outdoors is a brutal operating environment, even in the best of conditions. The combination of UV, moisture, and temperature cycles attacks and eventually breaks down all things, especially plastic. In order for products to continue to operate safely and consistently, they must be deliberately engineered and manufactured with a great deal of care and dedication to quality. It's imperative to use only the highest quality connectors in any solar plant - even more so when planning for arctic winters.

Original MC4 connectors are designed to be used with the standard 4mm or 6mm double-insulated solar DC cables, with tinned copper multistrand core for minimum resistance. To correctly assemble the connectors, a special crimping tool is required to properly crimp the multistrand cable to the inner terminal, which is then inserted and locked securely into the MC4 housing.

Original MC4 connectors are rated for 70 amps maximum (connector only, not including wire) and 1,500 volts max. Additionally, they are rated for a temperature range from -40°C to 90°C (-40°F to 194°F).

The MC4 connectors used in the Antarctic installation offered several valuable benefits. In addition to quality construction that provides for years of safe and reliable operation, the connectors are easily installed and suited



for use in the harshest environments. They utilize proven, low-loss MULTILAM technology, and are internationally certified with IEC, UL, JET, and cTÜVus.

The MULTILAM technology utilizes bands that are leaf-spring contact elements, with unmatched electrical and mechanical properties. The MULTILAM design produces a large number of louvers, allowing contact to be made through a large number of defined contact points, which substantially reduces the overall contact resistance.

Solar-array installers should also note that there are several varieties of MC4 look-alike-connectors on the market, and though these connectors may look similar, that does not mean they will always fit together securely. It is imperative that installers use the same type and make of connector.

Regardless of where solar panels are installed, experts recommend relying on qualified installers who use high-quality components, the correct tooling, and follow the manufacturer's installation instructions at all times

Brian Mills is Product Manager of Alternative Energy - North America, Stäubli, a manufacturer of solar electrical connectors and electrical contact systems.

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SOLAR DESIGNERS AND ENGINEERS

have faced site demands of weather and terrain for as long as solar energy has been around. It's not so much a case of wondering what ever happened to all the available protected, flat, unobstructed and rock-free sites, as much as it is realizing that those ideal locations never really existed in the first place.

Solar panel support structures are often built in exposed areas where they can take advantage of sun exposure. Their foundations drive deep into the earth and must withstand everything Mother Nature dishes out over a 20- to 30-year lifespan.

Designers face a big challenge in finding a site layout with proper ground clearances and minimal shading. Steep grades and aggressive grade changes, along with soft soils, rocky soils, and/or corrosive soils, all make foundation engineering a challenging puzzle that must be solved with conservative safety factors. In order to be permitted, both solar system structures and their foundations must be designed to resist high wind loads, snow loads, and seismic loads. Then, once the site is constructed and up and running, it must further endure heavy rains, ground erosion, flooding, ice storms, and snowdrifts for the remainder of its operating life.

While PV cell and module companies have continued to improve efficiencies and overall performance, individual solar panel efficiencies have begun to plateau. Regardless of what solar panel is used, including the latest bifacial modules, its annual power (kWh) production improves significantly when mounted on sun-pointing or tracking structures. In fact, single-axis solar trackers have been long accepted as the product of choice for the growing utility-scale applications.

Overall design and layout for single-axis trackers used in large solar farms have followed the conventional wisdom of north-south-oriented, "long row" architecture, with continuous structures built as close to the ground as possible. This format keeps the system's wind signature small while optimizing DC collection with strategically placed combiner boxes, inverters, and transformers.

But some sites, where the terrain is prone to extreme weather conditions like flooding and snowdrifts, solar panels require additional ground clearances. The typical long and continuous structure cannot navigate steep grades and grade changes effectively. The structural and electrical advantages of contiguous racking with shared foundations are often outweighed by design, construction, and operations and maintenance inefficiencies.

Commercial, industrial, and residential ground-mount solar systems were the first markets to utilize top-of-pole solar arrays. Also popular in agricultural applications, these decentralized structures inherently offer solutions to extreme weather and terrain conditions.

Independent foundation design for varying site conditions - Since each solar array (8-18 PV modules, over 7kW) can be mast on a single post or pile, the required embedment, casing, and reinforcing can be optimized by exposure and location.

Keeping Out of Harm's Way

Top-of-pole trackers

by Eddie Bugg

Easy remediation for rocky conditions - If you have driven or augured for post foundations, you know what "refusals" can mean on contiguous rows. Top-of-post tracker structures can be more easily relocated since they are not structurally tied to other arrays.

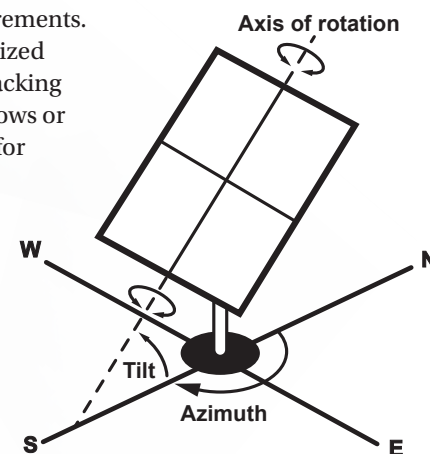
Arrays can be easily elevated, when necessary - Flood plains, erosion zones, deep snow and drifts, and even vegetation and livestock can be easily mitigated by simply increasing individual post lengths. Think "solar trees" vs "solar carpeting."

No maximum grade or change of grade limits - In most cases, as long as a proper foundation hole can be excavated, a top-of-pole tracker can be constructed.

Like all solar structures, top-of-pole systems have a downside, too. Taller structures are subjected to higher wind loads, which can lead to deeper or heavier foundation requirements.

DC collection design takes on a more decentralized approach. The same goes for powering solar-tracking actuating itself. It's more efficient to turn long rows or ganged rows than independent arrays. Solving for extreme weather and terrain conditions can be costly. But new top-of-pole products offer "passive" tracking drives that autonomously boost power with a single moving part - no motors, no cables, no computers, and no external power.

Simply put, top-of-pole trackers solve common problems associated with extreme weather and terrain. They will never compete on cost with conventional utility-scale solar systems on ideal sites. But remember, conventional wisdom will always make good sense, until the site conditions are unconventional!



One axis tracking PV array with axis oriented south.

Eddie Bugg is Founder of Pursuit Solar, which manufactures top-of-pole tracking solar racks.

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“Ten of our eleven projects currently under supply in the US are using bifacial equipment”



COLIN CAUFIELD, SOLTEC VP OF SALES NORTH AMERICA

Starting in 2015 with the supply of bifacial solar trackers in ‘La Silla’ (Chile), Soltec has a wide experience in bifacial tracking technology. At this PV plant, the Spanish company designed the first bifacial tracker specifically created to mount bifacial panels at utility plants at a global level. Since then, Soltec has been constantly implementing its bifacial trackers. Colin Caufield, Soltec VP of Sales USA, tells us more about the milestones of his company.



What is the current situation of Soltec in the US?

We’ve brought on 4 new customers over the past two fiscal quarters, and we expect to see that trend continuing throughout 2020. Our new customers are EPC contractors in some cases and in others we’ve contracted directly with IPPs who will be owning and operating their power-generating assets. We’ll supply over 500MW in the US in the first half of 2020, and this volume is split almost evenly between projects using bifacial crystalline products and First Solar’s Series 6 panels. Our projects are situated across the country with significant volumes in the Mid-Atlantic, the Midwest and in the Hawaiian Islands. This gives us a great variety of site conditions from high winds to significant snow loads and soft soils to grounds covered by volcanic rock. These are exciting times!

What are the forecasts of the PV market for the coming years in the US and what role will Soltec play in it?

Despite year-over-year step downs in the Investment Tax Credit incentives, all forecasts are showing that the US market will be the standout leader for utility-scale PV in the near future. Demand for new energy sources combined with a downward trend in PV equipment, execution and plant operating expenses will continue to foster new solar developments well into the 2020s. As an equipment supplier with over 15 years of experience and over 9GW of installations worldwide, Soltec intends to be a primary player in the single-axis tracker industry. Our R&D combined with our best-in-class equipment and breadth of ancillary services will make Soltec a strategic partner for many throughout the decade.

What plants has Soltec supplied in the US in the last year? How many of them have been bifacial?

We have 11 projects currently under supply contracts and ten of those projects are using bifacial equipment. How important will bifacial technology be in the next projects in the US market? Incredibly. We’re already seeing most crystalline projects trend in that direction. It’s of little surprise when you consider that the premium for procuring and installing bifacial equipment is relatively low while the yield boost is consistently greater than 7% even at sites with less-than-favorable conditions. It is key, however, that attention be paid not only to the use of certain bifacial panels, but also to the tracker choice and overall plant design. These are

major factors in how much extra yield one can expect to see when compared to a monofacial plant in the same environment. With the research that Soltec has been performing at our BiTEC facility in Livermore, CA, we’ve identified the ways that tracker design, algorithms and overall plant design can be optimized to see bifacial gains as high as 15.7% (yearly average under high albedo conditions). [We encourage industry partners to get in touch with us to learn how to maximize the potential of their power plants.](#)

What implementations or developments is Soltec carrying out to adapt to the US market?

A big key to our success will be expanding our team in order to give personalized service to an increasing customer base. As I mentioned earlier, we intend to work with Developers and IPPs in early development stages of projects to optimize the yield potential of their plants. The results will make their proposals far more competitive, and we’re committed to special attention to detail provided by our Project Engineering team. A similar focus will be put into our Project Management and Construction Success teams to ensure execution is as smooth as it can possibly be. After-Sales services is another area of focus that we’ve worked to expand and improve. Our SolMate platform has a state-of-the-art interface and commitment to speedy customer service to ensure minimal downtime and rapid diagnosis of operational issues.

What benefit does the Soltec solar tracker have compared to others in the market?

I focused a lot of the benefits that IPPs and Developers are seeing by using our equipment for bifacial plants and extra yield boost. First, I’d like to add that we intend to have IE studies performed that will allow those customers to see these benefits during project finance stages. This is expected to fuel the industry even more so, but I’d be remiss not to mention that EPC contractors working with our equipment have been noticing installations efficiencies that are exceeding their expectations, too. It was long assumed that 2-portrait trackers are more expensive to install, but recent project execution has been debunking that theory and doing so unequivocally. This not only allows them to save margin during execution, but also enables them to confidently bid more aggressively on future projects. The results are increasingly lower LCOE.

Recycling a Solar System - Part 2

Practical actions for managing solar module waste

by Dwight Clark, CHMM and AJ Orben



In the second of this two-part series, we focus on the actual waste management concepts related to solar panels, and the steps every company should take to develop a program for used solar cell components.



The first order of business: establish your risk tolerance as an organization. Some organizations choose to be more conservative than others. This decision point will likely drive the remainder of the decision-making process. To protect your organization from the EPA and/or repetitional risks, take note of the following key points.

Packaging is Key

Pay attention to how solar modules are packaged after removal from the racking.

For those panels considered suitable enough for reuse, management must require careful handling to reduce the possibility of cell damage from mechanically aided lifting.

For scrap panels - ensure that glass and other materials are not getting dislodged and landing on the ground. In some cases, the EPA can consider this a disposal or a spill. To help prevent the spillage in storage and transit, use either a pallet with a solid

top, or a corrugated tray with the edges bent up around the panels at 90 degrees (in addition to the banding and stretch wrap).

With new modules coming off a highly automated assembly line, robots precisely palletize the modules for safe shipment and placement in the racking for operations. Contrast this with the conditions of a solar farm on vacant desert land or an agricultural field, where pallets have been on the site since the installation - chances are they are weather rotted, the OEM spacers and other original packaging having long since disappeared. Even the basic step of loading the modules onto a truck without reliable protective packaging or a dock can risk damaging them.

Ensure Operability

When selling or donating PV Equipment for reuse, you must provide evidence of operability of the units by using appropriate testing methods. It is well documented that the cells within a solar module are susceptible to micro cracking and other damage during handling. When it comes to handling a used

solar module, the number of steps alone increases the probability of damage.

Flash testing and visual inspection may not be enough to ensure that the modules being sold are free from latent defects that can cause long-term underperformance. Even if production is performed to best-known practices, shipping and installation may be damaging for the modules delivered to a project site. For PV modules, EL is the technology of choice to detect micro cracks, which can be a signature of mishandling.

Select a Vendor

Develop a process and metrics for choosing which vendor will manage the solar modules (reuse or waste). Ensure that any "advice" provided by the vendor is verified.





Developing and implementing strategies to deal with e-waste is essential for companies of all size and in all industries. Minimizing waste, recycling electronics, managing the risks of disposal, and complying with regulations at the local, state, federal, and international levels are all important considerations. Compliance with appropriate regulations means knowing and understanding which laws and treaties apply to the particular waste in question, keeping proper records, and meeting permitting requirements.

Companies working with vendors to handle their e-waste can avoid liability by assessing vendors at the onset, and auditing them throughout the disposal process. Vendors should be required to provide assurance as to their ability to meet regulatory requirements, and present evidence that requisite permits and certifications are in place. To deal with these complexities, organizations may want to seek help from a provider with expertise in health, safety, and environmental compliance services. For e-waste, those services can include assessing the waste to determine proper handling; providing guidance on waste management and disposal; and evaluating disposal vendors to ensure they have proper certifications and valid permits (as well as reveal any past violations).

To avoid compliance lapses, companies may want help in reporting and record keeping requirements. Training, written program development, R2 Certification, EICC conformance, auditing, and permitting are other valuable services that companies may want to consider. As they work to optimize their e-waste management strategies, companies should seek to confirm that their insurance program provides the appropriate coverage for e-waste exposures that cannot be avoided by their proactive risk management efforts. Premises pollution liability policies can provide coverage for environmental risks on a particular site (including remediation when necessary), as well as coverage for liability arising from releases during transportation of e-waste, and releases from properly permitted third-party disposal sites. Companies may want to consider a policy that provides coverage for their entire business operations, whether on their own premises or at third-party locations. Also, for firms involved in e-waste management, contractor's pollution liability coverage can provide insurance for environmental risks at project sites owned by another entity - whether it be a government body or private company.

Responsibly disposing of solar panels has become a complicated business. Previously unregulated e-waste management practices have become subject to new and evolving regulations. Best practices dictate enlisting the help of experts in this rapidly evolving field. Check with your insurer - they may be willing to pay for associated auditing, training or other risk management services tailored for e-waste as part of a comprehensive coverage program. Safety is paramount, for both your company and the environment.



AJ Orben is Vice President, and Dwight Clark is Director of Compliance and Recycling Technology at We Recycle Solar, a single-source disposal provider for excess, recalled, and end-of-life solar products.

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Lessons Learned from California

Building a resilient grid

by Lior Handelsman

CALIFORNIA'S WILDFIRES AND PLANNED

power shutoffs are looming, home and business owners in high risk areas are becoming blackout weary, and everyone is hoping for long term solutions. Even those across the country who do not personally experience power outages as a result of wildfires or other extreme weather events, have witnessed in the news the devastation on the west coast, as well as in Australia where the impact on land, humans, and wildlife is extraordinarily horrific. It is becoming increasingly apparent that we need to take some proactive measures in terms of how we produce electricity.

Grid instability is a main focus due to a number of factors, including an aging power infrastructure that exposes vulnerabilities, the increasing frequency and strength of extreme weather, electric vehicle (EV) adoption, and even the increase in photovoltaic (PV or solar) energy installations. Yes, even

renewable energy - because of its inherent intermittency and growing penetration - adds stress to the grid. In the case of solar, nightfall makes it hard for the grid to ramp up energy production to meet evening consumption. In terms of grid instability for the rest of the country, California is like the canary in the coal mine.

While California does not depend on the nation's oldest power infrastructure - that designation is held by states on the East Coast - the Golden State still relies on a transmission network that wasn't built for today's technology or environmental and safety concerns. California's power lines stretch across thousands of miles, between trees and over dry grass, brush, and forests. Nationally, 70 percent of transmission lines and power transformers are more than 25 years old, with some parts of the network built more than 100 years ago (including power plants built right after World War II, when the power sector was rapidly expanding).

This aged infrastructure is also vulnerable to cyberattacks, like the one that hit California, Wyoming, and Utah in March. That wide-spread denial-of-service (DoS) cyberattack - the first of its kind - was possible because the long distances between power plants in those states made it easier to impact millions of people and businesses.

Grid stability is also at risk from extreme weather patterns. It is well documented that climate change has contributed to an increase in frequency and strength of severe weather. Low precipitation and heat waves that cause long periods of dryness in California, for example, make transmitting electricity over dry land a dangerous fire hazard. Other regions of the country often get hit with hurricanes, tornadoes, and tropical storms, all of which impact the stability of the network.

As for EV and PV adoption, the Solar Energy Industries Association and the Auto Alliance report that California is the leader in both areas - an extremely positive position, yet one that places a considerable strain on the existing power

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grid. EV adoption in California is greatly increasing energy demand, which could push the grid past capacity, especially during evening hours.

The intermittency of PV makes it difficult for utilities to control and manage the grid. This is especially prevalent in California, but can also be seen across the country. The higher penetration of renewable energy is simply more than the grid can handle in its current configuration. It must be managed and coordinated smarter and more efficiently with regard to how and where energy is produced, consumed, and stored. Fortunately, California's plan to install batteries with PV systems is one of the best ways to manage PV generation to improve grid stability.

We need to make a smarter transition with our power infrastructure to be distributed, decarbonized, and more cost-effective. The good news is that homeowners and utility companies are increasingly becoming the driving force in making that transition, as is evidenced by the CPUC announcement¹.

Solar energy systems with battery backup are solutions that can be implemented now. In the short term, they would alleviate the impact of blackouts and reduce the need to transport energy across long distances. In the long term and deployed en masse, solar-plus-battery systems can help utilities create virtual power plants (VPPs). This is where the energy industry is headed - it lets consumers play an active role in the energy market (as "prosumers," producers and consumers), while achieving greater grid independence and resilience. By launching VPPs that aggregate a large

quantity of distributed energy production and storage, California is once again leading the way in managing clean power.

As we reflect on the devastation the wildfires caused in California, the resulting power shutdowns and their impact, and efforts to lessen that impact in the future, let's view the experience as a major lesson learned from a state that is proving to be at the forefront of a solution for a resilient energy grid.



Lior Handelsman founded SolarEdge in 2006 and currently serves as Vice President of Marketing and Product Strategy. He is responsible for defining and steering SolarEdge's strategic global marketing activities, media outreach, product roadmap and vision, corporate product strategy, as well global product management, and corporate business development. Prior to founding SolarEdge, Mr. Handelsman spent 11 years leading power electronics research and development teams, and directing large-scale, multidisciplinary research and development projects. Mr. Handelsman holds a B.S. in Electrical Engineering (cum laude) and an MBA from the Technion, Israel's Institute of Technology.

SolarEdge /// www.solaredge.com

¹ <http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M321/K658/321658813.PDF>

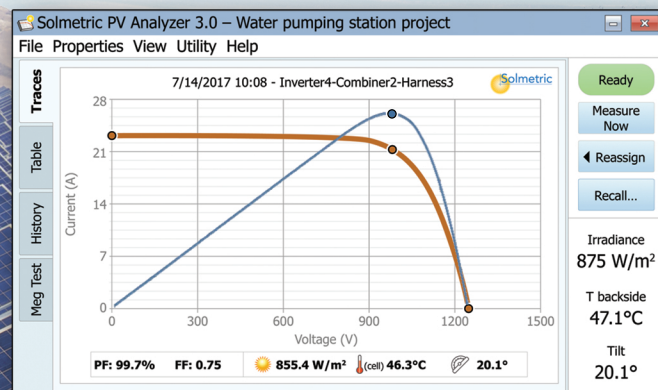


Compact Power-over-Ethernet switch

WAGO's new compact Power-over-Ethernet (PoE) expands its line of industrial grade Ethernet switches. Just two inches wide and four inches tall, the 852-1411/000-001 PoE switch is suitable for all applications with limited space. The wide voltage input of 24Vdc to 57Vdc, makes the 852-1411/000-001 switch an option for all PoE applications. The switch supports both PoE operation modes A and B, with all of the ports supporting 10/100/1000 Mbps/s. This new ECO (economy) PoE+ switch is unmanaged, supplies 30W of power per PoE port and has an operating temperature of 14°F to 140°F (-10°C to 60°C). It eliminates the need to run both an Ethernet cable and power cables to end devices, ultimately reducing cost.

WAGO /// www.wago.us

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www.solmetric.com





Residential storage hybrid inverter

Ginlong Technologies' Smart Home Solis Solution incorporates single-phase string technology into an intelligent hybrid platform to support maximum self-consumption, safely and reliably. Customers can maximize their self-consumption with flexible operating modes such as time-of-use, auto self-consumption, and off-grid backup, enabling smart time shifting to leverage TOU schedules and optimize energy use. UPS-ensured backup and smart EMS functions are among the latest safety components that protect homes and let homeowners glide through blackouts safely and reliably. The inverter includes a built-in Sunspec MLRSD signal transmitter and is ready for NEC 2017-2020 standards. The Solis hybrid inverter enclosure is completely sealed with a built-in AC/DC wiring box and an ATS (automatic transfer switch). Hybrid capabilities such as export values and battery configurations can be programmed through the inverter's large color LCD. Additional advantages include streamlined O&M through remote monitoring using their 24-hour intelligent energy management system. Compatible with LG Home RESU and other 120V-500V lithium batteries, the Solis hybrid inverter helps households maximize their PV energy and lock in energy savings.

Ginlong Technologies /// www.ginlong.com



A versatile way to make wire transitions

Zilla's patented Electrical Flashing Assemblies are purposely-built to provide a versatile, low-cost way to make transitions simple, fast, and secure. With Zilla Electrical Flashings, it is possible to choose a combiner box, j-box, conduit body, or other compatible transitional components to complete an installation as smoothly and efficiently as possible. Zilla Electrical Flashing Assemblies are available in two adapter sizes. The 3/4" O.D. NPSM adapter and flashing kit are conveniently packaged and sold in boxes of 30, and the 1-1/4" O.D. with 1" I.D. NPSM adapter and flashing kit is conveniently packaged and sold in boxes of 18.

