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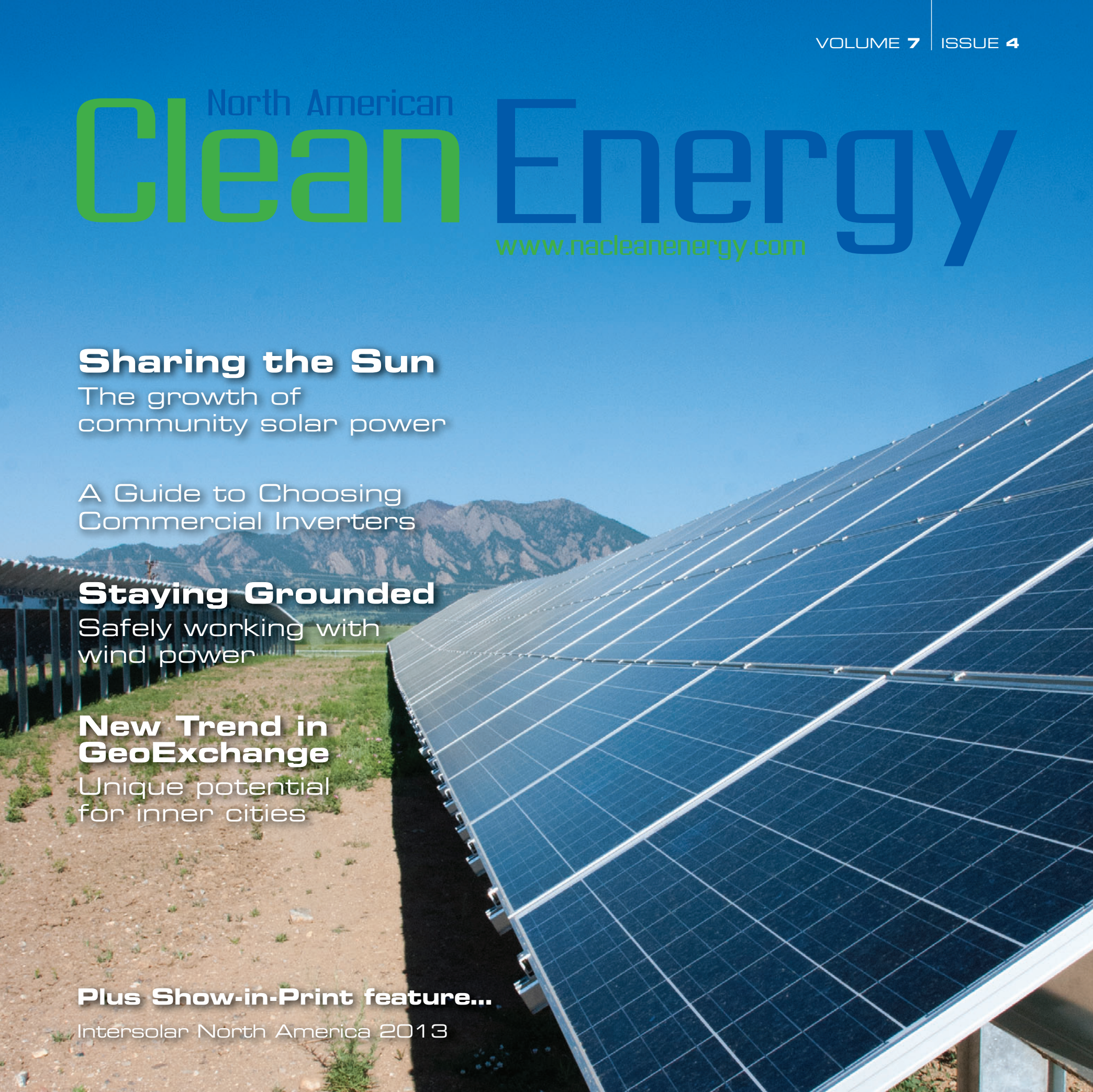
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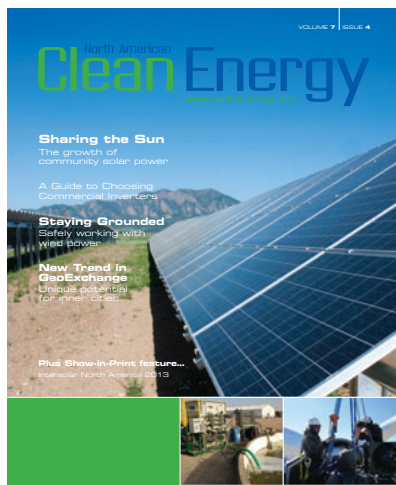


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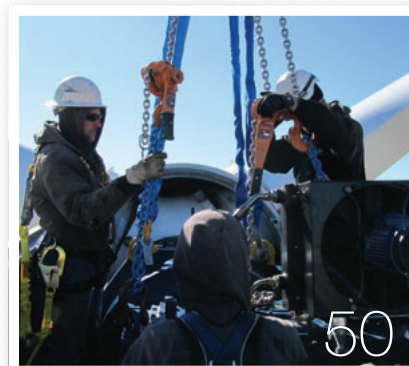
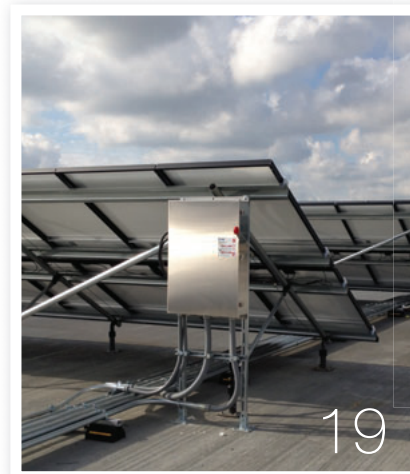
On our cover...

The 500 kW Boulder Cowdery Meadows Solar Array is the first community solar project built under Xcel's Solar*Rewards program. Read more on page 22.

Cover photo courtesy of: Ti Tower of Clean Energy Collective | www.easycleanenergy.com

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Photo by Michelle Moore



If there's any truth to the statement that there is safety (or strength) in numbers, then the solar energy market is having a good year in the United States. Despite the still sluggish economy, solar power has demonstrated one of its strongest first quarters to date, and what is expected to be another record year

for the industry. According to SEIA/GTM Research "US Solar Market Insight: Q1 2013," 723 megawatts (MW) of photovoltaic (PV) capacity were installed in the first quarter of 2013, representing a 33% increase in deployment levels over Q1 2012. The US now has over 8,500 MW of cumulative installed solar electric capacity—or enough to power more than 1.3 million average American homes (www.seia.org).

Perhaps of greatest note is the ever-increasing popularity of residential systems, which are showing a 53% year-over-year growth. This could be attributed to lower system costs (the average residential PV system price fell to below \$5.00 per watt) but, possibly, also to a basic preference for renewable energy. A recent Gallup poll found that 76% of Americans think the country should put more emphasis on developing solar power (www.gallup.com).

Trends in developing solar power seem to be shifting, however, at least residentially. Per the SEIA/GTM Research report, third-party owned (TPO) residential systems are representing a large portion of installations, particularly in states such as California and Arizona. Whether by lease or power purchase agreement (PPA), third-party financing is becoming the leading method by which homeowners can afford to install solar. This method allows host customer to purchase the services produced by a PV system, rather than the system itself.

And, for those who simply can't install solar (it's estimated about 75% of the population cannot because of rental, shading or, or cost restrictions), the power of the sun is not lost. Community-owned solar projects are becoming more prevalent than ever before. Also known as solar gardens, these projects enable members of a specific neighborhood or community—from homeowners to renters—to pool resources and share in the benefits of a single solar installation. In some cases, it's even possible to personally buy a panel or two, with the collected solar power offsetting some of the purchasing customer's home energy usage.

This issue's cover image showcases the first of four community solar projects currently being constructed in Colorado, under the state's Community Solar Gardens Act legislation implemented last year. The 500 kilowatt (kW) Boulder Cowdery Meadows Solar Array is also being completed under Xcel Energy's Solar Rewards Community program, which allows a utility's ratepayer to directly purchase energy from offsite solar gardens. Check out the article on page 22 for more information on community-shared solar projects.

Of course, solar power isn't the only form of renewable energy worth "sharing." The US leads in global production of small wind turbines (with capacities of 100 kW or less), and the residential and community market is expected to grow locally, as well as in less developed countries (check out pages 40 and 42). Geothermal energy, or more precisely geexchange, is also proving to be a potential clean energy solution, especially for large cities like New York (read more on page 71).

It would seem the more options and choices the better when it comes to harnessing renewables and developing more environmentally friendly communities. As the saying goes, there is safety in numbers.

Enjoy the read!

Michelle Froese



Putting turbines to the test

According to the American Wind Energy Association (AWEA), there are roughly 8,000 component parts in a utility-scale wind turbine—including the blades, rotors, generator, and other parts located inside the nacelle. To ensure safe and efficient operation, proper parts and component testing is necessary in the industry. To this end, The Department of Energy has recently launched a new site with information that's dedicated to supporting wind turbine testing and certification.

Check out www.wind.energy.gov/wind_testing_cert.html

US DOE | www1.eere.energy.gov

Condition monitoring system certification

GL Renewables Certification (GL RC) has published its new "Guideline for the Certification of Condition Monitoring Systems for Wind Turbines," compiled in cooperation with its Wind and Marine Energy Committee. Obtaining economical wind turbine operations is vital in light of initial wind farm development costs. Operators and manufacturers aim to achieve wind turbine availability of more than 97%. To reduce unplanned downtime and maintenance costs, continuous condition monitoring of wind turbines is indispensable. The updated guideline reflects the latest developments for wind turbines and future requirements.

"Currently almost all condition monitoring systems are operating independently from the control system, and almost exclusively the drivetrain is monitored," explains Dr Karl Steingroever, GL RC's expert for condition monitoring systems. "Future condition monitoring systems will be partly or fully integrated into the control system, and include the monitoring of the entire wind turbine. In this context, the definition of interfaces between the systems is playing a major role."

GL Renewables Certification | www.gl-group.com

US attracting M&A activity

A new report, entitled "Green Energy 2013: Renewable Energy M&A Activity in the Americas," has been released by CohnReznick LLP in collaboration with Clean Energy Pipeline, focusing on mergers and acquisitions (M&A) activity in the renewable energy (RE) sector in the Americas. Based on a survey of more than 800 senior executives in the RE industry worldwide, the results showed that the United States is by far the most attractive country for investors, with almost 45% of survey respondents planning to invest in or acquire in the US RE sector during the next 18 months. This more than doubles the number targeting second place Germany. Globally, a total of 591 acquisitions valued at \$37.8 billion were announced in 2012, a 58% increase by number on the 375 deals totaling \$42.1 billion announced in 2011.

Some report highlights:

- The Americas accounted for 42% of the total value of M&A deal activity last year;
- Wind and solar were the most active sectors, accounting for a combined 78% of the total value of all transactions; and
- Solar is the most attractive sector for North American survey respondents. Some 63% of survey respondents are targeting investments or acquisitions in solar PV, more than the number targeting biomass (45%), onshore wind (41%), or biofuels (39%).

A full copy of the report can be downloaded at www.cohnreznick.com/green-energy-2013.

CohnReznick LLP | www.cohnreznick.com

Price-competitive PEV's

Consumers who purchase an electric vehicle will find the ownership costs are competitive with conventional and hybrid vehicles, according to analysis conducted by the Electric Power Research Institute (EPRI). Based on pricing for the 2013 model year, the study considered several factors, including gasoline and power prices, incentives, financing, driving patterns, and maintenance.

The cost advantage of plug-in electric vehicles (PEVs) increases as gasoline costs rise, and decrease as they fall. If a buyer finances a vehicle purchase, total monthly expenditures for all options will be within 15% of the conventional vehicle purchase. So, PEVs are competitive with lower gasoline costs—payback will simply take a little longer.

The full EPRI report can be downloaded online.

The Electric Power Research Institute, Inc. (EPRI)
www.epri.com



PV power-rating suite

The Solar America Board for Codes and Standards has stated that there's an urgent need to characterize PV modules at different temperatures and irradiances to provide more comprehensive rating information. TÜV Rheinland Photovoltaic Testing Laboratory has responded by launching a new, power-rating suite for PV modules that will allow banks, investors, EPC's, and other stakeholders advanced and validated performance characterization of their products under various real-life conditions.

Specific engineering evaluation services provided within the new power-rating suite include: a complete irradiance versus temperature matrix; spectral response; incident angle effects, with best practices for evaluating light induced degradation (LID) and module operating temperature as a function of wind speed; ambient temperature; and irradiance incident on the module. This suite also uses a statistical method of sampling to report entire lots of PV modules. This service is offered for all countries and regions, and there are no limitations to the type/certification of a product to be tested per IEC 61853.

TÜV Rheinland Photovoltaic Testing Laboratories
www.tuv.com/us/ptl



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U.S. Weighs Legislation To Cut Renewable Energy Capital Costs

— *Businessweek*

4/30/2013

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To succeed in the **renewable energy industry**, you need more than technical accounting expertise. You need proactive insight, market-focused advice, and guidance that helps developers, lenders, and investors achieve success from their investments in renewable energy. Find out what CohnReznick thinks at CohnReznick.com/renewableenergy.

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Developing Renewable Power Projects

And the continued relevance of PURPA

By Larry Eisenstat (*left*) & Diana Jeschke (*right*)



Less than 10 years ago, the Public Utility Regulatory Policies Act of 1978 (known as PURPA or the “1978 Act”) was thought of as a relic of the pre-competitive era, headed for the scrap heap of history. Yet, PURPA remains a viable and important development tool for renewable power and cogeneration projects, especially in states that have yet to develop wholesale competitive markets. PURPA’s resilience underscores the enduring effectiveness of the original law, and the significant growing pains that the wholesale capacity markets have experienced.

Original PURPA statute

The 1978 Act* required electric utilities to purchase energy from qualifying cogeneration facilities and qualifying small power production facilities (QFs) at either the utility’s avoided cost or at a negotiated rate (the “mandatory purchase” provision). Generally, a small power production facility refers to a facility of not greater than 80 megawatts (MW) of production capacity, which uses biomass, waste, or renewable energy sources, such as wind, solar, or water, to produce electric power.

PURPA Section 210(m): A presumption of non-discriminatory access

The Energy Policy Act of 2005 added Section 210(m) to PURPA, providing for termination of the “mandatory purchase” requirement if, upon application by a utility, FERC determined that a QF would have non-discriminatory access to competitive markets.

FERC’s regulations under Section 210(m) created a rebuttable presumption that most of the FERC-approved regional transmission organizations and independent system operators (RTOs/ISOs) qualify as competitive markets. As a result, many utilities within those markets have sought and received relief from the mandatory purchase provisions of PURPA, pursuant to Section 210(m).

To date, FERC has found that the markets administered by the following organizations or operators are competitive markets: Midwest Independent Transmission System Operator, Inc. (which was subsequently renamed Midcontinent Independent System Operator, Inc. or MISO); PJM Interconnection, LLC (PJM); ISO New England, Inc. (ISO-NE); New York Independent System Operator, Inc. (NYISO); and the Electric Reliability Council of Texas, Inc. (ERCOT). FERC also found the markets administered by the Southwest Power Pool, Inc. (SPP) and California Independent System Operator (CAISO) satisfy some of the requirements under Section 210(m), such that a member utility of CAISO and SPP may also be exempted from the “mandatory purchase” obligation, with some additional showings.

Accordingly, many utilities within these markets have sought and received exemptions under Section 210(m). Moreover, QFs larger than 20 MW, which are interconnected with these exempted electric utilities, are now presumed to have non-discriminatory market access, and cannot invoke the mandatory purchase provisions.

Recent developments in state PURPA implementation

Although many RTO/ISO member utilities have been relieved from their PURPA mandatory purchase obligations, not one utility has been able to secure an exemption from its mandatory purchase obligation outside of the FERC-regulated RTOs/ISOs. Put simply, PURPA implementation has effectively been balkanized since passage of the 2005 Energy Policy Act—a mix of regions where the mandatory purchase requirement (rebuttably) no longer applies; and a critical mass of states where the 1978 Act continues to apply as it did 30 years ago. Clearly, a lot has been happening in some of these states as shown by the following examples.

• **California.** In 2007, California enacted the Waste Heat and Carbon Emissions Reduction Act (AB 1613), requiring the state’s investor-owned utilities to offer to purchase and deliver to the grid electricity generated by certain combined heat and power (CHP) generators. Implementing AB 1613, the California Public Utilities Commission (CPUC) mandated that the state’s investor-owned utilities offer a specified price to CHP generating facilities of 20 MW or less for purchase of electricity.

The CPUC also sought a declaratory order from FERC that implementation of AB 1613 wasn’t pre-empted by federal law. FERC granted the petition in part, determining that with regard to CHP facilities, which qualified as QFs, AB 1613 wasn’t pre-empted by the Federal Power Act so long as the CPUC rate didn’t exceed avoided cost.

• **Idaho.** Following a request from Idaho Power Company, Avista Corporation, and PacifiCorp d/b/a Rocky Mountain Power, the Idaho Public Utilities Commission (IPUC) opened an investigation, and, in 2011, reduced the QF eligibility criteria for published avoided cost rates from 10 average megawatts to 100 kilowatts (kW), effective retroactively to December 14th, 2010. The IPUC then rejected a number of QF agreements, which contained rates in excess of those permitted under and in effect pursuant to the new avoided cost rate eligibility criteria (because they weren’t fully executed until after December 14th). QF developers disputed IPUC’s findings regarding the agreements’ effective date, petitioning FERC to initiate an enforcement action against the IPUC.

FERC found that IPUC’s determination of the agreements’ effective date was contrary to PURPA and FERC’s implementing regulations because the IPUC failed to recognize that, under PURPA, a legally enforceable obligation could arise prior to the date of a contract’s formal execution—even if the contract never was to be fully executed. Upon presentation with a third instance of the IPUC violation, FERC announced its intent to act and, accordingly, initiated an action against the IPUC. This matter is currently pending in the United States District Court, District of Idaho. The proceeding marks the first time where FERC has exercised its enforcement authority against a state agency since PURPA’s enactment.

Future developments

The 1978 Act is fully in effect with regard to utilities that aren’t members of RTOs/ISOs, as evidenced by FERC’s recent enforcement action against the IPUC. QF developers in those states may continue to utilize PURPA’s mandatory purchase provisions to develop qualified projects. (Invoking the mandatory purchase requirement, of course, isn’t dispositive, since the developer must also demonstrate that its costs are at or below the purchasing utility’s avoided cost.)

However, PURPA is by no means forever obsolete, even in the RTO/ISO organized markets. Although QFs are now presumed to have non-discriminatory access to these

markets, and many utilities within these regions presently aren't subject to PURPA's mandatory purchase obligation, this presumption is rebuttable. It is by no means obvious why non-discriminatory access to transmission should be equated with non-discriminatory access to markets—the latter being the governing standard for exemption under Section 210(m).

In its order implementing Section 210(m), FERC determined that factors such as “operational characteristics and transmission limitations are not susceptible to a clear demarcation for purposes of establishing a rebuttable presumption,” choosing instead not to make any final determinations “as to whether any such factor, standing alone, is sufficient to rebut the presumption of market access.” Nonetheless, FERC still “agreed with commenters that these [and other] factors are relevant to the question of whether the purchase obligation should be terminated and, upon an appropriate evidentiary showing, may be sufficient to rebut that presumption.”

Specifically, FERC listed the following examples:

- “The QF has certain operational characteristics that effectively prevent its participation in a market [such as]: (a) highly variable thermal and electrical demand (from the QF host) on a daily basis, such that the QF cannot participate in a market; or (b) highly variable and unpredictable wholesale sales on a daily basis.”
- “The QF has no access to a mechanism to schedule transmission service or make sales in advance on a consistent basis, either because of the variability of the QF's electric energy production or because of market rules that prevent the QF from scheduling transmission service or participating in organized markets. Such operational characteristics might include, but are not limited to, dispatchability or some other characteristic.”
- The QF is “located in an area where persistent transmission constraints in effect cause the QF not to have access to markets outside a persistently congested area to sell the QF output or capacity [in which case] the Commission will consider [among other things] the opportunity for QFs, on a non-discriminatory basis, to obtain transmission upgrades to relieve constraints and whether the structure of the relevant market provides for the opportunity for the QF to sell notwithstanding the constraint.”

In short, FERC has recognized that numerous characteristics might prevent QF participation in a market, ranging from the variability of a QF's energy production, to the existence of a given market rule that prevents the QF from scheduling transmission service, or otherwise from fairly participating in the market in general.

Accordingly, even as to RTOS/ISOs, if a QF can show that it's unduly disadvantaged with respect to market entry in a given organized market, it should be able to make a strong case for rebutting FERC's market access presumption, and for reviving PURPA's “mandatory purchase” requirements in such areas.

* References and case citations for this article available upon request.

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Transforming Solar Laws Into more clean energy

By Jack Jacobs

SINCE IT'S INCEPTION, the United States has always been a place of innovation. From unique ideas of governance to high-tech gadgets, America has often been able to impress the world with its forward-thinking concepts and tireless originality. But, renewable energy has been slower to catch on in the US compared to other parts of the world, despite growing demand, abundant natural resources (such as solar, wind, and biogas), improving technology, and an increasing number of laws and policies.

Although many states have policies on their books designed to encourage the growth of renewables, only some have been successful at transforming those laws into clean energy. Not only determining which of those states have the most comprehensive solar policies in place, but also assessing whether or not those laws have actually led to increased generation of solar power, is good knowledge to have prior to the start of a solar power project.

In terms of numbers, there are a few clear winners with regard to those using their legislatures power as a mechanism to encourage the growth of renewable energy. The following table shows the top five states with the most solar energy laws and policies:

State	Solar Laws & Policies
1. Oregon	15
2. Maryland & New Mexico	14
3. Massachusetts & New York	12
4. Connecticut	11
5. California	10

Source: (DSIRE)

It's certainly true that the laws a legislature passes are often an accurate representation of a state's ideology, but the real test of legislative power is whether a bill can bring about the positive change intended by its drafters.

Accordingly, Oregon—the state with the most solar laws with a total of 15—should be adding more green electrons onto the grid each year than any other state. However, Oregon ranked 15th in the nation in installed solar PV capacity in 2012 (according to the Solar Energy Industries Association or SEIA). With the exception only of California, the states with the most solar laws did not attract more solar energy development. Similarly, New Mexico, the state with the second largest number of laws on the books, ranked 18th in its annual installed PV capacity for 2012 (see SEIA for a full ranking by state; www.seia.org).

State	Installed PV (MW) 2012
1. California	1032.7
2. Arizona	710.3
3. New Jersey	414.9
4. Nevada	198
5. North Carolina	131.9

Source: (SEIA)

Solving the law

Unfortunately, America's increasing arsenal of renewable laws and regulatory programs has been relatively ineffective at increasing the amount of clean energy produced. As a result,

the country's production of renewables still account for only a small sliver of the national energy pie.

The solution to the success of the renewable energy market may lie in the quality of legislation enacted, rather than the sheer quantity of laws passed. In this regard, legislators would be wise to sit down with industry leaders and work to tweak legislation, so it's in tune with the practical needs of businesses.

If this conversation happened, it likely wouldn't be a stretch to conclude that a revival of the federal cash grants would take place, aimed at reimbursing owners of solar energy projects—rather, than the continuation of current tax credits, which mostly benefit high net-worth individuals and corporations with enormous tax appetites.

It's also plausible that a smart feed-in tariff law that creates an economic incentive to conserve power, instead of net-metering legislation that encourages generators to use all the power they produce, would be enacted. And, ideally, a federal renewable portfolio standard would be passed, which would challenge the nations' utilities to develop clean energy resources, rather than rely on the existing patchwork of state standards that vary drastically across the US.

One cannot help but notice only Alabama (0), Mississippi (0), and Tennessee (2) have enacted fewer rules, regulations, or policies for renewable energy than the US federal government (see the Database of State Incentives for Renewables & Efficiency or DSIRE; www.dsireusa.org). Other than an energy efficiency guideline and interconnection requirement, Congress has been largely absent from the efforts to use its legislative authority to invigorate the renewable industry.

With a few swipes of the pen, Congress could change the energy paradigm in the United States forever by enacting a federal renewable portfolio standard, passing a national feed-in tariff, and giving cash-grant incentives for clean energy project owners. Some argue the most important step the federal government could take now is to remove the massive subsidies given to the oil and gas industry, thereby allowing natural market forces to take hold and level the playing field.

The US has been sitting at the crossroads of renewable energy for the many years. Vacillating between maintaining the stagnancy of the *status quo* by enacting ineffective laws and antiquated policies that discourage growth, instead of the forward-thinking policies that could propel the industry forward.

If used properly, the law can be an effective tool, encouraging development of the renewable energy industry and a stronger, healthier environment for future generations. But, when misused, the law can delay progress and inhibit natural growth. A few smart tweaks could revive the nation's renewable energy laws and help push the solar power industry forward.

Jack Jacobs is the founder and a managing partner of Cleantech Law Partners, a full-service law firm that caters exclusively to the legal and policy needs of renewable energy project developers and cleantech companies.