Zilla /// www.zillarac.com



High output microinverter

The QS1 is designed to accommodate today's high output PV panels up to 375W, offering 300W AC output per channel. The QS1 offers up to 3X faster data transmission speed than PLC and a wider MPPT voltage range means a greater energy harvest for homeowners. The unit significantly reduces installation time and costs, taking the place of four conventional microinverters per each QS1 installed while providing independent MPPT for each module. The QS1 shares common AC trunk cabling with APsystems' dual-module YC600 microinverter, offering flexible mix-and-match compatibility on the same circuit to enhance site design capability and maximize circuit capacity. The QS1 builds on APsystems' line of multi-module microinverters, simplifying installation while reducing installation costs and time on the job site.

APsystems

/// www.apsystems.com



10 gigabit managed ethernet switches

Antaira Technologies' LMP-1002G-10G-SFP, LMP-1002G-10G-SFP-24, and LMX-1002G-10G-SFP are industrial-grade equipment that is Ethernet ready to fulfill edge-level networking applications. These devices support high-density Ethernet port connectivity, with 10 gigabit fiber ports, long distance data transmission, and reliability. Antaira's LMP-1002G-10G-SFP will provide up to 30W PoE per port and two SFP+ slots with speeds of 1000Mbps or 10Gbps, depending on the SFP used. The switch can be mounted by DIN-Rail or wall mount (wall mounting plates included). These new 10 gigabit Antaira switches are fully managed with Light Layer 3 capabilities. The management software can allow for redundancy which can be built into the network using Spanning Tree, Ethernet ring technologies, or other available redundant features.

Antaira Technologies

/// www.antaira.com



UL 1741 certified medium voltage power station

SMA America's Medium Voltage Power Station (MVPS) represents a large-scale medium voltage PV power conversion station UL 1741 listed as a complete, assembled solution, creating interoperability and safety assurances as well as enhancing long term value for owners. Four power classes of the new utility solution are available throughout the Americas with offerings up to 4.6MW. The MVPS is built upon CSC-compliant container, meeting international safety standards to provide low transportation costs. The fully integrated MVPS reduces both logistical and installation labor costs. Plus, the medium voltage solution offers a full system UL 1741 certification, ensuring a safe, reliable choice for long-term, trouble-free operation. Various MVPS design features, including integrated switchgear and a hermetically sealed transformer, simplify O&M and reduce lifetime service costs. Simple integration of turnkey AC and DC coupled storage solutions from SMA allows system owners to capitalize on new revenue streams. SMA provides risk-sharing services to manage a partner's solar assets, including a full range of monitoring and service packages, technical support, and plant-wide O&M. The Sunny Central UP lies at the heart of the MVPS and elevates cybersecurity to shelter system owners and operators from threats to system health and profitability. Meanwhile, the SMA Solar Academy's support training and Virtual Support App gives field service professionals tools to improve service speed, minimize downtime, and reduce the risk of lost revenue from service events. Maximum design flexibility and pre-sales support from SMA's experts, including engineering services, speed project velocity and reduce risk of costly installation delays.

The SMA Group /// www.sma-america.com

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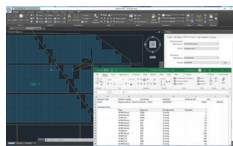
weryclesolar.com/nace



UL-system-certified rapid shutdown solution

Tigo Energy, Inc. announced a new addition to the add-on TS4 Platform, the TS4-A-S. This add-on safety solution brings a module-level power electronic (MLPE) multivendor UL-system-certified solution for rapid shutdown. Tigo's safety solution complies with NEC 2014, 2017, and 2020 with more than 100 inverters for residential, commercial & industrial, and utility customers. The TS4-A-S provides module-level shutdown when installed on each PV module and accompanied by the Tigo Access Point (TAP) and the Cloud Connect Advanced (CCA). DC production data can be analyzed via Tigo's SMART Website or App when connected to the cloud. The highlights of the new TS4-A-S (Safety Add-on) with rapid shutdown include: comply with NEC 2014, 2017, 2020 rapid shutdown requirements; choose compatibility from more than 100 UL-system-certified inverters; choose compatibility from any module up to 500W; manual or automatic shutdown in event of AC grid loss; automatic email or SMS alerts about faults or operational issues; protect PV system assets with full visibility of performance; lower O&M costs when identifying specific module problems; and utilize module manufacturer warranties when tracking module failures.

Tigo /// www.tigoenergy.com



Utility-scale solar design software

PVComplete released PVCAD Mega, its CAD software for utility-scale PV projects, built on Autodesk technology. PVCAD Mega delivers precise solar engineering and layouts for tracker and fixed-tilt projects of any size in five minute or less. In addition to enabling fast layout speed, PVCAD Mega also improves the accuracy of project modeling with advanced capabilities such as topography pier analysis. PVCAD Mega makes pier analysis at scale possible, replacing average grade with unique post heights for every pier on a project site. The result is more informed constructability and equipment decisions, as well as lower material and installation costs. Other key features include: click-and-drag full and partial tracker blocks and angled layouts; automatic placement of partial trackers, access roads, and equipment pads; quick advanced topography analysis, including custom topo data; side-by-side layout comparisons that reveal the outcome of different structural component selections; and NEXTracker and Array Technologies integrations. PVCAD Mega is available with or without bundled AutoCAD software on a monthly or annual subscription basis.

PVComplete
/// www.pvcomplete.com



Solid performance in harsh environments

WAGO has added two new Generation 2 PFC200 PLC controllers along with two new Generation 4 Ethernet based couplers to its XTR line of products. These new devices are designed to work in harsh environments and provide solid performance in extreme conditions. The 750-8212/040-010 and 750-8213/040-010 XTR controllers have two configurable M12 Ethernet ports and an onboard SD card slot for additional data storage for program updates. The 750-8212/040-010 has one configurable RS232/485 port, while the 750-8213/040-010 comes equipped with one CANopen port to connect to engine parameters via J1939. The 750-364/040-010 MODBUS TCP/UDP and 750-364/040-010 EtherNet/IP couplers each boast two M12 Ethernet ports with the rotary switches configuring the last byte of the IP addresses. All 4 of these devices share the following features: -40°F to 158°F (-40°C to 70°C) operating temp; temporary condensation permitted; 5g vibration and 25g shock; EMC protection; and flexible I/O system.

WAGO /// www.wago.us



Easy energy management

Plant operators and facility managers now have real-time, remote access to their machines' energy consumption data, with Phoenix Contact's EMpro. This second generation of energy monitoring devices offers simple configuration and operation, so no special skills are needed to install or commission the device. The EMpro tracks energy parameters such as voltage, current, and power at the machine or system level. It then communicates that data locally, or transmits it to cloud-based services, creating an IIoT energy-monitoring solution. EMpro energy meters measure energy data and communicates this information to a local control system or to remotely-connected services. Configure and integrate the devices in just a few steps, thanks to the web-based, user-guided installation wizards. Combined with a wide range of standard features, EMpro meters offer advanced functionality in simplistic and cost-effective packages.

Phoenix Contact
/// www.phoenixcontact.com



Valuable position monitoring

Canfield Connector released its Electronic Tilt Switch (ETS) series which triggers a precision output based on user defined specifications within 0.5° of accuracy. The ETS series works similarly to Canfield's Electrical Inclinator Sensor (EiS) series, intelligently creating an artificial horizon for measuring the slope, tilt, or elevation of an object with respect to gravity. Both products are essential to applications that merit alerts or changes in operation when equipment is not at an optimal position.

Canfield Connectors
/// www.canfieldconnector.com

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Solar fuses offer high amperage in a single case design

Littelfuse, Inc. has expanded its SPXI series in-line solar fuses to include 35 to 60 amperage models. Designed to integrate into in-line assemblies within a wire harness, these 1500VDC solar fuses protect photovoltaic (PV) installations from overloads and short circuits to minimize damage to solar panels. Key benefits of the higher amperage solar SPXI in-line string fuses include, a single body case design to increase reliability and simplify retrofitting within existing solar power systems, UL Recognized to UL248-19 standard, with 50 kA DC interrupting rating, product labels with QR codes offering real-time access to part numbers, voltage, programming terms, and date codes to save time with product replacements and inventorying.

Littelfuse /// www.littelfuse.com



Power to maximize system uptime

WAGO's Pro2 Power Supplies include six units ranging from 120-960W and an energy conversion efficiency up to 96%. The power supplies incorporate an interface allowing them to be tailored to any application requirement. The units also offer monitoring functions that provide continuous power supply data information and signal errors for application monitoring. They also have easy fieldbus connection with snap-on type communication modules with WAGO's high-performance TopBoost and PowerBoost capabilities, maximizing system uptime and lowering hardware costs. TopBoost boasts 600% extra output current, enabling protection for up to 15 ms compared to conventional circuit breakers. PowerBoost provides an extra 150% output current for five seconds providing superior reserve power.

WAGO /// www.wago.us



Heterojunction solar cells based on M2+ wafers

Hevel Group has launched production of heterojunction solar cells based on M2+ silicon wafers. A slight area increase has allowed to raise the HJT solar cell peak power up to 5,88Wp with maximum cell efficiency rate of 23.8%, while maintaining an average of 23.3%. At the same time, Hevel HJT modules have retained their respective dimensions, while receiving a boost in yield and efficiency thanks to the M2+ transition. HJT modules with increased power output of 330Wp and 390Wp were introduced to existing glass-backsheet 60-cell and glass-glass 72-cell module series, respectively. Enhanced performance combined with minimized annual degradation, better yield in hot climate conditions and aesthetic appearance make these HJT modules a solid pick for any project, where efficiency matters.

Hevel Group

/// www.hevelsolar.com/en



Universally compatible rooftop attachments

OMG Roofing Products has introduced PowerGrip Universal 7 (PGU-7), a rooftop attachment anchor for mounting solar racking systems and other products to virtually any commercial roof. PGU-7 units are designed to reduce or eliminate the need for ballast in solar racking systems, so there's less weight, material handling, and labor on the roof. Designed with wind performance in mind, PGU-7 units offer up to 2051lb/ft (9.12 kN) of tensile strength, 1581lb/ft (7.03 kN) of shear strength, and up to 2214lb/ft (9.84 kN) of compressive load strength. Made of heavy-duty cast aluminum, PGU-7 units include a base ring that is secured through the roofing assembly and into the structural roof deck, as well as a waterproof cover plate to prevent water from infiltrating the system. PGU-7 units transfer wind uplift loads to the structural roof deck for maximum strength and effectiveness. The system does not require any membrane welding, and PGU-7 units are typically installed in less than five minutes, saving both time and labor. In addition to ballast and rail-based solar racking systems, PGU-7s can be used for many other roof mounted items such as pipe supports, step crossovers, raceways, satellite dishes, small antennas, and HVAC applications.

OMG Roofing Products

/// outofthestoneage.com



Single-bolt module installation in 11 seconds

Array Technologies has announced the launch of RapidClamp, a single-bolt PV module clamp technology which drastically decreases solar module installation times with First Solar Series 6 modules. RapidClamp benefits include fast, simple three-step module installation; error-proof auto-alignment of modules; pre-assembled module clamp minimizes on-site assembly; provides a reliable mounting system with integrated electrical bond; the patent pending single-bolt clamp offers no-slip octagonal torque tube clamping; and eliminates gaps between modules or protrusions above the module for simplified cleaning operations and maximum row density.

Array Technologies, Inc. /// arraytechinc.com



Innovative switching solution

Southern States recently started shipping the TranSwitcher. Available at 15kV, 27kV, and 3 kV, the TranSwitcher is a simple, reliable, and cost effective solution for mitigation of undesirable inrush currents when connecting DER to utility distribution lines. The ability to connect and disconnect the DER to the utility line with minimal impact to the system voltage allows increased frequency of switching, extending the life of the transformer while also reducing costs associated with transformer losses.

Southern States, LLC

/// www.southernstatesllc.com

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Reduce BOS costs and LCOE

Trina Solar has formally crossed the 500W barrier in Monocrystalline PERC technology and is producing its latest VERTEX bifacial double-glass and standard backsheets modules in high volume production. Based on 210mm silicon wafer and monocrystalline PERC cell, the new modules feature several design features enabling high power output and module efficiency up to 21%. Technical innovations like superimposed three-slice split cell, non-destructive wafer cutting, high density form factor, and nine bus bars reduce resistive power losses, improve anti-hot spot performance, and increase energy harvest while improving module mechanical strength. The back-side generation from the bifacial modules can further increase energy generation by 5%-25%, depending upon the project albedo.

Trina Solar

/// www.trinasolar.com



Central PV inverter

The 3Power C Series Inverter continues Ingeteam's legacy of low CAPEX and low OPEX, offering power density at 464kW/m³ and a power rating up to 3400KW. Its control unit features an efficient, sophisticated method of inverter control via a digital signal processor. Drawing from the technology found in Ingeteam's power converters for the wind industry (+46GW), the liquid cooling system (LCS) provides increased thermal stability and optimized component usage as it contains fewer moving components which consume less power and require less maintenance. The LCS's fast connectors and anti-dripping system mean there is no risk of particle entrance, making it well-suited for harsh environments. Designed to comply with demanding grid connection requirements, the C-Series inverter contributes to the quality and stability of the electric system, as it features advanced functionalities in terms of grid support.

Ingeteam /// www.ingeteam.com

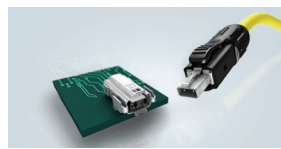


Inverter for ground-mount projects with 480Vac interconnections

SMA America announces the Sunny Highpower PEAK3 125kW as a solution for ground mount projects with 480Vac interconnection. This solution can connect to the grid at 480Vac without an additional transformer. The PEAK3 125kW is most applicable in community solar, agricultural aggregate metering, and other large distributed generation projects. For PV system developers and integrators, designing plants with PEAK3 and SMA's centralized, modular system architecture reduces balance of system costs, and speeds installation and commissioning. The PEAK3 125kW with 480Vac output requires no additional step-down transformer to interconnect with 480Vac services. PEAK3 also offers significant savings in both inverter and installation costs. For PV system owners, the PEAK3 delivers high energy production by eliminating the need for an additional step-down transformer and by reducing line losses throughout the system. Using fewer transformers and inverters reduces lifetime service costs by limiting potential points of failure, while the centralized, modular plant architecture simplifies operations and maintenance (O&M) further reducing costs. SMA also offers the PEAK3 150kW with 600Vac output for even greater cost savings in large-scale PV plants with medium voltage interconnections.

SMA America

/// www.sma-america.com



Single pair ethernet technology

HARTING Americas' Single Pair Ethernet communicates across industrial Ethernet protocols including Ethernet/IP, Profinet, EtherCAT, etc., but instead of using 4 or 8 wires, it accomplishes communication across 2 wires, a single twisted pair. Also, it utilizes Power over Data Line (PoDL) technology to not only bring communication to the device, but also the voltage and amperage needed to power the device itself. Benefits resulting from this technology include, space and number of connections are reduced on the device, the need for an external power supply is eliminated, and devices on the plant floor that have traditionally communicated over Fieldbus protocols can now join the same IP-based network that the rest of the devices on the network are using. This enables peer-to-peer communication, open-loop feedback of all devices, and smart functionality all the way from the main control room down to the individual device. HARTING will contribute several components to the SPE Ecosystem, with the core product being the T1 connector system. The T1 was selected as the standard mating face for Industrial Single Pair Ethernet. The product ranges from IP20 to IP67, and currently there are metric variants (M8 and M12), with further variants on the product roadmap. To fit all applications and truly be the standard for industrial applications, the mating interface was designed to be the same and interoperable across all IP-ratings. The T1 connector series is scheduled to be released later this year.

The HARTING Technology Group

/// www.harting.com



Streamline PV maintenance, track production, and prove ROI

Tigo Energy, Inc. announced a new addition to the add-on TS4 Platform, the TS4-A-M. This add-on module-level monitoring solution brings smart PV module technology and a high granularity of production data to Tigo's residential, commercial & industrial, and utility customers. With Tigo's monitoring solution, customers can choose between Premium or Free solar monitoring which offers various features into module-level data. The highlights of the new TS4-A-M (Monitoring Add-on) with Premium monitoring include: see power, voltage, and current data anywhere via the SMART website or app; view or download detailed charts of system energy production; configure 3rd party Modbus devices like inverters and AC meters in the Tigo SMART app; download data directly using the Tigo API; be alerted via automatic email or SMS of faults or performance issues; proactively maintain PV systems with a low cost of ownership; receive monthly or daily production reports; track individual module performance to easily identify issues; and predict maintenance requirements to reduce labor time.

Tigo /// www.tigoenergy.com

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 patent pending

HVHZ compliant Solar Racking
 Works with ISR, SSMR, Single-Ply & Asphalt
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Batteries

The energy storage market is growing larger by the year and will soon enable renewables to become a mainstream source of power. A reliable battery is a key component to any efficient and sustainable renewable energy system. Here are some of the more popular choices in the industry today...

SEE AD ON PAGE 37



Rolls Battery Engineering

Product: Rolls S48-6650LFP Lithium Battery

Description: Rolls LFP batteries offer rapid charge and discharge capability, minimal maintenance and reliable, long-term energy storage in a smaller footprint than traditional lead-acid battery banks.

Chemistry: Lithium-ion

Capacity (Ah @ 20hr rate): 130Ah

Voltage: 48V

Energy: 6.656kWh

Peak power: 130A

Dimensions: 18.5" x 13.7" x 14.7"

Weight: 192lbs (87kg)

Warranty: 10-year warranty or 38MWh

Certifications: UL

Key Features:

- Efficient and stable discharge;
- Rolls LFP batteries will not suffer negative effects from partial SOC;
- Integrated Battery Management System (BMS) to prevent abuse outside of current, voltage and temperature limits;
- Xanbus comm port provides plug and play integration with SE Conext XW+, SW, SCP, ComBox, and Solar Charge Controllers.

www.rollsbattery.com

SEE AD ON PAGE 39



U.S. Battery

Product: US RE L-16XC2

Description: Design optimized for maximum performance and life in stationary (non-vehicular) applications, including solar power and renewable energy installations, the OSP battery design and insulating DEFENDER "moss shields" increases life expectancy and performance.

Chemistry: Flooded lead acid

Capacity (Ah @ 20hr rate): 401Ah

Voltage: 6V

Energy: 2.41kWh

Cycle life: 675 Cycles at 80% DoD, and 1150 Cycles at 50% DoD

Operating temperature range: 0°F to 120°F (-17°C to 49°C)

Dimensions: 11.875" x 7.125" x 16.75"

Weight: 114lbs (51.7kg)

Warranty: 5-year warranty

Key Features:

- OSP outside positive plate;
- Higher peak capacity and increased initial capacity;
- Lower acquisition and per-cycle cost than lithium ion, nickel metal hydride, or other rechargeable battery systems.

www.usbattery.com



Strata Solar

Product: Energy Storage project development and turnkey installation

Description: Strata Solar's battery energy storage systems provide cost savings, reliability, and resiliency benefits, as well as quality and safety.

Chemistry: Lithium-ion

Energy: 1MWh to 1000+MWh

Peak power: 1MW to 250+MW

www.stratasolar.com



VRB Energy

Product: Vanadium Redox Battery Energy Storage System (VRB-ESS)

Description: VRB-ESS is scalable to any size from 250kW/1MWh to multi-megawatt size with four to eight hours of energy storage for utility-scale solar and wind time-shifting, peaking power applications, and microgrids. Components and electrolyte can be nearly 100% recycled at end-of-life, dramatically improving lifecycle economics and environmental benefits.

Chemistry: Flow

Voltage: 400/480VAC

Energy: 1000kWh

Peak Power: 250kW AC

Cycle life: >25,000 cycles

Operating temperature range: 32°F to 122°F (0°C to 50°C)

Dimensions: 80m2

Warranty: 10-year parts and labor warranty with zero capacity fade

www.vrbenergy.com



Dynamapower

Product: MPS-i-125 EHV Energy Storage System

Description: The MPS-i-125 EHV is a fully integrated behind-the-meter energy storage system. The MPS-i-125 EHV couples Dynamapower's efficient UL 1741 SA MPS-125 EHV inverter with Li-ion batteries in a temperature controlled battery NEMA-rated enclosure. The highly compact integrated system is easily deployed on a concrete pad, crushed stone, or on the ground with a forklift and minimal labor, reducing system installation costs for integrators and system owners. The system features Dynamapower's Dynamic Transfer which, in the event of grid disturbance, seamlessly switches a facility from grid-tied to battery backup power. Multiple MPS-i-125 EHV systems can be paralleled together to meet the sizing needs of any behind-the-meter installation.

Chemistry: Lithium-ion

Voltage: 480 - 600 VAC 3 Phase

Peak power: 125kW @ 480V, 150kW @ 600V

Operating temperature range: -31°F to 122°F (-35°C to 50°C)

Certifications: Inverter: IEEE 1547, UL 1741 SA Listing

www.dynamapower.com

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After two years of survival in extreme conditions in Northern Newfoundland and Labrador, at off grid homes, cottages and outfitters, the **HTL6-420** has out-performed all lead acid and AGM batteries that have been used over the past 20 years.

For larger, off grid Telecom and Utility back up UPS systems, the 2V 3000 Amp Hour Tubular GEL battery has no limit on expansion.

- Up to 25 year service life span
- 2V, 4V, 6V, 12V, 24V, 48V, 96V, 250V, 600V, up to 3000 AH per unit

A complete line of maintenance free GEL, AGM, and Lithium batteries, with system racks, connection bars and designs suitable for any energy storage application.



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50 years of experience in providing the highest quality solutions for the world of renewable energy.

SEE AD ON PAGE 38



AIMS Power

Product: 24 Volt Lithium Battery 200 Ah

Description: This battery from AIMS Power provides high cycles and no memory problems. Replaces up to 96 lead, GEL or AGM batteries over battery life span. Loaded with safety features. Available in 24V and 48V.

Chemistry: Lithium-ion

Capacity (Ah @ 20hr rate): 300Ah

Voltage: 24V

Cycle life: 3500

Weight: 184lbs (83.4kg)

Warranty: 10-year prorated warranty

Certifications: RoHS

Key Features:

- Wire up to 10 batteries in parallel;
- RS485 and CAN ports;
- BMS loaded with safety features;
- IP21 RoHS compliant;
- Mount in any orientation takes up less space and uses fewer connections.

www.aimscorp.net

SEE AD ON PAGE 35



Newfound Energies, Inc.

Product: L-16 deep cycle battery

Description: L-16-true deep cycle, maintenance free, gel storage battery, manufactured by C S Power Battery Co. Ltd.

Chemistry: Gel

Capacity (Ah @ 20hr rate): 420Ah

Voltage: 6V

Energy: 2.52kWh

Peak power (kW): 3kW varies

Cycle life: 1600

Operating temperature range: -40°F to 149°F (-40°C to 65°C)

Dimensions: 11.8" x 7.12" x 16.96"

Weight: 125.4lbs (57kg)

Warranty: 5-year warranty

Certifications: IEC 60896-21/22, IEC61427, JIS C8704, GB/T 19638, CE/IOS

Key Features:

- 100% maintenance free;
- Long 20+ year life;
- Non spill gel;
- Carrying handles, connection bars, and hardware included;
- Live 24/7 tech support line.

www.nfenergies.com



Battery Systems, Inc.

Product: Centennial CB6-400 AGM Deep Cycle

Description: L16 group size, large valve regulated lead-acid AGM deep cycle battery

Chemistry: Lead-acid AGM (Absorbed glass matt)

Capacity (Ah @ 20hr rate): 416Ah

Voltage: 6V, nominal voltage

Energy: 2.49kWh

Peak power: 24kW

Cycle life: 500 cycles @ 80% DoD, 1200 cycles @ 50% DoD, 3000 cycles @ 20% DoD

Operating temperature range: 23°F to 77°F (-5°C to 25°C)

Dimensions: 11.61" x 7" x 15.91"

Weight: 126.76lbs (57.5kg)

Warranty: 7-year limited solar/RE warranty (2-years free + 5-years pro-rated)

www.batterysystems.net



Iron Edison Battery Company

Product: Lithium Iron Battery

Description: Iron Edison Lithium Iron Phosphate Batteries are suitable main power storage and backup for photovoltaic systems and UPS systems.

Chemistry: Lithium-ion (Lithium Iron Phosphate)

Capacity (Ah @ 20hr rate): 100Ah to 5600Ah

Voltage: 48V (nominal)

Energy: 5kWh to 291kWh

Peak power: 100W to 52kW

Cycle life: 4000 cycles - 14,000 cycles

Operating temperature range: 32°F to 113°F (0°C to 45°C)

Dimensions: Single 30" x 12" x 10" enclosure to eight 48" x 27" x 8" enclosures

Weight: 140lbs to 6720lbs (272kg to 3048kg)

Warranty: 10-year warranty

Certifications: CE, UL1642, IEC62113

www.ironedison.com



Fullriver Battery

Product: DC400-6

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

Chemistry: Lead-acid suspension (Absorbed glass mat)

Capacity (Ah @ 20hr rate): 415Ah

Voltage: 6V

Energy: 2.4kWh

Cycle life: 1700 cycles to 50% DoD

Operating temperature range: 5°F to 104°F (-15°C to 40°C) recommended, -40°F to 159.8°F (-40°C to 71°C) maximum

Dimensions: 7.0" x 11.6" x 16.7"

Weight: 123lbs (55.8kg)

Warranty: 7-year warranty in approved solar applications

Certifications: ISO9001, ISO14001, ISO18001, UL, CE, TUV

www.fullriverbattery.com



Renogy

Product: Smart Lithium Iron Phosphate Battery (RBT100LFP12S-G1)

Description: The Renogy Smart Lithium Iron Phosphate Battery enables auto-balance among parallel-connections and provides a long life cycle and discharge performance. The integrated smart battery management system (BMS) not only protects the battery from various abnormal conditions but monitors and manages the charging/discharging process. Lightweight and safe for off-grid applications.

Chemistry: Lithium-iron phosphate

Capacity (Ah @ 20hr rate): 100Ah

Voltage: 12.8V

Energy: 1.28kWh

Peak power: 1.28kW

Cycle life: ≥4000 Cycles @ 80% DoD

Operating temperature range: -4 to 122°F (-20 to 50°C)

Dimensions: 11.38" x 6.77" x 7.38"

Weight: 26 lb (11.8 kg)

Warranty: 5-year prorated warranty

Certifications: UN38.3, MSDS, UL1642 (Lithium Cell)

www.renogy.com



Lithium Werks

Product: 12V7 Battery Module

Description: The LW12V7 is a high-performance, long lasting, safe, 12V battery, built on a Lithium Iron Nanophosphate chemistry platform. Developed as a lead-acid replacement for UPS and other power back-up systems, the LW12V7 is a robust, cobalt-free battery that saves customers weight, maintenance time, and money throughout ownership.

Chemistry: Lithium-ion

Capacity (Ah @ 20hr rate): 5Ah

Voltage: 13.2V

Energy: 66Wh

Operating temperature range: -22°F to 140°F (-30°C to 60°C)

Dimensions: 3.9" x 5.9" x 2.5"

Weight: 2lbs (0.9kg)

www.lithiumwerks.com



KORE Power

Product: Mark 1 Energy Storage System

Description: The KORE Power Mark 1 was built for stationary energy storage and includes proprietary NMC cells and modules. Safety features include integrated safety handles, concealed panel covers, and module front display. The Mark 1 maintains low installation and operation costs.

Chemistry: 631 Nickel, manganese, cobalt (NMC)

Voltage: 1500V

Energy: 110.7kWh

Dimensions: 88.9" x 20.4"

Weight: 1853lbs (840.5kg)

Warranty: 4- year defect free warranty

Certifications: UL1973, UN 38.3, IEC 62619

www.korepower.com



Blue Planet Energy Systems, LLC

Product: Blue Planet Energy Blue Ion LX-HV

Description: The Blue Ion LX-HV from Blue Planet Energy is a grid-optional commercial energy storage solution that integrates a wide range of energy sources to power businesses and critical infrastructure independent of, or in conjunction with, the utility grid. Fire-safe LFP batteries, site controller, and pre-tested/pre-configured battery inverter included.

Chemistry: Lithium-iron phosphate

Voltage: 480Vac 3-phase

Energy: 128kWh, expandable in 32kWh increments

Peak power: 125kW, expandable in 125kW increments

Cycle life: 8000 cycles at 100% DoD

Operating temperature range: -4°F to 113°F (-20°C to 45°C)

Dimensions: 119.6" x 32" x 76"

Weight: 1300lbs (590kg) per 32kWh cabinet

Warranty: 15-year warranty

Certifications: UL 9540, UL 9540A, UL 1642, UL 1741, UL 1973, UN 38.3, UL 1741 SA, IEEE 1547, Rule 21, HECO Listed

www.blueplanetenergy.com

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ROLLSBATTERY.COM



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LEOCH Battery Corporation

Product: PLC+C180FT Pure Lead + Carbon Battery

Description: LEOCH's Advanced Pure Lead + Carbon batteries have been specifically engineered to support energy storage applications. These high power, energy dense batteries offer high PSoC performance, fast charging from 0% to 90% in 1 hour, and a long deep cycle life of 3000 cycles at 50% DoD.

Chemistry: Lead acid

Capacity (Ah @ 20hr rate): 180Ah

Voltage: 12V

Energy: 2.43kWh (100hr), 2.19kWh (20hr)

Cycle life: 3000 cycles to 50% DoD, 5200 cycles @ 30% DoD

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

Dimensions: 22" x 4.92" x 12.6"

Weight: 127 lbs (57.6kg)

Warranty: 5-year full replacement limited warranty

Certifications: Conforms to IEC 60896 Test Standards

Key Features:

- Fast charge acceptance (1 hr. to 90% SoC);
- Exceptional Partial State of Charge (PSoC) performance and cycle life up to 3000 cycles @ 50% DoD;
- Rugged ABS-PC flame retardant jars provide maximum durability and a wide operating temperature of -40°F to 131°F (-40°C to 55°C);
- Large front terminal posts for low connector resistance;
- Rope Handles for ease of installation.

www.leoch.us

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MK Battery

Product: Deka Solar M100-33 Maintenance Saver

Description: Deka Solar Maintenance Saver High-Capacity Flooded-Batteries are available as a single, 3, or 6-cell configuration. They are designed to offer reliable, low maintenance power for renewable energy applications where frequent deep cycles are required and minimum maintenance is desirable. Design variations can be based on specific application needs.

Chemistry: Lead-acid

Capacity (Ah @ 20hr rate): 1896Ah

Voltage: 2V cells (optional 3 cell - 6V and 6 cell - 12V)

Cycle Life: 3400 cycles @ 50% DoD

Operating temperature range: -22°F to 122°F (-30°C to 50°C)

Dimensions: 12.81" x 6.56" x 31.3"

Weight: 275lbs (124.7kg)

Key Features:

- High capacity flat plate cells;
- Long life: 12 to 14 years in cyclic service application;
- Extended watering interval of up to six months due to the large reservoir for electrolyte;
- Thermally sealed cover to container with custom design modules;
- Robust, long-lasting epoxy coated steel trays.

www.mkbattery.com



Power Sonic

Product: BESS - Battery Energy Storage Systems

Description: Power Sonic manufacture and supply innovative Battery Energy Storage Systems (BESS) from 100KW to 50MW. Fully scalable and modular designs.

Chemistry: Lead acid, lithium-ion

Capacity (Ah @ 20hr rate): Battery solutions from 0.8Ah to 3000Ah

Voltage: Battery solutions from 2V to 900V

Cycle life: Over 4000 at 80% DoD

Dimensions: 10ft, 20ft, and 40ft containerized solutions

www.power-sonic.com



Saft

Product: Intensium Max 20 High Energy

Description: The Intensium Max 20 High Energy is Saft's unmanned and ready to install Energy Storage System (ESS) in a 20-foot container, enabling utility-scale storage solutions for grids, renewables and industries.

Chemistry: Lithium-ion

Voltage: 811V

Energy: 2.5MWh

Operating temperature range: -13°F to 131°F (-25°C to 55°C)

Dimensions: 22ft x 7.8ft x 9.5ft

Weight: <30t

Certifications: UL1642, IEC 62619, IEC 62093, IEC 62477, UL 1973, IEC 61000-6-4/IEC 61000-6-2, IEC 62477 overvoltage cat II, IP 54, ISO 668, IEEE 693 high level, IEC 60721, UN 3536 - class 9, UN 38.3, CE

www.saftbatteries.com



Phocos

Product: Phocos ECO-N-T Series, Solar Charge Controller

Description: Rugged housing and easy installation with corrosion-resistant screw terminals, makes this product suitable for SCADA systems and other off-grid applications. Versatile unit offers flexibility to operate a 12 or 24Vdc battery bank. HAZLOC UL certification for Class 1 Div 2.

Chemistry: Charge controller compatible with lead acid batteries

Voltage: 12 or 24Vdc (auto recognition)

Operating temperature range: -40°F to 140°F (-40°C to 60°C)

Dimensions: 4" x 2.4" x 0.8"

Weight: 0.35lbs (0.16kg)

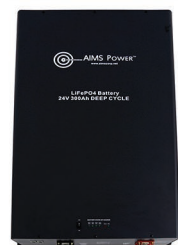
Warranty: 5-year warranty

Certifications: CE compliant, RoHS compliant, UL1741 listed, ANSI/ISA 12.21.01 listed

www.phocos.com

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Panasonic

Product: EverVolt

Description: EverVolt is Panasonic's residential energy storage system powered by the same lithium-ion batteries found in electric vehicles. With EverVolt users can store their excess solar power for when it is needed most or sell the surplus energy back to local utilities.

Chemistry: Lithium-ion (NMC)

Voltage: 46.2V

Energy: 11.4kWh useable Standard, 17.1kWh useable Plus

Peak power: 5.5kW off-grid, 7.0kW grid-tied

Operating temperature range: -41°F to 131°F (-40.5°C to 55°C) charging, -32°F to 122°F (-35.5°C to 50°C) discharging

Dimensions: 39" x 17.6" x 5.9" DC coupled, 33.7" x 18" x 6" AC coupled, 24.2" x 65.5" x 10" battery cabinet

Weight: 86.85lbs (39.4kg) DC coupled, 74lbs (33.6kg) AC coupled, 106lbs (48kg) battery cabinet, 55lbs (25kg) each battery module

Warranty: 10-year full system warranty

Certifications: UL 1741SA, UL 1973, UL 1642, UL 9540, CSA C22.2, IEEE 1547A, IEEE 1547.1, FCC Class B

na.panasonic.com/us/solar



Sol-Ark

Product: PCC-230

Description: Cost effective alternative to lithium with similar cycles and partial SOC. Built for battery backup, time of use, and long term off-grid applications.

Chemistry: Carbon Absorbant Glass Mat (AGM)

Capacity (Ah @ 20hr rate): 230Ah

Voltage: 12V

Energy: 2.8kWh

Cycle life: 3000 @ 50% DoD, 5800 @ 20% DoD

Operating temperature range: -40°F to 160°F (-40°C to 60°C)

Dimensions: 12.7" x 22" x 6.1"

Weight: 161lbs (73kg)

Warranty: 3-5-year warranty

Certifications: UL1989

www.sol-ark.com



EnerSys

Product: Genesis G200EP battery

Description: The Genesis G200EP battery, the largest amp-hour battery in the Genesis EP line, is a high-performance 12V battery that features Thin Plate Pure Lead (TPPL) technology, making it suitable for grid-tied solar power applications.

Chemistry: Lead-acid

Capacity (Ah @ 10hr rate): 200Ah

Voltage: 12V

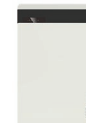
Cycle life: Up to 400 cycles at 80% depth of discharge

Operating temperature range: -40°F to 176°F (-40°C to 80°C)

Dimensions: 22.87" x 4.92" x 12.46"

Certifications: ISO 9001, ISO 14001

www.enersys.com



SOLAX POWER

Product: Triple Power LFP Battery

Chemistry: LiFePO4

Voltage: 115.2V

Energy: 5.8kWh to 23kWh in one hybrid system

Peak power: 4.0kW

Cycle life: 6000

Operating temperature range: 32°F to 131°F (0°C to 55°C)

Dimensions: 18.6" x 7.6" x 27.8"

Weight: 72lbs (32.65kg)

Warranty: 10-year warranty

Certifications: CE, RCM, TUV(IEC), UL1973, ROHS, REACH

www.solaxpower.com



Highview Power

Product: The CRYOBattery

Description: The CRYOBattery is a proprietary liquid air energy storage technology that delivers reliable and cost-effective long-duration energy storage to enable a 100% renewable energy future. The technology uses liquid air as the storage medium to deliver anywhere from 20MW/100MWh to more than 200MW/2GWh of energy and has a lifespan of over 30 years. Developed using proven components from mature industries, it delivers pumped-hydro capabilities without geographical constraints and can be configured to convert waste heat and cold to power.

Chemistry: Liquid air energy storage

www.highviewpower.com



Blue Solutions

Product: LMP 250 and LMP 40

Description: An air-tight outdoor metal enclosure that integrates the battery modules and electronic safety components. Does not need cooling systems. Will not self-ignite or explode. Product includes both Battery Management System (BMS) and Thermal Management System (TMS). No warranty provision on operating temperature range or depth of discharge.

Chemistry: Solid state

Voltage: 821V, 958V

Energy: 252kWh, 392kWh

Peak power: 125kW, 200kW

Cycle life: 4000+

Operating temperature range: -4°F to 149°F (-20°C to 65°C)

Dimensions: 78.5" x 90.9" x 40.4", 86.6" x 113" x 40.4"

Warranty: Based on number of cycles; 2-year equipment warranty, can be extended

Certifications: CE, UL, ISO 9001, ISO 14001

www.blue-storage.com

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Christie Dellario U.S. Battery
Employee Since April 1997



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WWW.USBATTERY.COM

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e-On Batteries

Product: EB48125 6.4kWh Energy Storage Module

Description: The EB48125 LFP module delivers safe and reliable energy storage in an easily stackable 6.4kWh format. Scalable from 12.8kWh residential applications to multi megawatt utility scale projects, the EB48125 offers proven safety to a wide range of applications.

Chemistry: Lithium iron

Capacity (Ah @ 20hr rate): 125Ah

Voltage: 51.2V

Energy: 6.4kWh

Peak power: 6.4kW

Cycle life: 5000 @ 90% DoD/C2

Operating temperature range: 0°F to 95°F (-17°C to 35°C)

Dimensions: 26" x 19" x 8"

Weight: 165lbs (75kg)

Warranty: 10-year product warranty. Performance based kWh production warranty also available

Certifications: UL1642 and 1973 listed, UL9540 Compliant, UN38.1. IEC Test Standard Compliant

Key Features:

- Officially UL1973 Listed (Not tested to the standard via an independant lab.);
- 580°F UL thermal safety rated LFP cells eliminate cell propogated thermal runaway;
- Internal cell pack BMS monitoring;
- California Energy Commission approved;
- Self Generation Incentive Program compliant.

www.e-onbatteries.com

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Chint Power Systems America (CPS)

Product: CPS Turnkey Commercial Energy Storage System

Description: Commercial turn-key energy storage system with CPS conversion technology, partnered with Energy Toolbase and ELM Fieldsight control ensures full product functionality including Microgrid backup, demand charge, time-of-use, and non-export.

Chemistry: Lithium-ion

Voltage: 480V

Energy: 268kWh to 1MW+

Peak power: 62.5kW to 500kW+

Cycle life: 10-years daily discharge

Operating temperature range: -25°F to 123°F (-32°C to 51°C)

Dimensions: 50" x 43" x 78"

Weight: 5247lbs (2380kg)

Warranty: 10-year full system warranty

Certifications: UL1741SA, UL 9540, UL1973

Key Features:

- Commissioning and start-up service included;
- All system pre-integrated, pre-tested;
- Scalable sizing;
- 10-year warranty;
- Performance guarantee.

www.chintpowersystems.com



NantEnergy

Product: SmartStorage

Description: The SmartStorage system for C&I facilities predicts demand peaks and cuts expensive demand charges by rapidly dispatching power from the energy storage system. When a company's energy demands increase, the system's intelligent, predictive controls trigger a rapid power

discharge to offset the increase, essentially flattening the peaks and reducing or eliminating the demand charges. The SmartStorage system can also enable critical back-up power and be retrofitted with existing solar systems.

Chemistry: Lithium-ion

www.nantenergy.com



iMperium3 New York

Product: iM3 lithium ion battery cell

Description: iM3 lithium ion battery cell is equipped with a cobalt and nickel free technology delivering 200Wh/kg energy density, top rated safety standard, and high cycle life at reasonable cost.

Chemistry: Lithium-ion

Capacity (Ah @ 20hr rate): 50Ah

Voltage: 3.9V

Energy: 195kWh

Peak power: 500kW

Cycle life: 3000

Operating temperature range: -22°F to 131°F (-30°C to 55°C)

Dimensions: 5.12" x 5.12" x 0.98"

Weight: 2.34lbs (1.06kg)

www.imperium3.com



Storage Battery Systems, LCC

Product: Renewable Energy Storage Cell SBS-6PzS967

Description: Designed and developed with precision in mind, these bolt-on renewable energy cells provide high charge acceptance and long and durable service life. The design and use of high-quality raw materials guarantees the reliability and efficiency of this energy solution.

Chemistry: Lead-acid

Voltage: 2V

Cycle Life: 3250 cycles at 50% DoD

Dimensions: 7.80" x 4.69" x 28.31"

Weight: 114lbs (51.7kg)

Warranty: 120 months: 5-year full warranty with balance prorated based on prices at the time of replacement

www.sbsbattery.com/solar

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ESS Inc.

Product: Energy Warehouse

Description: Utilizing earth-abundant iron, salt, and water for its electrolyte, and simple materials for battery components, the Energy Warehouse (EW) from ESS Inc. is a durable, environmentally safe, long-duration storage solution. The EW provides low levelized cost of storage (LCOS) and deep charge and discharge cycles.

Chemistry: Flow

Voltage: Standard DC Voltage: 765-935 VDC, 500 V max to PE ref. Optional AC Voltage: 400-480 VDC, 3-phase, 50/60 Hz

Energy: 400kWh

Peak power: 100kW (DC)

Cycle life: >20,000

Operating temperature range: 23°F to 122°F (-5°C to 50°C)

Dimensions: 320 sq. ft.

Weight: 35,274lbs (16,000kg) dry, 83,776lbs (38,000kg) wet

Warranty: 1-year comprehensive defect warranty, 10-year warranty backstop underwritten by Munich Re

Certifications: Inverter UL 1741 SA certified UL 9540, IP54, CE mark (EU version only)

www.essinc.com



Discover Battery

Product: Discover AES LiFePO4 7.4 kWh / 48V

Description: Discover Advanced Energy (AES) batteries allow for equipment design and functionality improvements and deliver productivity gains through enhanced cycling, charge time, and weight reductions in stationary and mobile applications. Improvements in cycle life and charge efficiency combined with zero maintenance requirements provide the end user with significant cost of ownership savings.

Chemistry: Lithium-ion

Capacity: 130Ah

Voltage: 48V

Energy: 7.395kWh nominal energy

Peak power: 6656kW 3s

Cycle life: 38MWh lifetime throughput

Discharge temperature: -4°F to 122°F (-20°C to 50°C)

Dimensions: 18.5" x 13.7" x 14.7"

Weight: 192lb (87kg)

Warranty: 10-year warranty, 38MWh lifetime throughput

Certifications: IEC 62133, UL 2271, UL 1973, UN 38.3

www.discoverbattery.com/solar



GS Yuasa Energy Solutions, Inc.

Product: SLR1000

Description: The SLR Series is designed for high cycle applications using GS Yuasa's Advanced Lead Nanocarbon battery technology. A Nanocarbon additive reduces sulfation while increasing charging efficiency, PSOC performance, and high capacity retention. The SLR100 utilizes GS Yuasa's HT Element X, providing extended life in high heat applications.

Chemistry: Lead-acid

Capacity (Ah @ 10hr rate): 1218Ah

Voltage: 48V

Energy: 48kWh

Peak power: 12kW

Cycle life: 5,000 cycles @ 70% DoD, 4000 cycles @ 80% DoD

Operating temperature range: 5°F to 113°F (-15°C to 45°C)

Dimensions: 29.74" x 23.15" x 79.86"

Weight: 3845lbs (1744kg)

Warranty: 10-year limited warranty

Certifications: UL 1989, ISO 9001, ISO 14001

www.gsyuasa-es.com



Nilar, Inc.

Product: Nilar EC Series

Description: Nilar offers a nickel metal hydride (NiMH) bi-polar design which provides safe, reliable, and cost efficient energy storage. The battery's compact high voltage design is made for industrial use.