He wrote the article with assistance from Matt Gluschkoff.

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Reducing System Costs With solar-powered smart modules

By James Bickford & Jing Tian

THE PRICE OF SOLAR CONTINUES TO DROP and the industry continues to grow. Recent report findings show that the installed price of solar dropped more than 24% over the previous year. At the same time, PV installations grew 33% last quarter compared to the Q1 of 2012*. These ever-declining prices mean that more projects can be sold to more customers. This is why the industry is hard at work and looking to squeeze every last penny of efficiency out of the products it produces.

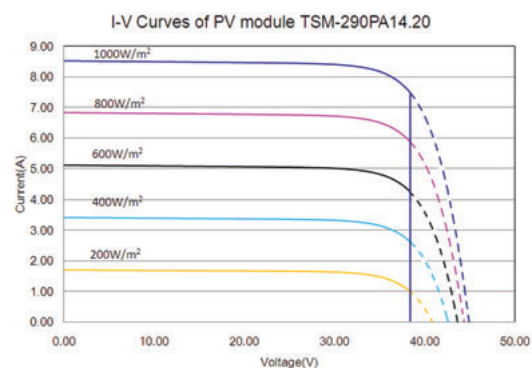
One way to do this is to increase the number of modules that are in a series of panels. The advantages of doing so are clear: more modules mean more energy. And so, the US solar energy industry continues to remain competitive and innovative, pushing from 600 volts (V) to 1000 volts (V). At the same time, news from Europe about the benefits of higher voltage systems, but with lower panel costs per watt, is garnering attention. In order to derive such benefits, fewer strings per watt of energy produced by a solar system are required. Having fewer strings per watt of energy also means having fewer combiners, fuses, disconnects, DC feeders, etc.—saving costs while generating more efficient power.

If this doesn't quite add up, just think of it as adding more seats to a bicycle. More cyclists can produce more power, but while still only riding on two wheels.

Smart thinking, smart modules

To enhance energy output even further, some solar companies are integrating smart module voltage regulation. Smart module voltage regulation reduces the maximum voltage of a module, while increasing the maximum number of modules that can be connected in series. This achieves the same benefit as moving to a higher maximum system voltage, and can be used in 600 V and 1000 V architectures.

A recent whitepaper by SMA North America indicated that the benefits of moving from a 600 V to a 1000 V system could be as high as savings of \$0.10/watt. On a one-megawatt (MW) array, this represents \$100k in savings as compared to a traditional 600 V system. This also represents a three percent reduction in overall system cost, providing a fairly dramatic advantage to the return on investment many investors see from their arrays.



ELECTRICAL DATA @ STC	TSM-285 PC/PA14	TSM-290 PC/PA14	TSM-295 PC/PA14	TSM-300 PC/PA14	TSM-305 PC/PA14
Peak Power Watts-P _{MAX} (Wp)	285	290	295	300	305
Power Output Tolerance-P _{MAX} (%)	0/+3	0/+3	0/+3	0/+3	0/+3
Maximum Power Voltage-V _{MP} (V)	35.6	36.1	36.6	36.9	37.0
Maximum Power Current-I _{MP} (A)	8.02	8.04	8.07	8.13	8.25
Open Circuit Voltage-V _{OC} (V)	44.7	44.9	45.2	45.3	45.4
Short Circuit Current-I _{SC} (A)	8.50	8.53	8.55	8.60	8.75
Module Efficiency η _m (%)	14.7	14.9	15.2	15.5	15.7

Values of Standard Test Conditions STC (Air Mass AM1.5, Irradiance 1000W/m², Cell Temperature 25°C). Power measurement tolerance: ±3%

Figure 1.

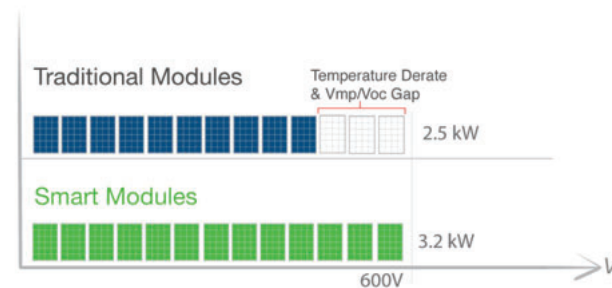


Figure 2.

The IV curve of a typical 72-cell module is shown in Figure 1. In the IV curve of this module, the open circuit voltage (Voc) is approximately 44.9 V at standard testing conditions. National Electric Code requires system designers to use the coldest day of the year to determine the modules' maximum voltage. Since the majority of systems in North America have minimum temperatures around -10° C (14° F), the maximum voltage used for this module must be 50.1 V.

When designing a system for North America, installers typically have a 600 V maximum safety rating. Dividing this by a module's maximum voltage yields the number of panels that can fit in a single string, while still remaining within the NEC code. For the 290-watt (W) panel shown in Figure 1, a system designer can install 11 modules (600/50.1 = 11.9).

With smart modules, the maximum voltage can be programmed in the factory, so the Voc is not only significantly lower, but also so the module's maximum voltage doesn't change with temperature fluctuations. This means that the Voc of a module and the maximum voltage of a module at -10° C (14° F) are the same (39.2 V). It also means that for a 600 V system, a designer can wire 15 modules in series (600/39.2), which is a 36% advantage over a traditional configuration. Note that this benefit is also true for a 1000 V system, wherein a smart module array would enable 25 modules connected in series, versus only 19 in a traditional module.

Since the voltage at maximum power of a module is six percent lower than the new voltage limit, this feature is rarely activated when a system is "on" or the inverter is drawing current. Realistically, it's only a few times a year when the voltage maximum power of a module increases to 39.2 or above (on very cold days) and, therefore, would require the optimizer to limit voltage. But even on these days, the module wouldn't lose power, as the smart module simply raises the amperage from that module, keeping the voltage at 39.2 V.

As mentioned, the great thing about this approach is that it has the same benefit for 600 V and 1000 V systems. So, as the US makes the transition to 1000 V systems, designers and installers can increase their modules per string by roughly 30% over traditional designs in either voltage environment. This reduces the number of balance of systems (BoS) components per string by around 25%, making install times 25% faster.

Overall, this benefit translates into about \$0.07/watts of savings for a typical commercial array in North America. These real-world savings demonstrate the kind of innovative technology that's necessary to ensure the price of solar energy continues to decline in the upcoming months and years. And, at the same time, declining prices will help to push forward and promote solar power's impressive growth.

* According to the "US Solar Market Insight: Q1 2013" report from SEIA/GTM Research; www.seia.org/research-resources/solar-industry-data

James Bickford is the director of Global OEM Channels for Tigo Energy; and Jing Tian is the director of Product Marketing at Trina Solar.

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With efficient control & conversion devices

By Bernard Richard, Claude Gudel & Stéphane Rollier

FOR YEARS, GERMANY HAS PAVED THE WAY as a global leader of solar photovoltaic (PV) installations, exemplified by their current capacity of over 30 gigawatts (GW) of pure solar power. For some perspective, that figure comes to about 24 times the amount of solar capacity in all of California, the solar energy leader in the United States.

Currently, Germany has a goal of producing 35% of electricity from renewable sources by 2030 and 100% by 2050. Lofty ambitions, perhaps, but the pioneering position on PV adopted by that country is slowly being repeated by others worldwide, as illustrated by Tables 1 and 2. Certainly, China is quickly catching up, but even the US is making strides. Every two years, for example, the US is doubling the amount of PV power connected to the grid, with the largest proportions being in California, followed by Florida.

As with any manufactured product, economies-of-scale also apply to solar power. And, as production volumes increase, prices for PV systems are decreasing, garnering some added attention from potential investors. Although greater interest is a good thing if other countries, such as the US, are ever to catch up to Germany, a trend in lower-cost systems can also lead to some heated discussions related to earlier system costs. At a certain point, initial preferential purchase prices for the kilowatt-hours (kWh) agreed upon might have to be re-negotiated to lower prices.

To meet increasing production demands, while reducing capital investment costs and purchase prices, efficiency becomes more significant than ever before. This isn't only true at the panel or module level but—if solar power is to ever become a widespread form of clean energy—at the conversion level as well. To maximize profitability, power must be fed to the grid with ease and efficiently.

Proper measures

In 2010, the cost to produce electricity from solar PV was in the range 0.16 to 0.20 \$/kWh (see Figure 1), as compared to about 0.10 \$/kWh to 0.15 \$/kWh for fuel cell and 0.04 \$/kWh to 0.07 \$/kWh for a wind turbine. For comparison's sake, electricity from coal-fired plants costs in the range of 0.05 \$/kWh to 0.06 \$/kWh.

About 98.9% of the energy produced by solar installations is connected to the grid via an inverter, and referred to as grid-connected (see Figure 2). The remaining 1.1% is not connected to the grid, and this off-grid power is often utilized to charge batteries for any local applications.

Whether grid-connected or off-grid, all solar PV installations require an accurate measurement of the generated current for efficient control of the inverter and for protection purposes. Today's market offers a choice of different inverters, each with their own advantages and their drawbacks, depending on the purpose (size, efficiency, weight, range, galvanic insulation, etc). For example, connection of a solar array through an inverter to the grid can be made directly or indirectly with the use of a transformer. Transformerless installations tend to be more time and cost-effective, but have no galvanic isolation, with a consequent risk of leakage.

Ultimately, choice is based on the project and the cost. Four main inverter designs are commonly available. Two designs, MPPT and DC current, use a transformer (at low or high frequency). The two other designs, DC current injection and leakage current, are transformerless and come with or without a DC chopper or step-up converter.

Hitting targets

For inverters to achieve the targets necessary in terms of accuracy with small currents, an efficient measuring and conversion device is required. To this end, closed-loop current transducers measure current over wide frequency ranges, including DC. They provide contact-free coupling to the current that needs to be measured, in addition to safe galvanic isolation and high reliability. Their output signal is a high-resolution image of the primary current with a very short delay.

New technology is now available in the form of a closed-loop fluxgate, or the CTSR current transducer range. A CTSR transducer exhibits certain differences from standard closed-loop transducers. For one, the Hall element used for feedback is replaced by a fluxgate detector, which provides better feedback—"better" in this case because it offers a higher voltage developed per unit of current linkage (a quantity that's called open-loop sensitivity). The fluxgate's low offset drift also explains its selection.



CTSR xx-P and TP current transducers

Country	Total installed in (2009) Gigawatts (GW)	Country	New installed capacity (2009) Gigawatts (GW)
Germany	9.779	Germany	3.800
Spain	3.386	Italy	0.730
Japan	2.633	Japan	0.484
United States	1.650	United States	0.477
Italy	1.186	Czech Republic	0.411
South Korea	0.520	Belgium	0.292
Czech Republic	0.465	France	0.185
Belgium	0.363	South Korea	0.168
China	0.305	China	0.160
France	0.272	Spain	0.069
India	0.120	Greece	0.036
Worldwide Total	22.893	Worldwide Total	7.216

Numbers include grid-connected and off-grid PV systems

Table 1. Total solar PV energy installed per country at the end of 2009 | Solar PV capacity installed in 2009

Country	New installed capacity (2009) Gigawatts (GW)	Country	New installed capacity (2010) Gigawatts (GW)
Germany	0.381	Germany	7.418
Spain	0.091	Italy	4.000
Japan	0.490	Japan	0.904
United States	0.510	United States	0.977
Italy	0.750	Czech Republic	1.490
South Korea	0.100	Benelux	0.417
Czech Republic	0.410	France	0.852
Benelux	0.292	South Korea	0.130
China	0.186	China	0.400
France	0.351	Spain	0.205
India	0.035	India	0.077
Greece	0.040	Greece	0.104
Worldwide Total	7.435	Worldwide Total	18.092

Numbers include grid-connected and off-grid PV systems

Cumulative installations GW worldwide as of year-end 2009: 21.5 GW; and as of year-end 2010: 39.6 GW

Table 2. Solar PV capacity installed in 2009 & 2010 per country | Total solar PV energy installed in 2009 & 2010

The magnetic head of the CTSR has been optimized to measure the residual current (the algebraic sum of the currents flowing in the wires that pass through the aperture of the transducer). This residual current should be a maximum of only a few hundred milliamps (mA), compared to the main current, which usually consists of several tens of amps in each wire.

The CTSR embodies a number of additional functions that enhance its applicability to the PV inverter residual-current measurement problem:

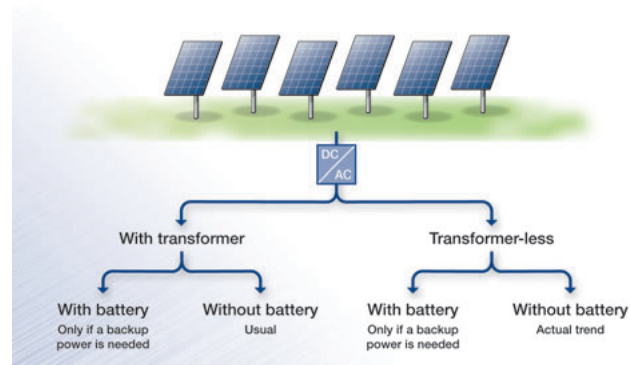
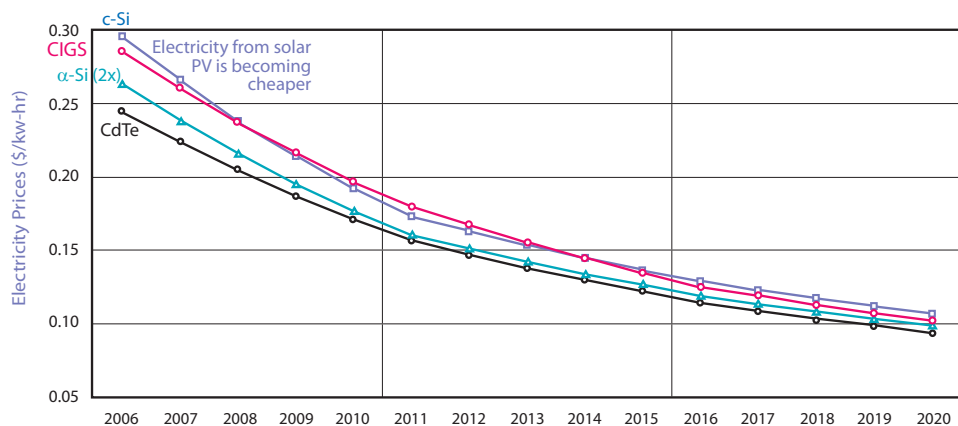


Figure 1. Cost comparison of PV energy (Source: Deutsche Bank)

Figure 2. Grid-connected solar installation

- It contains a self-test function activated via the reference pin, which verifies correct operation;
- It has a demagnetization function, also accessed through the reference pin or at “power-on,” which removes any magnetization offset; and
- It’s suitable for use on single-phase and multi-phase grids.

The complexity of a fluxgate-based current transducer is comparable to that of a transducer based on a Hall effect IC (integrated circuit). In both, some AC signal processing and synchronous rectification is applied. The fluxgate transducer, however, also requires a detector. Despite the complexity of the signal chain, use of a custom IC keeps the device at a competitive cost level in comparison to Hall effect current transducers.

Conclusion

Solar energy has been making headlines on the global market for some time now, especially in European countries such as Germany. As the rest of the world is trying to catch up, the PV industry isn’t slowing down, pushing forward with ever-changing technologies and more cost-effective systems.

With decreasing product costs and purchase prices, solar energy companies must find ways to remain competitive in today’s market. Reliability and efficiency have become driving factors in PV installations and, ideally, should be seen at every level—from the panel to the inverter to the grid. Conversion electronics can help ensure maximum profitability and returns when feeding power to the grid. Advanced transducer technology provides one key element that can help support and enhance the quality, reliability, and efficiency of that new generating capacity.

Bernard Richard is the business development manager for Renewable Energy and Power Supply at LEM. Claude Gudel is the Research & Development senior engineer for the company, and Stéphane Rollier is LEM’s Product and MarCom manager.

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Solar tracking system

DEGER's new generation of tracking systems combines numerous technical enhancements with a price level that's more than 20% lower than before. The new systems are faster and easier to assemble, providing a greater yield. The first product in this new generation is the DEGERtracker D100, wherein the development engineers at DEGER increased the angle of elevation (which now ranges from 10° to 90°), while reprogramming the MLD sensor. In addition, the D100 features a more developed version of the EK-6 energy converter. With these improvements, greater yields can be achieved with less sunlight, such as at sun-up and sundown.

DEGER also simplified the electrical installation: sensor technology and connecting cables in the DEGERtracker are pre-assembled, so the cable routing and strain relief are already prepared. Wiring inside the system is superfluous, and possible sources of error during installation have been largely eliminated. This further reduces costs and installation time.

DEGER | www.degerenergie.com



Compact connector

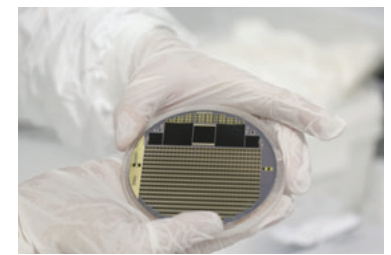
Anderson Power Products (APP) introduces the 3 Position Mini PL connector. This compact, environmentally sealed (IP68) connector is capable of 22 amps at 600 volts (UL). The 3 Position Mini PL connector features a manual release latch to prevent accidental un-mating, and is touchsafe on both sides (per UL 1977 section 10.2). Its rugged shell is fire-resistant (UL94 V0) and weather-resistant (UL746C F1). The 3 Position Mini PL leverages PowerMod pin and socket contact technology. These 30μ gold plated contacts will accommodate wire sizes from 24 AWG to 14 AWG (0.50 mm² to 2.50 mm²). The pins are available in three lengths, providing sequencing capabilities for design flexibility.

Anderson Power Products
www.andersonpower.com

Failsafe solar safety

McCune Works Inc. and its subsidiary, McCune Solar Works, LLC, have announced a new, inexpensive family of patent-pending safety devices. Potential Voltage and Hazard Stop System will be available for licensing and distribution under the trademark PV Stop. PV Stop provides a failsafe method to switch off all solar panels, at the panels, for a higher degree of fire-scene safety. Fire fighters no longer have to consider blanketing solar panels, so as to allow water streaming and roof cutting in attacking a fire without concern for the potential voltage present. The PV Stop function is initiated by any signal available, remote or on site, or by an emergency stop button on the central unit. Solar installers can handle PV panel installations without concern for any hot leads, while handling the panels in sunlight. In addition, PV Stop shuts off any and all PV Stop-enabled hazards including (but not limited to): grid-supplied voltage; solar PV/CSP panels; backup generators; battery banks; wind turbines; gas; process piping; machinery; or any other utilization equipment. There are no building layout or distance limitations to the functioning of the system.

McCune Works Inc.
www.mccuneworks.com



Four-junction solar cell

Soitec recently announced the industry's first four-junction solar cell device, which works under concentrated sunlight—putting the company on the solar energy industry's technology roadmap at a world-class level of an outstanding 43.6% efficiency. Confirmed by the Fraunhofer ISE Calibration Laboratory, this technology was made possible through strong collaboration between solar cell device and epitaxial growth centers of expertise, combined with Soitec's decades-long leadership in substrate-bonding and layer-transfer technologies. This measurement was achieved at a concentration level of 319 (319 suns). The new cell has demonstrated more than 43% energy-generating efficiency over a concentration range between 250 and 500.

The four-junction cell uses two new, dual-junction sub cells grown on different III-V compound materials, which allows optimal band-gap combinations tailored to capture a broader range of the solar spectrum. This maximizes energy-generating efficiency. Soitec's innovative cell is designed to increase the conversion efficiency of commercial CPV systems to the highest level achieved by any PV technology to date.

Soitec | www.soitec.com



Certified, smart junction boxes

SolarEdge Technologies has obtained global certification for its second-generation smart junction boxes. The certification is not only valid for European IEC and EN, but for North American UL standards as well. SolarEdge smart junction boxes represent the module-embedded version of the SolarEdge power optimizer, incorporating power optimization, safety, and module-level monitoring into a junction box. The acquired certification allows module manufacturers to easily upgrade standard modules to smart modules, and is valid for all standard module categories worldwide. Due to its unique design and high efficiency, SolarEdge smart junction boxes have zero impact on a module's temperature.

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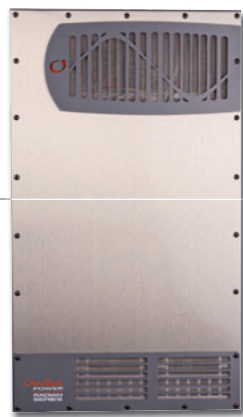
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Enhancing Panel Performance

Consider better backsheets

By Michelle Lamontagne

As solar continues to be the key element of the world's overall energy mix, the demand for panels has spurred the need for lower-cost technology to provide maximum durability and longevity for solar power projects. Although growth is undoubtedly good for the industry, solar panel manufacturers are left to not only design superior panels to successfully compete in the industry, but also expected to choose from a number of different components that enhance and protect their panels over time.

Photovoltaic (PV) backsheets are one of those components, and a significant one, as they play an important role in protecting and preserving solar panels over their lifetime. However, backsheets are available in various materials, using different design and construction elements, meaning solar panel manufacturers have a wide selection to pick and choose from. Though choices are nice to have, selecting the right backsheet for a specific panel or project can be challenging, as well as costly.

The key selection criteria to consider for PV backsheet materials are performance, price, and availability. Ensuring the best option for a particular application requires an understanding of each of these variables. Even though any associated differences might sometimes seem subtle or trivial, making an informed decision from the start can save time and capital. Perhaps, most importantly, it ensures panels perform durably and reliably for their expected lifetime, guaranteeing project efficiencies and warranties.

Backsheets over time

First developed for residential siding in the early 1960s, polyvinyl fluoride film was the original material of choice for backsheet construction. DuPont's Tedlar film paved the way in the industry. With a history of solid performance in demanding indoor and outdoor applications, Tedlar quickly became a popular and preferred choice of manufacturers.

In the original backsheet construction, Tedlar film was the "bread" of a two-layer material sandwich: two layers of fluoropolymer film flanked one layer of polyester (PET) in the middle. The early thinking was that it took two layers of fluoropolymer (T/P/T) to provide effective UV protection. However, over time, it became apparent that the two layers required a highly engineered, expensive product design. With fluoropolymer being the priciest layer in backsheet construction, and Tedlar becoming increasingly difficult to obtain, designers turned to other options. Some of these included single-layer fluoropolymer and non-fluoropolymer designs.

Growth & evolution

Along with material changes, technology advances and standards affected the growing backsheet industry. The development of the solar energy industry also placed demands on backsheet manufacturers and suppliers. Backsheets are now a key component of safe and effective solar module designs.

In terms of goals, successful backsheets presented with the following characteristics:

- UV protection;
- Moisture protection;
- Electrical insulation;
- Durability; and
- A role in helping panels generate power more efficiently.

As the current demand for backsheets has increased, the need for lower cost and higher durability has intensified. Changes in standards, for example, increased backsheet requirements and electrical insulation performance. The International Electrotechnical Commission (or IEC; the international standards and conformity assessment body for all fields of electrotechnology) mandated that a 1000 volts direct-current (VDC) partial discharge must be passed for panels, which meant a minimum backsheet thickness of ~300 mm. Technology and safety standards are always evolving for greater efficiency and safety measures. Fortunately, solar panel production commonly has quite a range of flexibility, and can be easily adjusted for production with new backsheet or encapsulation materials.

Today's backsheets

Today, it's common for manufacturers to test beyond the 1000-hour, damp-heat requirement, thereby placing greater importance on the durability of laminating adhesives. Design engineers can also select from not just one, but currently three different types of backsheet material constructions, depending on a project's requirements:

1. Double fluoropolymer

This is the Cadillac of backsheet component construction. As one might expect, it's at the

Did you know?

- The goal of backsheets is to provide UV and moisture protection, electrical insulation, and some degree of durability for solar panels.
- A high-performing laminating adhesive is important, as it can enhance film bonding for strength and durability.
- Ideally, solar panel production should offer a range of flexibility, so as to be properly adjusted for production with a new backsheet or encapsulation material.
- Production line methods vary. Some are manual and materials are physically put into place and fed into lamination ovens; whereas, others utilize robotic automation systems that fully automate the process.

top of the price scale—but, some might argue that you get what you pay for. Typically, double fluoropolymer is available as either double layers of Tedlar or double layers of Kynar. The two polymers are similar in quality performance, but Kynar is more readily available.

2. Single fluoropolymer

Developed as a more affordable option, single fluoropolymer still provides excellent performance and durability (contrary to what early thinkers believed), and utilizes just one layer of Tedlar or Kynar. It has quickly become the construction of choice for the majority of solar power applications.

3. Non-fluoropolymer

This third option is by far the most affordable, and it has steadily grown in popularity as module manufacturers migrate to more cost-effective alternatives. Despite its competitive price point, non-fluoropolymer is not only becoming a common choice from an economic perspective, but also from a performance one. So far, it hasn't disappointed, and has demonstrated an ability to support varying warranties.