Chemistry: NiMH

Capacity (Ah @ 20hr rate): 10Ah

Voltage: 144VDC

Energy: 1.44kWh

Cycle life: 2000

Operating temperature range: -4°F to 122°F (-20°C to 50°C)

Dimensions: 13.26" x 12" x 5"

Weight: 75lbs (34kg)

Certifications: IEC 62485-2, IEC 62675

www.nilar.com



Fortress Power

Product: eFlex

Description: The eFlex scalable energy storage battery solution has a built-in data storage and Wi-Fi for remote monitoring and troubleshooting ability. Additionally, the BMS monitors and balances the voltage and temperature of each individual cell to maximize reliability and longevity.

Chemistry: Lithium-ion

Capacity (Ah @ 20hr rate): 105Ah

Voltage: 44V to 58.4V

Energy: 5.4kWh

Cycle life: 6000

Operating temperature range: 32°F to 113°F (0°C to 55°C)

Dimensions: 18" x 23" x 7.3"

Weight: 108lbs (48.9kg)

Warranty: 10-year warranty

Certifications: UL1973, UL1642(cells)

www.fortresspower.com

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Those who count on wind or solar power systems to run their businesses, homes – and lifestyles – turn to Crown for renewable power storage solutions. We've been at the forefront of energy storage innovation since 1926 and offer tough, earth-friendly and budget-wise batteries to meet the needs of today's RE system owners.

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www.crownbattery.com

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Crown Battery Manufacturing Company

Product: 6CRP430

Description: The 6-Volt 6CRP430 rugged construction manufactured in a highly automated production process delivers electrical efficiency and durability. The low maintenance design ensures reduced preventative maintenance frequency, lower service costs, and best-available user ROI.

Chemistry: Lead-acid

Capacity (Ah @ 20hr rate): 430Ah

Voltage: 6V

Energy: 2.85kWh (100hr) 2.50kWh (20 hr)

Cycle life: 525 cycles @ 100% DoD; 2100 cycles @ 30% DoD

Operating temperature range: -40°F to 120°F (-40°C to 49°C)

Dimensions: 12.38" x 7.19" x 16.13"

Weight: 122lbs (55.3kg)

Certifications: Conforms with BCI and IEC Test Standards

Key Features:

- Rugged internal construction with SolidCast plate, cast-on strap, and terminal-post components, which deliver strong performance and durability;
- Posi-Wrap Plate Protection ensures active material retention, protecting from internal short circuits to deliver ROI for customers;
- Low-maintenance design features reduced frequency of preventative maintenance to lower service costs and total cost of ownership;
- Include fixed handles to enable safe and easy handling as well as the flexibility to be installed with or without battery racks;
- Lead-acid batteries are 99% recyclable.

www.crownbattery.com

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Bioenno Power
www.bioennopower.com

Bioenno Power

Product: BLF- Series of LiFePo4 Batteries

Description: Bioenno Power LiFePo4 batteries provide up to 3000 charge cycle, 10 to 12 year service life, and are lightweight.

Chemistry: LiFePo4

Capacity (Ah @ 20hr rate): 6000Ah

Voltage: 12V

Energy: 72kWh

Peak power: 72kW

Cycle life: 3000

Operating temperature range: 160°F (71°C)

Warranty: 5-year warranty

Certifications: UN38.3, UL1642

Key Features:

- 2000 to 3000 charge life cycles;
- Built in circuit protection against overcharging, overdischarge, overcurrent, and overvoltage;
- Lightweight;
- Up to 70% less total cost of ownership;
- 95% Depth of Discharge.

www.bioennopower.com



BAE Batteries USA

Product: Energy Storage Stationary Battery

Description: Low carbon, deep cycling, and high reliability advanced lead-acid batteries for demand response or frequency regulation for renewable and energy storage applications.

Chemistry: Lead-acid

Capacity (Ah @ 20hr rate): 67Ah to >4000Ah

Voltage: 2VDC to >1000VDC

Energy: Depends upon application

Peak power: Depends upon application

Cycle life: 2000 to >5000 depending upon discharge parameters

Operating temperature range: -4°F to 113°F (-20°C to 45°C)

Warranty: 5-year full warranty, 10-year warranty on post/post-seal

Certifications: ISO, IEEE 535 (Europe), IEC Testing Requirements

www.baebatteriesusa.com



BMZ

Product: ESS 9.0

Description: A modular, lithium-ion based energy storage system, which stores the surplus of collected solar energy for later use. Energy can either be directed into the storage system or be fed into the public grid via an inverter.

Chemistry: Lithium-ion NCA

Capacity (Ah @ 20hr rate): 6.265A for 20 hours, total usable capacity 125.3Ah

Voltage: 54V Nominal

Energy: 8.5kWh Nominal, 6.8kWh Usable

Peak Power: 18kW

Cycle life: 5000 cycles

Operating temperature range: 35°F to 113°F (1°C to 45°C)

Dimensions: 19" x 25" x 17"

Weight: 214lbs (97kg)

Warranty: 10-year, 5000 cycle warranty

Certifications: CE, UN 38.3, IP21

www.bmz-group.com



Lithium Power, Inc.

Product: Solar Energy Storage Battery Solution

Description: High energy density, slim rooftop design, solar energy storage with DC/AC and AC/DC conversion. Built-in over/under voltage, temperature, current, and short circuit protection. Battery conditions constantly monitored and available through various communication protocols or saved in history data log. Battery pack allows parallel connection. Safety regulations such as UL/IEC are available.

Chemistry: Lithium-ion

Capacity (Ah @ 20hr rate): 42Ah

Voltage: 48V

Energy: 2.016kWh

Cycle life: 2000+

Operating temperature range: -4°F to 131°F (-20°C to 55°C)

Dimensions: 21" x 16.07" x 3.28"

Weight: <55lbs (<25kg)

Warranty: 5-year warranty

Certifications: UL, IEC, UN

www.lithiumpowerinc.com



Darfon America Corp.

Product: B09ULF LFP Battery

Description: The Darfon B09ULF can be installed floor-standing or wall-mounted and two can be stacked for 19.2kWh. The enclosure installs empty so one person can easily install. All wiring are quick disconnects, to speed up installation. Since the B09ULF uses LiFePO4 chemistry, it has a long lifespan and is safe.

Chemistry: Lithium-ion

Capacity (Ah @ 20hr rate): 200Ah

Voltage: 48V

Energy: 9.6kWh

Peak power: 9.6kW

Cycle life: 6000 cycles @ 80% DoD @ 77°F (25°C)

Operating temperature range: 14°F to 113°F (-10°C to 45°C)

Dimensions: 22.4" x 11.2" x 45.3"

Weight: 275.6lbs (125kg)

Warranty: 5-year warranty

Certifications: UL1642, UN38.3, IEC62619, UL1973

www.darfonsolar.com

Commercial Energy Storage a Win-Win

A case study for commercial energy storage solutions

In January 2019, CPS America partnered with Allied Energy to install an energy storage solution for an Allied Energy commercial client. They chose to work with CPS America’s smart storage system specifically designed to meet the needs of commercial and industrial customers. Commercial and industrial customers are often an overlooked segment of the energy storage market, with many storage companies focusing solely on residential or utility-scale needs.

The client, located in San Diego, California, came to Allied Energy with a specific goal in mind – to reduce their demand charges. Like many commercial customers high demand charges made up a large portion of their electrical bill. On review and design, Allied Energy and the client determined that a target reduction of 20kW made the most sense for the site and savings.

ABOUT THE CPS AMERICA SOLUTION

The client and Allied Energy chose to go with the CPS ESS turnkey system because it not only provides a fully integrated solution, with power conversion, lithium batteries, and balance of system components engineered to work seamlessly, but for the integrated software package and financial performance warranty. Using advanced Energy Toolbase analysis, Energy Toolbase’s Intelligent Energy Management System–iEMS, and Energy Datahub monitoring, CPS ESS systems offer performance guarantees of 80% of modelled savings depending on the site. Microgrid backup capability can be incorporated into the system’s functionality which gives added value for the customer for a small added cost. Listed to UL9540, with a NEMA-3R enclosure, and a 10-year warranty, the CPS ESS system is built to last.

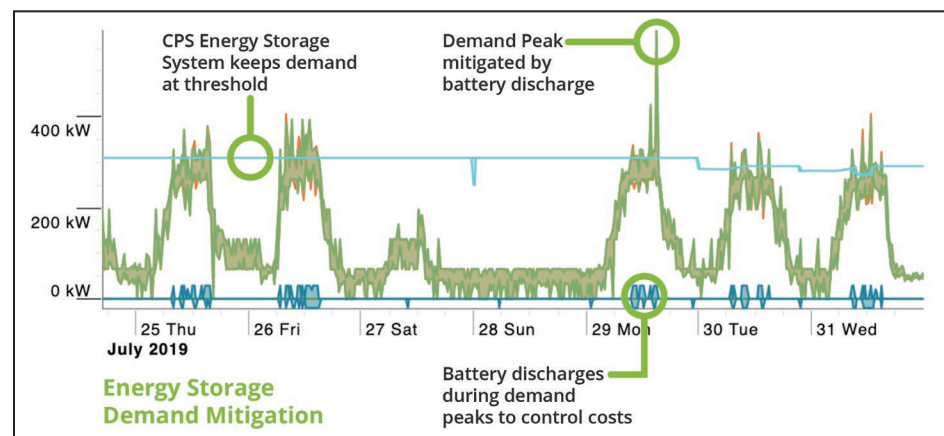


INSTALLATION

Allied Energy, along with CPS America – who provides on-site commissioning services as part of the standard warranty for commercial ESS solutions, began installation of the new CPS ESS-30kW/65kWh system on a lovely San Diego morning. Installation was quick and was completed in three hours.

Allied was thrilled with the ease of installation, which lowered overall labor costs, and minimized impact to the client. “This is the easiest storage installation I’ve ever done,” stated Simon Allan, the president of Allied Energy.

For Solar + Storage systems, EPCs can increase their corporate margins by 50% to 100% by adding batteries to existing solar installations.



RESULTS

The client is consistently seeing actual demand reductions of 25kW and more every month as predicted by the Energy Toolbase Analysis.

By adding CPS Energy Storage Systems, paybacks will be improved by mitigating demand and time-of-use charges. Battery systems are well positioned to take advantage of increasing Demand and Time of Use charges as tariffs become less solar friendly.



CPS America, a subsidiary of Chint Electric, is a smart energy solution provider focused on value and performance for our customers. With over 85,000 PV inverters in the U.S. and an exceptional engineering and service team based in Texas, CPS America is ready to support your next smart energy project.

www.chintpowersystems.com



CLEANPOWER 2020

The WINDPOWER Conference and Exhibition will continue in 2021 as the heart of CLEANPOWER, with the addition of exhibition space and conference programming for utility-scale solar, storage, and other clean energy technologies. By incorporating these technologies into a single exhibition hub, CLEANPOWER will create efficiencies for exhibitors and attendees with pan-renewable business models. Pure play businesses will benefit from increased show traffic and opportunities to build beneficial partnerships across the cleantech industry. Unfortunately, CLEANPOWER 2020 has been cancelled due to the COVID-19 outbreak, but here's a look at what you would have seen at the show.

www.cleanpowerexpo.org

show in print

Features just some of the companies and technologies attendees would have seen at this year's show.



Wind energy education and training

Providing wind energy education and training since 2004, Iowa Lakes Community College offers the AAS in Wind Energy & Turbine Technology and continues to adapt to the changing wind industry landscape. Competencies that enhance their student's resumes through advanced safety, realism, challenge, and mentorship, the team at Iowa Lakes Community College invests in student's development, providing a positive impact on America's energy and environmental future.

Iowa Lakes Community College

www.iowalakes.edu



Elevator safety and training

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

Elevator Industry Work Preservation Fund

www.eiwpf.org



Electrical equipment and services

Electrical Consultants Inc. (ECI) was incorporated in 1985. For over 34 years, their in-house portfolio of services, including overhead and underground transmission engineering, substation and switchyard design, industrial power systems design, land survey and construction staking, right-of-way services, environmental planning, project management, construction management, and procurement services have provided a key resource for hundreds of utilities. ECI brings extensive experience in power delivery services through 500kV to their clients.

Electrical Consultants, Inc. (ECI)

www.electricalconsultantsinc.com



Electrical insulation

Pittsburgh Electrical Insulation is a manufacturer, converter, and distributor of electrical insulation materials focused on the OEM and service industries associated with motor, generator and transformer production and repair. With over 70 years of continuous operation, PEI remains a cost efficient, customer focused company dedicated to the supply of electrical insulation materials, IEEE and UL components, systems, and supplies for new power generation technology or for an unplanned outage on existing equipment. They maintain an inventory of high performance materials, both rigid and flexible, and are able to convert those products to customer requirements with short lead times. They represent manufacturers such as St. Gobain, 3M, and Kaneka, augmented with a global sourcing practice that gives their customers options for any application.

Pittsburgh Electrical Insulation

www.peipittsburgh.com



Tension & Torque tools for Wind Turbines

- Bolt Tensioning Systems
- Torque Wrench Systems
- Nut Runners (Torque Multipliers)

Micro-MAX

The compact, lightweight tensioner pump



Type CX

Ultralight, high-speed torque wrench



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Carbon brushes and brush holders

Helwig Carbon is a manufacturer of carbon brushes, brush holders, and quick disconnect fittings for wind turbine generators. They offer complete wind generator upgrades for longer service life. They also make a wind pitch motor bearing protection kit designed to protect pitch motors from premature bearing failure.

Helwig Carbon Products, Inc.

www.helwigcarbon.com/industries/wind



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INVESTMENT SECURITY.

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



bachmann.



Battery torque wrench

Torkworx introduces the new Digital BRAD, up to 2x faster than their previous version. The DBRAD powered torque wrench is a digital cordless 18V lithium-ion battery tool with advanced patented technology containing digital display and single increment torque settings. With programmable preset torque and angle settings, this torque wrench has an accuracy of +/-5%. It offers an automatic 2-speed gearbox and available gear turning accessories.

Torkworx

www.torkworx.com



Automatic fire suppression system

Firetrace automatic fire suppression systems provide a fire protection solution for the unique environment in a wind turbine and are not affected by vibration, dust, airflow, or temperature. Their specialized systems protect the nacelle and down tower including, the control panels, capacitor cabinets, braking system, transformer, and other at-risk areas of the turbine, without requiring power or excessive space. Firetrace systems use clean agents which are safe for people and equipment and leaves no residue after discharge and does not require clean up.

Firetrace International

www.firetrace.com/wind



Versatile and durable torque tester

SmartCheck is a newly launched small sized, versatile, and easy-to-use torque tester suitable for any workshop and service vehicle. Its compact dimensions coupled with its rotatable display and the ability to mount it horizontally or vertically, provides versatility in any location. With a splash-proof display and keypad, it can be operated through power supply or battery. SmartCheck quickly provides information on whether or not a torque wrench is within the prescribed tolerances or if it requires adjustment. The integrated visual and audible overload protection mechanism and impact resistant plastic housing ensure the durability associated with STAHLWILLE products.

STAHLWILLE

www.stahlwille-america.com



Wind product specialist

Rm Wilson Company, founded in 1966, is a product specialist supplying numerous European manufactured components and parts. Rm Wilson can provide a variety of solutions and services to owners and operators of the wind energy sector. They can provide current technology in gear manufacturing as well as upgrade solutions for older gearboxes in the field. Headquartered in Wheeling, WV, with locations throughout the United States, Rm Wilson is able to provide service to the end user. Along with Power transmission solutions, Rm Wilson also represents Svendborg Brake, a global supplier in both yaw and rotor brake systems, and Thiele Chain GmbH, a supplier of round steel chains and accessories for lifting, moving, and securing loads.

Rm Wilson Company

www.rmwilson.com

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www.electricalconsultantsinc.com



Sintered friction material

KUMA Brake Pads is a manufacturer of sintered friction material for wind turbine applications. The products are used on the hydraulic brake Galiper on the high-speed rotor. Designed according to OEM specifications for GE, Vestas, Gamesa, Siemens, Nordtank, Senvion, and most turbines, KUMA sintered brakes pads and products are submitted to extreme conditions tests to ensure high quality. The product is manufactured in North America based on ISO 9001-2015 standards and is also approved by GE for its 1X and 2X turbine platforms.

Kuma Brake Pads

www.kumabrakes.com



Synthetic lubricant solutions

AMSOIL specializes in developing synthetic lubricants backed by a long-term warranty. AMSOIL PTN 320 is formulated with extreme-pressure additives, providing high resistance to scuffing wear and micropitting fatigue on gear surfaces operating under extreme pressures and shock loads. The next-generation additive technology delivers outstanding overall performance in areas critical to wind applications, including water resistance, filterability, long-term foam control, rapid air release, rust and corrosion inhibition, and paint and seal compatibility. PTN 320 has earned approvals from wind turbine, gearbox, and bearing manufacturers including GE, Siemens Gamesa, Vestas, ZF, Winergy, Moventas, NGC, SKF, Timken, Envision, Eickhoff, FAG, Flender, and more.

AMSOIL, Inc.

www.amsoilwind.com



Smart components

EMA Electromechanics is the designer and manufacturer of the VDH/GSMI outdoor 38kV combined vacuum circuit breaker and high speed, mechanically interlocked grounding switch, a unique and patented system specifically designed for switching and grounding of wind and solar energy collection circuits. It replaces traditional use of oil insulated grounding transformers combined with conventional circuit breakers in every feeder of a wind or solar power substation, improving overvoltage mitigation and reducing costs.

EMA Electromechanics, Inc.

www.emaelectromechanics.com

Wind energy solutions

Bachmann retrofits help increase lifespan, production and efficiency through new technologies, while meeting legal requirements through grid monitoring, voltage control, and safety. Bachmann ensures spare parts supply and updates to the latest technology and grid compliance.

Bachmann electronic

www.bachmann.info



SKYLOTEC.COM



ONE SHOCK ABSORBING LANYARD THAT COMPLIES WITH THE ANSI, CSA AND EN 6' & 12' PERFORMANCE REQUIREMENTS

Most shock absorbing lanyards only comply with 6' or 12' performance requirements. SKYLOTEC eliminates this confusion by offering the Skysafe Pro shock absorbing lanyard which covers both performance requirements in one product. This increases safety, eliminates the need for two different shock absorbing lanyards, simplifies employee training, and improves your bottom line.

CARABINER

Aluminium. Robust & lightweight 16kN / 3600 lbs steel gate. The Grey & Orange hardware assists in identifying left & right sides while in use and prevents twisting of lanyard legs.

RESCUE LOOPS

On both legs. Easy attachment of the rescue device. Ensures safe & fast rescue operations.

FLEX FUNCTION

No slack rope, reduces risk of tripping. Great handling. Flex length is 4 ft.



L-0558-1,8

SHOCK ABSORBING SYSTEM

Reduces the impact force to below 1349 lbf. (6kN) in the range from 110 - 340 lbs with a deceleration distance of max 48" according to ANSI Z359.13 when at a 6' free fall and max 60" according to ANSI Z359.13 when at a 12' free fall.

FALL INDICATOR

On both legs. Easy fall detection, Easy inspection.

PROTECTIVE COVER

Removable and replaceable protective cover. Enables 100% inspection of the entire device (ACS-0216).

Works without limitation for user weights from 110 up to 340 lbs! Meets ANSI Z359.13 for 6' & 12' free fall & CSA Z259.11-E6



L-0562-1,8



L-0623-1,8



L-0533-1,8

IGNITE PROTON WIND



RESCUE PRO 2.0



NEW CLAW



MEETS ANSI/ASSP Z359.16

NEW SIRIUS



NEW ACX POWER ASCENDER



SKYLOTEC offers you a highly innovative and functional range of fall protection, rope access and rescue equipment. The **IGNITE PROTON WIND** and **RESCUE PRO 2.0** Harnesses feature light-weight designs built for durability and comfort. The smooth running **CLAW** Vertical Cable Sleeve for 3/8 & 5/16 inch diameter wire ropes. **SIRIUS** is our first self-locking descender specially designed for all kinds of rope-based access and rescue. The **ACX** power ascender allows for battery operated portable ascent and descent. These products are ideal for work at height in the wind energy, telecommunications, and electrical utilities industries.

For more information please email us at: info-us@skylootec.de.

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



SKYLOTEC



Community acceptance and security around wind farms

Technostrobe present LIDS (Lighting Intensity Dimming Solution), a new solution that helps wind energy developers gain a greater level of community acceptance for their projects by reducing the intensity of the lights on wind farms. LIDS technology can effectively and safely adjust the intensity of the light to the surrounding visibility present at wind farms. Light intensity can now be dimmed by 90% under clear skies conditions (10km or more of visibility). When the intensity of the lights is adjusted according to the surrounding visibility, pilot safety is maintained when they are flying near wind farms, and it significantly mitigates the impact of the beacons on local communities.

Technostrobe

www.lidsinfo.com

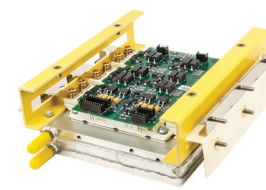


Fall arrest cable sleeve

The new SKYLOTEC CLAW Vertical Fall Arrest Cable Sleeve is designed to fit a wide variety of wire ropes and travel along the vertical system while providing fall arrest when needed. Engineered to fit 3/8 and 5/16-inch wire rope, this high quality, lightweight stainless-steel device travels smoothly up and down the vertical system without hanging up. The redundant safety features reduce the risk of improper installation and unsafe situations. The CLAW is independently tested to meet ANSI ANSI/ASSP Z-359.16, ANSI/ASSP A14.3, OSHA, and CSA Z259.2.5-17 requirements.

SKYLOTEC

www.skylotec.com



Rotor and line assemblies

Ludlum Wind provides new upgraded ESS and non-ESS rotor and line IGBT assemblies for the GE I.X series turbines. They have been providing parts to the wind industry since 2010, featuring short delivery times (typically 3 days) with products maintained in stock. Ludlum has over 400 employees and is a vertically integrated manufacturer that began in 1962. Upgraded components with higher power ratings over OEM and Ludlum's custom AEBM board are integrated to provide improved operation at high temperatures and a long operating life. Reusable packaging with custom cut high-density foam and custom reusable steel shipping plates protect delicate components and the bus connections during shipments to the customer ensuring products arrive safely every time. Ludlum's highly integrated manufacturing allows them to have control over product quality, delivery time, costs, and allows them the capability to offer long-term support.