New research shows the photovoltaics market is projected to reach \$155 billion in the next five years. At the same time, the solar industry is exiting a dark period marked by the loss of government and financial subsidies, strict competition, and consolidations. Solar panel manufacturers who think beyond just panels alone, and consider the quality of the components involved, have the opportunity to help successfully drive the renewable energy market forward. Backsheets that combine high-quality performance with a feasible price point best serve to support solar panels achieve efficiency and longevity, guaranteeing project success.

Michelle Lamontagne is the director of Photovoltaic & Barrier for FLEXcon.

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DC load break switches

Woehner USA has announced a range of Telergon's new S6000 DC load break switches. The new DC load break switches can be used in string combiner boxes, re-combiner boxes, and inverters for AC and DC applications and for non-fused, load-break switching. The DC applications are predominantly for PV and power conversion applications. The modular design of the S6000 DC load break switch allows the switch to achieve a smaller footprint in PV combiner box and inverter applications. The elimination of bridging link accessories reduces the total installation space, cost of building the unit, and saves on the amount of labor required. The new switches will be available in 2-, 3-, 4-, 6- and 8-pole configurations at ratings of 600 VDC to 1500 VDC.

Woehner USA | www.woehner.com/en/



Rotating rack xenon tester

Q-Lab Corporation has announced that the new Q-SUN Xe-2 xenon test chamber is now available for the weathering testing of materials and coatings used in the solar, wind, and renewable energy industries. Featuring a rotating rack design, reliable air-cooling, and a full range of optical filters for all major weathering standards, the Q-SUN Xe-2 tester is one of the simplest and most easy-to-use rotating rack xenon arc testers currently available. The Xe-2 tester complements its flat-array sibling, the Q-SUN Xe-3 test chamber.

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Changing with the Times

Evolving BoS components support maximum PV harvesting

By Brendan Foley



THE PV INDUSTRY IN THE UNITED STATES, and worldwide, has had strong growth over the past few years. In fact, the solar market in the US is expected to have another record year in 2013. A total of 723 megawatts (MW) of photovoltaic (PV) capacity were installed in the first quarter alone, which represents a 33% increase in deployment levels over Q1 2012*.

As the solar energy industry continues to grow and expand into new markets, projects have increased in size, accordingly. Certainly, there are more residential and commercial solar projects (residential projects actually grew by 53% in Q1 2013 over the same quarter last year), but there are also now utility-scale applications that are hundreds of megawatts in size.

As new technology is installed in new markets, and as systems improve and increase in capacity, there's often increased awareness, resulting in higher standardization and governance. As a result, today's solar installations involve

various regulations and code compliance. To remain competitive, it's important to keep up with the ever-evolving technology and standards in a manner that's efficient and cost-effective. This is not only true for the solar systems, but also for the components that support their success.

BoS basics

Regardless of system size, technology changes, or code enhancements, balance of system solutions (BoS) fundamentally still do the same thing: connect solar PV modules to the grid. Used across all solar installations—from residential and commercial to utility-scale solar applications—BoS solutions include direct and alternating current switching and protection, as well as solar inverters. They should be designed to maximize energy harvest and system performance, while enhancing safety and optimizing equipment and installation costs.

Combiner boxes are a key element of solar BOS solutions, and continue to evolve to meet changing application requirements. As the name implies, combiner boxes combine outputs from a number of solar strings into a single circuit to provide overcurrent protection. Up until recently, this was a basic box with fuse holders that joined string output circuits into one circuit. However, with an increased emphasis on enhanced safety and reduced costs, innovations in design and functionality are generating combiner boxes that help to improve overall PV system performance and expenses.

System monitoring

To help with some of those costs, effective system monitoring is extremely important, and can happen at the combiner box level. Efficient monitoring at the string level (inside the combiner box) could measure string-level current and voltage, as well as alarm settings, to provide enhanced solar system diagnostics—which could be used to enhance performance.

Over time, PV system performance declines due to soiling, aging, shading, and uneven pitch angles, which result in power curve variations of each string. These issues only get worse if not properly addressed or maintained. Central inverters are designed to maximize the power output by tracking the maximum power point of an entire array—so, the average of all

the strings. Since the maximum power point tracking (MPPT) is the average of all the arrays, there's a power loss (energy harvest reduction) from all of the strings with a power curve out of alignment. Ultimately, this reduces revenue for integrators, PPA providers, and anyone with a financial interest in system performance.

In this case, diagnostic information from a combiner box could yield information, which could be used to identify system issues that are negatively impacting system performance and reducing any financial returns.

Progressive standards

The National Electrical Code (NEC) 2011 code changes address safety concerns and poor design practices. Previously, combiner boxes were often located far from the inverter, without a disconnect nearby to interrupt the current for servicing. A visible means of disconnect became required in the 2011 NEC 690.16(B), which must be no more than 50 feet away from the fuses.

Combiner boxes with integral disconnects became standard relatively quickly, as they address a number of functions. Integral disconnects enhance operator safety during maintenance operations by opening the circuit and being used as a lock-out, tag-out (LOTO) device. These safety functions were never incorporated into earlier systems. As there are more utility-scale solar systems than ever before, however, such features are increasingly critical for personnel and system safety. Now, all equipment with integral disconnects should be tested to meet the Underwriters Laboratories (UL) 98B standard.

Beyond the integral disconnect requirement, the 2011 NEC code also required arc fault protection, which wasn't new technology. AC Arc fault protection has been required for residences for more than a decade. The 2011 NEC just put it into writing, though didn't specify where the arc fault protection should be located. Currently, placement is up to the industry to decide.

Although placing arc fault protection in the inverter can be done with a low initial cost, determining where a system fault occurs is time-consuming. The protection can also be included at the module level, which also makes it fast, but costly to find a fault. Plus, the upfront costs are prohibitive. Placing arc



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fault protection in the combiner box makes the most sense from a functional and economical perspective. And, there are string combiners with arc fault protection currently in the works.

Optimizing energy harvest

New switched combiners that incorporate the functionality of a combiner box and separate disconnect provide a visible means of disconnect and fuse protection in a single, convenient enclosure for enhanced safety and simplified installation. Now, operators can verify that the blades are disengaged when the switch is turned off.

Much like previous devices, switch combiners integrate multiple inputs from a solar array into a single output. They also isolate the DC side of a PV system closer to the fuse holders, meeting the NEC 2011 code requirements. Newer combiner boxes can also include surge protection, string monitoring, and wireless communications. In the near future, look for combiner boxes that also enable increased system performance.

** According to the "US Solar Market Insight: Q1 2013" report from SEIA/GTM Research; www.seia.org/research-resources/solar-industry-data*

Brendan Foley is a Product Line manager at Eaton.

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Sharing the Sun

Community solar gaining momentum

By Andy Noel



*The 500 kW Boulder Cowdery Meadows Solar Array is the first community solar project built under Xcel's Solar*Rewards program*

As the price of solar energy continues to drop, solar electric systems can be spotted on an increasing number of homes and businesses throughout the country. However, despite rapid growth and compelling economics, the overlooked reality is that solar energy remains out of reach for a surprising number of Americans.

Estimates indicate that up to 80% of homeowners and businesses can't install solar on their rooftops even if they wanted to. Whether it's because of rental or lease agreement limitations, roofing restrictions, excessive shading, or even less than ideal credit ratings, a variety of barriers to solar power exist. Upfront panel and project costs alone can be fairly restrictive.

The challenges associated with gaining solar power for this portion of the market won't change anytime soon. However, community solar is an emerging solution that breaks down many of these barriers. Where such projects exist, the programs offer significantly expanded access to clean energy's many benefits. And, possibly the best part: no roof is required.

Shared renewables

In a community solar program (also known as solar gardens or shared renewables), electric utility customers subscribe or buy a portion of a specific, offsite solar system. This subscription or purchase is typically for a defined time period and, in some cases, subscribers can have individual solar panels assigned to them.

Subscribers then receive credits on monthly utility bills for the equivalent portion of electricity produced by their share of the system. These bill credits are, generally, adjusted to account for use of a utility's infrastructure to deliver electricity from the offsite solar system to a user's home or business.

The installer, owner, or a service company will provide the operation and maintenance (O&M) required of the solar system over time, ensuring it's well managed and peak performing. The goal of this shared energy source is, ultimately, to make solar power more accessible to a broader array of potential customers. With the right solar system (one that's productive and cost-effective) and the right group of people (those who are invested in renewable energy), a community solar program can be extremely successful.

Case in point

Although promising, true community solar programs are currently few and far between. By far, the largest such project today is Xcel Energy's Solar*Rewards Community program in Colorado. This program received final regulatory approvals and solicited applications for the first time last year, and has garnered an eager response from interested parties. During the most recent application window in June of this year, the utility received 39 applications for sub 500-kilowatt (kW) projects within just the first 30 minutes for a total available capacity of 4.5 megawatts (MW).

The popularity of the Colorado's Solar*Rewards Community program demonstrates the interest that developers and consumers have in models that make solar ownership simple and affordable.

Any utility customer—even high-rise tenants, renters, low-income residents, and industrial facilities—can simply and easily buy into a community's solar garden where available, and enjoy the benefits of predictably priced clean energy. Furthermore, community solar programs turn solar into an asset that can be sold, donated, or transferred when a customer moves to a new residence within that utility territory.

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Thanks to such portability, this form of shared solar eliminates much of the uncertainty involved with investing in a home or a commercial system.

Utilities, too, have reason to be interested in community solar. Increasingly, utilities are expressing concern that solar program funding—generally collected from all ratepayers—is expended in a fashion, benefitting only those who are able to install rooftop or commercial solar. Community solar provides utilities an easy way to share the benefits of clean energy with a much-broader base of ratepayers, while minimizing the need for incentives and reducing the costs of compliance with renewable energy policy mandates.

Powering communities

The first community solar systems have recently come online in Colorado. The 500 kW Boulder Cowdery Meadows Solar Array is the first project to be completed under

Xcel's Solar*Rewards program—with many more planned arrays to come. Homeowners and businesses in Boulder County have already been able to purchase as little as one kilowatt to begin saving on electricity costs with the program.

Although the community program in Colorado was the product of legislation (House Bill 10-1342, enacted in 2010), legislation isn't always required for community solar to be a feasible and legal option for utilities. However, certain states are taking note and beginning to enact regulations.

In California, for instance, two separate bills have been passed by the Assembly and Senate, which allow for up to 500 MW of shared renewable projects. Senate Bill 43 and Assembly Bill 1014 would enable residential and commercial consumers to purchase solar energy from offsite systems of up to 20 MW each. Unlike Colorado's program, however, homeowners and businesses in California wouldn't be able to subscribe to a specific solar project. Rather, customers would have to purchase a portion of the solar project directly from the utility, and would only have access to fixed, pre-determined pricing. Nevertheless, it's a start and a push toward shared renewables.

With installed solar electric system prices plummeting by over 20% in 2012, and zero-down solar opportunities becoming widely available, solar energy is an increasingly compelling prospect for homeowners and businesses. Community solar programs dramatically expand access to the huge sector of the population, and without a rooftop that's traditionally required for generating solar power.

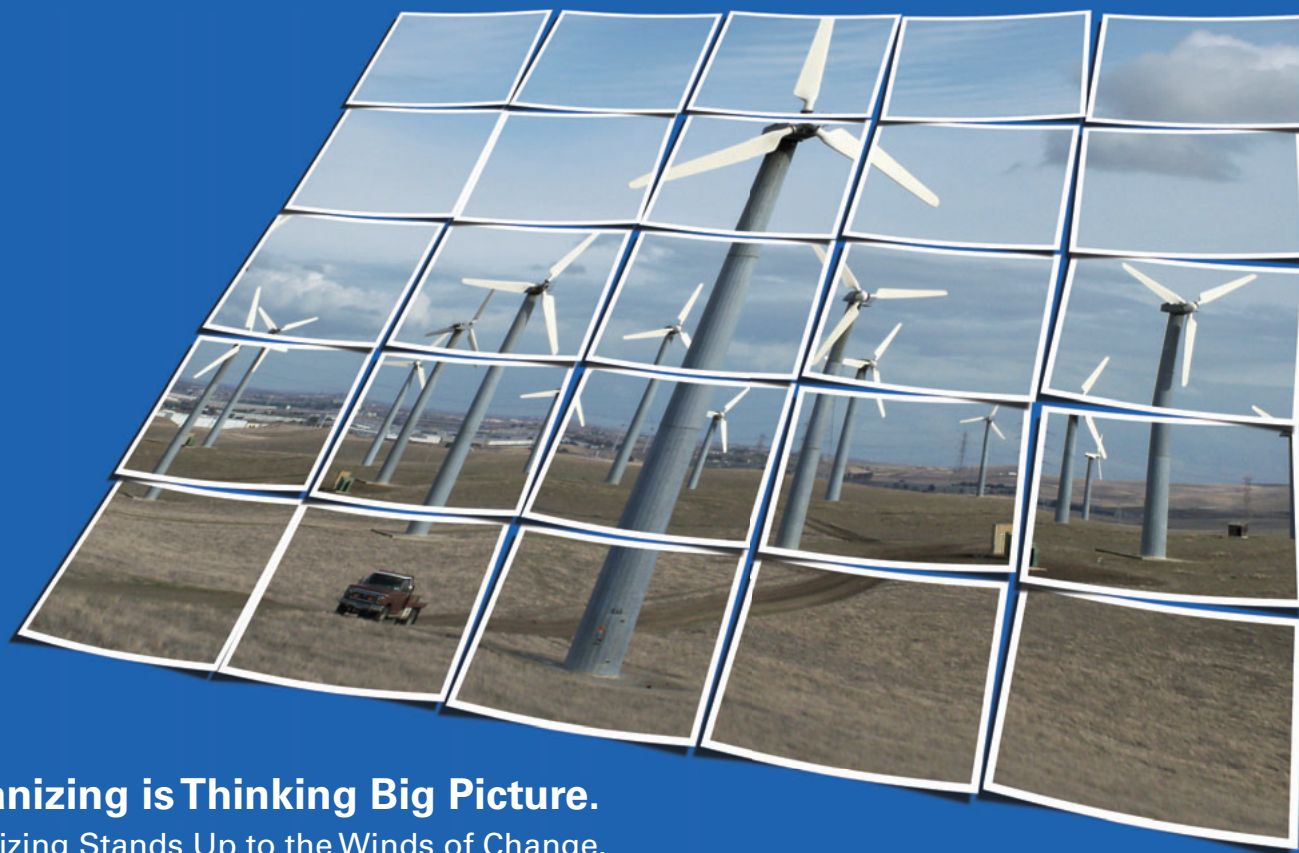
Increasingly, anyone with an interest in saving money on electricity bills and investing in clean energy will be able to access affordable, clean solar power.

Andy Noel is the director of Utility Scale EPC at REC Solar.

Companies such as community solar developer Clean Energy Collective and national solar installer REC Solar are utilizing economies-of-scale and their industry experience to design and maintain cost-effective solar installations for shared use. The two companies jointly collaborated, and helped build The Boulder Cowdery Meadows Solar Array in Colorado.

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Technology Trends in Residential Solar Energy Monitoring

By Daniel Liu



Zigbee data concentrator for residential solar monitoring applications

BEFORE THE EXPIRATION OF GOVERNMENT SUBSIDY PROGRAMS for solar power installations, smart energy monitoring systems had primarily only been of interest to utilities and commercial sites looking to improve production efficiency. For residential solar installations, there simply hadn't been a strong financial incentive for homeowners to invest in energy monitoring. Over the past couple of years, however, this situation has changed dramatically as the market—or to be precise, the business model—for the industry has evolved.

One of the most interesting new business models that have emerged for the residential market is the concept of a solar system solution provider that builds and owns the equipment, and then “sells” the electricity at a discounted price. With this arrangement, homeowners are no longer faced with a large, upfront investment prior to enjoying the benefits of a residential solar power system. Rather, it's possible to now “buy” solar energy as needed and available.

From the perspective of the system provider, there's a strong incentive to monitor energy production for each system and home connected, so as to:

1. Ensure efficient power generation;
2. Sustain system health and conduct preventive maintenance; and
3. Integrate with existing or planned automatic meter infrastructure.

Maximizing the system

One of the key components for solar monitoring systems is the data concentrator, which

collects and makes available the raw monitoring data from attached inverters, weather sensors, and power meters. Not all systems are the same, however. There are fundamental differences in priority between residential, commercial, and utility solar systems that affect their requirements for data concentrators (see Table 1).

	Utility	Commercial	Residential
Computing power	High	Medium	Low
Cloud-based data collection	Low	High	High
Extended temperature tolerance	High	High	Low
Low cost	Low	Medium	High

Table 1. Priority of data concentrator requirements

Compared to commercial and utility systems, residential solar systems are characterized by a smaller size and a wider geographical distribution. For residential energy monitoring systems, raw computing power is less important than the ability to connect remotely over a wide area network. Flexibility with different communication interfaces is also significant because of the wide variety of inverters and microinverters that may be installed at a site.

Currently, the most common interfaces are Zigbee and Power Line Communication (PLC). Preferably, data concentrators for residential solar power systems would exhibit:

- Zigbee or PLC interface to talk to the local inverter;
- The ability to log and process information into a database format; and
- A cellular or WiFi WAN interface to upload data to a cloud server.

Since residential installations are much more cost sensitive than utilities and commercial installations, it's critical for a data concentrator to strike the right balance between functionality and price. Commercial, off-the-shelf data loggers used by utility and commercial sites are often far over-powered and over-priced for residential use, especially over the lifetime of a system. Instead, many solar system solution providers are finding that lightweight RISC-based platforms are a cost-effective solution, providing the added benefit of very low power consumption.



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Figure 1. Monitoring interface showing current and historical solar energy production

Managing connections & communication

One of the biggest technical challenges faced by solar system solution providers is the management of communication between the different inverters, data concentrators, and cloud servers. Although Zigbee and PLC are well-known technologies, many installers are recognizing the benefits of utilizing one vendor. Ideally, inverters and data concentrators should employ communication chips from the same vendor using the same communication profile. At the very least, it's advisable for the data concentrator manufacturer to work closely with the inverter manufacturer to ensure seamless communication and interoperability.

Another technical obstacle to overcome is the network connection factor. Connections to cloud servers are often wireless or cellular, and it's almost inevitable interruptions in network service will occasionally occur. The ability to recover easily and automatically from any breaks in connection is especially important for residential systems, since the data concentrator is located remotely and isn't readily accessible. Built-in tools or application programming interfaces (APIs) can help software programmers set the appropriate reconnection parameters and configure a hardware "watchdog" of sorts. This step not only saves a trip by the solution provider's engineer, but also saves time, ensuring the system automatically reboots and restores after a network interruption.

Finally, the actual monitoring data presents its own challenges, since it must be put into a format that's easily stored, presented, and analyzed. In practice, this usually means formatting the sensor and power meter data into well-defined XML or CSV files, which are stored on a cloud server and dropped into a database. This can involve a high degree of technical programming, so for efficiency sake, it's preferable this process be as simple as possible for solar installers.

One solution is the trend toward greater standardization in data types,

through organizations such as the SunSpec Alliance. Hardware manufacturers can also offer simple APIs or software development kits (SDKs), which make it relatively painless for programmers to call up specific information.

The solar industry has undergone dramatic shifts in the past few years. But, with these shifts have come new opportunities. The industry continues to look for efficient ways to bring affordable solar power to the masses, and the trend toward solar system solution providers is one of the most promising efforts.

Key to this effort will be the ability to cost-effectively monitor solar power production, feeding it to homeowners as well as to

utilities. New technologies are also essential to keep up with demand, and one development now being seen is related to data concentrators. Lower cost solar systems, remote communication flexibility, and cost-effective, simple tools for data processing are a requirement. Fulfilling these needs will be instrumental to ensuring success in this market.

Daniel Liu is the Business Development manager for Moxa Americas, Inc.

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Left: VF Coalition Outdoor Campus PV project took 160 days to complete, using 39 AE 3TL three-phase string inverters (Courtesy of Hawkeye Aerial Photography)

Above: Close-up of an AE 3TL three-phase string inverter (Courtesy of Stacy Geiken Photography)

A Guide to Choosing Commercial Inverters

Finding the right system for a successful solar project

By Mike Dooley

Much like the consolidation that's been happening among photovoltaic (PV) panel and module manufacturers over the past few years, the inverter market is following suit on a global scale. Given that there are fewer inverter manufacturers fighting for market share at the top, the decision of which inverter or design to choose for a project should start not with the product itself, but with the inverter manufacturer.

When selecting an inverter provider for a commercial project, three key factors a developer should consider are: bankability; flexibility in product offering; and the pre- and post-installation services available, including warranties.

1. Bankability. As solar energy continues to scale and move toward securitization, the issue of a company's bankability will become increasingly important for solar project investors—and, in turn, for project developers choosing an inverter manufacturer. A surprising amount of system owners and financiers have considered cash on hand to be a sign of strong bankability, but without considering debt-to-equity ratio, which indicates what proportion of equity and debt a company is using to finance its assets. Debt-to-equity ratio could be considered a major factor that led to some solar companies going out of business.

Nonetheless, that's just one factor to consider. Those that are most important in terms of bankability (and that are publically available for most companies) include:

- **Profitability:** Consistent profitability indicates strong management and alignment of product offering, value proposition, and corporate strategy to support investments for the future.
- **Debt-to-equity ratio:** As has been mentioned, a company that has too many liabilities has less flexibility to respond to market changes in the short term, without enough equity to fund long-term initiatives.
- **Balance sheet strength:** The strength of a balance sheet ensures there's enough cash for a company to meet its liabilities for the next year.

- **History:** Longevity usually means that a company is more likely to have the processes, foresight, and experience to prevent and overcome challenges related to supporting an install base and service organization for years to come.
- **Transparency:** Having as much information as possible in a standard, audited format, enables in-depth credit analysis.
- **Diversification:** Pure-play PV companies are more easily affected by fluctuations in their target markets than diversified companies. On the other hand, if a company has too many divisions, it can be more difficult for smaller divisions to attract customers and investors. An even balance between PV solar and non-PV solar business is ideal.

2. Flexibility. Choosing an inverter provider with a robust suite of commercial products and technology topologies is important, as it means they are most likely to deliver the best possible inverter solution for a project across a range of project applications and their unique design challenges. A flexible inverter manufacturer can offer a centralized and decentralized inverter design, referring to an architecture that utilizes multiple inverters throughout a project to achieve the lowest levelized cost of energy (LCOE) possible.

Although there's still growing demand for a common system architecture utilizing a centralized inverter, designing in three-phase string inverters for a decentralized PV system is gaining in popularity. This is particularly true in commercial applications where space is at a premium or in an odd form. In determining whether to select a central or decentralized inverter design for a project, a developer should always consider the following:

- **Uptime:** A decentralized design reduces lost output in the event of inverter failure. Typically, string inverters are replaced with new ones or repaired offline. In most cases, it's recommended that spares are kept directly onsite to reduce downtime. Although the repair time of a central inverter may require factory service expertise, the uptime can be increased with a service plan. The decision between a decentralized and central inverter approach can sometimes be driven by the labor available, and by the mean time to repair (MTTR).
- **Reliability:** When comparing decentralized and centralized, it's important to take into account the respective failure rate and the number of inverters that will be used in the project to best assess the reliability impact of the system as a whole. Ideally, a reliability study should be carried out to evaluate these two factors.
- **Operation & Maintenance (O&M):** With a decentralized approach, maintenance can be reduced given that string inverters don't require any preventive maintenance as is typical for centralized inverters, such as inspection of the cooling system and thermographic imaging.
- **Investment performance:** To financially capture all of the advantages and disadvantages of both approaches, a system designer should calculate several financial metrics, including the return on investment, LCOE, internal rate of return, as well as the net present value.
- **Space constraints:** Space-constrained projects typically fair better with decentralized designs. However, determining if there's room for a wall mount versus a pad, or if there's a requirement to mount on the roof versus the ground (among other space-related considerations), will help steer a designer toward the right inverter.
- **Code compliance and interconnect requirements:** System designers will also need to consider the varying codes and utility requirements for each project location, selecting an inverter that meets those requirements.

3. Services. Although inverters constitute a small portion of a solar energy system's cost, ensuring they run as efficiently and reliably as possible is crucial to delivering on long-term production goals. Strong services pre- and post-installation, will help system owners maximize uptime and power generation, and prevent unanticipated issues from impacting production.

For pre-installation services, project developers should consider whether a provider offers project design, application engineering and site commissioning support, and project management of the delivery. Ideally, there should be a level of collaboration in advance of deployment, where project developers can call on inverter manufacturers to participate in some of the project planning, at least in terms of reviewing the design plans or participating in technical "kick-off" meetings.

In regards to post-installation services, system owners should look for ongoing data monitoring, preventative maintenance, O&M services, a quick MTTR, and a bankable warranty with a strong track record. All of these considerations need to be made before purchasing an inverter for a solar energy system.

Keeping an inverter manufacturer's ability to hold up to a robust definition of bankability, to offer flexible design and product solutions, and to provide reliable post-installation services and warran-

ties, top of mind will help guide commercial project developers to a vendor that helps achieve their goals.

Mike Dooley is VP of Marketing at Advanced Energy Solar Energy.

Advanced Energy Solar Energy
www.advanced-energy.com/solarenergy





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Solar rooftop attachment system

Anchor Products has introduced the U-Anchor 2400 for customers preferring a direct connection to a structural element of the building. Most of Anchor Products offerings, including the U-Anchor 2000, do not penetrate the membrane. The U-Anchor 2400 is a lightweight, rooftop attachment system consisting of a 5.5" galvalume-coated steel plate, with a 3/8" to 16 x 3/4" tall stainless steel stud. The cover is factory sealed to the top of the plate. The product weighs just eight ounces (227g) on most membranes, but can vary depending on the membrane. The U-Anchor 2400 was tested in accordance with ASCE 7-05 ASTM E330-02 (2010) and TAS 117B. Third-party independent testing found the product to have approximately 1,000 pounds of ultimate load capacity. Due to high-tensile strength, it can perform in conditions that exceed hurricane-force winds.

Anchor Products, LLC | www.anchorp.com



SALES OFFICE

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Bohemia NY 11716
USA

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rodney.esposito@kippzonen.com
www.kippzonen.com

Passion for Precision

Accurately Monitoring the Performance of your Solar Energy System



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

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



String monitoring

The Fronius String Control 250/30 string monitoring system has been specifically developed to meet the requirements of central inverters, ensuring PV systems with inverters generate a dependable yield. Module strings can now be professionally monitored and their data compared. If a problem such as shading, module failure, or broken or chafed cabling occurs in one or more strings, the early fault detection system informs the operator immediately, preventing yield loss. With a current carrying capacity of 250 A and maximum input voltage of 1,000 V, the Fronius string monitoring device is ideal for the monitoring of PV systems that use Fronius Agilo inverters. Up to 30 module strings can all be connected together on one DC main line. As the cables are connected directly to the DC main line (V terminals), installation can be carried out quickly and easily without any special tools, saving time and money.

Fronius | www.fronius.com



Conduit protective system

AerosUSA has launched the OPTOflex, highly flexible opto-electronic conduit protective system. These small-diameter conduits are characterized by a metallic core manufactured from galvanized steel or stainless steel, with an outer jacket of non-flame propagating PVC sheathing or fiberglass braiding and external silicone rubber sheathing. The conduits are characterized by unique properties, which provide excellent lateral pressure resistance, stretch resistance, low flammability, as well as a wide resistance to solvents and chemicals. They are free of halogen and cadmium, and are known for their precise bending radius. Geared toward laser and opto-electronic devices, these conduits have a temperature range of -60° C to +600° C (-76° F to +1112° F), depending on the configuration, and are available in sizes ID 2.5 mm (3/32") to ID 12 mm (1/2").

AerosUSA | www.aerosusa.com



Solar fastening system

Mudge Fasteners and SolarFastener-Expert.com introduce the new and improved EJOT Solar Flashing system. The EJOT Solar Flashing system is specifically designed for waterproof installations on three tab strip asphalt shingle roofs, with a standard 5" to 5-1/2" row course. With this fastening system, PV and solar thermal racking systems can securely be anchored on existing or new roofs. The EJOT Solar Flashing system can be purchased online at one of the only solar-specific retailers.

Mudge Fasteners

www.mudgefasteners.com
www.solarfastenerexpert.com



Mounting hook

Quickscrews International has designed a new mounting hook for curved tile roofs. The hook has a feature that allows the installer to adjust the height, so as to accommodate the elevation differences found in curved tiles. The bracket can be screwed into the roof joists, coming out at the top of the barrel every time. Using Quickscrews' new L-foot, installers can attach to side mount rails, as well as to bottom mount rails.

Quickscrews International

www.quickscrews.com



Mass flow measurement & control

Alicat Scientific introduces its MS and MCS series of mass flow meters and controllers for aggressive gases, now with compatibility for silane (SiH₄) and six other aggressive gases. Using 316L stainless steel construction and FFKM elastomers to resist corrosion from gases, such as ammonia (NH₃) and nitrogen trifluoride (NF₃), the MS and MCS series are available in full-scale ranges from 0-0.5 SCCM to 0-3000 SLPM with turndown ratios of 100:1. Alicat's laminar flow technology allows real-time gas selection from more than 30 standard gas and gas mix calibrations in its MS and MCS series, which require no warm-up time and feature 50-ms meter and 100-ms control speeds and lifetime warranties. Alicat MS and MCS series mass flow instruments offer precision solutions for PV or semiconductor coating applications that require the use of aggressive gases.

Alicat Scientific, Inc.
www.alicat.com/msmcs



One-step module production

3D-Micromac launches the first production equipment worldwide, which can conduct the integrated series-connection of a thin-film solar module on one single platform and in one single production step. The new One-Stop-Patterning process (OSP) only structures the modules once all of the functional layers have been deposited on the substrate. This significantly simplifies the production process. Formerly, thin-film modules were structured with a laser or a mechanical unit after each individual layering step, which required expensive cleaning steps, lengthened processing times, and led to efficiency losses. The OSP process minimizes dead zones to less than 100 micrometers, simplifying manufacturing and increasing efficiency. In addition, the new process prevents inaccuracies, which are caused when the substrate is positioned and aligned on different tables—an improvement that increases the efficiency of a thin-film module by up to 0.8%.

3D-Micromac AG | www.3d-micromac.com



Solar tracker

The FlexRack Tracker is the latest in innovation from Solar FlexRack, a company with 40 years of design experience. The FlexRack Tracker has a distributive drive system for field layout flexibility, with minimal power loss if a drive fails. The system uses a linear actuator, which requires no maintenance over the lifetime of the system, and Teflon-filled bearings, which require no lubrication while reducing friction. Each tracker also has an automatic stow feature at high-wind detection. The lightweight components of the FlexRack Tracker don't need any heavy equipment during installation, making it a cost-effective solution for today's solar market.

Solar FlexRack | www.solarflexrack.com

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www.contour-track.com



The innovation CONTOUR TRACK is a horizontal, single-axis tracker for solar modules suitable for all terrain topographies and provides:

- minimum of grading
- maximum flexibility for plant design
- maximum reliability and durability
- surplus of 25 %
- minimized maintenance





Wafer-head screw

IBC SOLAR AG presents the IBC ASD, a wafer-head screw for mounting solar power systems on roofs with above-rafter insulation. The IBC ASD is designed for installing solar modules on wooden structures with insulation. With its under-head thread, the special screw prevents the pressure on the insulation material from becoming too high due to the PV system. If further force-absorbing loads occur, they can be redirected using partial-thread screws (screwed fastening brackets at roof pitch 60°). With the under-head thread and the corresponding distance screw connection, the pressure strain is transferred directly to the rafters, with low-strength and pressure-resistant insulation. The under-head thread also fixes the counter batten in place. The high-precision screw tip of the IBC ASD prevents the counter battens from splitting during assembly. The IBC ASD can be used for all conventional insulation material without pressure-resistance requirements, and has building authority approval in accordance with Z-9.1-652 and ETA-12/0132.

IBC SOLAR AG | www.ibc-solar.com



The Power of PV Systems Testing in The Palm of Your Hand...

The new HT line of portable test instruments for PV system efficiency and I-V curve trace analysis are ideal for module manufacturers, PV system installers and test labs alike, for both laboratory and in field PV module-string and end to end PV system performance testing.

- I-V Curve Trace Meters
- Module & String Efficiency Testers
- AC Power Quality Analyzers (Single & Three-Phase)
- Megger Insulation Safety Meters
- Solar Radiation Sensors (Direct & Global Irradiance)

HuksefluxUSA also offers an extensive range of ISO Class solar radiation sensors and turnkey solar monitoring solutions for DNI, Global Insolation and Plane of Array solar irradiance measurement.



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Single-post mounting system

Engineered for product longevity and highly pre-assembled for fast installation, the single-post FS Uno is now ETL Classified, passing complete system (UL Subject 2703) electrical bonding requirements. In addition to meeting UL standards, FS Uno is wind tunnel tested, also meeting or exceeding all applicable IBC and ASCE standards. FS Uno features include: high-quality galvanized steel; increased distance between foundation supports; south facing and east-west facing (Uno-100) configurations; a high level of pre-fabrication; in-house engineering services at no additional cost; as well as geological services for those systems over 250 kW. Intertek, the issuing organization of the ETL Mark Classification, engaged in extensive system testing to qualify the system in its entirety, including all components.

Schletter | www.schletter.us

Black half-cell module

Bosch Solar Energy launches a new, premium module onto the market, which offers more output and an improved product design. The Bosch Solar Module c-Si M 60+ S Module has an output of up to 285 watts, assured by a new generation of cells with a black, half-cell design and a burned-in anti-reflection coating on the micro-structured. The toughened front glass also enables greater light absorption. A highly transparent encapsulant foil provides additional light exposure, while newly structured cell connectors reduce electrical and optical losses in the module, further increasing the output.

The new premium module consists of 120 half-monocrystalline, high-performance solar cells, measuring 156 mm x 78 mm. Reliability tests to date far exceed the standard requirements, confirming the durability and long-term stability of the module. Drainage corners have also been incorporated into the design, allowing rainwater to flow away at the corners. This improves the self-cleaning of the module, lessening soiling and moss in the lower section, which can reduce output. The drainage corners also provide additional grounding options.

Bosch Solar Energy

www.bosch-solarenergy.com

Liquid-cooled inverters

The expansion of large solar parks is progressing rapidly worldwide, and development represents a challenge to the builders of power stations. Plant technology needs to be more effective to re-finance the investment costs faster than ever before. The focus has primarily been on efficiency at the central inverter level, and the new inverter generation from LTi provides noticeable gains in terms of efficiency and reliability. The PVmaster II series liquid-cooled inverters from LTi REEnergy are already being used successfully, converting more than 99% of solar electricity into AC. Performance is made possible by a novel circuit, for which LTi has applied for a patent. The engineers use a topology that can achieve higher voltages and lower currents, a crucial factor for the inverter as a whole. Water-cooling is still used, but heat loss is cut in half with this new design, so stable operating conditions are guaranteed, even at high ambient temperatures.

LTi REEnergy | www.lt-i.com

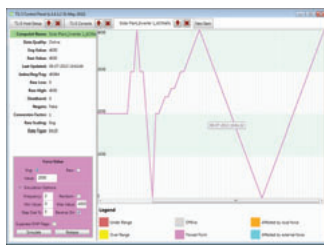


Ventilation unit

Kipp & Zonen introduces the CVF4, a new ventilation unit for its pyranometer and pyrgeometer range. Ventilation of radiometers improves the reliability and accuracy of the measurement by reducing dust on the dome, removing dew and rain droplets, and melting frost and snow, which would otherwise affect the measurement. The latest flow simulation software, microflow, and temperature measurement devices were used in the development process of the CVF4 to maximize its performance. At the top of the pyranometer dome, the flow is very high and it swirls to improve the air distribution over the dome. The position of the heaters and the new cover material ensures only half the heating power is needed to melt frost and snow compared to older ventilation units. CVF4 is easy to use, operates in all weather conditions, and significantly improves the availability of high-quality measurement data from pyranometers and pyrgeometers.

Kipp & Zonen

www.kippzonen.com



Solar controller

Trimark Associates, a provider of measurement and communications solutions for the electric power industry, has announced the release of T1-S Solar Controller. T1-S Solar Controller is a SCADA system engineered specifically to manage output from utility-scale PV power inverters. The nature of solar electricity generation creates challenges for maintaining consistent power factor, frequency, and voltage across the grid. Trimark's T1-S Solar Controller enables secure adjustments to inverter control algorithms. Control commands may originate from the facility operator or an authorized external authority (e.g. local utility or ISO) over a secure network. Trimark is collaborating with Sandia National Labs to test T1-S Solar Controller.

Trimark Associates, Inc.

www.trimarkassoc.com



Solar thermal collector

WATT-USA has released its newest solar thermal collector, the 2251S. WATT-USA's all-aluminum solar thermal panel, the 2251S is designed to offer high performance at a lower price. As with all solar thermal products from WATT-USA, the 2251S is constructed to a high-quality standard. Features include BlueTec ETA Plus absorber, laser-welded collector piping, clear solar glass, and aluminum tray construction produced without seams, rivets, or fasteners. The attractive 2251S comes in an aluminum or dark grey powder-coat finish, and is backed by WATT's 10-year warranty. All WATT collectors have been redesigned this year to work with WATT's no-tool, leak-free connections and new collector racking.

Watt-USA | www.watt-usa.com



High-isolation reed relays

Standex-Meder Electronics announces its KT Series of high-isolation reed relays, which are ideal for renewable applications requiring a small profile. They are particularly helpful in measuring isolation resistance across several components in a solar energy system prior to grid connection, preventing injury or further current leakages. Available in three coil voltages of 5V, 12V, and 24V, each version exists in either a surface or through-hole mounting. Like all of Standex-Meder's high-isolation reed relays, the KT series has dynamically tested contacts and can perform millions of reliable operations. It's also RoHS compliant.

Standex-Meder Electronics

www.standexmeder.com

Solar thermal potting

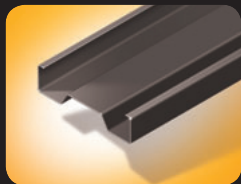
ITW Solar has released the Insulcast RTVS 400 series of thermal potting for the solar industry. This new line of primerless, silicone potting is ideal for solar applications due to its combination of low durometer and high thermal conductivity. This leads to less stress on components during periods of thermal cycle and mechanical shock. The RTVS 400 series is comprised of the Insulcast RTVS 400, 440, and 480. Each product has a unique combination of flexibility and thermal conductivity with the ability to minimize solder joint fatigue, as well as the stress on components for micro-inverters, power optimizers, and charge controllers. The RTVS 400 series are also low in viscosity, which helps the silicone flow more easily to cover the components that it protects. The products are easy to mix and apply because of their one-to-one ratio, and they fully meet the flammability requirements of UL 94V-0.

ITW Solar | www.itwsolar.com

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AE 3TL AT A GLANCE

- Industry-leading CEC efficiency rating of 98%
- Solves problems of shaded and multi-pitch roofs
- UL 1741 Certified
- kW Ratings from 12-24, 600 V option
- Assembled in the USA
- Basic and premium monitoring options



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SEE AD ON PAGE 13



Product: Conext Core XC-NA Central Inverter
Application: Large commercial and centralized PV plants
Continuous Output Power: Variety of power outputs up to 680 kW
Weighted CEC Efficiency: 98% (preliminary)
Peak Efficiency Range: 98.5% (preliminary)
DC Voltage Operating Range: 440 V to 850 V

Operating Temperature Range: -20° C to 50° C (-4° F to 122° F); low-temperature option to -35° C (-31° F)
Dimensions: 227.1 cm x 322.0 cm x 80.5 cm
Certifications/Approvals: UL listed to 1,000 VDC
Warranty: 5 years

Key Features:

- Compact footprint for easy integration;
- Built-in hardware for 1,000 VDC start-up and grid management features; and
- Integrated DC combiner with a variety of fuse sizes and quantities, along with optional string monitoring.

Website: www.schneider-electric.com



AEG Power Solutions

Product: Modular Solar Inverters MPV.015-MPV.150

Application: Central inverters for commercial systems

Continuous Output Power: Ranging from 15 kW to 150 kW

Weighted CEC Efficiency: 96.5%

Peak Efficiency Range: >97%

DC Voltage Operating Range: 250 VDC to 600 VDC

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

Dimensions: 28" x 34" x 51" (up to 75 kW); or 74"H (up to 150 kW)

Certifications/Approvals: Certified to UL 1741; CEC Listed

Warranty: 5-year standard, with up to 20 years available

Key Features:

- Three-phase, transformerless central inverter, delivering high-efficiency in a compact, modular package;
- Utilizing 15 kW inverter power modules, the smaller cabinet scales from 15 kW to 75 kW, and the taller cabinet scales from 15 kW to 150 kW (inverter modules are turned on as needed to match the power required);
- Class leading GFDI, with integrated AC and DC disconnect switches; and
- Integrated Web server with remote monitor application and onboard data storage.

Website: www.aegps.com



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Come follow us to the sunny side – seed SolarMax inverters into your solar power plant.



MT A series

TS A series



www.solarmax.com

SEE AD ON PAGE 33



Product: SolarMax MT A
Application: Residential and commercial solar power plants
Rated Output Power: 12 kW to 18 kW
Weighted CEC Efficiency: 97.3% to 97.5%
Peak Efficiency Range: 97.6% to 98.0%
DC Voltage Operating Range: 250 V to 1,000 V
Operating Temperature Range: -25° C to +60° C (-13° F to 140° F)

Dimensions: 21.5" x 37.0" x 7.9"
Certifications/Approvals: FCC Part 15 Subpart B, Class A; IEEE 1547; UL 1741, CSA C22.2 No. 107.1; Intertek
Warranty: 10 years standard, with extended warranty up to 15, 20, or 25 years available
Key Features:

- With an input voltage of 1,000 V, plant operators and investors benefit from low, total system costs and high efficiencies;

- Three MPP trackers and a broad input voltage range provide the highest level of flexibility, even in the event of asymmetrical divisions of the solar generator or different module types;
 - Lightweight construction and easy to access connections allows for quick and convenient installation; and
 - Integrated RS485 and Ethernet interfaces can be used to design communication networks easily and quickly.
- Website:** www.solarmax.com



Advanced Energy Solar Energy

Product: AE 3TL
Application: A three-phase transformerless string inverter for commercial applications
Continuous Output Power: Configurable from 12 kW to 23.2 kW
Weighted CEC Efficiency: 97.5% to 98%
Peak Efficiency Range: 98.2%
DC Voltage Operating Range: 125 V to 450 V
Operating Temperature Range: -25° C to +55° C (-13° F to +131° F)

Dimensions: 21" x 35" x 11"
Certifications/Approvals: Certified to UL 1741 and UL 1998 Standard (for US and Canada) by Underwriters Laboratories
Warranty: 5-year standard warranty, with 10- and 15-year extended warranties
Key Features:

- Lightweight and easy-to-install, reducing shipping and labor costs, and speeding time to system commissioning;

- Shortened run-lengths, reducing overall solar PV BoS costs; and
 - Modular and distributed design allows site owners to maximize valuable space on a solar installation, providing increased uptime, higher system yields, and precise trouble-shooting and maintenance.
- Website:** http://solarenergy.advanced-energy.com/solar-inverters



Bonfiglioli

Product: RPS TL-UL Modular Inverter System
Application: Utility-scale solar power plants
Continuous Output Power: Scalable ratings from 367 kW to 1400 kW
Weighted CEC Efficiency: 98.0% (estimated)
Peak Efficiency Range: 500 VDC to 700 VDC
DC Voltage Operating Range: 500/550 VDC to 875 VDC (dependent on inverter model)
Operating Temperature Range: -20° C to +55° C (-4° F to 131° F)

Dimensions: 94.5" to 197" x 83" x 31.5" (dependent on inverter model)
Certifications/Approvals: Listed to UL1741-2010; IEEE 1547
Warranty: 5-year standard, with optional extended warranty to 20 years
Key Features:

- Dual UL/CSA listing at 1,000 VDC;
- Modular design and optional configurations to support floating and grounded arrays;

- Multi-MPPT Tracking capability for increased energy harvest; and
 - Power management functions, including LVRT, HVRT, frequency ride-through, and power factor control.
- Website:** www.bonfiglioliusa.com

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In addition to our popular and innovative **Eos-Array String Monitoring System** and new transformerless and fanless **ISGA PV Inverters**, CARLO GAVAZZI also offers **Energy Meters**, **PV Surge Arresters**, as well as **Irradiation**, **Temperature** and **Wind Sensors**.

CARLO GAVAZZI

ISGA Inverter featuring low production voltage, up to two inputs, water/dust resistant NEMA3R housing, free graphical user interface software, informative mimic panel display and up to a ten year warranty.

Eos-Array is the innovative and expandable solution for turning an underachieving combiner box into an overachieving PV string monitoring, management and control solution.

Now featuring Open Connectivity with ethernet & cellular communications.

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Chint Power Systems America

Product: 23 kW & 28kW, 1,000 VDC 3-Phase String Inverter
Application: Commercial and Small-utility PV
Continuous Output Power: 23 kW / 28 kW
Weighted CEC Efficiency: 98%
Peak Efficiency Range: >98%
DC Voltage Operating Range: 300 V to 900 V
Operating Temperature Range: -25° C to +60° C (-13° F to 140° F)
Dimensions: 24" x 39" x 9"
Certifications/Approvals: UL/CSA
Warranty: 5 to 20 years
Key Features:

- Dual independent MPPT's;
- ARC-fault detection; and
- A horizontal option available.

Website: www.chintpower.com/na

SEE AD ON PAGE 27



Product: PVI 50-100 kW
Application: PV systems 50 kW and greater
Continuous Output Power: 50 kW, 60 kW, 75 kW, 85 kW, and 100 kW
Weighted CEC Efficiency: 96.0% to 97.5% (depending on output power and nominal output voltage)
Peak Efficiency Range: 96.5% to 97.8% (depending on output power and nominal output voltage)
DC Voltage Operating Range: 300 VDC to 500 VDC

Operating Temperature Range: -40° C to +55° C (-40° F to +131° F)
Dimensions: Side-facing disconnects: 78.2" x 50-53" x 33" (1986 mm x 1270-1346 mm x 838 mm) | Forward-facing disconnects: 78.2" x 79-88" x 33" (1986 mm x 2007-2235 mm x 838 mm)
Certifications/Approvals: UL 1741/IEEE 1547; IEEE 1547.1; CSA C22.2#107.1; FCC part 15B
Warranty: 5-year standard, with 10-, 15-, and 20-year optional warranty; extended service agreement and uptime guarantee

Key Features:

- Highest peak and CEC efficiencies currently offered in the PV industry;
- MODBUS communications and user-interactive LCD;
- Multiple options, including: premium efficient models, fused or breaker subcombiners, forward-facing subcombiners, stainless steel enclosure, sub-array monitoring, built-in cellular connectivity, and dust filter;
- Options for utilities include: real power curtailment, reactive power control, voltage, and frequency ride-through.

Website: www.solectria.com



JEMA Energy USA LLC

Product: 100 kW Central Inverter & Battery Charger
Application: Commercial-scale PV installations, battery storage, grid-tied & off-grid
Continuous Output Power: 100 kW at full power and temperature range
Weighted CEC Efficiency: 95.5% (transformer included)
Peak Efficiency Range: 96.5% peak efficiency between 294 VDC and 340 VDC
DC Voltage Operating Range: 290 VDC to 580 VDC
Operating Temperature Range: -20° C to 50° C (-4° F to 122° F)
Dimensions: 72.8" x 47.2" x 35.4"
Certifications/Approvals: UL1741, CSA C22.2 n°107.1-01 (Master Contract Number 254602); IEEE1547, IEEE1547.1
Warranty: 5-year standard and 10-year optional

Key Features:

- Transformer isolated (transformerless optional) with advanced control algorithm for extended voltage range and anti-islanding detection and disconnection;
- Intelligent power module with a robust robust, low-maintenance design (based according to anti-seismic guidelines), and long life components;
- Reactive power management, DC & AC switch integrated, and 6 kV surge tested; and
- Fully integratable with different SCADA systems.

Website: www.jemaenergy.com



SolarEdge

Product: SE20kUS-480
Application: Three-phase utility interactive inverter
Continuous Output Power: 20 kW
Weighted CEC Efficiency: 98%
Peak Efficiency Range: N/A as it's a fixed voltage inverter
DC Voltage Operating Range: N/A as it's a fixed voltage inverter

Operating Temperature Range: -25° C to +60° C (-13° F to +140° F); -40° C (-40° F) version available
Dimensions: 30.5" x 12.5" x 10.5" (including AC/DC safety switch)
Certifications/Approvals: UL1741, IEEE1547; FCC Part 15 Class B
Warranty: 12-year standard, with extensions to 20 or 25 years

Key Features:

- Small, lightweight (<80lb), and easy to install on provided bracket;
- Built-in module-level monitoring, with high efficiency (98%);
- Integrated AC/DC safety switch, and communication to Internet via Ethernet or Wireless; and
- Outdoor and indoor installation possible.