Ludlum Wind

www.ludlumwind.com



Anchor bolts and fastening systems

Cooper & Turner is a manufacturer of high quality, high strength, safety critical, large diameter (M16 to M100) hex bolts, double ended studs, and thread rod. Employing automation (including in process NDT inspection) and robotics results in high quality and consistent products, having full lot traceability, for supplying the global wind turbine market, OEM's, and major tiers as well. Recently opening an anchor bolt manufacturing plant in Pueblo, CO., they use 100% USA material and manufacturing, producing anchor bolts to ASTM A615 Grade 75 and Grade 90, plus ASTM A722 Grade 150, with all accessories (nuts, washers, and PVC sleeves), with bolt caps and grease optional. All assemblies are tested in a USA independent lab.

Cooper & Turner

www.cooperandturner.com



Heavy and specialized transportation

Landstar provides specialized and heavy haul transportation services. Whether hauling a single machine or managing a complex project, Landstar has the experience, capacity, and equipment to move any heavy/specialized freight. Their vast array of specialized equipment includes flatbeds, stepdecks, double drops, extendables, multi-axles, steerables, lowboys with 40-80 ton capacity, RGN units, beam, perimeter, and more. Landstar provides safe, secure, claim-free deliveries of over-dimensional, heavy weight freight.

Landstar

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Transportation, distribution, and storage

The Port of Stockton is an inland facility located in the extended San Francisco Bay Area that has handled breakbulk cargo since 1933. It has 2.5 miles of on-dock rail connecting to the UP and BNSF that offer service throughout the United States. The Port is adjacent to less congested highways, I-5, CA-4, and CA-99, and is an hour from I-80. It has handled shipments of clean energy cargo of all shapes and sizes. The Port of Stockton has around the clock security and uniquely offers customers 24/7 access to their freight.

Port of Stockton

www.portofstockton.com



Carbon neutral gear oil

Shell Lubricants has engineered next generation solutions designed to maximize wind turbine performance in both on-shore and off-shore temperature extremes. They partner with OEMs and aftermarket customers to enhance performance through their purpose-designed oils and greases, specialist support, and sustainability efforts. They have introduced their most technologically advanced gear oil: Shell Omala S5 Wind 320, which offers a 10-year warranty, is approved by all major gearbox OEMs, and is now carbon neutral. They offer a complete portfolio of advanced wind turbine lubricants for applications from gearboxes to hydraulic systems to bearings and everything in between. They also offer services, such as Shell LubeAnalyst fluid condition monitoring, that are designed to maximize uptime and help ensure asset life reaches its full potential.

Shell

www.shell.us/power



Developer & operator

BayWa r.e. Wind, LLC is a turn-key developer and operator of renewable energy projects in North America. Headquartered in Carlsbad, CA, the company has been active in the U.S. since 2001. The company's business model is to develop, construct, own and operate renewable energy projects. It seeks to complete the life-cycle by either divesting of or partnering on the operating assets. The company is actively seeking new renewable energy projects.

BayWa r.e. Wind, LLC

www.baywa-re.us

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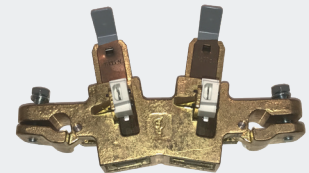
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SR13-15
BRONZE SLIP RING



HCH-30X
CG677 BRUSHES



BR09-06
BRUSH-HOLDERS



WWW.MERSEN.COM





Solar resource monitoring platform

Campbell Scientific's MeteoPV is a solar resource monitoring platform suitable for distributed PV monitoring plane-of-array, albedo, soiling, and back-of-module temperature. This system can communicate with smart pyranometers, reference cells, back-of-module temperature sensors, and compact weather sensors. The MeteoPV features simple configuration and setup, easy-to-create field commissioning reports, sensor metadata and management, and a communications troubleshooter. With its small footprint and DIN-rail mounting, the MeteoPV can be easily integrated with existing combiner boxes or other control panels. The MeteoPV also obtains Power-over-Ethernet compatibility, a convenient method for supplying power, eliminating the need for additional power supplies. The MeteoPV hosts an intuitive onboard user interface accessed by a web browser. This interface simplifies the initial communication configuration and long-term sensor management.

Campbell Scientific

www.campbellsci.com



Electrical life extension products and services

RESA Power provides start-up commissioning and acceptance testing as well as on-going electrical maintenance and repair services to help keep renewable energy producers operating with minimal downtime.

RESA Power

www.resapower.com



Multi-brand expertise, transparent, flexible, and impartial service

Deutsche Windtechnik, with its more than 1540 employees, provides manufacturer independent full scope O&M services worldwide. The services include the planning and implementation of maintenance, inspections, and repairs of all components, repowering, QHSE, engineering expertise and consulting, and much more. One key component of Deutsche Windtechnik's business model is that it provides services for all leading turbine technologies such as Siemens, Vestas, Senvion, NEG Micon, AN Bonus, Nordex, and Gamesa. All technicians have a broad technical capability, most of them working directly for the manufacturer in the past, continuing their education on original turbines in the Deutsche Windtechnik Training Center. The flexible maintenance contracts offered by Deutsche Windtechnik give operators decisive influence over the profitability of a project.

Deutsche Windtechnik

www.deutsche-windtechnik.com/usa



Single technician ladder-mounted lift

The Climb Auto System by 3S Lift allows technicians to focus on the job and not on the climb. The single technician ladder-mounted lift eliminates the need for climbing completely, improving uptime, AEP, and Health & Safety. Installing a Climb Auto System reduces climbing related injuries and the amount of sick leave. It creates heightened user satisfaction and motivation, increasing technician retention. This leads to increased employee efficiency and saves hiring and training costs. The Climb Auto System can transport personnel and equipment. It offers an advanced level of safety by providing independent fall-arresters for the operator and the system. The Climb Auto System is easily retrofitted into almost any modern wind turbine, often in 8 hours or less. It provides the ease-of-use of a service lift with the low cost, low maintenance, and reliability of a climb assist. The Climb Auto System is certified in accordance with UL, ANSI, and OSHA, and has been installed more than 30,000 times worldwide.

3S Lift

www.3SLift.com

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The **HEICO-LOCK® wedge locking system** is the reliable solution to the problem of **securing bolted joints** in high vibration assemblies against self-loosening by rotation!

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Project development and planning

Burns & McDonnell's renewable energy staff solves the challenges resulting from the complex evaluation of numerous factors, including a site's wind resource and permitting requirements to protect this critical source of power. From siting to startup, their multi-disciplined team does it all. They know wind and how to make it work for their customers. Their full complement of engineers, architects, construction, and environmental professionals combine their specialized skills and knowledge to design, permit, construct, and manage a wind project. They partner with 1898 & Co., their business, technology, and security solutions consultancy, to provide engineering and consulting services for renewable and wind power markets. Their team is integrated and committed through every phase of a wind project.

Burns & McDonnell

www.burnsmcd.com



Renewable energy infrastructures

CONSERTEK USA provides complete EPC products and services in the renewable energy sector for all meteorological analysis projects, including engineering, procurement, construction, instrumentation, and commissioning of met towers. In addition, CONSERTEK USA provides inspection and maintenance services on any MET Towers as per TIA-222 standards. CONSERTEK USA also provides support booms and accessories, instrumentation cabinets, and ancillary services for wind farms. The cabinets are designed, assembled, and installed by CONSERTEK USA's technicians. The logger program is in lab pre-tested. The support booms are compliant with the latest edition of IEC 61400.

CONSERTEK

www.consertek.com



Constant-rate descender for fall protection

The Checkmate MAX 150 Descender is a versatile constant-rate descender. Available models include automatic hands-free operation and multiple descent, with advanced rescue functionality. Power-assisted option also available, with the use of a Checkmate-approved drill, sold separately. The MAX-150 model is a single-user device, attached to a user and/or casualty, with a maximum weight capacity of up to 330lbs., designed to be attached to an anchor point in regular or inverted mode of operation. The device is completely symmetrical, allowing full use of all functions regardless of the direction the MAX is running, which provides full functionality for each multiple descent or rescue.

Pure Safety Group

www.checkmateuk.com



Transportation and logistics

TP&L's services can be introduced anywhere along the supply chain. They serve OEM's, project developers, and transportation companies. TP&L is also available to help plan rail load outs from port to pad. Their in-house engineer is open top loading certified and available every step of the way. TP&L's partners bring with them over 40 years of combined transportation experience in all sectors-port, truck, rail, and distribution services.

Transportation Partners and Logistics

www.tpandl.com



A QUANTA SERVICES COMPANY

EPC PROVIDER & CONTRACTOR

We understand the complexities inherent to renewable energy projects and can complete these projects on time and on budget, even in remote environments. We have performed construction services for general contractors, owners, and developers. Our experience and success as an EPC lead, subcontractor, or EPC partner differentiates us from our competition.

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M. J. ELECTRIC RENEWABLE ENERGY

Ryan Muha, Operations Manager
rmuha@mjelectric.com | 219.252.1585

www.mjelectric.com





EPC provider and contractor

M. J. Electric, LLC can complete renewable energy projects on time and on budget, even in remote environments. They have performed construction services for general contractors, owners, and developers. They have experience and success as an EPC lead, subcontractor, and EPC partner.

M. J. Electric, LLC
www.mjelectric.com



Tools

Dakota Riggers is a stocking distributor for Tuff Bucket products. These high-quality lifting buckets feature the innovative roll-down closure system. This closure system allows for the bucket to fully load, rated both right side up and upside down. Tuff Buckets are available in a variety of different sizes, in either heavy-duty canvas or vinyl-coated polyester material.

Dakota Riggers
www.dakotariggers.com



Self-rescue and evacuation kit

The SRK-15 is used for the self-rescue and evacuation of any worker at height. This CE and ANSI certified self-rescue kit has been field tested for over a decade and is used in multiple industries globally. The SRK-15 micro self-rescue kit assures an independent, immediate, and adaptable evacuation and self-rescue capability. The self-rescue and evacuation kit is easy to use, compact, and lightweight - the 350ft (107m) kit weighing 8lbs (3.6kg) and the 600ft (180m) kit weighing 12.3lbs (4.8kg). Custom rope lengths are available. This adaptable rescue kit can also be paired with a StepWise Fall Arrest Lanyard to perform a self-rescue after a fall. The SRK-15 micro rescue kit can also be inverted and used for an assisted rescue. The SRK-15 has been 3rd party certified up to 600ft (180m) by TÜV SÜD as meeting the CE certification EN341: 2011/2D and 3rd party certified up to 600ft (180m) by UL as meeting ANSI/ASSP Z359.4-2013.

Tech Safety Lines
www.techsafetylines.com



Automatic obstruction lighting

DeTect developed the HARRIER Aircraft Detection Lighting Systems (ADLS) for automatic obstruction lighting activation for aviation obstructions such as wind farm turbines, high voltage transmission lines, and communication towers. The HARRIER ADLS provides reliable, continuous 360° radar surveillance of the airspace around wind farms, power lines, and other installations that require aircraft obstruction lighting from the ground level to above aircraft flight altitudes, automatically issuing signals to activate lighting when aircraft are detected at a defined outer perimeter. ADSB integration minimizes lighting activation from high altitude commercial aircraft. The HARRIER ADLS is also multi-function capable and can provide site security for aircraft, ultra lights, and drones as well as bird detection for environmental monitoring and risk mitigation. HARRIER is also fully compatible with all SCADA systems and turbines.

DeTect
www.detect-inc.com

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Versatile reinforced laminates

For more than 60 years, Reef Industries has been manufacturing and fabricating reinforced film laminates and composites. Griffolyn, the original division of Reef Industries, has been manufacturing quality, internally reinforced polyethylene laminates designed for a wide range of applications. Griffolyn's patented, high-strength reinforcement provides superior puncture, tear and abrasion resistance. Use Griffolyn for corrosion protection, equipment storage/shipping covers, landfill covers, vapor and moisture barriers, dust and environmental partitions, contaminated soil covers, athletic field covers, greenhouses, boat tarps, crop protection, or many other possibilities. From outstanding weathering characteristics to custom features, such as fire retardancy, anti-static properties, corrosion inhibition, or heat shrinkability, Griffolyn products offer high performance. Griffolyn plastics can be customized to any size and shape, ensuring a customer's exact requirements are met. Griffolyn is available in white, black, and clear. Custom colors are also available upon request.

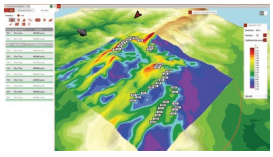
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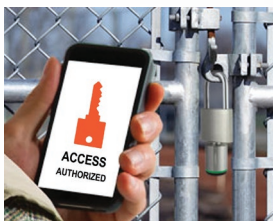


Wind engineering and climatology software and services

Meteodyn is a wind engineering company that provides software and services to the wind energy industry, from design to operation of wind farms. Meteodyn WT is a user-friendly CFD software which provides an accurate wind resource assessment. It can compute the wind on any terrain, including mountains, forests, and lakes. It determines the best location for wind turbines to maximize production. Meteodyn SPA is a SCADA data processing and analysis software for wind farms. It evaluates the real power curve of wind turbines and makes it possible to detect a loss of energy production, analyze failures, and diagnose the underperformance. Forecast is an accurate and reliable wind power production forecasting service. It forecasts the energy production for the entire wind farm, from minutes to 14 days ahead. It also provides wind speed and direction, as well as probability distribution of production.

Meteodyn

www.meteodyn.com



Keyless entry systems

Supra is a brand of keyless entry systems for commercial segments including utilities and real estate. The Supra TRACcess System provides smartphone-enabled wireless access control for remote sites. The TRACcess eKEY app transmits access data in real-time to transform field operations. Supra's TRAC-Guard padlock is a Bluetooth-enabled wireless lock that adds convenience and security in place of traditional mechanical or combination locks. It provides authorized, secure access, and is a solution for installations in telecom or utility stations, storage units, or other locking points.

Supra

www.suprasystems.com/traccess

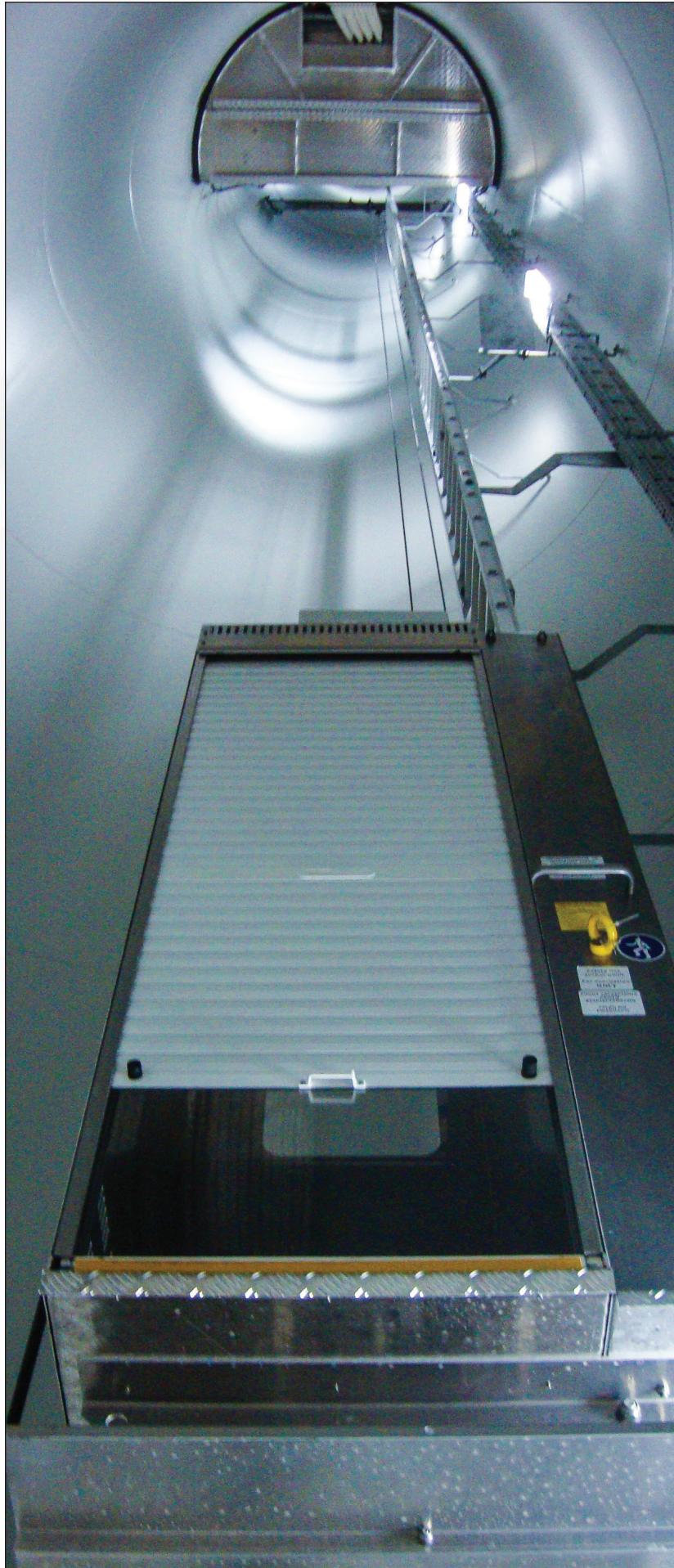


High speed camera inspections

WindCom remains on schedule for the year as they continue to cautiously operate at full capacity in the field. Now, more than ever, they are recommending Chronos Inspections (high speed camera inspections) which allow technicians to stay on the ground reducing their contact with other workers and uptower equipment.

WindCom Services

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KASK

www.kask.com



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The HEICO Group offers a wide array of products. HEICO-LOCK WEDGE-LOCK WASHERS are a reliable locking system for demanding bolted joint applications including those under extremes of vibration or dynamic loads. The HEICO Group continues to expand its product portfolio with the addition of the HEICO-TEC TENSION NUT, which provides easy, fast, and reliable assembly of large bolted joints. HEICO-TEC TENSION NUT eliminates the need for complex, bulky, or heavy tools, and makes securing large bolted joints convenient and easy.

Heico Lock

www.heico-group.com



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EDF Renewables North America is an independent power producer and service provider with over 30 years of expertise in renewable energy. The Company delivers grid-scale power: wind (onshore and offshore), solar photovoltaic, and storage projects; distributed solutions: solar, solar+storage, EV charging and energy management; and asset optimization: technical, operational, and commercial skills to maximize performance of generating projects. EDF Renewables' North American portfolio consists of 16GW of developed projects and 11GW under service contracts. EDF Renewables is a subsidiary of EDF Renouvelables, the dedicated renewable energy affiliate of the EDF Group.

EDF Renewables

www.edf-re.com



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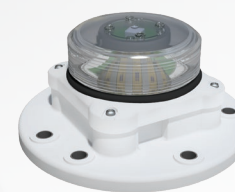


Load indicating fasteners

Valley Forge & Bolt Mfg. Co. produces fasteners including their Maxbolt load indicating fastener that continuously measures and displays the amount of tension in a bolt or stud. This fastener offers one method for accurate joint assembly and continuous monitoring of load while the fastener is in service. Another method is the SPC4 load indicating technology from Valley Forge that can monitor load remotely utilizing wireless, WiFi sensors that connect to the bolt or stud. Suitable for critical applications where bolt failure can result in lost productivity, maintenance cost, or both.

Valley Forge & Bolt Mfg. Co.

www.vfbolts.com



Wind turbine obstruction light

Compliant to FAA and international lighting standards, Flash Technology obstruction lights mark more than 17,000 wind turbines and MET towers around the world. The new FTS 350i is an economical FAA L-864 / ICAO Type B red LED lighting system specifically designed for wind turbine operators that do not require the additional features of the Vanguard FTS 370i-2 lighting system. The FTS 350i is a fully integrated, stand-alone obstruction light that does not need an additional controller mounted inside the nacelle. The weather-resistant plastic construction provides greater than 50% weight reduction over the FTS 370i-2.

Flash Technology

www.flashtechology.com/wind



Wind turbine slip rings

United Equipment Accessories manufactures low-maintenance, high-quality slip rings for OEM and aftermarket clients. These slip rings feature a new brush technology designed to provide long life in harsh environments. UEA's design engineers work with their customers to custom build slip rings that meet a wind turbine's specifications. UEA can take current slip ring specs to design an interchangeable slip ring for any wind turbine. Single brushes can be replaced at any time, removing the need to replace entire units or sets of brushes. UEA products maintain functionality in a wide range of electrical and electronic circuits, environmental conditions, and rotational speeds.

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Clir Renewables is a Software as a Service company in the renewable energy industry, providing a solution developed by engineers for engineers. The cloud-based AI platform provides asset managers and owners with tools to maximize annual energy production and provide clarity on portfolio performance. Their proprietary algorithm cleans and analyzes ingested data providing actionable insights. Founded in early 2017, the company now supports over 6GW of assets worldwide, with clients typically seeing increases of up to 5% in AEP in the first year.