Website: www.solaredge.us



SMA America

Product: Sunny Tripower 12000TL-US/15000TLUS/20000TL-US/24000TL-US
Application: Solution for decentralized commercial systems
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Weighted CEC Efficiency: 98.0%
Peak Efficiency Range: >98%
DC Voltage Operating Range: 150 VDC to 1,000 VDC

Operating Temperature Range: -25° C to +60° C (-13° F to 140° F)
Dimensions: Approximately 26.1" x 27.1" x 10.4"
Certifications/Approvals: None
Warranty: 10-year standard warranty, with up to 20 years available
Key Features:

- Improved economics through 1,000 VDC design (also applicable for 600 VDC systems);

Key Features:

- OptiTrac Global peak minimizes the effects of shade for maximum energy production;
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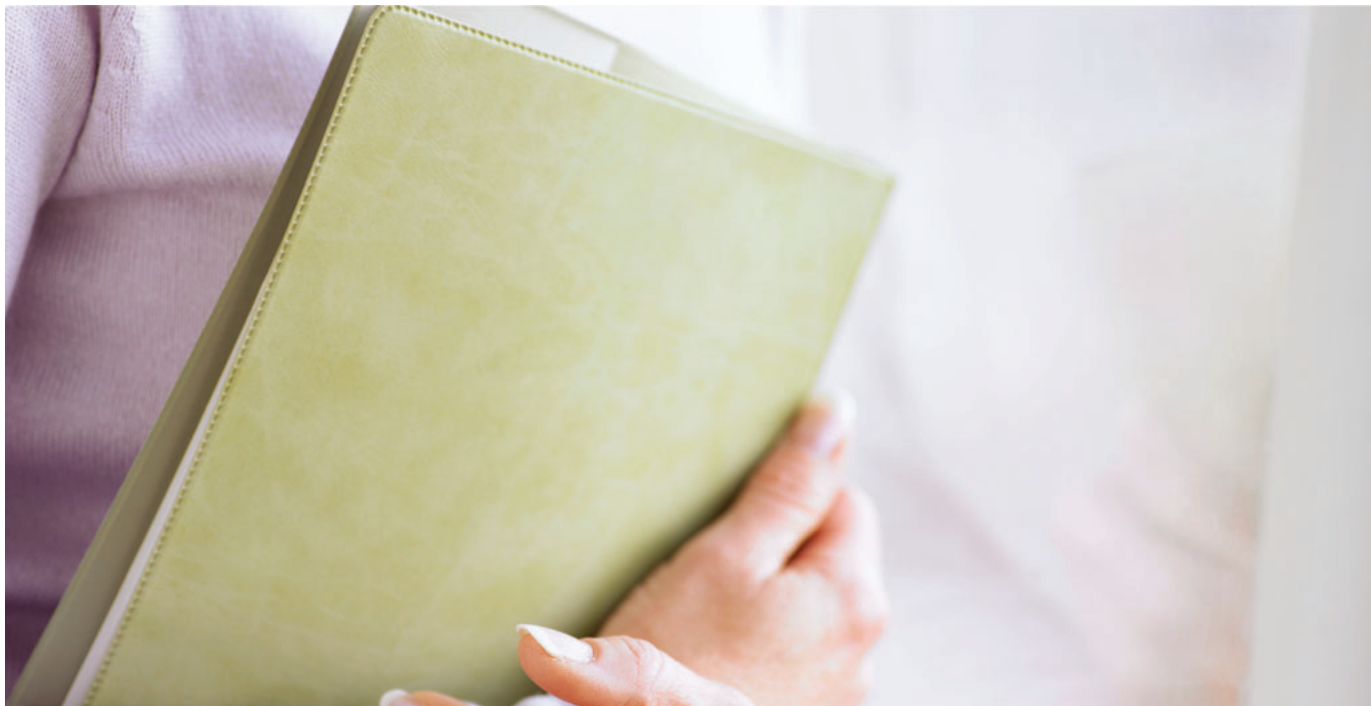
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Build, Buy, Partner, or Exit

Know your business plan

By Mark Kanjorski

Business managers are familiar with the “build, buy, partner, or exit” decision framework. Whether applied to product portfolios, channel development, or an entire business unit, the framework helps managers lay out a set of strategic options (outcomes), evaluate the relative attractiveness of those options, and select the best path forward.

Though useful at most any time, the framework often surfaces during extreme market conditions. For example, at times of rapid expansion when a business struggles to grow quickly, or at times of contraction when getting back to core competencies are a means of company survival.

Today’s solar PV market is dynamic to say the least. Interestingly, it seems to have the hallmarks of both market extremes. PV is booming with demand for those able to serve end-markets, which seem to shift location every few months. Meanwhile, many players are pulling back on expansion, idling capacity, re-deploying, or divesting assets to cope with competitive pressures, such as oversupply and commoditization.

In this environment, “build, buy, partner, or exit” decisions are playing out every day for all to see, with many business managers asking themselves, “What is the right combination of strategies for my business?” That answer depends...

• Build

“Build” decisions are often the most natural for managers. Need a better offering to compete? Design and build it. With the right capabilities, time, and money, this can make a lot of sense. For example, some PV module manufacturers began to vertically integrate more than five years ago. In doing so, these solar businesses essentially eliminated supply chain margins and gained more control of the sales pipeline.

Whether grown organically or through acquisition, these businesses systematically built differentiated enterprises, and look more like energy companies today than PV module companies. Not everyone had the foresight to make that call, however, and even fewer companies had the resources. But it was a reasonable strategy at the time that seems to be paying off for some.

• Buy

When time isn’t a luxury “buy” decisions are a recognized, practical strategy. Got a household brand name, but new to solar? Not a problem. Just buy the PV modules of one company, along with the microinverters of another, and launch your own brand of AC modules for the do-it-yourself residential market. Need a global support footprint? Simply outsource system O&M to specialists. Missing certain inverters from your product mix? Arrange to private-label products from a competitor to fill out the line card, or just acquire the competitor outright.

The fast-to-market buy approach can successfully leverage the abilities of others, provided that stacked margins or the over-payment for acquired assets don’t completely price a business out of an increasingly competitive market.

• Partner

To “partner” and establish the right set of commercial alliances is an ongoing priority for managers. Strategically, it can be an especially powerful lever to gain an edge in today’s challenging PV climate. In fact, a May 2013 report (published by Lux Research, Inc.) identifies the increasing role of partnerships to position for growth in the resurging solar market, especially in areas like system deployment and balance of system (BoS) technologies.

Successful partnerships offer the combined virtues of build and buy strategies—solutions with sustainable differentiation, which are brought to market quickly and at a lower level of investment. At an industry-level, collaborative alliances with open standards can help drive innovation and focus away from individual component costs, toward total project economics that are more competitive.

Properly structured, industry alliances should include: a common vision to align interests; foundational technology and intellectual property to give partners or members a lasting advantage; and defined standards to manage change, while offering customers a variety of interoperable products or services.

• Exit

Perhaps the most difficult strategic choice is to “exit.” Although the decision to sunset a legacy product isn’t so complex, choosing to exit a market or business is not easy—strategically, operationally, or emotionally.

Thoughtful observers of the PV industry have understandably predicted a shakeout and consolidation at every point along the supply chain. And, it has been happening. In just the last year, some of the strongest, most diversified global PV players have exited lines of business, or the entire PV space altogether, to better deploy their resources. More exits, strategic or otherwise, are certain to come.

Choosing wisely

Build, buy, partner, or exit. This decision-making framework can be a useful tool for business managers during these dynamic times in PV. Every news cycle reveals the strategic choices of customers, partners, and competitors. What is your plan?

Mark Kanjorski is the director of Marketing at Ampt, as well as the chair of the HDPV Alliance.

The HDPV Alliance is an example of a partnership strategy in solar. A commercially focused network of companies, the HDPV Alliance works together to realize up to 50% improvement in PV system ROI.

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Green is the New Black for Homebuyers

A look at energy efficient mortgages

By Brent Taylor

No two homes are exactly alike. Although this may seem like an obvious statement, even homes built in the same neighborhood of a similar size, layout, and design, might have one significant difference—and that's efficiency. From better insulation and windows to lighting and appliances, a more energy efficient home isn't only kinder on the environment, it can also be kinder on the pocketbook of homeowners, at least in the long-run.

However, before then, certain features can increase the value of a home. Efficient windows or LED lighting is one thing, but imagine the integration of solar panels on a roof or a built-in residential geothermal cooling and heating system. Potential homebuyers, in this case, might want to consider a "green mortgage" when negotiating a house that interests them.

A green mortgage used for purchasing a home can be beneficial for buyers for a couple of reasons. For one, it can mean decreased utility costs. Secondly, it can mean larger mortgage loan amounts, making a home that's potentially just outside one's reach financially, a real possibility.

Conserving consumption

Energy costs. Not only does it impact the environment when generated from traditional sources, but it also costs residential owners so that every light left on or air conditioner turned up adds up over time.

Interestingly, however, the US Energy Information Administration has found that in residential buildings across the country, energy consumption has remained relatively stable in recent years. And, that's despite an increase in the number of occupied residential properties. It's believed this stability can be attributed not only to better awareness and conservation in terms of power usage, but also to the overall trend of green living and green housing, which has become substantially more popular over the past decade. Even back in 2008, Americans saved more than \$19 billion, avoiding greenhouse gas emissions equivalent to those of 29 million cars through choices made with energy savings measures and energy efficient homes. (www.epa.gov)

Clearly, Americans are opting for greener choices in their day-to-day lives. And, why wouldn't they be? Efficiency adds up, both for the environment and for the homeowner when it comes to utility costs. For these reasons alone, a home that's already rated high on the efficiency side of the meter, can be an attractive buy for a potential new owner. It only makes sense that an energy efficient mortgage be considered as well.

Efficient mortgages

According to ENERGY STAR—a program that's run through a partnership of the US Environmental Protection Agency (EPA) and the US Department of Energy (DOE)—an energy efficient mortgage (EEM) is a type of mortgage loan that can be used to purchase a home, which has been determined to be more energy efficient than a standard home. This determination befalls a professional energy efficiency rater, who will assess a home to establish whether it falls under the category of being efficient, prior to a buyer being approved for this mortgage.

EEMs often offer buyers the chance to be approved for a higher mortgage because the home of interest uses more cost-effective energy sources. Note, there's also a mortgage known as an energy improvement mortgage (EIM), which is considered to be a type of EEM. An EIM, however, is used to purchase an existing home that requires updating so as to be considered energy efficient. Herein, the buyer is taking on the responsibility of using the excess of the loan over the value of the home to make improvements that will lead to an increase in energy efficiency.

Green mortgage benefits

Whether purchasing an energy efficient home, using an EEM to make some needed upgrades, or building a brand-new home with energy saving goals and technology in mind, there are some benefits to making this decision.

- As mentioned, homeowners who opt for EEMs are often able to qualify for a higher mortgage amount to enable them to buy a better home;
- Even though energy efficient homes often cost five to ten percent more than standard homes, the amount saved in utility costs over time typically more than makes up for the difference in monthly mortgage payments;
- It's usually easier to sell a home that has energy efficient features when the time comes to move on.

Determining eligibility

The US Department of Housing and Urban Development (HUD) outlines the requirements for qualifying for an EEM loan to help buyers figure out if they are eligible.

All buyers qualify for an energy efficient mortgage if they qualify for a regular mortgage, but they must choose to buy a certain type of home to use an EEM for their purchase. Older homes that need upgrades can be purchased with an EEM if the modifications can actually be done. An older home, which needs renovations that aren't possible (because of safety issues or a lack of available space), are not eligible.

Any home that has already been constructed with energy efficient features is eligible for an EEM. Buyers may also consider building a new construction with energy efficiency prioritized when using an EEM.

New developments

There are some new and ongoing developments that relate to the different types of mortgages, which can be considered to be EEMs. For example, there's currently an EEM available to veterans and active military members that allows this select demographic to borrow between \$3,000 and \$6,000 over the cost of a home, to make energy efficient improvements.

Homes requiring a small down payment due to guarantees from the Federal Housing Administration (FHA) might also be eligible for an EEM. Buyers should contact a real estate office that's eligible to offer FHA loans to learn more about this, as well as any other opportunities for buying or investing in an energy efficient home. An energy efficient mortgage helps put power savings within the reach of any buyer who is qualified for a mortgage.

Brent Taylor writes for MortgageLoan.com, a site that aims to provide complete and up-to-date news and information about finance and housing market to readers and consumers.

MortgageLoan | www.mortgageLoan.com



Mitigating the Risks Of wind energy growth

By Lauren Berry

A recent Gallup poll* revealed that Americans overwhelmingly want a greater emphasis on renewable energy production, with 71% of respondents favoring increased production of domestic energy through wind power. Wind farm owners, operators, and developers can capitalize on these positive consumer sentiments about renewable energy production, but they must also be aware of various risks that can arise around wind farm development.

Following are several key risk areas that business owners should discuss with a risk professional around theft, maintenance, and transportation.

• **Theft**

The equipment and materials that make up wind farms can be worth hundreds of thousands of dollars or more. From generators with valuable copper power cables, to the components of sophisticated control systems, thieves stand to make significant gains by targeting unprotected wind farms. Theft threatens a wind farm's growth, as business disruptions could result in heavy costs related to replacing expensive equipment materials and/or lost revenue from turbine downtime. Such interruptions might not only lead to losses in power, but to lost clients as well.

• **Maintenance**

Though business may be growing, many wind farm owners and operators might delay purchasing new equipment in favor of saving costs by using existing machinery. This can help minimize expenses and maximize financial growth for the wind farm in the near-term—assuming the equipment is being properly maintained. As turbines work harder or longer to meet growing demand, however, performing timely maintenance becomes even more critical.

Skipped maintenance updates can cause equipment to age more quickly, increasing the likelihood that an entire system will need to be replaced. In some cases, this might mean the difference between replacing a \$200 part and buying an entire gearbox for \$600,000. Many owners have a tendency to rely on manufacturers' warranties to cover needed repairs or replacement. But, it's important to note, that warranties rarely address all the issues wind equipment could potentially face. Without proper maintenance, any equipment damages or failures that aren't covered by a warranty can create a significant financial and operational burden on a wind system.

• **Transportation**

Transportation becomes an issue when an owner wants to expand or establish a new site. Moving or re-locating costly and oversized 50-ton wind turbines, or 150-foot blades from the manufacturer, requires experienced shippers who have a dedicated focus on wind

transportation. In fact, turbine transportation costs account for 20% of a project's total expense, which has to be taken into consideration when expanding to a new site.

Targeted risk management

There are simple best practices that can be implemented by wind farm owners and operators to help mitigate costs and potential risks. Consider these three tips:

- 1. Security measures.** Prevention can save a lot of hassles, headaches, and unplanned (and unnecessary) expenses. Consider flood lighting, security systems, and fencing at any wind farm site. Employing security patrol services can also go a long way to helping deter theft and criminal activity. Wind farms can also work with an organization specialized in recovering stolen equipment and materials to avoid major financial setbacks in the event theft occurs.
- 2. Checks & balances.** Regularly completing diagnostic tests as part of a maintenance schedule is critical to keeping equipment in good operating condition. Operators and owners should work with an insurance agent or broker to identify the recommended diagnostic tests, and when such analysis should be performed as part of the maintenance schedule. The following tests are recommended as part of an effective maintenance plan to help troubleshoot areas that are prone to malfunction. These five steps help serve as important indicators of early problems:
 - **Battery load test.** Battery testing is essential, and typically takes minimal time to complete since failure can place the turbine in a precarious position. Further, it could take days to get a replacement installed, necessitating downtime that can sap productivity and profits. It's also worth noting that batteries do not last as long in colder climates.
 - **Oil analysis.** This test provides information about what's happening inside the gearbox through the presence (or absence) of metal particulates in the oil. It's generally inexpensive, and serves as one of several reliable indicators of the overall health of the turbine. The goal is to conduct this test often, so as to address causes of wear before catastrophic damage.

- **Vibration analysis.** All turbines have a baseline vibration. A vibration test involves an analysis of the gearbox, shafts, bearings, and other rotating parts to ensure they are working harmoniously. A higher level of vibration is an easy-to-detect sign that something isn't working optimally. A blade could be out of balance, for example, a gear might need to be changed or aligned, or a bolt could be loose.
- **Acoustical testing.** This is similar to the vibration test as it "listens" for many of the same things, indicating physical stress or fatigue to the equipment. All turbines generate some level of sound, so it's important to establish a baseline; an extra-noisy turbine is an indication something might be out of alignment.
- **Gearbox internal inspections.** These inspections should be done annually, or sooner if indicated by vibration or oil samples. They're usually performed with a borescope camera, which is basically a small camera on a flexible wand that can view those areas between gears. A borescope camera is used to look for abnormal wear. This inspection can also be a leading indicator of the health of the turbine, and can be used proactively to identify any necessary repairs or possibly prevent catastrophic damage.

Many testing companies require a baseline reading, so they can then detect deviations and possible issues upon further testing. Don't forget to run these tests when running new equipment for the first time—especially the oil and vibration analysis and acoustical testing.

3. **Safe travels.** Operators considering expanding and moving operations to new site locations need to ensure that equipment and materials are safely transported from the manufacturer. Given most wind farms are in remote locations, and equipment will likely need to travel significant distances from the manufacturer, working with a risk management professional and an insurance provider specialized in wind transportation is important. This collaboration helps ensure the owner's transportation risk exposures are properly addressed.

When choosing insurance coverage, wind farm operators should consult with a carrier that offers specialized risk management professionals, who go beyond simply outlining an insurance policy and can identify unique risks to the business.

Increased demand for renewable energy presents a significant growth opportunity, and investing in the right risk management solutions can help owners and operators obtain the support needed to weather long-term risks and, ultimately, achieve business success.

** References available upon request.*

Lauren Berry works for Travelers, Clean Energy & Technology practice.

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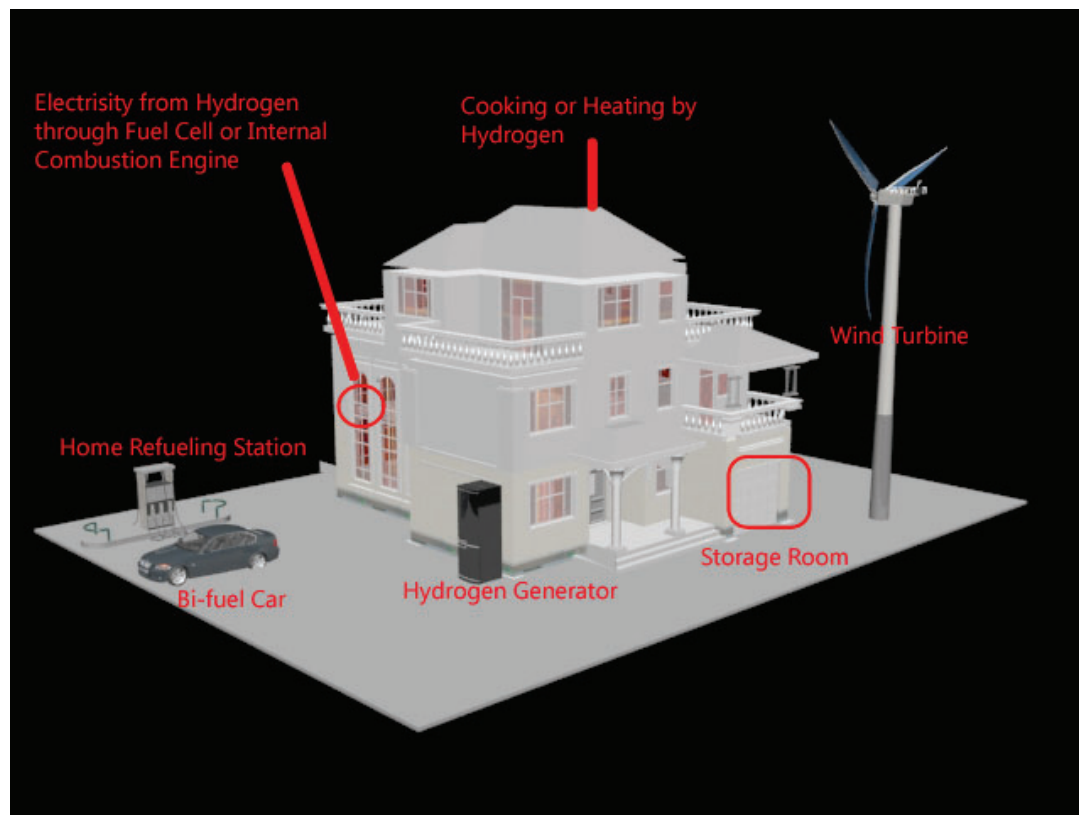
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Developing Powerful Communities

Small, community wind & storage projects

By Xu Liu & Nick Ni



A hybrid, residential energy system incorporating wind power and storage

DERIVING POWER FROM THE WIND IS NOTHING NEW. Reports have windmills dating back to 200 B.C. What began as small-scale attempts to harness energy, have developed into multi-megawatt producing machines today. As technologies have advanced, approaches to generating power from the wind are more efficient than ever before. We're collecting clean, renewable energy from wind comprehensively in larger and larger scales. But what does that mean for those smaller wind energy systems...or should we simply relegate them to the past?

Larger turbines might have replaced smaller ones in many cases, however, not everywhere. The global market for small and medium wind turbines (SMWT) is actually forecast to double by 2015, especially in developing markets, reaching US\$634 million.

Aside from the environmental benefits of small wind (saving fuel transportation costs and transmission lines), perhaps the best argument for developing these turbines and incorporating them into residences and local communities relates to their flexibility. They can stand alone independently or integrate easily into hybrid systems, working together with solar power systems (even diesel, if need be, to reduce some of its impact) or hydrogen storage systems.

Recently developed wind-to-hydrogen conversion and storage technology offers a prime example of such a partnership. On a larger scale, the National Renewable Energy Lab

(NREL) has launched a wind-to-hydrogen (Wind2H2) demonstration project at the National Wind Technology Center in Colorado. The Wind2H2 project links turbines to electrolyzers, which pass the wind-generated electricity through water to split it into hydrogen and oxygen. The hydrogen can then be stored and used later to generate electricity from an internal combustion engine or a fuel cell (www.nrel.gov). In terms of the value of smaller scale distributed wind utilization, this is also possible. Project developers from Eastern Europe, for instance, have been developing a distributed community wind project that involves a number of villages, with the help of hydrogen generators and fuel cells.

More locally, the Fuel Cell Technologies Office—a key component of the Department of Energy's (DOE) Energy Efficiency and Renewable Energy (EERE) portfolio—is seeking information related to a potential H-Prize competition* involving home hydrogen refueling systems, which would further the purpose of H-Prize in accelerating the development and commercial application of hydrogen energy technology. These systems would be designed to produce hydrogen applicable to residential settings for vehicle fueling, using feedstock with an existing residential delivery infrastructure. The potential prize award would be \$1 million.

Now just imagine a system that coupled a hydrogen generator with distributed small-scale wind turbines. It could offer an efficient, environmentally friendly hybrid solution, providing storage and a refueling system. As wind is intermittent in nature, storage often remains the missing link, filling the gap and potentially providing continuous power during those less than windy times.

With the right technology, SMWT can offer many of the same benefits as larger turbines, just on a smaller scale. It just depends on the project. In fact, per kilowatt-hour (kWh) over the lifetime of a system, small wind can be cheaper than small-scale PV and some small-scale hydro solutions (www.ruralelec.org). In 2011, the American Wind Energy Association estimated the cost of small wind turbines in the United States to be \$6,040/kW, an 11% increase from 2010 (www.awea.org). Of course, interested parties and communities need to be able to front those costs, but in some cases programs either encouraged by government or pursued by private owners are available to help. (Note: there are incentives in almost every state; for a summary of what's available, check out www.dsireusa.org.)

Working with the wind

Distributed community wind projects are usually located adjacent to a community, directly supplying energy to end users. The exact power scale depends on the energy demand of the community served, but this is usually fairly small. Generally, these projects consist of a few single small wind turbines, which are readily available for residential, farm, business, and public sector applications.



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• **Agricultural**

Modern farms are often filled with various types of machinery—from tractors and harvesters to trucks and even small planes. These are all energy consumers, and serve as ideal examples where self-sustaining wind turbines can offset some of the power costs involved in running a farm. Moreover, The US Department of Agriculture offers various grants and other funding opportunities through their Rural Energy for America Program. Beyond agricultural endeavors, farmers might find new profitable sources by selling excessive energy from wind turbines to the local grid.

• **Rural communities**

For rural, especially remote residences and businesses, community wind projects can be established, owned, and shared, saving expenses on infrastructure for electricity transmission.

Usually, small communities can invest and own the system and, therefore, can together decide upon what procedures to adopt. Herein, hybrid systems could make a significant contribution, particularly where energy storage is concerned. For example, if a hydrogen generator and storage tank were properly equipped, supply could be further stabilized through the availability of a storage system. Residents could enjoy rural life without worrying about energy costs or power losses.

• **Urban communities**

For urban areas, where infrastructure is well developed, wind turbines seem to only provide an ancillary effect. However, with hydrogen-driven public transportation coming in the near future, refueling stations are becoming necessary and more popular. Small wind turbines could serve to help power hydrogen generators.

• **Commercial**

Due to energy density characteristics of commercial areas, community wind projects are supposed to be designed and equipped larger than ordinary projects. The intent is not only to produce sufficient energy to meet commercial demands, but also to sell some excess to utility company. Although larger equipment costs more, the cost of per kilowatt-hour decreases when compared to smaller systems.

In terms of eco-friendly engineering, low-cost energy, energy security, and economic growth, distributed small and community wind projects have the potential for great contributions. Small wind projects are constructed to be flexible, working for a specific site or community, and able to work within hybrid systems.

Ideally, to strengthen the advantages of SMWTs, the installation, maintenance, and operation of these turbine should be further simplified, and storage systems integrated to serve for any intermittency in the wind.

**The purpose of the H-Prize is to accelerate the research, development, demonstration, and commercial application of hydrogen and fuel cell*

technologies by offering prizes to motivate and reward outstanding scientific and engineering advancements. The H-Prize is currently administered by the Hydrogen Education Foundation (HEF) for the Department of Energy.

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When Knowledge is Power

The potential of small wind in developing countries

By Simon Rolland

SMALL AND MEDIUM WIND TURBINES (SMWT) offer some of the most environmentally friendly and cost-competitive technology currently available for rural electrification, especially in developing countries. A small wind system can be connected to the electric grid through a utility or power provider, or it can stand alone as an off-grid system. This makes small wind electric systems a good choice for rural areas, which aren't yet connected to the electric grid.

According to the Energy Department (www.energy.gov), small wind electric systems can:

- Lower electricity bills by 50% to 90%;
- Help to avoid the high costs of having utility power lines extended to a remote location; and
- Help uninterrupted power supplies ride through extended utility outages.

Small wind can also be easily integrated in hybrid systems with solar energy or diesel. Such hybrid systems offer a more sustainable, higher quality, and lower costs solution than diesel-only systems.

In spite of the benefits, more often than not, SMWT are still left out of the energy solutions discussed and implemented by decision-makers and project developers. So, why aren't these technologies more widely used, particularly in developing countries where power isn't often widespread and cost is a serious issue?

According to an information questionnaire* presented to wind energy advocates in an effort to better understand the barriers faced with advancing small wind development, there are a few reasons why SMWT aren't as prevalent and popular as they could be.

Here's why...

- **Knowledge.** Despite the benefits of SMWT, the market information remains relatively unknown to decision-makers in developing countries. Through regulation, governments are directly responsible for the growth of their utility market, as well as the performance

and safety of electrical systems, but many aren't fully aware of the potential of wind energy. Overall, knowledge and experience with small wind power is still quite rare among practitioners from the public and the private sector.

- **Production.** The production of SMWT is highly concentrated in developed countries. Today, there are about 250 companies in 26 countries manufacturing small wind turbines. More than a third of these, including the largest, are based in the US, though the UK and the Netherlands are also home to other big manufacturers. Great numbers, possibly, but not for rural or developing countries.
- **Cost.** In the United States, the price of small wind lies between USD 0.15 to 0.35 per kilowatt-hours (kWh) over the lifetime of a system, making it (under favorable conditions), cheaper than small PV, small hydro, and other renewable and non-renewable solutions, such as diesel or kerosene. However, determining a proper siting and location for any wind system (even small) is essential to maximizing energy production. A sometimes complex and exhaustive onsite wind resource assessment is key during a project's formulation. Unfortunately, collecting this data is often too expensive and the study's duration is just too long for developing countries to invest in, especially for such a small-scale project.
- **Standards.** Currently, there's a global lack of quality standards and certifications for small- and medium-sized turbine technologies and the related installation process. Specific codes and standards would not only guarantee the reliability and safety of smaller wind systems, but could simplify the process. It could also positively affect production quality, ensuring any lesser-valued products, which tend to damage the image of the industry, aren't an issue.



Strobe lighting

H&P announces new FlashGuard XR Series Strobe Systems. Available in L864(red), L865(white), and L864/L865(red/white) models, the FlashGuard XR is ideal for the lighting of tall structures, including wind towers. The medium-intensity XR series is the latest innovation from Hughey & Phillips, which comes with a five-year limited warranty on all FlashGuard XR Series Strobe Systems and Lighting Kits. Investing in a complete system, consisting of a flashhead and power supply, or a FAA Lighting Kit, provides a five-year warranty on the flashhead.

Hughey & Phillips | <http://hugheyandphillips.com>

Perhaps the most common barrier identified was the lack of information/awareness on the part of energy decision-makers. Without proper knowledge and data—and with such a small amount of small wind systems installed in developing countries to serve as examples—it's difficult for those responsible to create a suitable legal framework for fostering SMWT. To become prevalent, it's imperative reliable, transparent, relevant, and tailored information about SMWT be developed. Certain aspects must be considered for each project, and pertinent information be made available, such as: how to evaluate if SMWT technology is suitable for a specific area; how to select a suitable product; and how to operate and maintain a project long-term.

The good news is that the global market for SMWT is forecasted to double between 2010 and 2015, particularly in developing and emerging markets, reaching US\$634 million. Moreover, efforts have been made to initiate contact and provide information on small wind, and decision-makers in developing countries have shown interest and curiosity about renewable energies in general—and, wind in particular. Renewable energy sources seem to tick all the boxes off their particular energy needs, providing a solution to the rising price of fossil fuels, the increasing electricity needs in off-grid areas, and financial concerns. In some case, there's an availability of international financing for renewable energies.

With the right effort and information, barriers to the successful implementation of SMWT can be broken down and overcome. Small- and medium-sized wind turbine technology can not only cost-effectively power a rural community, but if properly implemented can also have far-reaching effects, positively impact a developing country—and the environment.

** At the beginning of 2012, the international Alliance for Rural Electrification (ARE) asked their wind members to identify barriers they faced while doing business in developing countries. To tackle these barriers, ARE launched the Small Wind Campaign. The key tool made available by the Small Wind Campaign is a position paper, entitled "The Potential of Small and Medium Wind Energy in Developing Countries," which doesn't only give information about the technology, but also provides recommendations and policy tools (available for free download online).*

Simon Rolland is the secretary general of the Alliance for Rural Electrification.

Alliance for Rural Electrification

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Deciding on Distributed Wind Energy With a web-based comparison tool

By Tim Ledbetter

MUCH LIKE THE WIND ITSELF, renewable energy policies and incentives tend to wax and wane, and change direction over time. As interest in wind power and other sources of alternative energy are growing, however, there's a clear need for current, reliable informational resources. From the consumer level up, wind energy advocates, industry representatives, and other interested parties, deserve to know the benefits and challenges involved in wind power.

With the goal of advancing smaller-scale wind generation in the United States, a free web-based tool is available, which makes it possible to identify incentives and other factors that impact the bottom line of wind turbines that are up to 100 kilowatts (kW) in size. This information will influence a range of decision-making—from homeowners, who have the interest and the space to install a turbine, up to federal and state officials, who must determine the most effective uses of funding for advancing distributed wind generation.

One-stop information shop

The web-based Distributed Wind Policy Comparison Tool is helping to inform policy makers, project developers, as well as potential owners and consumers of small and distributed wind energy. Funded by the US Department of Energy's Office of Energy Efficiency and Renewable Energy, the tool was created as one component of a broader effort to significantly boost wind energy generation in the United States by 2030.

Developed by eFormative Options, Pacific Northwest National Laboratory, the North Carolina Solar Center, and the National Renewable Energy Laboratory, the electronic resource serves as a one-stop shop for multiple databases related to the cost, policies, incentives, and other factors associated with distributed wind energy. Initially, it was geared toward providing up-to-date information on government incentives, policy, and technical information, primarily to those who formulate policy. As upgrades and refinements have been added over the past 18 months, the content has evolved and expanded, making the data relevant to a much broader audience.

Now, officials at federal, state, and local levels can access the tool to keep current on the frequently changing landscape of wind energy policies and incentives. Additionally, advocates and homeowners can use it as a touchstone for determining whether their plans for utilizing smaller-scale wind energy are cost-effective and realistic. Ultimately, the tool provides all users an understanding of how different policies impact key financial indicators in the distributed wind power industry.

Real-life scenarios

The Distributed Wind Policy Comparison Tool is quite easy to navigate. Upon entry, a user simply selects the US state they're interested in, and then chooses a "scenario" (residential, commercial, or non-taxed), which includes a suggested turbine model and tower type. Factors such as wind class and annual energy production are automatically populated. From this information, the tool quickly calculates information, such as the projected internal rate of return, payback, net present value, and energy cost. The wind class and technical inputs can also be easily changed by accessing the "Technical" tab, allowing for a range of comparisons. User tips are available on the main web page.

The tool draws its incentive-related information from the regularly-updated Database of State Incentives for Renewables and Efficiency (DSIRE), which is currently considered the most comprehensive resource for data on incentives and policies that support renewables and energy efficiency in the US. The tool's managers augment this content with a mix of other informational resources, which are regularly updated and incorporated.

Beyond potential scenarios, this wind-related resource can also surface information about how policy changes in a given state can impact energy costs, essentially comparing the past to the present. In 2010 in Colorado, for example, the state offered a capacity-based, flat-rate rebate for residential and commercial turbines, which resulted in funding of at least 36 small wind turbines totaling 90 kW. This rebate was discontinued in September 2011. The tool provides a comparison of the cost of energy of small-scale wind turbines—before and after the rebate's end—and concludes the result has been a significant increase of nearly six cents per kilowatt-hour (residentially speaking) in Colorado's small-scale turbine energy costs.

Scope-specific content

In terms of content, this web-based tool is useful within its intended scope, but not comprehensive. For instance, large wind turbine enterprises likely won't find much constructive information here—the turbines listed are only up to 100 kW. Also, an individual wanting to purchase a turbine for residential use won't find any how-to guidance on siting or installing a unit. But, they will be able to identify information that helps answer other questions, such as how use of a taller tower would impact electricity production and whether production-based incentives exist in their state.

The tool has recently been updated to improve usability. Pop-up information boxes allow users to access explanations and added guidance. Two additional resources include a user's guide for those who want more information about navigating the resource itself, and the Distributed Wind Policy Comparison Tool Guidebook (located at the bottom of the entry page). This 63-page guidebook provides a more in-depth overview of distributed wind energy incentives, feed-in tariffs, net metering rules, portfolio standards, renewable energy credits, and other policies.

The Distributed Wind Policy Comparison Tool is an ideal starting point for anyone gathering information or making decisions related to small or distributed wind policies or projects, and especially for those interested in integrating renewable energy into their community.

The Distributed Wind Policy Comparison Tool is located at www.windpolicytool.org. Upon accessing, users are asked to provide their names and answer several questions, but no account set-up or password is required. This user information is intended to help tool developers to better understand audience needs to effectively tailor information and improve functionality.

Pacific Northwest National Laboratory | www.pnnl.gov

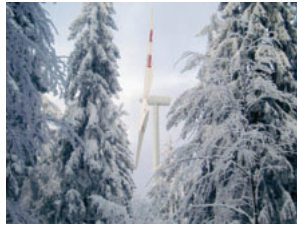


Induction bearing heaters

LUDECA, Inc. announces the addition of two new models to their line of induction heaters: the EDDYTHERM Portable and the EDDYTHERM 2x. Both models allow precise setting of time and temperature to prevent premature bearing failures due to improper or overheating for installation. A magnetic temperature probe continuously measures and displays actual temperature, while a stand-by feature permits holding temperature at a pre-set level for an indefinite time. They automatically demagnetize bearings after heating, and visual and audible signal announces termination of the heating/demagnetizing cycle.

The EDDYTHERM isn't only designed for shrink-fitting of bearings for proper machine installation, but is also ideally suited to heat sleeves, impellers, rings, couplings, crane wheels, gears, etc. Proper shrink fitting extends the life of roller bearings and all these other work pieces. The EDDYTHERM 2x features a swivel arm and is suitable for bearings up to 176 pounds, while the EDDYTHERM Portable is suitable for bearings up to 22 pounds.

LUDECA | www.ludeca.com



Blade monitoring

BLADEcontrol, the continuous monitoring system from Rexroth, detects the state of each individual rotor blade around the clock. The sensor system notes the first signs of damage, which often go unnoticed during a visual inspection. This allows wind farm owners and operators to take appropriate steps at an early stage, avoiding turbine downtime. In the event of serious damage, BLADEcontrol immediately sends a signal to the system control unit, which can then shut down the turbine to avoid blade breakage. In addition to direct damage to the rotor blade, BLADEcontrol also detects other rotor problems, including aerodynamic imbalances, loose parts in the blade and hub, and incorrect pitch settings. By doing so, the system makes an additional contribution to the operational safety of the turbine.

Bosch Rexroth

www.boschrexroth-us.com/windenergy



Next-generation turbine

GE debuts the newest addition to its wind turbine portfolio: the GE 1.7-100 meter wind turbine. The 1.7-100 advances the 1.6-100 wind turbine series by using electrical system upgrades and the power of the Industrial Internet, which works to connect data points across the turbine's ecosystem. As the most efficient wind turbine in its class, the 1.7-100 provides six percent more power than GE's current model, allowing for higher energy capture in lower wind speed environments.

Earlier this year, GE announced its 2.5-120 wind turbine, currently the world's most efficient high-output wind turbine and GE's first "brilliant" wind turbine. GE's brilliant wind turbine platform helps manage wind's variability by providing short-term predictable power, while communicating seamlessly with neighboring turbines, service technicians, and operators. GE's engineers have also created three battery-enabled software applications that integrate seamlessly with the turbine to provide enhanced wind power availability. Wind developers and operators can select the application or combination of applications that best suits individual site needs.

GE | www.ge.com

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A KEB demonstration of a wind turbine pitch control system, featuring a 160-volt ultracapacitor module (Maxwell Technologies)

Producing Cleaner Power Begins with reliable parts & subsidies

By Chuck Cook

Last year the wind industry faced uncertainty as the renewal of the Production Tax Credit (PTC), an income tax credit of 2.2 cents per kilowatt-hour for wind turbine electricity production, faced expiration. When Congress failed to extend the PTC in its payroll extension tax cuts bill last February, wind power developers throughout the nation were forced to delay 2013 projects. Fortunately the credit, which was supposed to expire at the end of 2012, was granted a one-year extension on January 1st of this year.

The American Wind Energy Association (AWEA) expects the continuation of the PTC to save up to 37,000 jobs and revive business at almost 500 manufacturing facilities across the country. Although the credit has been extended, it can be argued that inconsistent federal policies have affected wind energy development in the United States.

However, as the US strives to remain a clean energy leader, manufacturers of renewable power sources must also do their part. For example, wind turbine manufacturers need to ensure the applications developed use reliable, clean components to create an energy source that's truly green and dependable. Various types of energy storage and power solution options must also be carefully considered. Only those systems that best help turbines deliver unfaltering power and that best provide a safe and clean environmental source of energy should be implemented. Of course, implementing environmentally friendly power sources and storage solutions can be challenging, especially in remote locations where most wind farms turbines are built.

Choosing clean components

To develop a clean, reliable source of renewable energy, it's perhaps best to start with the parts involved. Regardless of the size of a wind turbine, manufacturers must implement a pitch-control system to adjust the positioning of blades and accommodate for wind variations, ensuring optimal performance and safety. Smaller turbines in the US have typically used hydraulic pitch control. Larger turbines can benefit from the implementation of electro-mechanical pitch control systems.

There are many economic and environmental benefits to using electric over hydraulic pitch control. In an electric pitch-control system, the turbine's electronic controller examines the power output of the turbine multiple times per second. When the power output becomes too high, the controller gives an order to the blade pitch mechanism, which immediately turns the rotor blades slightly away from the wind. Once the wind drops again, the blades are turned back into the wind. Conversely, when the power output is too low, the pitch blade mechanism turns the rotor blades directly into the wind to

achieve the most output and increase efficiency. Moreover, electric systems consume less power than hydraulic systems, and are safer for the environment as there isn't any risk of hydraulic fluid leaks.

To ensure a turbine functions properly in any condition, however, electric pitch control systems require backup power. And, that requires the use of either ultracapacitors or batteries. Wind turbine manufacturers have increasingly adopted ultracapacitors in electric pitch systems because of their long operating lives, minimal maintenance requirements, and their ability to perform properly in extreme temperatures. Ultracapacitors have an operating temperature range of -40° F to 149° F (-40° C to 65° C), whereas battery performance can become compromised in such extreme temperatures, resulting in a limited lifespan. Due to these limitations, batteries repeatedly need to be replaced throughout the life of a wind power plant. Implementing an ultracapacitor solution provides a virtually maintenance-free energy source that delivers power bursts safely and reliably for more than one million cycles. With no moving parts, ultracapacitors provide a simple, reliable, and energy source-agnostic solution to cushion temporary disparities between the power available and the power required.

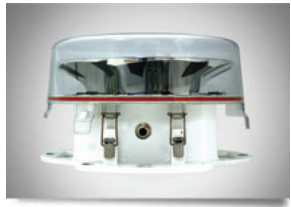
An uncertain future

Although the wind power PTC received a one-year extension, its future is still uncertain. After the extension period is over, it's anyone's guess what will happen next. With any hope, Congress will implement a wind power production tax credit with a longer shelf life so the industry can avoid being hindered by expiring subsidies.

Consistent government support would allow wind manufacturers the resources needed to create better, more powerful turbines that produce cleaner, more reliable power. Cleaner pitch control systems, for example, directly translate to more reliable backup power systems. Currently, developers are working to use electric pitch control to reduce stress and vibration on critical parts of the turbine, improving reliability and reducing operations and maintenance costs. With greater—or, at least, more predictable—resources, it's possible that even greater results could be achieved. That is, if the goal is to further develop the nation's renewable energy sector, ultimately creating a greener environment for Americans.

Chuck Cook is senior application engineer at Maxwell Technologies Inc.

Maxwell Technologies Inc. | www.maxwell.com



Wind certified LED beacon system

Dialight's Vigilant Series L-864 LED medium-intensity beacon system has achieved FAA certification for wind turbine applications per the FAA's AC 70/7460-1K specifications. Unlike competing systems comprised of separate components, the Dialight Vigilant features an integrated GPS controller and complete monitoring system inside the beacon housing for a more rugged, weather-resistant unit. Global GPS synchronization ensures precise flashing of multiple beacons, and Dialight's precision, patented optics design offers a sharp cut-off angle for a community-friendly lighting solution with maximum aerial visibility and safety.

The Vigilant Series also offers quick payback and a faster ROI with significant energy and maintenance savings compared to traditional Xenon and incandescent technology. The vibration, static, and high-voltage resistant system delivers long-life performance in a maintenance-free solution, which is backed by Dialight's five-year, full-performance warranty covering the entire fixture. The high-efficiency system can draw just 3.3 watts average for a more efficient lighting solution to complement sustainable wind energy production.

Dialight | www.dialight.com



Wind power air filters

Custom wind turbine air filters are the answer for power gen engineers looking to prevent energy production loss due to harsh environments. Universal Air Filter (UAF) offers Wind Turbine Air Filters to protect from dust, as well as wind-driven sand, rain, and salt fog. Wind turbine filters provide superior water and airborne contaminant protection in compliance with stringent industry standards, including NEMA and IP enclosure codes. UAF filters replace OEM supplied products for improved contamination control, durability, and serviceability. Base enclosures, as well as power transformation, communications, and other interior turbine equipment use UAF filters.

Universal Air Filter Co.

www.uaf.com



Aluminum cable connections

HELUKABEL's latest cable crimp technology connects aluminum/copper or all-aluminum cable lugs and connectors to aluminum conductor cables, such as the flexible-aluminum WK-POWERLINE ALU. The C8 crimp technology, which has been IEC 61238-1 Class A high-voltage tested and approved, can withstand the warming caused by an electric current flowing through aluminum, which has a lower conductivity level than copper. This allows HELUKABEL to be the only company currently capable of delivering an aluminum cable and lug or connector assembly with an approved connectivity technology up to 777 kcmil (400 mm²).

Additionally, HELUKABEL offers a vast array of wind turbine cables, which have been developed and tested to provide more than 20 years of operation service time. Constructed using specially stranded copper or finely stranded, flexible aluminum and unique conductor/jacket insulation compounds, the HELUKABEL HELUWIND WK-Series offers turbine manufacturers and operators resistance to torsional stress, low-surface adhesion/abrasion, a wide operating temperature range [-55° C (CCV) up to +145° C (HCV)], as well as global approvals (UL/CSA/VDE/CE).

HELUKABEL | www.helukabel.com



High-voltage DC breakers

ABB recently developed a powerful, high-voltage, direct-current (HVDC) breaker that will significantly impact the use of wind-generated electricity. The HVDC breaker removes a 100-year-old technological barrier in the development of DC transmission grids. DC can carry three times more power over long distances, with up to 50% less power loss than alternating current. In the past, it wasn't widely used due to an inability to safely stop the current or identify errors across a power grid. The new HVDC technology facilitates the long distance transfer of offshore wind energy into electricity networks in a safe, cost-efficient and power-saving manner.

ABB

www.abb.com | www.abb.com/hvdcgrid

Next-generation small wind turbine

WindPower Innovations, Inc. announced that its wholly owned subsidiary, WindPower Solutions, has reached a milestone with its next-generation 85 kW wind turbine, successfully completing its 100,000 kilowatt-hour test and ready for market. The next-generation 85 kW wind turbines are ideal for any remote location with abundant wind, such as rural towns, schools, farms, etc. In addition to new installs, they're designed to replace the 65 kW turbines, generating 30% more energy from the same tower. With state-of-the-art gearbox assembly and controllers, the turbines are equipped with a heavy-duty braking system and a good service factor. Plus, with the acquisition of RIG construction, WindPower Solutions now also has the ability to construct the concrete foundations for new wind turbine towers.

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www.wpienergy.com

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Staying Grounded

Safely working with wind power

By Matt Dell

Wind energy might still be a growing industry, but the hazards of the job aren't unique. Wind energy workers are exposed to various dangers, not only because of the heights they work at, but also because of the power they're helping generate. Whether it's from human error or mother nature, anything from induced voltage and backfeed to static electricity and lightning all pose serious risk factors, which can result in critical injury or death.

Protecting workers should be the main priority at any jobsite, and employees should fully understand and engage in workplace safety to protect themselves from hazards. Ensuring fall protection measures are in place, it's just as important to keep power in check as at any point a line could become energized. This begins with staying safely grounded.

Putting safety first

Staying safely grounded includes abiding by standards and working with the correct equipment, as well as proper inspections, cleaning, storage, maintenance, and re-certification. However, completing a job safely should always begin with the knowledge and understanding of a company's Safe Work Practices, including a hazard assessment prior to work [see OSHA 29 CFR 1910.269(a)(3) & .269(c)]. This will help guide workers through the completion of a job in a safe and efficient manner—from beginning to end—and will include information on the proper grounding practices.

Grounding standards

Grounding equipment must be capable of conducting the maximum fault current, which could flow at the point of grounding, for the time necessary to clear the fault. When custom building ground sets, it's important to utilize a professional testing facility that specifically meets the needs of a jobsite. It's not a time to cut corners. Protective grounding should have an electrical impedance low enough to cause the immediate operation of protective devices, in the case of accidental operation of the lines or of any equipment [OSHA 29CFR 1910.269(n)(4)].

Installation and removal of protective grounding should always be done with live-line tools, with the ground-end connection installed first and removed last [OSHA 29CFR 1910.269(n)(6)]. Live-line tools should be properly inspected before use for any damage that could inhibit their protective properties. Any equipment that has suspected damage should be removed from use in the field, and sent to a professional testing facility (American Society for Testing and Materials/ASTM 711-02, 8.1).

According to John Grzywacz, Professor Emeritus of the OSHA National Training Institute, "Most utility accidents and fatalities with respect to line contact are a result of a lack of appropriate PPE and insulated line cover-up, or a lack of appropriate grounding."

Choosing wisely

When building sets, a variety of grounding clamps (including smooth jaws, pressure terminals, snap-on clamps, and bronze body styles with serrated jaws) and ferrules (shrouded and un-shrouded) are available. Clamps and ferrules are furnished in different types and classes, or grades. Bear in mind that the wrong clamp can fly off whatever it's clamped to under fault conditions, so choose wisely based on the job.

Cable can be purchased with colored jackets or clear. Colored jackets, such as yellow, can offer better visibility of the ground set; whereas, a clear jacket offers the reassurance of seeing the cabling inside, making inspection easier. Ground cables are stated in American Wire Gauge numbers (AWG), and are also classified by type. Cables should be stocked in various lengths to accommodate different applications. Ground clusters installed with excessive cable length can whip violently under fault conditions, causing serious injury or worse. Specifications for temporary grounding equipment can be found in ASTM F855-1990.

Daily inspections

Each and every day before use, inspection of clamps, cables, support studs, shrink tubing, and ferrules should occur to ensure there isn't any structural damage. Clamps should be free of loose parts, sharp edges, splits, and cracks, and should be operated smoothly and easily by hand (see ASTM F855-09,10,23,36). Carefully inspect the area where the cable meets the ferrule for any breakage. Also examine the cable jacket for any corrosion (indicated by swollen or soft spots), any flattened or smashed sections, or any cuts or breakage in the cable jacket.

Damaged ground set should be taken out of use and sent in for repair and re-certification. Though damage can sometimes be easily identified, regular wear and tear, extreme voltage, and moisture can also cause unseen impairment. For this reason, an industry best practice is to establish planned repair and re-certification intervals, based on the type and frequency of work.

Cleaning & storage

Dirt and water can actually conduct electricity. Moreover, the everyday petroleum-based products that grounds come in contact with can damage the integrity of a ground set,

reducing protective properties. So, regular cleaning of ground sets are needed to maintain and prolong life.

Wire brushing of the ground clamps to remove corrosion and dirt, as well as cleaning of the grounding cable with a Rubber Goods' cleaner, should be done immediately before and after each use (and don't forget to wire brush the cable where the clamps are attached to). Proper cleaning will also allow for a better inspection of the equipment, and may yield damage that would have previously gone unnoticed.