Clir Renewables

www.clir.eco

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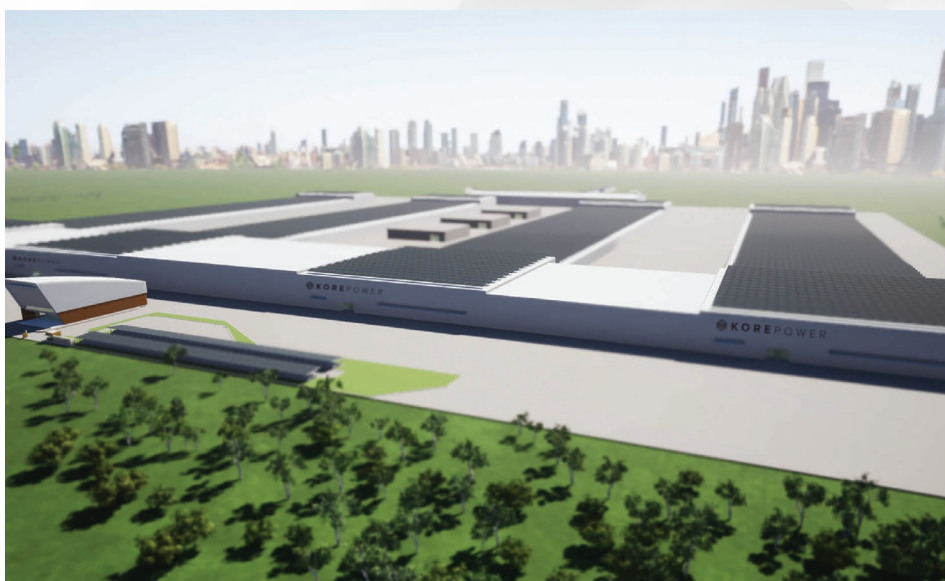
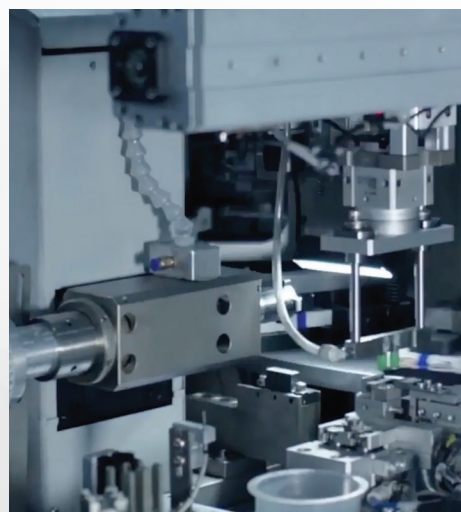
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Wanted Made in the USA

by Lindsay Gorrell



THE GLOBAL ENERGY STORAGE MARKET IS ON A TRAJECTORY

to nearly quadruple its deployments from 4 GWh in 2019, to more than 15 GWh in 2024. Battery manufacturing is growing exponentially in every part of the world. Over the past few years, however, the supply chain has experienced turmoil: Battery supply shortages, virus-related factory shutdowns, and a general uptick in demand that is already difficult to meet with today's manufacturing capabilities. We depend heavily on Chinese and South Korean battery manufacturing supply chains to deliver the majority of our energy storage. Without diversifying manufacturing locations and providers, achieving our proposed clean energy standards may be impossible.

Current manufacturing infrastructure

Manufacturing is a vital component of the supply chain. Equally important is the access to materials for battery development. China exclusively produces a number of these raw materials, giving them an especially strong foothold within the market.

The impact of limited diversity in the chain is clearly illustrated by the EV market. Almost all of the major auto manufacturers plan to roll out new EV models over the next couple of years. These will require next-generation batteries (currently produced by Chinese and other manufacturers) to meet consumer demand.

Some automakers have had to suspend EV production due to battery supply chain issues. Until battery manufacturers can scale up production to meet these demands (which may take upwards of a year), car companies are looking at dwindling revenue, as well as reduced adoption by consumers. They're starting to realize that their continued dependency on Chinese and South Korean labor and manufacturing capabilities will restrict their ability to scale, and that they must seek innovation and partnerships at the battery manufacturing level of the supply chain.

A short timeline to meet environmental and sustainability targets

EVs are among some of the "nice to have" consumer luxuries, giving manufacturers a bit more time to ramp up production. Energy storage for industrial applications such as solar plus storage, wind plus storage, and microgrids, have a stronger sense of urgency behind them due to the changing environmental regulations, and need for stationary energy storage capable of meeting regulatory and individual utility-set targets.

Take, for example, the adopted regulations in New York State aimed at phasing out less efficient peaker plants. With such aggressive environmental goals, New York is explicitly creating new regulations to reduce greenhouse gas emissions 40 percent by 2030, and shift to 100 percent clean electricity by 2040 (implementing hefty fines where efforts do not meet the pre-determined targets).

Over the next ten years, utilities will need to have adopted energy storage into their operations to meet these targets. To scale up battery manufacturing in time, the industry must begin bringing manufacturing efforts to the U.S. immediately.

What to consider when bringing manufacturing operations to the U.S.

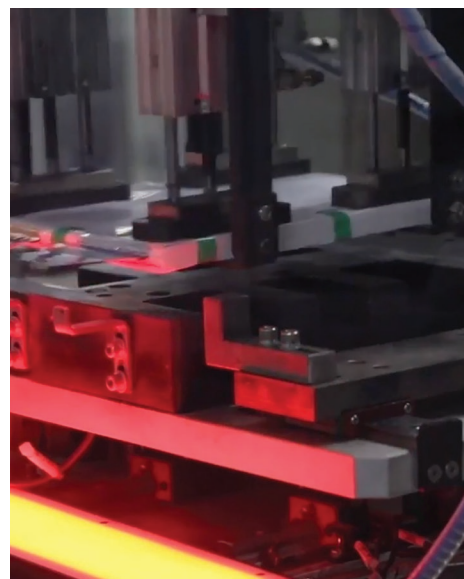
A scalable U.S. manufacturing plant provides us with production independence. It also diversifies the supply chain and creates stability by eliminating reliance on a single country or region to meet demand. Integrating U.S.-based manufacturing into the broader battery market can help better prepare the entire industry, especially in a time when unexpected production challenges create a ripple effect across the globe. The coronavirus outbreak, for example, halted production for over two weeks in China. Similar concerns, from natural disasters or other unpredictable events, could create comparable outcomes.

Establishing a battery manufacturing plant in the U.S. will require an investment of time, research, and capital. With strategic and well-executed plans, however, the long-term payoffs can be exponential. Before construction can even begin, however, certain factors must be taken into consideration.

What are the region's available resources?

Location is critical when building a battery manufacturing plant in the U.S. Numerous states understand the value that sustainable technologies - particularly energy storage - bring to a region in terms of creating jobs and addressing climate change. This opens the door for possible incentives and tax breaks, which can offset building costs.

Location can impact your access to labor and talent. The larger the plant, the larger the space needed to operate, and the more people needed. Sizable operations can employ up to 2,000 people for a variety of jobs, including technology development, shipping and logistics, customer service, and administrative roles. To accommodate a larger physical footprint, remote locations tend to be more appealing; however, they should be close enough to your talent pools to encourage employment.



Is the plant design as sustainable as your technology?

Energy storage systems are touted as a more sustainable option, yet the manufacturing process has historically produced heavy carbon emissions and industrial waste. Energy storage and battery manufacturers need to take full advantage of their technologies when designing a manufacturing plant.

To reduce costs, utilize renewable energy resources, and minimize their carbon footprint, manufacturers should consider incorporating their own solar plus storage (or wind plus storage) solutions into the plant design. Once energy storage solutions are introduced, more opportunities for cost savings become readily available to manufacturers. For example, there is an option to simultaneously use a manufacturing plant as co-generation plant, which establishes carbon-neutral operations while creating a net-positive reserve of energy that can be fed back into the grid.

The structure and deployment of renewable sources, if not planned properly, can potentially disrupt and displace surrounding wildlife. Manufacturers must create a facility design and manufacturing process that properly disposes of waste and raw materials to ensure operations don't pollute neighboring water sources or disrupt natural habitats.

Are you establishing partnerships to gain control over the supply?

Partnerships play a critical role in scaling operations and gaining control over the supply chain. By forging relationships with international companies that have access to raw materials and existing manufacturing lines, it's possible to leverage a replicable model that reduces operational risks and concerns. On the other end of the supply chain, working with companies that specialize in niche areas, such as battery recycling, can expand your service offerings to clients and help to reclaim materials for future use.

Today's U.S.-based battery manufacturers have an opportunity to create stability within the supply chain and help meet global demand for energy storage. The growth of this industry presents a pressing need for new manufacturing locations, and the U.S. is well-positioned to become a key player in the global manufacturing market.



Lindsay Gorrill is CEO of KORE Power, a developer of high density, high voltage energy storage solutions for global utility, industrial, and mission-critical markets.

KORE Power /// korepower.com



Next generation solar energy storage solutions

Fronius and BYD are working closely together in the field of energy storage to develop efficient battery storage solutions for both households and businesses. All GEN24 Plus hybrid inverters are equipped with a battery connection, energy management, monitoring, and open interfaces for hot water heating, an electric car wallbox, or home automation as standard. They will be available as the single-phase Primo GEN24 Plus with power categories from 3 to 6kW and the three-phase Symo GEN24 Plus from 6 to 10kW from the end of the second quarter of 2020. The BYD Battery-Box Premium storage systems are made up of individual storage modules according to requirements and can be combined with the GEN24 Plus in two different designs: the Battery-Box Premium HVS from 5.12 to 10.24kWh and the Battery-Box Premium HVM from 11.04 to 22.08kWh.

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Ensuring Clean Energy During COVID-19 Pandemic and Beyond

by Henk Van Alphen

Due to the COVID-19 pandemic, greenhouse gas emissions are down and outdoor air quality has gone up. Shut-downs of economic activity have caused transportation-related pollution to momentarily decrease. However, as we appreciate this silver lining during an otherwise dismal pandemic, the reality is that the only way for us to leave our children, grandchildren, and future generations a healthy planet is to ensure that we don't take our collective feet off the alternative energy pedal.

The COVID-19 pandemic, which drastically reduced traffic, industrial and commercial activity, led to a significant decline in air-polluting emissions. We've been given an unprecedented glimpse into what happens to the air we breathe when emissions are eliminated.

Someday in the - hopefully near - future, COVID-19 will be a memory. When we look at how best to ensure the world's clean energy revolution, an examination of the transportation sector is vital. "Given the role that transport plays in causing greenhouse gas emissions, any serious action on climate change will zoom in on the transport sector," said Yvo de Boer, Executive Secretary of United Nations Framework Convention on Climate Change, in 2009.

Flash forward eleven years. Today's transport sector is responsible for about a quarter of global energy-related carbon emissions. You've no doubt heard from the growing chorus of health officials working to implement policies that reduce carbon emissions from the transportation sector. It is clear that a paradigm shift is happening now.

The way we humans use energy, store it, and think about it, is being transformed by new technology and applications. Hydrocarbons are a store of energy, and have powered the world for over a century. However, in order to release energy from hydrocarbons, we need to burn them. This burning process causes pollution and, ironically, energy loss. Plus, it still relies on a mechanism to get that released energy to do a job.

The lithium-ion battery has a tremendous energy storage capacity relative to size/weight. It's allowed us to have energy available when we need it, and can capture it when we don't. The simplest example is solar panels working during the day to power your lights at night. By storing energy efficiently and in a usable format, the possibilities for renewable energy generation open up dramatically. Wind, tidal, geothermal - all are sources of energy which become viable and mainstream now that the issue of storing that energy is heading towards a solution.

Even in cases where we still use hydrocarbons, we can use them more efficiently and generate less pollution by using lithium-ion batteries. A single hydrocarbon-fired power plant that sends electricity to households to charge multiple electric vehicles is much more

efficient, and generates less pollution than each of those vehicles running their own individual hydrocarbon-fired power plant. The promise of electric vehicles (EV) is the most visible aspect of the profound changes happening in the world today, thanks to the energy paradigm shift being led by lithium-ion battery technology.

Automakers have embarked on a clean energy revolution. For example, Volvo Cars committed to putting one million electrified cars on the road by 2025. Every new Volvo car launched from 2019 onwards has an electric motor. France plans to end sales of all gas and diesel cars by 2040, and Germany has mandated that all new cars are to be electric by 2030.

Battery makers worldwide are expanding their production and will continue to do so over the coming years. Lithium's moniker is 'white petroleum' due to dramatic need for supplies from the rise of battery gigafactories, electric vehicles, powerwalls, and energy storage businesses.

Lithium-ion batteries even play a major role in the production of ventilators. Michael Farrell, CEO, ResMed, noted that his company needs help with the acquisition of lithium-ion batteries to produce these valuable breathing machines.

For our world to reach its environmental and life-saving goals, it is important to understand the necessity of acquiring an ample supply of lithium from geopolitically stable countries. Chile and Australia are the largest current producers of lithium. Australia, China and Chile are the top three reserves holders, eclipsing the rest of the world's reserves. As EV and ventilator demand skyrockets, stable countries with major lithium resources need to play a greater role in the world's energy shift, creating a powerful positive feedback loop of stability, prosperity, and industry leadership.





Lithium is the clear incumbent metal in the race to use rechargeable batteries as part of future energy consumption. The paradigm shift is accelerating, and as lithium-ion batteries are more widely used in automobiles and power storage devices, demand is accelerating as well.



Henk Van Alphen is CEO of Wealth Minerals, which focuses on the acquisition and development of lithium projects in South America.

Wealth Minerals /// wealthminerals.com



Platform to determine utility bill savings for residential applications

Energy Toolbase has worked with SolarEdge to validate the StorEdge inverter specifications and charge/discharge profile programming instructions on the Energy Toolbase platform. The integration enables users to run a 365-day StorEdge dispatch simulation and determine the optimal mode of operation for how to program the Energy Storage System (ESS) throughout the year. The implementation of StorEdge into Energy Toolbase will output the optimal fixed schedule of operations for each unique proposal, based on the homeowner's load profile, solar PV system specifications being paired, Time-of-use (TOU) utility rate schedule, and Net Energy Metering (NEM) assumptions. With StorEdge implemented in Energy Toolbase, users can quickly determine the utility bill savings and project economics of adding StorEdge + LG RESU10H to a project. There is no additional cost for Energy Toolbase users to utilize the feature that simulates StorEdge. The implementation works seamlessly with all of Energy Toolbase's existing features, including the ability to import interval meter data from any file format or synthetically create a 365-day load profile using the ETB Load Profiler and the ability to create fully customized proposal document templates.

Energy Toolbase /// www.energytoolbase.com




High energy storage capacity

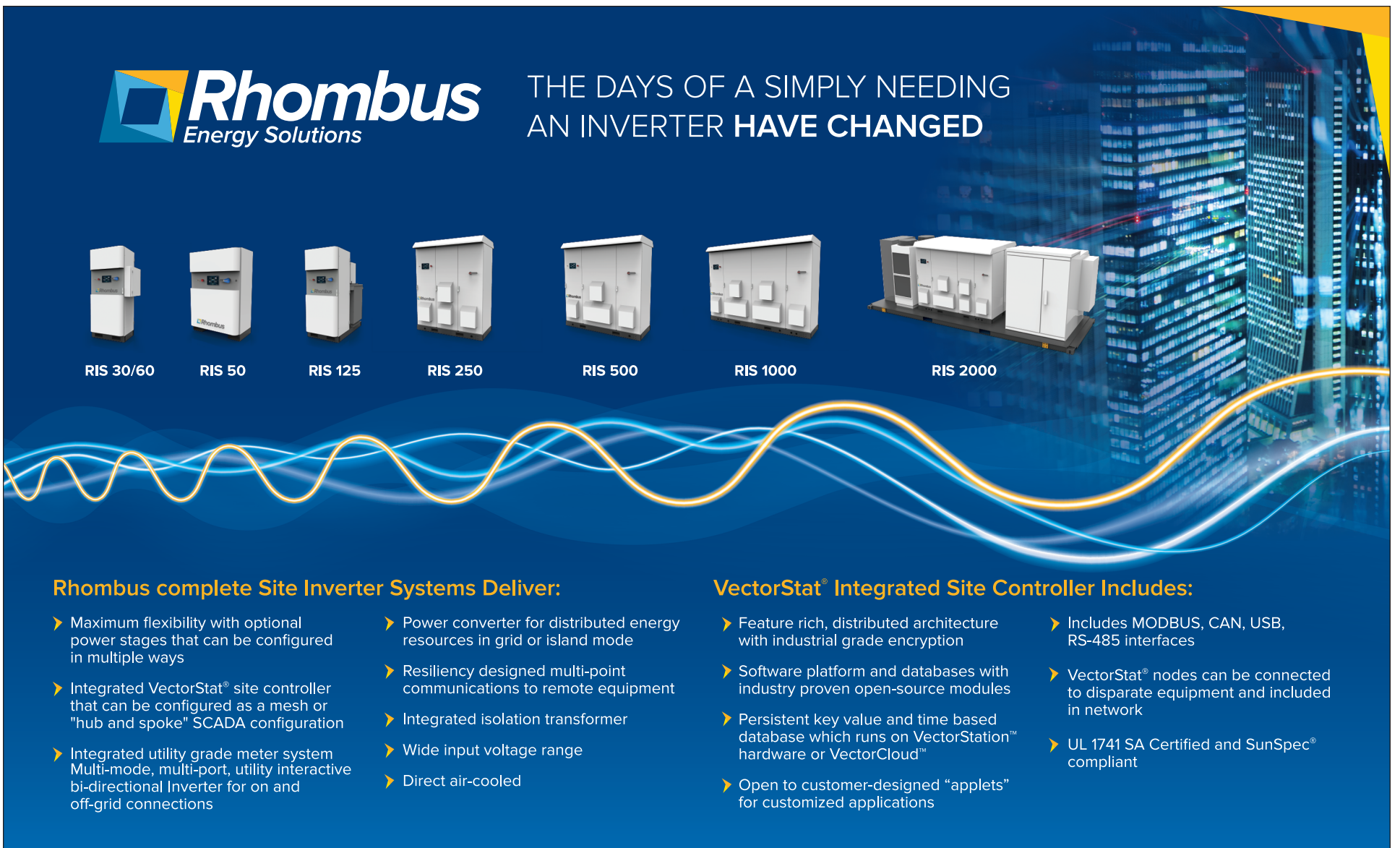
New from OutBack Power, The EnergyCell XLC battery system is a solution for today's demanding backup power, off-grid, and self-consumption applications requiring higher energy storage capacity. The EnergyCell XLC battery system incorporates a time-saving modular design. The integrated XLC cabinet provides a cost-effective solution for all installers and users, saving over 40% of installation time compared to a traditional battery rack. Proven lead-acid VRLA technology, combined with enhanced carbon additives, make it safe. The EnergyCell XLC has high performance backed up by a 10-year full replacement warranty (subject to terms and conditions), delivering 3800 cycles at 50% DoD and 17 years standby life. The XLC is optimized to operate seamlessly with OutBack Power equipment and OPTICS RE connectivity with real-time access to critical battery performance data.


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AIMS Power /// www.aimscorp.net



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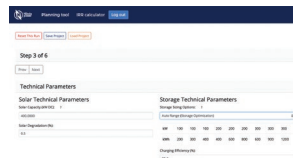
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IEC 61000-4-30 Class B, IEC 61000-4-11 Class B, IEC 61000-4-12 Class B, IEC 61000-4-13 Class B, IEC 61000-4-14 Class B, IEC 61000-4-15 Class B, IEC 61000-4-16 Class B, IEC 61000-4-17 Class B, IEC 61000-4-18 Class B, IEC 61000-4-19 Class B, IEC 61000-4-20 Class B, IEC 61000-4-21 Class B, IEC 61000-4-22 Class B, IEC 61000-4-23 Class B, IEC 61000-4-24 Class B, IEC 61000-4-25 Class B, IEC 61000-4-26 Class B, IEC 61000-4-27 Class B, IEC 61000-4-28 Class B, IEC 61000-4-29 Class B, IEC 61000-4-30 Class B, IEC 61000-4-31 Class B, IEC 61000-4-32 Class B, IEC 61000-4-33 Class B, IEC 61000-4-34 Class B, IEC 61000-4-35 Class B, IEC 61000-4-36 Class B, IEC 61000-4-37 Class B, IEC 61000-4-38 Class B, IEC 61000-4-39 Class B, IEC 61000-4-40 Class B, IEC 61000-4-41 Class B, IEC 61000-4-42 Class B, IEC 61000-4-43 Class B, IEC 61000-4-44 Class B, IEC 61000-4-45 Class B, IEC 61000-4-46 Class B, IEC 61000-4-47 Class B, IEC 61000-4-48 Class B, IEC 61000-4-49 Class B, IEC 61000-4-50 Class B, IEC 61000-4-51 Class B, IEC 61000-4-52 Class B, IEC 61000-4-53 Class B, IEC 61000-4-54 Class B, IEC 61000-4-55 Class B, IEC 61000-4-56 Class B, IEC 61000-4-57 Class B, IEC 61000-4-58 Class B, IEC 61000-4-59 Class B, IEC 61000-4-60 Class B, IEC 61000-4-61 Class B, IEC 61000-4-62 Class B, IEC 61000-4-63 Class B, IEC 61000-4-64 Class B, IEC 61000-4-65 Class B, IEC 61000-4-66 Class B, IEC 61000-4-67 Class B, IEC 61000-4-68 Class B, IEC 61000-4-69 Class B, IEC 61000-4-70 Class B, IEC 61000-4-71 Class B, IEC 61000-4-72 Class B, IEC 61000-4-73 Class B, IEC 61000-4-74 Class B, IEC 61000-4-75 Class B, IEC 61000-4-76 Class B, IEC 61000-4-77 Class B, IEC 61000-4-78 Class B, IEC 61000-4-79 Class B, IEC 61000-4-80 Class B, IEC 61000-4-81 Class B, IEC 61000-4-82 Class B, IEC 61000-4-83 Class B, IEC 61000-4-84 Class B, IEC 61000-4-85 Class B, IEC 61000-4-86 Class B, IEC 61000-4-87 Class B, IEC 61000-4-88 Class B, IEC 61000-4-89 Class B, IEC 61000-4-90 Class B, IEC 61000-4-91 Class B, IEC 61000-4-92 Class B, IEC 61000-4-93 Class B, IEC 61000-4-94 Class B, IEC 61000-4-95 Class B, IEC 61000-4-96 Class B, IEC 61000-4-97 Class B, IEC 61000-4-98 Class B, IEC 61000-4-99 Class B, IEC 61000-4-100 Class B



Energy storage software platform

Nikola Power's Ratio is a sizing and analysis tool designed to help developers tackle the key challenges in solar+storage and standalone storage project development. A core component of Ratio is its sizing feature that determines a system's optimal battery size. Ratio accounts for numerous factors when optimizing a system, such as capital expenditures, tariff structure, load profile, financial targets, and operational needs. Ratio also gives the user the flexibility to tailor their analysis to a project by providing optionality regarding tariff structure, operational limitations, and financial parameters. Ratio has been launched as a beta version and is available at no cost.