When storing ground sets, keep them in a protective ground set bag. As with all safety equipment, care should be taken to ensure sets are stored in a temperature-controlled environment, out of direct sunlight and high humidity.

Maintenance & re-certification

Broken and damaged grounds should immediately be sent in for repair and re-certification. Though it's highly recommended that ground sets without any obvious structural damage also be sent in for regular re-certification. The complexity of this process requires highly skilled and experienced personnel, so it's better to be safe than sorry, and utilize an experienced testing laboratory.

Certified test labs will completely disassemble and clean each component, including the ferrules, clamps, and cable, testing each one separately. Any necessary repairs or replacement parts should be made as the device is being reassembled, with the entire ground set tested as a unit upon completion. Afterwards, it should be labeled with the test date and due dates for future re-certification.

Proper grounding not only ensures proper jobsite compliance but, most importantly, it safeguards wind energy workers while working on turbines and on the line. A line that's de-energized can just as quickly and easily become energized, so stay safe and safely grounded at all times, and remember: "if it's not grounded, it's not dead!"

Matt Dell is the owner of Hi-Line Utility Supply, a provider of lineman's transmission and distribution tools, equipment, and services since 1960. Hi-Line is a one-source stop for custom ground sets, service, testing, and tool repair.

Hi-Line Utility Supply
www.hilineco.com



Turbine upgrade

Suzlon Group's S97-2.1 megawatt (MW) wind turbine has been upgraded to handle higher wind speeds in a 60 hertz (Hz) version for application in the North American market. The S97 will achieve higher average wind speed operation through modifications to the controller software and use of enhanced blade fiberglass materials, which further improves blade strength, durability, and stiffness. Customers can expect a cut-in speed of 3.5 meters per second (m/s), a cut-out speed of 25 m/s, and a rated wind speed of 12 m/s. Available in a 60 Hz version for now, the S97 will be available for delivery in December 2013. Suzlon is currently considering having the turbine available for the 50 Hz markets as well.

The Suzlon Group | www.suzlon.com



Wind blade protection coating

Erosion on the leading edge of wind blades can lead to a significant loss in annual energy production, costing owners and operators thousands of dollars. Blade repair and protection cannot only reduce costly downtime, but can also help provide annual energy production improvements and protect the integrity of blades. 3M Renewable Energy Division recently introduced Wind Blade Protection Coating W4600, a two-component polyurethane coating that provides excellent erosion protection properties to help prevent and repair leading-edge erosion on wind blade. Designed to offer game-changing performance and protection, 3M Wind Blade Protection Coating W4600 provides significant reductions in blade erosion and helps to extend maintenance and service intervals. The coating is designed for application in OEM facilities, and can be easily applied via brush or casting.

3M | www.3M.com



Gearbox treatments

Gearbox Express (GBX) introduces its "Revolution" gearbox upgrade. Revolution is a set of upgrades, based on a new thought process for wind energy gearboxes between 1.5 MW up to 2.3 MW. Developed by the GBX team, Revolution addresses the most common pre-mature failure characteristics of gearboxes. Revolution features: a case-carburized ring gear; case carburized and coated cylindrical roller bearings in the HSS, IMS, and planet positions; Water-Lok, which maintains low water concentration; a GBXtreme Filter to six micron, maintaining a high flow at 1,000 beta; a non-desiccant, GBX Water Blocker Breather System; as well as a factory filled with Amsoil EP55, ISO 320 oil. Revolution also comes with a five-year, no-risk warranty.

Gearbox Express (GBX)
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H&N Wind recently completed the build-out on this in-house rescue training platform

Providing Protective Safety Measures

With onsite fall protection & rescue training

By Jonathan Glessner

ONE OF THE GREATEST CHALLENGES a service company can face in the wind power industry isn't necessarily the stress of a new project, but the hiring of new, quality technicians, especially when a large job is on the horizon. Finding a qualified, quality technician is one thing, but finding one with the required fall protection and rescue training necessary in the wind industry can be tough. Nevertheless, fall protection safety training is non-negotiable, and every technician placed on a wind farm jobsite is required to carry the certification of completed training.

Working at heights is a near-daily requirement when it comes to building and maintaining turbines, and attention to detail is mandatory. Whereas certain jobs might allow for an off day, there's no margin for error when working in such extreme conditions. Safety will always be the number one priority in the wind industry. As a result, every service and engineering company placing workers at heights requires a fall protection and training plan that's accurate, up-to-date, and practiced by all employees or contractors to the same standard.

Even with the best training and safeguards, however, accidents do happen. Jobsite rescue training and preparation is as critical as injury prevention, and the process should be just as practiced and consistent. In most if not all cases, rescue certification must (or should) be accompanied by First Aid and CPR certification as well.

Although basic First Aid and fall protection training might seem like obvious "must haves" when it comes to the wind power industry, it's not uncommon for technicians to be missing the proper certifications. Some might have simply allowed their certifications to expire. Others might be brand-new to the industry and have never received it, or been focused on the engineering aspect of their trade and not the safety aspect. Regardless, it's imperative and a "must get" before any work at a jobsite begins.

Onsite training

Often times, a service company is at the mercy of a client's schedule to complete safety training, creating potential delays in starting a project. Herein lays some benefits of having a fall protection and rescue training platform that's in-house. It not only saves time, but also ensures consistency among workers. A company can tailor a teaching platform to best meet the wind industry's standards, as well as their own needs. For example, training could combine ladder rescue and nacelle rooftop rescue in one course as opposed to just offering one or the other (or both, but at different times).

Ultimately, in-house capabilities place control into the hands of a service provider by allowing them to guarantee certain standards and to handpick qualified technicians that are ready to go at a moment's notice. But this doesn't only make sense from a service company's point of view, it also serves the employees by making sure each and everyone feels comfortable with the fall protection and rescue requirements expected. A worker who isn't concerned about safety or safety measures is likely to perform his or her task(s) with better focus, and to a better standard.

Training can also bond co-workers together, ensuring everyone is on the same page. A team of technicians that will need to work together at a specific jobsite can first train together in preparation. Additionally, an onsite training platform provides workers opportunities to attend any ongoing refresher courses or re-certification training—prior to expiry. This allows a technician to avoid any missed work or work days, potentially becoming re-certified while still on the job.

This type of training process offers benefits that trickle down from the operation side to the customer side, as well. Providing an onsite training platform offers many



Arc-resistant switchgear

American Electric Technologies, Inc. will begin offering arc-resistant switchgear, allowing end users to create safer work environments, comply with electrical regulations for the workplace, and better protect lives and assets. AETI's arc-resistant switchgear is designed for onshore and offshore applications, significantly increasing the safety of the operator around the entire perimeter of the equipment. Arc flashes can be channeled through venting ducts out of the top of the system and away from the operator. Arc-resistant switchgear also helps to comply with Occupational Safety and Health Administration (OSHA) and National Fire Protection Agency (NFPA) regulations that require operators review and modify their electrical systems and work procedures to reduce hazards from arc flashes. In addition, AETI offers an arc-mitigation system, which can be paired with arc-resistant products to isolate the arc-fault and reduce the incident energy contributed by the source.

American Electric Technologies, Inc.
www.aeti.com



Floating offshore wind technology

The University of Maine's Advanced Structures and Composites Center has unveiled VoltturnUS, the first grid-connected floating offshore wind turbine to be deployed off the coast of the United States. The approximately 65-foot-tall turbine prototype is 1:8th the scale of a six-megawatt (MW), 423-foot rotor diameter design. It's the first floating turbine of its kind in the world, using advanced material systems with a unique floating hull and tower design. The VoltturnUS technology is the culmination of more than five years of collaborative research and development conducted by the UMaine-led DeepCwind Consortium. The program's goal is to reduce the cost of offshore wind to compete with other forms of electricity generation without subsidies. Maine has 156 gigawatts (GW) of offshore wind capacity within 50 miles of its shores, with a plan to deploy 5 GW of offshore wind by 2030. The 5 GW plan could potentially attract \$20 billion of private investment to the state, creating thousands of jobs.

The UMaine Composites Center
www.umaine.edu



Low wind-speed turbines

Northern Power Systems has expanded its product offerings with two new turbine models, specifically designed for low wind sites. Both the NPS 60-23 and the NPS 100-24 are based on the proven NPS 100-21 platform, but leverage product features that produce higher energy capture in low winds, while reducing the noise profile of the turbine and enabling more siting opportunities.

The NPS 100-24 is based on the proven platform of the NPS 100-21, which was originally designed to service remote areas such as Alaska, where regular maintenance is not an option. The NPS 100 is a highly reliable turbine that utilizes permanent magnet direct-drive technology and has fewer moving parts than a conventional gearbox based wind turbine. The larger rotor diameter, lower rpm, and tip speed of the NPS 100-24 and 60-23 makes for quieter operation, while the longer blades capture more energy at lower wind speeds. The NPS 60 model generates 59.9 kW rated power, and is utilized in areas where grid connection capacity is a constraint.

Northern Power Systems
www.northernpower.com




advantages, including: a safer jobsite; consistency among workers; and a quicker turn-around time on projects, which could equate to cost savings in the long run. New jobs typically have tight deadlines. Sending new techs offsite for certification can negatively impact production schedules. Onsite training eliminates any outsourcing, so service providers can make hiring and training decisions based on a project's timeline, rather than on a technician's training schedule.

Perhaps the biggest payoff, however, is peace of mind in knowing exactly what type of safety and rescue training each and every technician at a wind energy jobsite received. Teaching can remain consistent over time with the right instructor(s), and lessons or knowledge updated immediately as new technology or information becomes available. This more structured approach doesn't only provide for better quality control methods when certifying workers, but it also allows for consistency in training, which should lead to a safer, more structured and efficient work environment—the primary goals of any wind energy site.

Jonathan Glessner is the VP of H&N Wind.

H&N Wind provides full drivetrain services, including generator and gearbox repair, as well as maintenance services such as oil changes, parts replacement, and specialty large correctives.

H&N Wind
www.wazeeco.com/wind





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Educating Wind Energy Workers

A multi-disciplinary approach

By Anna Young & Mark Herral

For the United States to meet its federal goal of 20% wind power by 2030, universities across the nation need to establish education programs to train students entering the wind energy industry. Without incumbent workers and students with multi-disciplinary backgrounds—ranging from business to engineering to atmospheric science—most companies may not be able to successfully expand their workforce to meet this energy goal.

Many of the issues the wind power industry encounters cross multiple sectors within certain disciplines, such as mechanical, electrical, and civil engineering. However, specific issues within engineering impact or are impacted by other disciplines, such as atmospheric science, business, and political science. To better appreciate how a change in a specific field impacts the broader scope, it's important to first understand the links between multiple disciplines. A multi-disciplinary education program is, therefore, required for the industry to grow quickly, without suffering any major setbacks.

Assessing standards

Traditionally in academia, wind-related programs offer either a wind engineering or a wind science approach. The concept of a silo, or single discipline, education program offers a limited perspective to the many dynamics of wind energy. Students who understand how specific engineering concepts can impact legal and financial agreements maintain a competitive advantage over those students from a silo program, especially when it comes to applying for a job or working at a jobsite.

A comprehensive education program should be firmly founded on a long-term history in wind science and engineering. The program should consist of courses from an atmospheric science and wind

engineering perspective. A complete understanding of how complex atmospheric conditions change and impact wind engineering principals is critical not only for designing a successful wind farm, but also for identifying contributing factors related to wind farm failures. Students should also graduate with an understanding of how and why a windstorm forms, how it can affect a wind farm's structures, as well as a wind farm's revenue bottom line, which is critical for success in the industry.

Ideally, a comprehensive multidisciplinary education program would include courses in the following areas, specifically designed to meet the growing wind industry:

- Atmospheric science
- Business
- Construction technology
- Civil, mechanical, and electrical engineering
- Economics
- Law
- Mathematics
- Political science

Currently, most wind energy education programs in the US are based within a certain department, within a specific school. Sometimes education programs in specific departments, however, face challenges



in terms of providing students with a broader understanding of the wind industry. This can be due to course length, training principles, or internal university politics. Regardless of the reasons, for a multi-disciplinary program to be effective, it's important to consider the quality of the course work, as well as the breadth of a program.

Starting at the top

A multi-tiered education program is not only critical for increasing the value of future workers in the industry, but it's also essential in terms of providing students with continued access to accelerate their education. Ideally, degrees for a Bachelor's, Master's, and PhD in wind energy would be established to support the evolution of wind energy education. However, this can be difficult to create, as starting any educational program from scratch is a challenge at most universities. Not only are there cost and enrollment issues, but also various departments or colleges commonly attempt to absorb new programs (often using existing faculty to claim student enrollments). For example, wind engineering courses are usually held within a university's College of Engineering, while atmospheric science typically resides within the College of Arts and Science.

By offering students the opportunity to obtain a degree, universities could play an integral role in increasing education standards and student marketability. Beforehand, however, it would make sense to create a PhD program. In doing so, a university could begin building courses that are specifically tailored to educate students.

Universities should only begin a Bachelor's course once a critical mass of research and course work in wind energy is achieved at the school. Without this research, coursework, and a developed PhD program, a Bachelor's degree program may not prove successful. Student enrollment is critical for the success of a Bachelor's program as it is often the main funding source for an undergraduate program. Usually, this degree does have substantially more student enrollments than PhD programs and, therefore, requires established coursework and competent teaching assistances (TA's) to support the massive instruction load. Qualified and

committed TA's are hard to find—but are often created by notable PhD programs.

Thinking outside the box

Perhaps one of the best or only ways to create a multi-disciplinary degree in wind energy is to design an education program outside of an existing college or school. But this program would need a baseline faculty group to teach, and to ensure critical courses are offered and sustained. This proposed structure would allow students obtaining a degree in engineering or science to double-major, minor, or take additional courses to prepare them for work in wind and related industries. This structure also gives students the unique capability to tailor their education to meet career goals. For example, if a student wants to design wind turbines, it would be possible for him or her to obtain a major in the engineering college, while receiving a major, minor, or certificate in wind energy—thereby receiving a well-rounded, multi-disciplinary education in wind energy.

Note: *Texas Tech University has formed the National Wind Institute (NWI), which offers a multi-disciplinary research and education program. NWI has 40 years of history in Wind Science and Engineering, and currently offers the only PhD program in wind science and engineering in the US, as well as the only Bachelor's degree program in wind energy (www.depts.ttu.edu/nwi).*

Group NIRE | www.grouppnire.com



Fast drying mid-coat

International coatings manufacturer Hempel announced the launch of HEMPADUR 47300, a new NORSOK-approved epoxy mid-coat that can reduce drying times for offshore wind tower manufacturers by up to 25%, helping to drive down production costs. Specially formulated for offshore wind towers, HEMPADUR 47300 is a low-solvent epoxy mid-coat that offers vastly improved curing times for manufacturers. The coating can be handled just four hours after application at 20° C (68° F), compared to an average of five hours for standard equivalent coatings. This enables manufacturers to reduce production line bottlenecks and increase line speeds. HEMPADUR 47300 is approved and certified according to NORSOK M-501, System 1. It can be applied with airless spray and has a volatile organic compound content of just 190 grams per liter, which means very little VOC is released during application.

Hempel | www.hempel.com



Turbine-mounted Lidar

Wind Iris is a turbine-mounted Lidar that measures horizontal wind speed and direction at multiple distances, out to 400 meters in front of a wind turbine. It provides the same level of accuracy as a Class 1A anemometer, the standard for performance optimization of a wind turbine. The Wind Iris can measure wind turbine power curves without a met mast and detect turbine yaw errors and underperformance, enabling users to maximize the energy production of their wind turbines. Installing safely and easily in half a day, its rugged design has no moving parts, which allows for exceptional reliability. Users can rapidly optimize several wind turbines with one unit through repeated installations. By detecting and correcting underperformances, the Wind Iris helps users gain a quick return on investment on a wind farm scale. New to the North American market, Wind Iris is designed and manufactured by Avent, a collaboration between NRG Systems and Leosphere.

NRG Systems | www.nrgsystems.com



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SEE AD ON PAGE 56



Product: PMI Avatar Deluxe

Application: Designed for fall-arrest, rope access, and rescue

Key Features:

- Equipped with AustriAlpin COBRA quick-release, color-coded buckles;
- Adjustable, integrated upper and lower harness sections;
- Buckles at the waist, plus the dorsal attachments are spring loaded;
- Made in the USA, and available in standard and large size; and
- Training is available through PMI's Vertical Rescue Solutions.

Training/Certifications: NFPA 1983, Class III; ANSI Z359.1

Website: www.pmirope.com



Capital Safety

Product: DBI-SALA Powered Climb Assist System

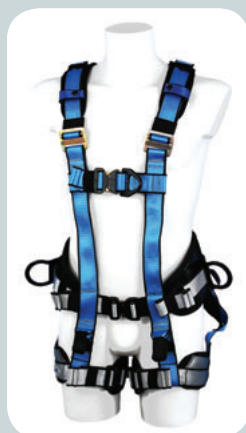
Application: Specifically developed to provide assistance for those who climb the internal ladders of wind towers

Key Features:

- Equipped with a wire cable, wire cable grip and lanyard assembly, portable motor control unit, cable tensioning system, as well as top and bottom bracket assemblies;
- Adjusts to environmental conditions and adapts to end-user movement to allow users to ascend and descend effortlessly;
- Suits a wide range of climbing styles and user weights; and
- Easily transported to support multiple systems and wind towers.

Training/Certifications: All of Capital Safety's fall protection and rescue systems are backed by extensive training, and come with technical assistance

Website: www.capitalsafety.com



Safety Technology Ltd

Product: Sirocco TH-245 Fall Arrest Harness

Application: The Sirocco TH245 harness is a high-quality, lightweight harness, designed in conjunction with wind turbine technicians to ensure safe working on onshore and offshore turbines

Key Features:

- Equipped with rear fall arrest attachment point, lower work positioning and rescue attachment points, as well as sliding D-rings to increase ergonomics;
- Ergonomically shaped back pad has additional padding at the sacrum point for extra support/comfort;
- Breathable hexafoam pad lining prevents excess sweating during climb;
- Fully opening with quick-release buckles for easy access and removal; and
- Articulated leg straps spread the load up to the back pad, ensuring better protection in a fall situation, and significantly reducing injury and effects of suspension trauma.

Training/Certifications: The Sirocco TH 245 fall arrest harness is compliant with the ANSI standards, as well as the EN and CE standards

Website: www.safetytechnologyusa.com



Corgo Industries

Product: Custom Rope Bags

Application: For anytime cord is needed on the job; ideal for everything from fall protection kits and rescue positioning systems to mobile platform ropes, rope access inspection, and more

Key Features:

- Rope and stuff bags can be tailor-made to fit exact user requirements;
- Custom-manufactured to exact specifications with choices of closures, materials, colors, and sizes;
- Corgo will help select the right material for the work environment; and
- These bags can be load rated if needed, depending on the job requirements.

Training/Certifications: All of Corgo Industries' products are seam-tested, and all of the materials used are tera-tested. CTT Textile testing seam; CGSB Testing on materials

Website: www.corgoind.com



Power Climber Wind

Product: IBEX 1000P Climb Assist

Application: Intelligent climb assist for wind turbine technicians

Key Features:

- EasyClimb Controller puts control at climber's fingertips;
- Designed to retrofit in any wind turbine tower, providing personalized performance with increased safety and better productivity;
- Patented, closed-loop control offers adaptive ride performance, and the multiple assist settings allow users to Up and Down set independently; and
- Truly portable control box (which is 8.5 pounds), durable, and weatherproof.

Training/Certifications: N/A

Website: www.powerclimberwind.com



TUF-TUG Products

Product: Wind Tower Flange Deflector Plate

Application: Designed for wind towers with internal ladders facing an outside wall, which have flange clearances of less than 30" in violation of OSHA 1910.27(c)1

Key Features:

- The Deflector Plate provides a compliance solution to the restricted climb path issue associated with flange obstruction per OSHA fixed ladder safety standards;
- Easy installation retrofit kit bolts into place with existing fasteners;
- Custom installations available for most wind tower applications; and
- Made in the USA.

Training/Certifications: OSHA standards and training with TUF-TUG climb certification available

Website: www.tuf-tug.com



Transcat, Inc.

Product: Gear Keeper Super Coil Personal Tethering Systems

Application: Allows users to tether tools to a person or a structure for improved safety while climbing wind towers

Key Features:

- Protect employees, their tools, and the work site from falling objects;
- A variety of sizes are available based on the weight of a tool and the specification application;
- All tethers are serialized for tracking; and
- All tethers are Load Certified and Made in the USA.

Training/Certifications: All Gear Keeper tool tether ratings are load tested with up to a 100% safety margin beyond the break point to safely handle the shock load of a dropped tool

Website: www.transcat.com



Tractel Ltd. - Fallstop Division

Product: Elastrac Harness

Application: Full-body safety harness for all work applications at heights, with a specific model available for the wind industry

Key Features:

- Dual ElasPac controls excessive webbing stretch, which can lead to increased fall distances;
- Independent leg/seat support with comfort pads;
- TracX comfort pad with breakaway lanyard keepers;
- Construction-style waist pad with removable tool belt; and
- Five-point adjustability.

Training/Certifications: Standards ANSI Z359.1-2007 and A10.32-2004; OSHA 1926

Website: www.tractel.com

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Snap-on Industrial

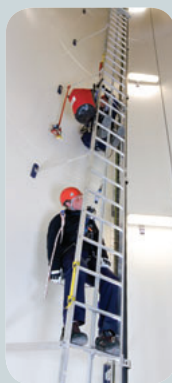
Product: Tools @ Height Engineered Tool Drop Prevention System

Application: Any elevated work environment, such as on wind turbines

Key Features:

- Uniquely engineered attachment points on tools that maintain or enhance functionality;
- Small parts/tool pouches for easy reach-in retrieval with a self-closing feature; and
- Third-party rated lift bags with secure closures and multiple D-ring attachment points included inside.

Website: www1.snapon.com



Avanti Wind System

Product: Avanti Fall Protection System

Application: Developed to prevent service technicians from falling off the ladders in wind turbine towers

Key Features:

- Avanti Fall Protection System has been designed as part of the ladder;
- Technicians have a special click-on runner on the harness, which can be attached to the safety rail (in the center of the ladder), and it follows a user as they move up and down;
- The runner immediately locks if the technician loses his grip on the ladder.

Training/Certifications: All Avanti products are designed in compliance with, or have been tested and certified by third parties, to comply with the standards in Europe, USA, Canada, Australia, New Zealand, and Brazil

Website: www.avanti-online.com



Gravitec Systems

Product: G4 Industrial Rescue & Evacuation System

Application: Developed as a means of rescue and evacuation for those in the wind industry, and revamped for universal use

Key Features:

- Offers versatility in accommodating evacuation, lowering, lifting, and suspended or assisted rescue;
- There's 350' of 11mm rescue rope (previously 300'), finished with factory-stitched terminations and stainless steel thimbles;
- All carabiners are aluminum with triple locking for extra security, and most feature a captive eye to prevent loss and increase safety;
- New accessory bag comes complete with a daisy chain storage so the pulley system, anchors, pick-off strap, and accessories can be carried directly on a users hip; and
- Includes upgraded, progress-capture pulley with locking cam feature.

Training/Certifications: Gravitec Systems provides a host of training options for the G4, including: Authorized Rescuer; Competent Rescuer; and Train the Trainer options. The G4 Kit is made with ANSI and NFPA approved equipment (ANSI Z359.12, Z359.1, and NFPA 1983-2012) equipment

Website: www.gravitec.com

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www.intersolar.us

show in print

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



Heat pump water heater

The Stiebel Eltron Accelera 300 Heat Pump Water Heater can extract up to 80% of its energy requirements from the energy in the air around it. Compressor and fan consume only one kilowatt-hour (kWh) of electricity to generate the heat equivalent of 3 kWh to 5 kWh. Among heat pump water heaters, the Accelera 300 has the largest capacity (80 gal), highest energy factor (2.51), lowest power input (2.2 kW), and lowest power consumption (1739 kWh/year) as determined by DOE testing. The low-power consumption (500 W heat pump only; 2200 W including back-up element) makes the Accelera 300 a viable option for connecting to a PV system. The Accelera 300 is Energy Star certified, and eligible for any available tax credits or rebate incentives. There is also a 10-year warranty.

Stiebel Eltron

www.stiebel-eltron-usa.com

Booth 7715



Solar panel cleaner

The GEKKO Solar Farm was designed specifically to clean free-field solar power plants, and can clean entire panel rows in just one pass. Even at certain North American and Central European latitudes, efficiency increases of 10% to 20% can be achieved through regular cleaning of solar panels. With a standard speed of over 300 meters per hour and a maximum width of almost seven meters, the robot can clean over 2000 square meters per hour. Multiple process-controlled, non-slip rubber suction cups secure themselves to the panel and move the device forward. Thanks to its proven soft-brush technology, the ingenious cleaning system ensures panels are cleaned carefully and with optimal results. The GEKKO Solar Farm uses eco-friendly, de-mineralized water and excels due to its low water consumption of five liters per minute.