Nikola Power /// www.nikolapower.com



Fully integrated residential energy storage system

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

Electriq Power /// www.electriqpower.com



Simple, one-person installation

With the new high-voltage storage system from LG Chem and SMA Solar Technology AG (SMA), PV system owners can flexibly use self-generated electricity even when the sun is not shining. With the combination of a Sunny Boy Storage battery inverter and an RESU 10M battery from LG Chem, installers benefit from significantly reduced transport and installation costs. The RESU 10M high-voltage battery is a new modular home battery from LG Chem. It offers more value thanks to its innovative shape, as it is divided into two separate battery modules with a cover. Each battery module weighs approximately 79lbs (36kg), making installation easy for solar power professionals. With its robust material and sophisticated design, the battery can be installed both inside and outside the home. The Sunny Boy Storage is a powerful battery inverter for private homes. It has an integrated emergency power supply with manual changeover, which ensures that important appliances are still supplied with power even in the event of a grid failure. Thanks to AC coupling, the Sunny Boy Storage is suited for flexibly equipping new or retrofitted systems with high-voltage batteries.

SMA Solar Technology AG /// www.sma.de



Powerful, scalable storage system

PWRcell features a modular battery pack system, equipped with 8.6kWh batteries. The system is fully customizable, and can expand up to 34.2kWh. With the Generac PWRcell, solar-plus-storage is made simple. The fully-integrated, easy-to install solar energy storage system is a powerful, flexible, and efficient solution for the residential market. The included bi-directional, REbus-powered inverter offers an efficient design method for integrating smart batteries with solar. PWRcell is easy to install, with the heaviest individual component of the system weighing less than 75lbs. Generac PWRview technology is the easy-to-use home energy monitoring system that tracks home energy use and provides powerful insights into the home's electricity consumption. PWRview can also be a valuable presales tool as users can calculate their energy savings if they were to purchase PWRcell.

Generac Power Systems, Inc. /// www.generac.com

EV Charging

EV chargers are a necessity for EV owners. Without a gas tank to fill up, EV's get their fuel from electric chargers. There are different levels of EV chargers and in this product spotlight, we highlight some of the available options on the market today...

SEE AD ON PAGE 59



Rhombus Energy Solutions

Product: Rhombus RES-PCS and Dispenser

Maximum output current per connector: ±200A

Maximum output power per connector: 60kW or 125kW

Connectors: CCS 1

Cable length: 25ft (up to 8m)

External enclosure: NEMA 3R

Dimensions: 16" x 23" x 75" (40.6cm x 58.4cm x 190.5cm), custom sizes available

Protection: Insulation monitor

Status indicator: Standard multi-color LED or LCD touchscreen

Communications: Wifi or Ethernet

Authentication: OCPP1.6J and Rhombus VectorStat

Operating temperature: -4°F to 113°F (-20°C to 45°C)

Humidity: 0 to 95% (non-condensing)

Certificates and compliance: UL 2202, UL 2231, UL 1741 / UL 1741-SA, UL 9741

Key Features:

- Bi-directional for V2G capability;
- High power;
- Designed for continuous operation at rated loads.

www.rhombusenergy.com



Paired Power

Product: SEVO SunStation - Solar EV Charging Station

AC input: DC input only from solar PV

Maximum output current per connector: 40A

Maximum output power per connector: 16.8kW

Connectors: 6

Cable length: 13.1ft (4m)

External enclosure: Rain Proof / NEMA 4 Rating

Dimensions: 41" x 35" x 9.8"

Protection: Isolation Monitoring Device (IMD)

User interface: Customer smartphone web app

Status indicator: Customer smartphone web app or EV charge port LED indicator

Communications: Cellular, WiFi optional

Authentication: Cellular

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

Humidity: 5% to 95%

Certificates and compliance: UL 508A, FCC Compliant NFPA 70, National Electric Code (NEC), Art. 625
www.pairedpower.com



FreeWire Technologies, Inc.

Product: Boost Charger

AC input: 3Ø Y 208V, 1Ø 240V

Maximum output power per connector: 120kW

Connectors: Dual-port CHAdeMO and CCS

Dimensions: 57" x 39" x 95" (145cm x 100cm x 242cm)

Protection: IP 54

User interface: 24" (61cm) ruggedized LCD touchscreen

Communications: 4G LTE

Operating temperature: -4°F to 131°F (-20°C to 55°C)

Certificates and compliance: UL Pending
www.freewiretech.com



Phillips & Temro

Product: EVOCHARGE EV Charging Stations

AC input: 208Vac to 240Vac

Maximum output current per connector: 40A

Maximum output power per connector: 7.2kW to 7.7kW

Connectors: SAE J1772

Cable length: 18ft and 25ft (5.48m to 7.62m)

External enclosure: NEMA 4 rated

Dimensions: 16" x 15" x 11"

Status indicator: Yes

Communications: OCPP 1.6

Certificates and compliance: UL
www.phillipsandtemro.com



Envision Solar EV Charging

Product: EV ARC 2020

AC input: 10A @ 120V

Maximum output current per connector: 18A

Maximum output power per connector: 4.3kW

Connectors: 1-6 (J1772)

Cable length: 12ft to -25ft (3.66m to 7.62m)

External enclosure: 6.08ft x 8ft x 2.17ft (1.85m x 2.44m x 0.66m), at 9ft (2.74m) above ground level

Dimensions: Basepad footprint 18ft x 7.5ft (5.49m x 2.29m), max height 15.3ft (4.66m)

Protection: Ground fault protection to prevent shock

User interface: Online monitoring showing solar, battery, and charging data

Status indicator: Low battery indicator available to show when system is off due to low battery

Communications: 4G LTE cellular network

Authentication: Depending on EV charger selection, user authentication is available

Operating temperature: 0°F to 120°F (-17.8°C to 49°C)

Humidity: 0 to 100% humidity

Certificates and compliance: Inverter: UL1741, CSA C22.2 No. 107.1, UL1778, Annex FF; Charge controller: UL1741, CSA C22.2 No. 107.1; EV Charger: UL2231; Battery Cells: UL1642; Battery BMS: UL2271; Solar Panels: UL1703
www.envisionsolar.com



SemaConnect

Product: Series 6 Smart EV Charging Station

AC input: Level II: 30A; Line 1, Line 2, and Earth (no neutral)

Maximum output current per connector: 240VAC@30A

Maximum output power per connector: 7.2kW

Connectors: SAE J1772

Cable length: 18ft (5.5m)

External enclosure: Aluminum

Dimensions: 20" x 6" x 6" (51cm x 15cm x 15cm)

Protection: Safety: ground fault circuit interrupt: 5mA CCID with auto retry (15 min delay, 3 tries). Surge protection: 6kV@3,000A

User interface: Backlit LCD screen

Status indicator: 270° visibility, multi-color visual status indication

Communications: Commercial CDMA or GPRS cellular network

Authentication: RFID card, Apple/Android app, and automated phone system

Operating temperature: -22°F to 122°F (-30°C to 50°C) ambient

Humidity: Up to 95% non-condensing

Certificates and compliance: UL Certified; CCID per UL 2231-1, -2; Meets UL2594; NEC Article 625 Compliant
www.semaconnect.com



Power Electronics

Product: NB60

AC input: 480V

Maximum output current per connector: 150A

Maximum output power per connector: 60kW

Connectors: CCS-1, CHAdeMO, AC Type 1

Cable length: 9.8ft (3m)

External enclosure: NEMA 3R

Protection: Isolation monitor, over/under voltages, currents, temps

User interface: 10" touchscreen

Status indicator: LED indicator

Communications: OCPP 1.6, Ethernet, 3G/4G connectivity, Wifi

Operating temperature: -13°F to 122°F, optional from -22°F to 122°F (-25°C to 50°C, optional -30°C to 50°C)

Humidity: 4% to 95%

Certificates and compliance: UL 2202, UL 2594, NEC 625, FCC Part 15 Class A
www.power-electronics.com



Blink Charging

Product: Blink IQ 200

Maximum output current per connector: 80A

Maximum output power per connector: 19.2kW

Connectors: SAE J1772

Cable length: 25ft (7.6m)

External enclosure: NEMA Type 3R Indoor/Outdoor

Dimensions: 13.95" x 10.65" x 5.23" (35.4m x 27.05m x 13.3m)

User interface: 7" LCD, color, 800x480, with touch panel

Status indicator: LED and audio

Operating temperature: -22°F to 122°F (-30°C to 50°C)

Humidity: 0 to 95% relative humidity, non-condensing

Certificates and compliance: UL, cUL, NEC Article 625, RoHS, Norma Oficial Mexicana (NOM), ADA, Energy Star Certified
www.blinkcharging.com



After the Storm

The electric utilities sector long-term implications of COVID-19

by Dr. Graham Ault

THE ELECTRIC UTILITY SECTOR PRIDES ITSELF ON contingency readiness. Power grid design, communications and control systems, organizational flexibility, and the wider supply chain are set up to protect power supply to customers for an incredibly wide set of events.

Major grid failures in recent years stem from 100-year outliers from elemental sources such as storm, drought, ice, and fire. If extreme weather has always been understood to be an 'act of god', then the emergence of the biological phenomenon of Coronavirus is something completely new and different. The ease and speed of contagion, as well as the real and potential impacts on people across the globe, put COVID-19 into a category all of its own.

Pandemics have been part of utility contingency planning for many years, yet the emergence of COVID-19 is likely to have wide reaching implications on the power grid and power sector.

Firstly though, we must all applaud the work of the system operators and electric utility companies themselves. At a time when life is in danger and basic supplies looked

precarious, it is a relief to society that the power supply is secured in the way it is.

Implementing and adapting contingency plans for the Coronavirus have manifested in adding more layers to the 'layers of security' or 'lines of defense' philosophy. Specific measures reported include segregating control and operational teams, setting up temporary additional backup control centers, ensuring connection robustness for critical customers (e.g. hospitals), supply chain and contractor continuity checks, and cancellation of non-critical works to avoid workforce distraction or putting the networks into less secure states.

The New York Independent System Operator (NYISO) reported that teams of their control room staff are not only segregated, but also living in isolation at the control center to ensure staff availability throughout the crisis.

What demand changes have we seen so far?

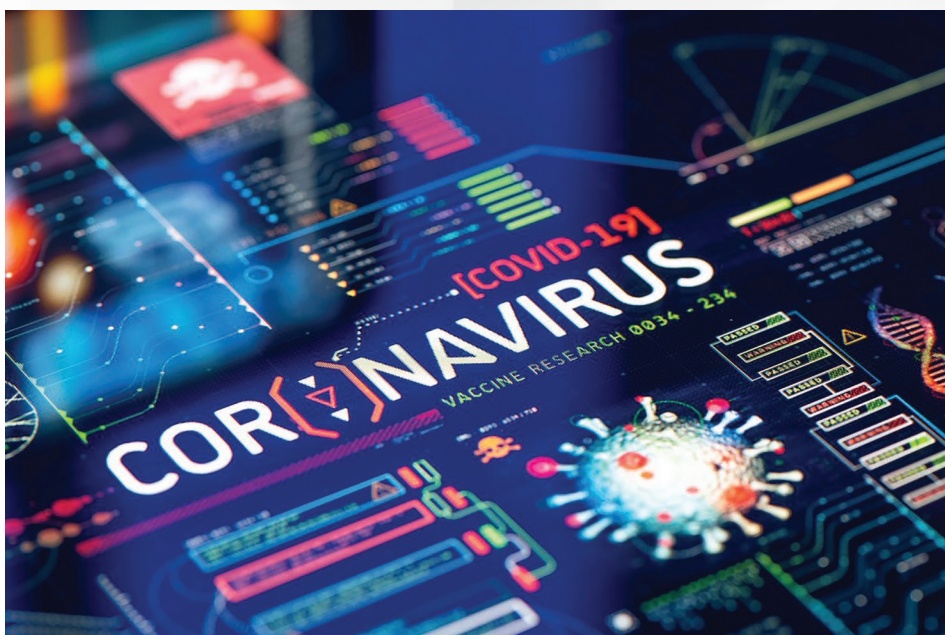
With enormous changes to the shape of work and life as we know it, there have been stark and immediate changes to electricity demand patterns, with the knock-on effects on generation and power markets.

A reported 5 to 15 per cent reduction in peak and energy demand across the US, European, and Australian systems started mid-March, compared to the average for last few years.

Weekday demand is looking more like weekend demand, with a later and slower morning ramp up. We're also seeing lunchtime peaks from home dining, and earlier evening tail-offs resulting from reduced late-night office hours and leisure activities.

There's been a switch from the usual industrial and commercial demand intensity to residential. Week-on-week, we are seeing the expected seasonal demand shifts amplified compared with previous years.

There's also a higher share of the electricity mix from low marginal cost renewable generation as fossil generation drops from the merit order in lower demand periods, as well as more negative wholesale prices with more feed-through to end prices for time-of-use tariff consumers.



What are the implications?

Some of these changes actually make the job of grid management more challenging - larger shares of intermittent renewables must be balanced, along with different ramping patterns (e.g. amplified Duck Curve) and system stability issues from lower demand troughs. Some of these factors will become more difficult as the seasonal transition continues (e.g. more solar PV output not yet balanced by the additional summer air conditioning load), and lower overnight demand creates voltage management issues for transmission operators.

Key questions right now include how much of the home working trend will stick after the crisis? How much of the observed 'demand efficiency' and renewable energy transition is simply an acceleration of existing trends, and how many of the new utility operational measures will persist beyond the COVID-19 crisis?

There is also a clear pandemic disruption within the business of the energy sector, with reports of reduced solar PV installations, deferred grid maintenance and upgrades, shuttered EV production, sales, and deliveries.

Beyond these reported fact-based changes, there is the general slowing of procurement and implementation of grid modernization programs, including smart grid and digitalization initiatives (due to travel, physical work environment restrictions, and 'critical work only' orders). These are the very measures that will add resiliency for customers and grid operators to future shocks.

What about long-term?

While it is difficult to know exactly what the long-term effects might be, one thing we can predict is that investment in clean energy is likely to take a dip in 2020 as a result of construction and supply chain constraints.

Most analysts believe the fundamentals remain unchanged, that there will be a bounce back after the restrictions pass. Some go further and link the damaging effect of the crisis on hydrocarbon energy sources, and a heightened awareness of sustainable living, to a speeding up of the clean energy transition.

Hopefully, the short-term robustness

of the grid continues, and the disruptive effects on the energy business are quickly fixed. Ideally, the new normal will include an acceleration of the clean energy transition with added emphasis on digitalization and decentralization, resulting from greater value being placed on virtualized living and working, and from local, resilient solutions.

A clear outcome from the Coronavirus outbreak is that the sector has come together quickly and collaboratively to create new methods and processes to continue development, delivery, and support in virtual and constrained circumstances. Long may that agile, flexible, rapid problem solving, and grid security and improvement mindset continue.

Dr. Graham Ault is Executive Director at Smarter Grid Solutions, a software company that provides technology that allows distribution utilities and owner/operators to interface DER to both markets and networks.

Smarter Grid Solutions

/// www.smartergridsolutions.com

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Elements of Surprise

by Grant Leaverton



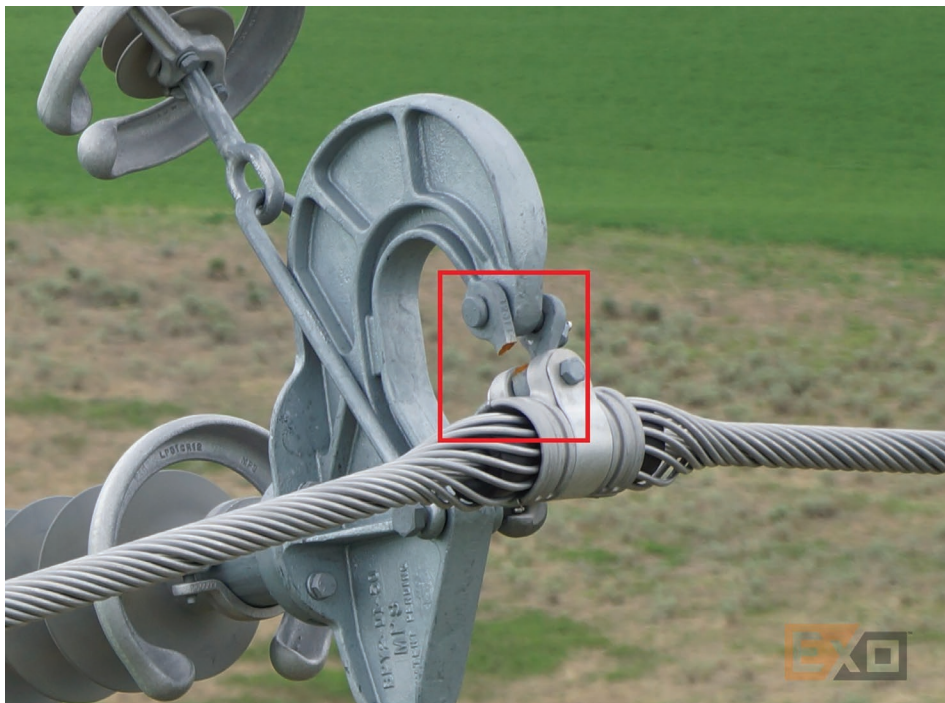
IN AN INDUSTRY WHERE MOST CRITICAL INFRASTRUCTURE

is left outdoors to face the elements day in and day out, mother nature's wrath is one of the many operational challenges that renewable companies must contend with. Whether you operate a solar farm or wind park, wind, lightning, ice and hail can all wreak havoc on valuable assets and equipment. And while damage to a single turbine or solar array is costly, the prospect of losing potentially all of your generating capacity due to a failed collection or gen-tie transmission line could be even more catastrophic. While great steps have been taken to mitigate those risks to the generating assets themselves, more work can be done to harden the balance of plant infrastructure, specifically overhead collection and transmission interconnects.

Over the last two decades, a significant investment in renewable energy has been made across the country. A disproportionate amount of that development has occurred in the American heartland. Turbines have sprung up like wildflowers from the gulf coast of Texas to Minnesota and North Dakota. Unfortunately, this part of the country also experiences the most extreme weather imaginable. Severe thunderstorms and even tornados can be a weekly occurrence this time of year for operations in this part of the USA, which brings with it an increased level of damage risk. For those of you that don't live in Tornado alley, here is something to consider: all 50 states in the union have recorded tornado touch downs since 1950, even Alaska and Hawaii. No one is completely immune from this risk. So, while the threat may be more severe for some, every renewable operation should have a strategy in place to plan for and deal with failures and outages from extreme weather and anything else that mother nature can throw at you.

A recent tornado outbreak in Oklahoma inflicted catastrophic damage on a wind park's gen-tie transmission line, leaving the entire site offline for an extended period of time while repairs were made. With all 150MW of generating capacity unavailable, the asset owner lost a large amount of revenue, in addition to the restoration costs needed to bring the site back online. In total, five steel

transmission poles collapsed where a tornado tore through the line. The owner quickly mobilized an inspection team to survey the line for damage using a drone to capture high definition imagery. The data collected served two purposes. First, it identified the failed towers, and provided identification of potential safety hazards for the restorations crews before they arrived. The enhanced situational awareness gave the line crews additional insight to help them accomplish their repairs safely and efficiently. Second, the inspection documented other portions of the line where damage was less obvious but equally important. In one instance, critical hardware that supported conductor suspension assemblies had broken but not yet dropped conductor to the ground. A walking inspection would almost certainly have missed this hidden damage, leaving the line at high risk for another subsequent failure. The detailed drone inspection documented several storm related weaknesses that lines crews were able to fix along with the failed towers. To emphasize the risks further, this outage was the third storm related failure this site experienced on their transmission line in three consecutive years. Severe weather will likely continue to be a threat for these operations as long as they exist, so the value in routinely inspecting, strengthening, and hardening our balance of plant infrastructure cannot be understated. Here are some practical steps that every site owner should consider taking to make their renewable assets more storm ready.



1. Owners that are in the process of building new sites or upgrading existing ones would be advised to ensure your overhead line structures are designed to the wind and ice loading requirements of ASCE 74. This will result in stronger, more resilient structures in your balance of plant system. Many sites only design to the minimum NESC “safety” standards which are woefully inadequate as design criteria for extreme weather events.
2. No matter the material for the poles and towers, ensure they are specified to be designed to a “minimum” strength. Did you know wood poles are typically specified as a “mean” strength, while steel and concrete poles are typically specified to a “minimum” strength?
3. Make sure your purchase specifications are current and appropriate for the new project. A proper specification must identify the right materials for the probabilistic severe weather events expected (wind/ice). Your specifications should also address quality assurance protocols for how to properly design, fabricate, and install such infrastructure. Manufacturing defects in steel poles or towers can make them susceptible to fatigue and failure during severe weather and high wind events. With the right quality assurance program, this risk can likely be avoided.
4. For sites already built and in service, a thorough asset management plan that involves a structural review of your infrastructure (not just electrical) is critical. If you know that your assets were under designed or built with little to no safety factors, modify your preventative maintenance strategy to take these weaknesses into account. Conduct more regular and detailed inspections to identify potential issues that may fail during a storm. If you have steel poles in your system, inspect them for corrosion issues or fabrication defects that might adversely affect the performance of your transmission line.
5. Your asset management strategy should also include a detailed storm response plan. Be ready to conduct drone inspections on the line following a storm to document even the smallest of defects that could prove significant to restoration efforts. Make sure that whoever is evaluating that data has a strong understanding of structural matters in addition to electrical matters. Consider having a safety stock of poles and structures on hand to replace failed components quickly, removing the risk of longer lead times and potential price hikes for emergency product.

Unfortunately, there is nothing we can do to change the weather that impacts our renewable energy assets. However, there are plenty of proactive steps that owners, operators, and developers can take to mitigate these risks and improve the overall reliability and performance of our operations. When something as small as a single loose or missing cotter pin can take an entire site offline, it stands to reason that we should be taking greater care in the way we design, build, and maintain our balance of plant and transmission infrastructure so that our assets can stand up to the worst mother nature has to offer.

Grant Leaverton is Senior Account Manager at Exo, a U.S.-based company that has over 100 years of experience of infrastructure inspection, evaluation, remediation, and manufacturing.

EXO /// exoinc.com

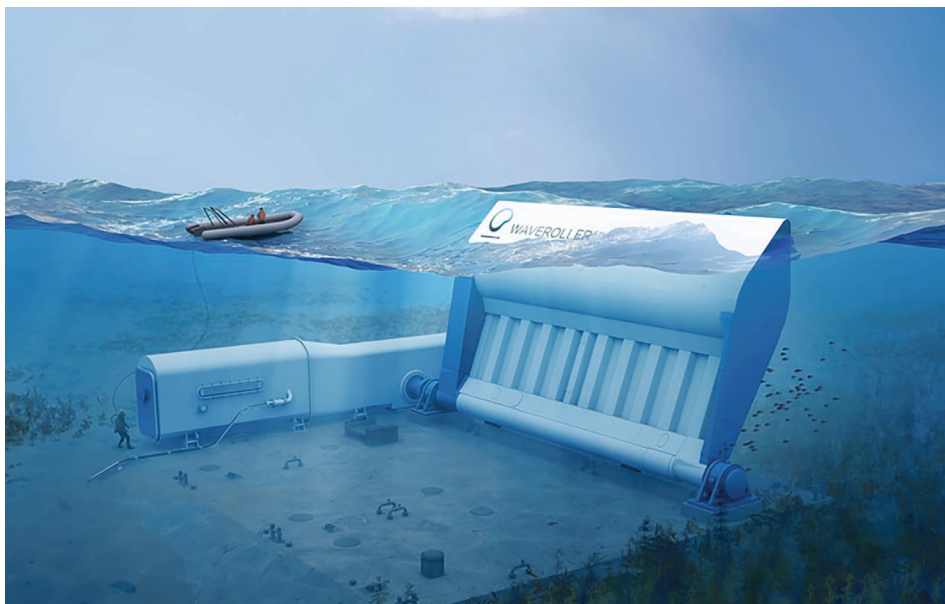
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The potential of the global ocean's resources is mind-boggling. Between large water surfaces and marine resource diversity, there are a wide variety of energy extraction options available.

Recently report by Ocean Energy Systems (OES), the global wave and tidal stream energy production has risen ten-fold over the last decade. The density of wave energy could even equal the offshore wind sector, considering that waves are a concentrated form of energy capable of travelling large distances with minimal losses. Curiously, we have barely tapped this promising sector of the clean energy market.

Supplying Demand

The theoretical global potential of wave power is around 29500 TWh/yr, from which currently only a small fraction is extracted near ocean coastlines, islands, or semi-enclosed basins.

If we take 2 percent of the world's 800,000 kilometers of coastline with a wave power density of 30 kilowatts per meter (kW/m), and an estimated global technical potential of about 500-gigawatt electrical energy (GWe) – based on a conversion efficiency of 40 percent – by just utilizing 2 percent of our coastlines, we can generate 4,383TWh of ocean power annually, enough to meet 16.4 percent of the world's electricity needs.

In the European marine energy market, the successful development of marine energy technology could generate 188 GW (10 percent) of Europe's electricity needs by 2050. For this to happen, wave energy deployment would begin in 2022 – just two years from now. One promising option is bringing together wave energy devices with existing coastal onshore wind farms by connecting and sharing the onshore localised power hub and grid infrastructure. This would help accelerate and develop wave industry in areas with moderate wave energy potential.



Making Waves

Transforming the renewable energy mix

by Christopher Ridgewell



Market Opportunities and Storing Energy

In summer, California renewable power production comes from both the sun and the wind (wind courtesy of hot desert days). But winter sees a big drop off in this power production. Given the 80 percent renewable scenario, the gap in December is about five terawatt hours. California could store energy in the summer and deliver it to the grid in the winter, but the amount of rare materials you would need for that amount of storage is mind-boggling.

Five terawatts hours is the same amount of wave energy coming into 70 miles of coastline in the winter months. That gap between the summer and winter can be filled with wave energy, which could help deliver renewable energy across all seasons.

Predictability

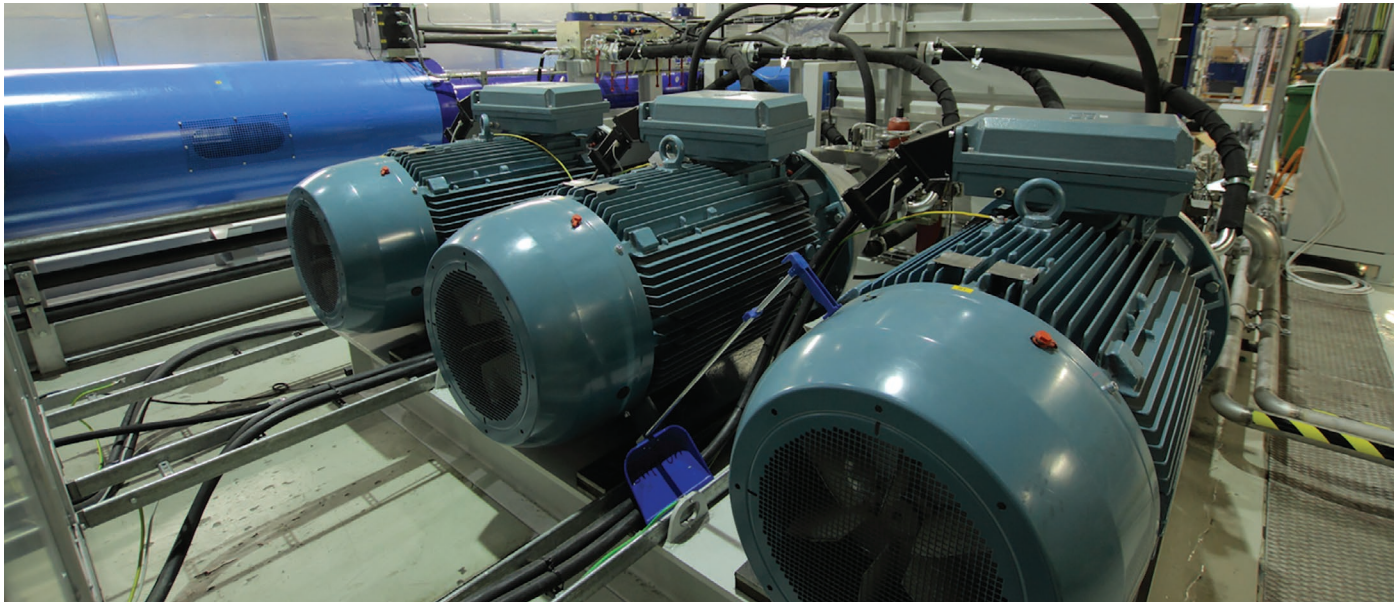
Compared to wind and solar, wave energy is highly predictable. Decades of marine engineering has driven advances in weather simulations that has given us the ability to accurately predict wave energy. In the major oceans, it's possible to predict wave energy about a week ahead. About two weeks for the tropical oceans. With wave energy, we could have the prospect of selling next week's renewable energy.

LCOE or LVOE?

As more solar comes onto the grid, when it's sunny, solar competes with itself. Each new solar panel you put in it will compete with the others. And you see the same in wind as well where the levelized cost of energy is called in to question. However, wave energy is considered not as a competing industry, but rather an indispensable addition to the renewable energy mix. With energy production more closely matching the demand, it will result in a higher levelized value of energy for the owner or operator.

Not a "one type fits all" approach

There is no one technology that can meet all the requirements we demand; a team effort will bring optimal results. Wave energy will play an important role, complementing other renewable energy sources to create increased grid stability. In Chile and Australia, for example, the amount of wave energy coming into the coastline is far greater than the electricity demand in the country. California's waves can easily fill the winter shortfall left by both wind and solar.



Drawing energy from waves

Waves are generated by the winds. Even when the wind stops, the waves continue coming into the beach. The top layers of the entire ocean has stored energy that travels in waves. That wave energy acts just like a battery storage system – aggregating and smoothing. If you convert the slow rolling motion of the wave into linear motion, that linear motion can be used to pump hydraulics. It's similar to the low frequency, high force principle used in rudder systems for ships and oil and gas riser systems. The hydraulic pressure induced by wave forces can feed hydraulic motors that rotate generators. By storing and smoothing the power, rotation is kept continuous, constantly delivering power to the grid.

Because the mechanics stay close to the shoreline – but far enough out to benefit from incoming wave energy – the critical electrical components can stay on land. As with offshore wind turbines, cables deliver the energy to a substation. Maintenance carries fewer risks than wind because technicians can just walk up to an onshore substation, without having to be transferred to an offshore turbine tower.

Challenges and opportunities.

Wave energy's biggest challenge is being a newcomer to the renewables market. Initially, costs are high compared to wind and solar. But remember, the same thing occurred with wind and solar in their infancy. With similar incentives and support, wave energy can start with a lower levelized cost of energy than wind (in its early days). The challenge is to overcome this hurdle and move to larger commercial projects to really get the costs down... and they will come down.

As the share of wind and solar renewables continues to increase constraints on site availability, transmission infrastructure and intermittency will make it more difficult to reach our increasingly ambitious renewable energy targets. One benefit of wave energy is that it can be fed to the grid at different times, compared to present forms of renewable energy, and sites are readily available close to existing transmission lines.

A market that values predictability, low variability, and production that mirrors demand, will encourage developers to co-locate wave energy into their projects.

Sustainable ecosystems must be a priority.

It's vital to understand the impact wave energy harvesting may have on the local communities and marine ecosystem. Nearshore wave energy converters operate in a shallow zone where trawling with nets for fish is not feasible. But fishing by other means is permitted.

This is where wave energy converters could add value, because, just as we've seen with offshore wind turbines, the wave energy substructures form artificial reefs, which create valuable sanctuaries for marine life.

While Europe is still the world leading market for wave energy technologies, other countries are progressing quickly. The challenge for any government will be to recognize a long-term 'horizon,' with an energy charter that supports a full and balanced renewables mix.

Christopher Ridgewell is CEO at AW-Energy Oy, a Finnish company that creates commercial-scale technology to absorb energy from waves. The industry's first commercially-ready wave installation - WaveRoller - currently feeds Portugal's grid.

AW-Energy Oy /// aw-energy.com



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Voltage Volatility

Advances in distribution grid monitoring

by Conrad Oakey

THE POWER DISTRIBUTION GRID IS UNDERGOING

unprecedented levels of change. The traditional, one-way model of voltage regulation presumed that voltages would drop predictably along feeders from substation to customers. The proliferation of larger scale Distributed Energy Resources (DER) along feeders, however, means that traditional models and regulation techniques are incapable of maintaining delivered voltages within ANSI C84.1 guidelines.

This is spurring new approaches in grid measurement, monitoring, and control that provide real time measurements, enabling Distribution Management applications to better manage voltages and maintain high power quality.

Voltage Fluctuation from DER

The traditional power delivery model pushes electricity from a centralized power generation plant, through distribution feeders, to the point of consumption. Power is consumed along the line: utilities are using tap changers, voltage regulators, and capacitor banks to regulate voltage, and ensure delivery remains within an ANSI guideline range of +/- 5% all the way to the end of the line. Historically, the key concern was ensuring voltages did not fall below or above these standards.

Enter DER, electricity-producing resources or controllable loads that are connected to a local distribution system. DER can include solar panels, wind turbines, battery storage, generators, and electric vehicles.

These points of power generation inject power along the distribution feeder, which may increase or decrease voltage levels outside ANSI guidelines. In other words, increasing integration of renewables results in variable load and generation fluctuations, which work against the constant voltage profile model.

In addition, solar and wind DER are, by nature, intermittent. Managing unpredictable intermittency without measurement, monitoring, and control is even more difficult, and can result in oscillatory voltages in the system. Voltage rises at injection points may also create reverse systemic power flow.

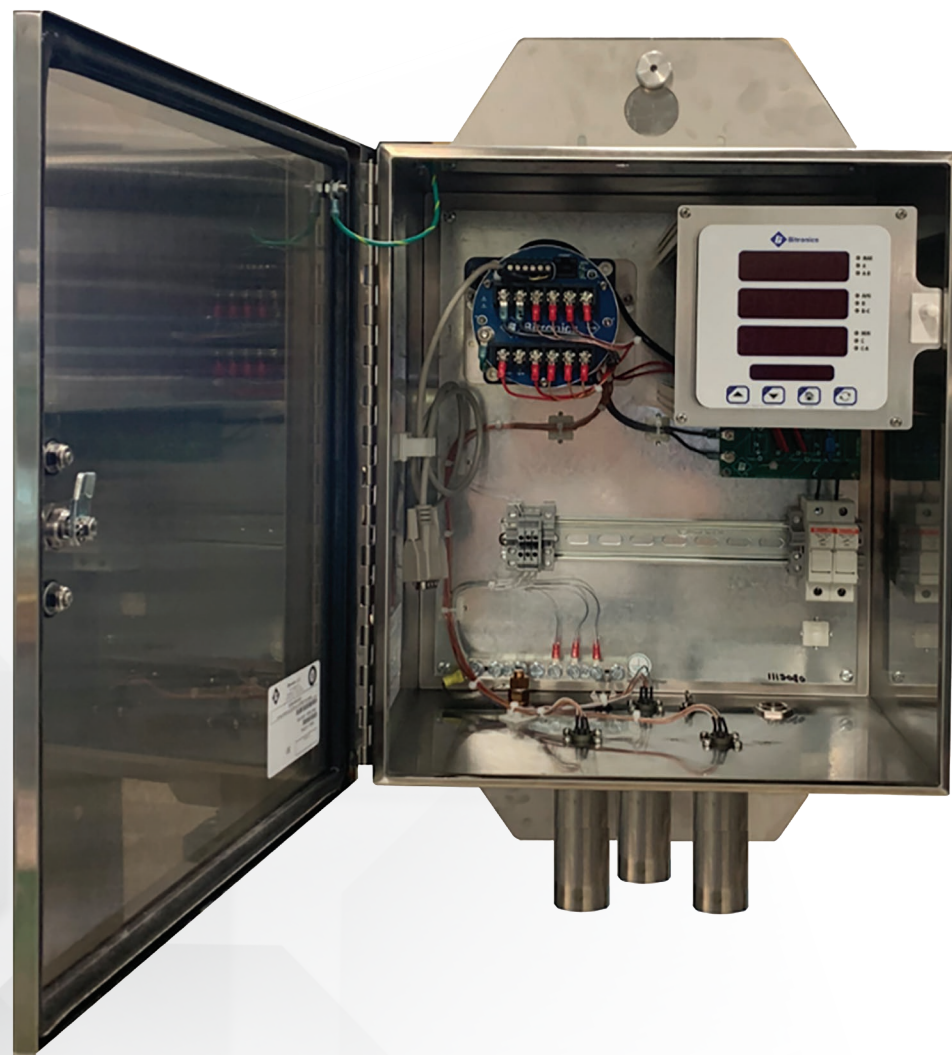
As a result, utilities require more advanced power monitoring and control systems that can precisely and quickly measure voltage to enable their Distribution Management Systems (DMS) to respond and regulate the voltage on their feeder lines. But this means DER integration needs real-time data to implement their control strategies.

Unpredictable voltage delivery can not only disrupt service to household, commercial, and industrial customers all along the feeder, it can also damage motors and equipment

More Precise Monitoring and Control

The challenge of effectively controlling unpredictable, variable, and potentially bi-directional voltage flow starts with measurement. The only way to control this kind of variability is to have measurements along distribution feeder lines. These measurements are accurate, and can communicate data to control systems fast enough to modulate the voltage and keep it under control. All in real-time.

Voltage delivery monitoring and control can be the domain of DMS. These systems have evolved over the years. Currently, advanced DMS models use Volt/Var optimization (VVO), where capacitor banks, voltage regulators, and solid-state systems are switched on and off to maintain acceptable levels of power factor



and voltage. More recently, Distributed Energy Resource Management Systems (DERMS) have emerged in response to the increasing amount of renewables-based distributed energy resources. These are complex control systems for monitoring and controlling sources of energy.

DERMS require accurate, real-time measurement of voltages, loads, reactive power, fault data, and even weather data. A key consideration has been how to design and install these monitoring systems in a way that is cost-effective for utilities. This has called into question the traditional approach of grid monitoring with conventional magnetic current transformer (CT) and potential transformer (PT). The installed cost of CTs and PTs is expensive and time-consuming, plus the feeder must be powered down for their installation.

An alternative lower-cost approach is to employ low voltage (0-10V ac) sensor technology for all voltage and current measurements. These sensors are safe, accurate for all required measurements, and can be installed without taking an outage.

Three raw voltages and currents can be wired to a Distribution Grid Monitor (DGM) pole-top measurement system, making dozens of useful measurements, including voltages to better than .5 percent, loads, power factor, real, and reactive power. An ANSI 51 overcurrent element enables reporting of fault pickup and peak fault currents, all of which are reported to DMS and DERMS through DNP3 over radio.

Initial DGM deployment at a New England utility drove further DGM enhancements, including new measurements for 'Normalized Voltage' to accommodate sensor readings instead of PTs and CTs, additional surge suppression, and 'safety shields' to prevent tampering of cable connectors.

Trends indicate DER integration will increase significantly each year. So, too, will the need to maintain voltages, power factor, and frequency within desired limits. New grid measurement and monitoring technologies are essential to keep these factors under control.

Conrad Oakey is the Vice President, Strategy and Communications for NovaTech, a supplier of automation and engineering solutions for electric utilities and process manufacturing industries for over 30 years. The Orion Substation Automation Platform performs automation and security applications in electric utility substations.

NovaTech

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Business Interruption Risks for 2020

by Carl Angelo Dill

While cyber incidents rank as the top global business risk for the first time, a survey of companies in the renewable energy sector placed business interruption (BI) as their top risk concern in 2020. *NOTE: The survey was conducted in late 2019 before the COVID-19 outbreak. Pandemic risks ranked 17th among the most important global business risks at that time.*



Half of those surveyed ranked BI as their number one risk. Tying for second place was climate change and fire/explosion. Cyber incidents and natural catastrophes round out the top five risks for the industry.

Business Interruption

The trend for larger and more complex BI losses continues unabated. Fires and natural catastrophes are the major causes of BI losses, and can cost as much as 45 percent more than the corresponding property damage from such incidents. However, more exotic triggers like digital platforms and supply chains, political risks,

pandemics, and environmental factors are rapidly becoming more relevant for businesses.

Given growing commercial pressure, as well as the complex and often leveraged financing structures, it is not surprising that loss of revenues resulting from BI remains a leading risk in the renewable energy sector. Recent cable losses in the offshore wind industry, for instance, have re-confirmed the trend that the costs of BI far exceed those caused by physical damage.

Thorough assessment of bottlenecks, effective contingency plans, and efficient spare part management are among the actions clients can take with their insurers to reduce BI risk.

Climate Change

Businesses are face an increased risk of disruption from extreme weather activity, global health issues, and environmental factors.

There is overwhelming scientific evidence that global warming exists and is already leading to more frequent and severe natural catastrophes. Businesses fear an increase in physical losses as the leading threat from climate change. Rising seas, drier droughts, fiercer storms, and massive flooding pose threats to production sites and other corporate assets, as well as transport and energy links that tie supply chains together.

More intense windstorms, hailstorms and flood events can all make renewable energy a risky business for insurers and investors alike. But these traditional risks are only part of the story.

Businesses may also face liability risks. A good example is the devastating 2018 Camp Fire, caused by faulty equipment and fueled by extreme drought. This type of failure to mitigate risks can not only force companies into bankruptcy, but result in significant reputational risks.

While companies have started to develop robust ESG processes and other tools, more effort is required to help businesses understand and manage climate change risk from a holistic perspective. By backing the United Nations Principles for Sustainable Insurance, insurers have made a first step towards working with clients and business partners to raise awareness of ESG issues, manage risk and develop solutions.



Fire and Explosion

Recent fires in onshore wind turbines have caused insurance claims in the millions. Severity events, like the 2017 Binhai offshore wind substation fire in China, are a constant threat. Only by assessing and maintaining a regular upkeep of fire mitigation practices onsite can companies lower the risk of loss.

Cyber Threats

Cyber incidents are ranked as the fourth leading risk for renewable energy companies. The power industry is part of vital public infrastructure and thus a potential target for cyber-attacks. Hacking attacks on power grids have been widely reported, and the imminent risk of blackouts is a major threat. The evolution of remote control and monitoring systems in the renewable energy industry is likely to open new paths for attackers. Therefore, the risk of cyber-attacks is likely to increase over time.

Many incidents are the result of human error. This can be mitigated by training, especially in areas like phishing and spoofing, which are among the most common forms of attack. Training can also help mitigate ransomware attacks, although maintaining secure backups can limit damage. Business resilience and business continuity planning are also crucial, although response plans need to be tested and regularly reviewed.

Natural Catastrophes

Natural catastrophes rank as the fifth top business risk for the renewable energy sector. A range of Natural Catastrophe models are available to all industry sectors, but every site is different. Thorough assessment of design standards as well as site specific conditions will help to mitigate the risk of losses.



Carl Angelo Dill is Senior Underwriter for Renewable Energy at Allianz Global Corporate & Specialty. Allianz works with companies around the world to create industry-specific insurance solutions.

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/// www.agcs.allianz.com



MAY

- 05 Building a Business in Difficult Times**
WEBINAR – 9:30-11:30am; www.calssa.org/webinars
- 05 Utilizing Digitization to Maximize Operational Performance**
WEBINAR – 3pm CET; www.calssa.org/webinars
- 07 Designing and Selling C&I Storage Systems**
WEBINAR – 9:30-11:30am; www.calssa.org/webinars
- 07 Succeed When You Leave: Strategies for Ensuring Persistence of Savings on Energy Projects**
WEBINAR – 2pm EST; www.cxenergy.com/cxenergy-virtual-schedule
- 07 National Community Solar Partnership**
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- 04-05 Solar and Energy Storage Texas**
Hyatt Regency Hotel – Houston, TX; www.events.solar/texas/
- 08-09 f-cell+HFC 2020 Hydrogen and Fuel Cell Event**
Vancouver Convention Centre – Vancouver, BC; www.hyfcell.com
- 09-10 Tax Equity Structures & Solutions for Today's Renewable Projects**
Virtual Master Class – 9am - 1:15pm PST; www.infocastinc.com
- 16-17 Solar Power Puerto Rico**
Puerto Rico Convention Center – San Juan, Puerto Rico; www.events.solar/puertorico/
- 18 Summer Solstice Celebration**
Governor's Residence – Denver, CO; www.cossa.co/solstice

JULY

- 06-09 NABCEP Continuing Education Conference**
St Charles Convention Center – St Charles, MO; www.nabcep.org
- 09-10 Community Solar Power Summit**
Philadelphia Marriott Old City – Philadelphia, PA; www.events.solar/community-solar/
- 26-28 ESA's 2020 Annual Energy Storage Conference & Expo**
David L. Lawrence Convention Center – Pittsburgh, PA; www.esacon.energystorage.events.org
- 27-29 2020 SEPA Grid Evolution Summit**
Washington, DC; www.sepapower.org/event-complex/2020-sepa-grid-evolution-summit/

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