Serbot AG | www.serbot.ch

Booth 7449



Multi-pin connector

Anderson's Solar SPEC Pak meets the PV industry requirements specified in UL 6703A and BS EN50521, passing the same harsh environmental tests used to qualify solar panels. It has power-handling capabilities up to 1000 volts, and features a locking latch compliant with NEC 2008 section 690.33(C). The IP68 environmentally sealed shell has a flammability rating of V-0 per UL 94 and a weatherability rating of F1 per UL 746C, along with a temperature range from -40° C to 105° C (-40° F to 221° F). The core technology within the SPEC Pak shell will hold up to four Powerpole power contacts, 16 signal contacts, or a combination of both. Individually, power contacts are rated to 40 amps, handling wire sizes from 20 AWG to 10 AWG (0.50 mm² to 4 mm²). Ground contacts are First Mate/Last Break per NEC 2008. Solar SPEC Pak is highly configurable, providing many design options for each unique requirement.

Anderson Power Products | www.andersonpower.com

Booth 9128



Inverter transformers

As part of CG's ongoing drive to offer high reliability and high value to the industry, CG has announced the addition of the LHL 3-Winding to its popular line-up of CG SolarPAD series inverter transformers. The new LHL style winding allows for galvanic isolation of two inverters when connected to the same transformer, while maintaining a high impedance between each inverter as required by many of the largest inverter manufacturers. The LHL style 3-winding offers similar performance to the industry proven 4-winding style, along with the benefits of reduced complexity and cost, particularly for inverters one megawatt or smaller. Moreover, the typical SolarPAD is significantly smaller and lighter than a conventional substation. It's available in a wide range of kilovolt-amperes (kVA), voltages, ambient conditions, and colors to suit the particular requirements of the end user.

CG | www.cgglobal.us

Booth 8117




CITEL INC
BOOTH 8318





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Inverter, optimizer & gateway

SolarEdge Technologies has unveiled a new line of products for commercial applications in the North American market, including: a line of 3-phase solar inverters from 9 kW to 20 kW in size; a 600 W capable power optimizer, enabling a two-to-one connection for 60 cell modules; and a new gateway for site communication and PV monitoring. Implementing the new line of commercial inverters will simplify PV system design and lower installation costs. The new line of 3-phase inverters allows designers to install significantly longer module strings than with traditional inverters, lowering electrical labor and component count by half. These inverters reach a high-weighted CEC efficiency of up to 98%, due to a fixed string voltage design that ensures optimal DC/AC conversion. Supporting two 60-cell crystalline solar modules, the 600 W power optimizer builds on SolarEdge's high-efficiency electronics offerings, reaching a maximum efficiency of 99.5%. By taking the maximum power point (MPP) trackers out of the inverters and putting them into the power optimizers, SolarEdge can optimize the PV system, increasing energy harvest, offering module level monitoring, and enhancing system safety.

SolarEdge Technologies | www.solaredge.us
Booth 8421



Deep-cycle batteries

Trojan Battery offers a wide range of deep-cycle batteries engineered specifically for renewable energy and backup power applications. Trojan's broad portfolio of high-quality, deep-cycle flooded and VRLA batteries include the Industrial, Premium, Signature, AGM, and Gel lines, which offer the durability and performance customers have come to expect. To simplify maintenance of flooded batteries, Trojan offers a Single-Point Watering Kit. Proper maintenance and periodic watering are important factors in maximizing the performance and life of deep-cycle flooded batteries. Since battery maintenance can be costly and time-consuming, the Watering Kit enables precise battery watering saving valuable time and money. Trojan batteries are used in more than 100 countries and in a variety of renewable energy systems, providing reliable power under the most challenging conditions.

Trojan Battery
www.trojanbattery.com
Booth 8244



Solar-ready shade structures

Baja Construction announces their new SR Series solar-ready shade structures, engineered and optimized to site-specific applications. The rugged, yet sleek structures feature a simplified design and integrated PV module mounting system, resulting in faster assembly rates and labor savings on every project. Available in a variety of structural types and finishes, these solar support structures feature tilt angles up to 10°, and optional solutions for water and snow protection. The integrated module mounting system features high-strength Power Rail components, including the revolutionary RAD lock-in-place clamping system and certified integrated grounding. PV module mounting is available in portrait, landscape, or side-tilt orientations for increased energy production and simplified electrical connections. Baja Construction also offers professional, code-approved installation services of the SR Series structures for locations anywhere throughout the Americas and abroad.

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Sapa Extrusions North America
www.sapagroup.com/na
Booth 9346



Pre-wired systems & controller

OutBack offers new standard FLEXpower models and a new system configurator. All pre-wired and tested FLEXpower systems now come standard with OutBack's advanced MATE3 system programmer/controller. The dual-inverter FP-2 systems also ship with two FLEXmax charge controllers as standard. System options include off-grid, grid-interactive, as well as 120, 120/240, and 230V versions. Other configurations are available with OutBack's new FLEXpower System Configurator.

OutBack | www.outbackpower.com
Booth 8021



Ground-mount systems

Creotecc US specializes in the design and manufacturing of ground-mount systems, which feature their innovative insertion rail design. With no clamps to fasten, modules are placed quickly and easily into rails from underneath the array for faster panelization. The clamp-free design also protects modules from mechanical stress caused by thermal expansion, contributing to the lifetime of the array. Creotecc is a global manufacturer, which develops scalable, ground-mount systems that are made in the USA, as well as UL 2703 recognized, P.E. certified, and supported by an experienced team of engineers.

Creotecc | www.creotecc.us
Booth 9623



PV connector system

Phoenix Contact has introduced Sunclix, a DC plug and receptacle connector system for PV applications. The connectors can be assembled in the field or factory, greatly reducing the cost of installation. The one-piece DC connectors use spring technology for quick and easy assembly and termination, without the use of crimp tools. The connectors can only be disconnected with the use of a screwdriver, which eliminates the possibility of accidental release, while meeting NEC requirements. The new plug-in connectors also make it possible to connect PV conductors from 14 AWG to 6 AWG, with a voltage of up to 1500 V IEC 1000 V UL using only two versions. The connectors, classified with IP69 degree of protection (2 m/24 h), meet the requirements of the DIN EN 50521 standard and are ETL-certified to UL 6703.

Phoenix Contact
www.phoenixcontact.com
Booth 9234



Grounding, bonding & connectivity

ILSCO is a component manufacturer, supplying grounding, bonding, and connectivity solutions to the solar industry. ILSCO SOLAR lay-in connectors feature stainless steel hardware, and some offer a unique, patent-pending clamp design that eliminates the need to drill holes in the frame or add mounting hardware. The SGB-5 provides an elevated conductor wire way to accommodate various rack and panel designs. ILSCO SOLAR connectors are UL Listed for grounding and bonding, as well as CSA Certified. ILSCO also has the ability to design and build custom products.

ILSCO | www.ilSCO.com
Booth 9135

WILEY

The Wiley WEEB: It's What's In Store

When it comes to harnessing renewable energy, more businesses are finding that the answer is right in front of them. Well, right above them.

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has been revolutionizing the installation of PV systems—making solar projects more viable.

For example, BURNDY has supplied the WEEB solution to help IKEA reach its goal of producing 100% of the energy consumed by its stores from renewable sources by 2020. Through the Wiley WEEB's simple, reliable and low-cost method of bonding PV module frames and racking systems together, **installers save up to at least two minutes of installation time on each PV module.** And when you're talking about dozens of projects (IKEA just finished its 39th nationwide), that time adds up.

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Efficient mounting systems

Schletter's new product offerings are designed for the highest level of component efficiency and easy installation. Fix-EZ is an all-inclusive, ballasted flat-roof solution for quick and simple installation. Ideal for large commercial rooftops, the system makes it possible to fit many single-panel rows into a small area. Schletter's Fix-EZ system consists of everything needed to finish the job quickly, including the ballast blocks, which are specially designed to reduce and distribute loads evenly across the roof. For ground installations, Schletter has also recently released the ballasted PvMini, which increases ground clearance without increasing installation difficulty. It utilizes smaller foundations for sites in which ground disturbance must be kept to a minimum. A newly developed rail profile, the ProfiPlus XT, achieves longer spans and facilitates efficient use of all of the system components as a whole.

Schletter | www.schletter.us

Booth 9323



Mass flow controller

Photovoltaic cell manufacturers have long relied upon Alicat Scientific's sub-100 millisecond control speeds to prevent costly target poisoning in their vacuum deposition processes. Alicat's MCV series of mass flow controllers for vacuum marries this ultra-fast control speed to an integrated, positive shut-off valve, providing a leak-tight shutoff of 1×10^{-9} atm-scc/s (He) to prevent contamination of the coating process when no gas is flowing. The MCV series is available in full-scale ranges from 0-10 SCCM to 0-20 SLPM, and comes standard with Alicat's laminar flow technology with 200:1 turndown ratios, no warm-up time, and 30 on-board gas and gas mix calibrations. Every mass flow product is backed by customer support and a lifetime warranty, which is currently an industry first. And, all of this comes in a device that weighs just three pounds and is only 1.5 inches deep, making the Alicat MCV a cost-saving, space-efficient choice for PV coating systems.

Alicat Scientific, Inc. | www.alicat.com/mcv

Booth 8533



High-voltage contactor

GIGAVAC announces a new addition to their extensive line of EPIC Sealed Contactors, the HX22. Designed and manufactured in the US, the HX22 is RoHS compliant and is pending UL508 approval for 1000 VDC, 175A loads. Approval would make the HX22 the smallest UL recognized contactor for high-current switching at 1000 VDC. Rated for continuous duty up to 300 amps, the HX22 was developed for use in solar combiner boxes and inverters. Lightweight and compact (about 3.6" x 3.2"), the HX22 utilizes GIGAVAC's EPIC sealed switching technology, which means it can safely be used in nearly any harsh environment, including at temperatures from -55° C to 85° C (-67° F to 185° F). The HX22 is not position sensitive, which allows for easy mechanical arrangement in any circuit.

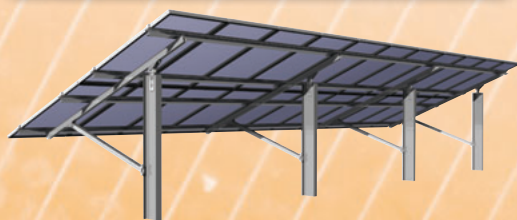
GIGAVAC | www.gigavac.com

Booth 8025

Performance and Simplicity Connect



Large Scale Installations



Power Peak™ Ground Mount

The Power Peak™ ground mounting system combines high strength steel components, lightweight module rails and patent pending RAD™ module clamp for faster installations.

Optimized to site specific conditions, the Power Peak assembles quickly over pile driven beams with built in adjustability and module layouts that also reduce wiring time and materials.

The Power Peak is the newest member of DPW Solar's field proven ground mount solutions including Multi-Pole Mounts (MPM-G2), Large Ground Mounts (LGM), and Top-of-Pole Mounts (TPM).

Life just got easier for Pile Drivers and PV rack installers

Visit our booth #9401 at InterSolar North America
July 9-11, 2013

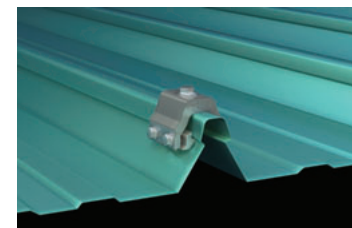


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NACE-7-13



Metal-roof clamp

S-5! presents its newest metal-roof ancillary attachment solution, the S-5-K Grip clamp. The S-5-K Grip was specifically developed to fit Klip-Rib and other bulb snap-together seams. The design utilizes multiple inserts (sold separately) to accommodate a variety of bulb snap-together profiles, without piercing the metal roof panel. Each insert has a unique shape that allows for a tight fit, providing increased holding strength over other attachment options. The S-5-K Grip also eliminates the large moment arm utilized by other clamps fitting these profiles. Instead, it features a low mounting surface area, with the mounting bolt placed directly over the center of the seam. This dramatically increases the strength of the clamp, making it ideal for use with heavy-duty applications. Plus, S-5!'s non-penetrating attachment method will not jeopardize roof manufacturers' warranties or cause leaks.

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

Booth 9223



Dual-certified PV cables

Nexans AmerCable is the only United States cable manufacturer offering dual-certified (UL/TÜV) and ETL-approved solar cables in a 2000V (UL)/1000V (TÜV) rated construction. This versatile, single-conductor cable is designed for solar applications, including connection to module junction boxes and required cable routing in balance of system (BOS) integration. AmerSol, which is also available in a 600V (UL)/1000V TÜV rated construction, consistently delivers some of the tightest diameter tolerances in the industry. Nexans AmerCable also manufactures high-quality Type PV UL4703 2kV, with CSA and UL certification, and Type TC 2kV multi-conductor cable with UL certification. Each PV cable is compatible with all major connectors. Nexans AmerCable also provides additional engineering and customer service support.

Nexans AmerCable
www.nexansamercable.com
Booth 9112



Utility ground-mount racking system

The FlexRack Utility Ground-Mount is an all-steel racking system featuring the patented, unfolding design for one of the fastest and easiest installations on the market today. FlexRack Utility offers many integrated features, including a wire management system built-in to every rack, integrated grounding, and adjustability's allowing for up to a 20% slope in topography in the E/W direction. The FlexRack Utility comes standard with a leading 20-year warranty. Solar FlexRack certified installers can also provide full turnkey installations.

Solar FlexRack | www.solarflexrack.com
Booth 9439

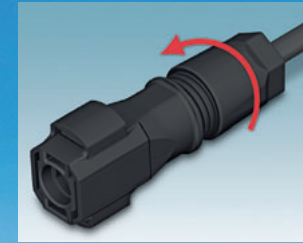


Electric pump & motor

SubDrive SolarPAK from Franklin Electric combines solar technology with proven, groundwater pumping equipment, offering a rugged, high-output system that tackles the challenges of off-grid pumping. SolarPAK, featuring a standard four-inch Franklin Electric pump and motor packaged with a solar controller, will couple with a new or existing array to offer electric pumping options in applications where electrical power may not be accessible or cost effective. Available in 45 gpm and 90 gpm ratings.

Franklin Electric | www.franklin-electric.com/products.aspx
Booth 8836

Connection outlook: Sunny!



SUNCLIX – quick assembly, without tools

PV system installation now has a more efficient way of wiring cables of various lengths from the module through to the inverter: the SUNCLIX connection system from Phoenix Contact. Terminate one-piece DC connectors quickly and easily with spring technology — and without tools.

The spring technology of SUNCLIX:

- **ETL certification — approved for use in North American installations**
- **Reliable, long-term, stable conductor connections**
- **Available in up to 6 AWG and 1000 V, minimizing power loss**

To find out more information call **1-800-322-3225** or visit www.phoenixcontact.com/sunclix



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Solar power solutions

SMA presents a variety of solar solutions, including the Sunny Boy 240-US, a micro-inverter system that enhances design flexibility for installers. It features simple installation and a reliable communications platform. The Sunny Boy 3000TL-US/4000TL-US/5000TL-US offers dual MPPTs and SMA's OptiTrac Global Peak MPP tracking, which mitigates the effect of shade and allows for installation at challenging sites. A unique, secure power supply feature provides daytime power, even in the event of a grid outage. The Sunny Tripower-US is a three-phase transformerless inverter, featuring peak efficiency above 98%. Applicable for 600 VDC and 1,000 VDC applications, the Sunny Tripower allows for a lower levelized cost of energy. The Compact MV Power Platform is a turnkey solution for maximum energy production, providing 110% power output at temperatures up to 25° C (77° F). It's engineered for maximum ROI, offering reduced system costs and best-in-class system efficiencies above 97%.

SMA America | www.sma-america.com

Booth 8321



Utility-scale PV power conversion systems

Bonfiglioli designs and manufactures efficient, reliable, and cost-effective power electronic and control systems, with the expertise to manage every aspect of PV energy generation—from PV array layout design to utility generation. Bonfiglioli's product portfolio includes a wide range of inverters, from compact solutions with outputs between 30 kW and 200 kW, to RPS TL transformerless modular systems and RPS Station turnkey solutions up to 2.8 MW. Available in master slave or multi-MPPT configurations, Bonfiglioli's high-performing, scalable inverter systems provide design flexibility, advanced grid integration, and management features such as active/reactive power control, voltage and frequency ride-through, and active power reduction for over-frequency response. Bonfiglioli successfully delivers, commissions, and services utility-scale inverter systems anywhere in the world.

Bonfiglioli USA | www.bonfiglioliusa.com

Booth 8311



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PV component manufacturer

Schunk Graphite Technology is a manufacturer of carbon fiber reinforced carbon (C/C), insulation materials, and graphite, including SiC and PyC coating for PV manufacturing equipment. Their products are used in c-Si (Cz and DSS) and thin-film (CIGS and CdTe) processes, as well as in polysilicon production. Schunk Graphite manufactures products to exact customer specifications, including: crucibles; wafer carriers and boats; heating elements; C/C plates and susceptors; insulation cylinders; and boards.

Schunk Graphite Technology

www.schunkgraphite.com

Booth 7645



Transformerless inverters

Solectria Renewables' introduces the PVI 14TL, PVI 20TL, PVI 23TL, and PVI 28TL transformerless, three-phase inverters with a dual MPP tracker. These inverters come standard with AC and DC disconnects, a user-interactive LCD, and an eight-fuse string combiner. Their small and lightweight design makes for quick and easy installation and maintenance. These inverters include an enhanced DSP control, comprehensive protection functions, and advanced thermal design, enabling high reliability and uptime. They also come with a standard 10-year warranty, with options for 15 and 20 years.

Solectria Renewables, LLC

www.solectria.com

Booth 8211

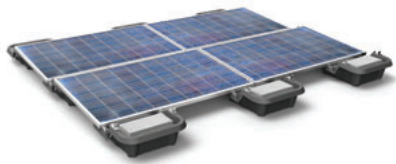


Solar foundation solutions

Cantsink Manufacturing is a manufacturer and installer of helical piles, as well as a total foundation solution provider. With engineers on staff to provide soils analysis, pile specifications, and array design, Cantsink is an informative resource for ground-mounted solar energy installations. Additionally, Cantsink now also provides driven piles and installation.

Cantsink Manufacturing | www.cantsink.com

Booth 9341



Fully ballasted racking systems

Sollega Inc. specializes in fully ballasted racking systems with optional mechanical anchors. Sollega's FastRack (FR5) 5-degree, low-pitch roof solar mounting system compliments their existing InstaRack (IR10 & IR15) product line, and is the first truly universal one-piece modular mounting system engineered to mount all 60- and 72-cell modules. The lightweight, stackable design is efficient to ship and quick to stage and install by attaching easily at the four corners of each module. All attachments utilize one tool, a standard half-inch socket. Engineered as a fully ballasted mounting system, optional mechanical attachments are available for low PSF and seismic requirements. The inter-row spacing is nine inches for a high density on the roof. Manufactured of recycled HDPE plastic that's enhanced with an ultra-violet (UV) inhibitor, the FR5 is guaranteed for 25 years.

Sollega Inc. | www.sollega.com
Booth 9627



PV inverter series

The SolarMax MT A was engineered for optimal return on investment and overall PV system profitability. The solution's maximum input voltages of up to 1000 volts enable longer PV strings to reduce cable losses and expenses, while achieving greater energy harvests. In addition, the increased power density of the inverters help to reduce installation time and cost. Unlike other PV inverters, the MT A was designed for commercial PV applications where inverters need to withstand challenging environmental conditions, including extreme cold, heat, and humidity.

SolarMax | www.solarmax.com
Booth 8411



Ballasted ground-mount

Patriot Solar introduces their Ballasted Ground-Mount racking system. With galvanized rails and electroplated powder-coated truss and postow PSF (pounds per square feet), it is ideal for landfills or brown fields. The ground-mount racking system is low profile, with multiple post angles and an adjustable height position. The racking assembly requires no heavy machinery or equipment, as all can be done by hand. It also comes with a 10-year guarantee against mechanical failure (breakage) of the frame construction.

Patriot Solar | www.patriotsolargroup.com
Booth 9811




Patented QuickBOLT

The Four Blockage Points 100% Waterproof

Intersolar Booth # 9139



Blockage Point #1
 As the rain slides down the roof, the outer rim of the compressed washer provides the first layer of blockage.



Blockage Point #2
 Filling sealant around the hole provides second layer of blockage.



Blockage Point #3
 The bolt compresses the EPDM washer down around the hole and the roof, making it impenetrable and 100% waterproof.



Blockage Point #4
 If the above wasn't enough, filling the hole with sealant provides a fourth layer of blockage.



L-Foot
 Aluminum L-Foot with offset 3/8" bolt hole to avoid mounting conflicts.



Flashing (MADE IN USA)
 An EXTRA layer of blockage, this domed roof flashing fits over our patented QuickBOLT and wahser roof mount kit.

20-Year Guarantee

Quality Installation Made Easy



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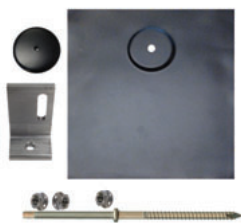


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www.QuickScrews.com



Mounting systems

Quickscrews International is showcasing the now patented QuickBOLT Mounting System, which is available with flashing. The flashing system is available in black and in galvanized. QuickBOLT without the flashing is 100% waterproof, and backed by a 20-year guarantee. Quickscrews has also designed a new mounting hook for curved tile roofs. The hook allows installers to better accommodate the height differences found in curved tiles.

Quickscrews International | www.quickscrews.com

Booth 9139



Solar monitoring web server & modem

Carlo Gavazzi has launched two Eos-Array Web modules: the VMU-C Web Server and the VMU-W Cellular Wireless Modem. They further complement the Eos-Array, which is dedicated to the management, monitoring, and control of systems for PV plants. Full monitoring of solar plants is accomplished by the combination of Carlo Gavazzi's existing Eos-Array modules, along with the newly released EOS-Web modules: the VMU-C and VMU-W. VMU-S string-level monitoring module, VMU-P the environmental measurement module, and VMU-O the input/output module, handle measurements and control function split into independent modules. The VMU-C Web module, acting as a compact web server, is able to gather data from EOS-Array modules, inverters, and Carlo Gavazzi AC Energy meters. VMU-C EOS-Web module, in combination with Eos-Array, is capable of showing the efficiency yield graphs, and handling the management of information, all accessible to the user through the web browser.

Carlo Gavazzi | www.gavazzionline.com

Booth 8233




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9247

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Surge protector

CITEL's DS2x0-xxDC surge protector is designed to protect equipment connected to a DC power supply (or AC) against lightning surges. These devices are based on high-energy varistors (MOV), matched with the DC operating voltage (from 12 VDC to 350 VDC). The MOV are equipped with internal thermal disconnectors to provide safe end-of-life. The indication of the disconnection status is provided by a mechanical indicator, and is transmitted through a remote signal mechanism. The pluggable module allows for fast and easy maintenance.

CITEL Inc. | www.citel.us

Booth 8318



Smart modules

Upsolar's smart modules feature embedded intelligence from the industry's leading providers of power optimization technology. While a conventional PV system will instinctively lower its output to match that of the worst performing module, Upsolar's smart arrays maximize power harvest at the module level. Additionally, smart modules enhance system performance and system design flexibility, simplifying the installation process and reducing balance of system costs. Upsolar's smart module systems are also equipped with real-time monitoring capabilities, allowing greater transparency into a system's performance through module-level monitoring.

Upsolar | www.upsolar.com

Booth 7401



Sollega™

The Simple Solar Racking Solution™



Sollega FastRack

- Simple, fast, & intuitive to install
- One tool top mount installation
- Compatible with all PV modules
- Cost effective light weight stackable design
- Fully ballasted with optional mechanical anchoring

- Roof friendly system adapts to obstacles and contours
- Manufactured from recyclable HDPE with built in UV inhibitor
- Wind tunnel tested and UL2703 compliant
- Full layout and engineering support provided

Visit us at InterSolar North America Booth 9627

T. 855.725.RACK E. info@sollega.com www.sollega.com



Solar electric generator

Liberty Solar Box is a newly patented and UL approved generator for the domestic solar water heating industry. The product is a solar electrical generator that uses PV panels instead of regular solar thermal collectors. The Liberty Box allows PV panels to be used in solar thermal applications, independent from the grid voltage. A typical residential application uses only 1.2 kW to 1.6 kW of light PV panels for a 50- to 80-gallon electric tank. Liberty Solar Box serves not only as a source of power supply, but it's also a digital impedance transformer, which transfers a water heater element's impedance according to the sun energy density. Only three to four 400-watt PV panels on a roof can supply a family of four with ample amounts of hot water. The system doesn't require fluid or glycol, and has no moving parts, pumps, plumbing, or copper.

EDS-USA Inc. | www.usa-eds.com

Booth 7826



Energy optimization system

A Silicon Valley-based energy storage technology company, Stem's energy optimization system reduces electricity bills by up to 20%. For commercial businesses, peak demand charges can make up half of monthly electricity bills due to usage spikes. The Stem system works by combining smart battery storage technology with data analytics to charge and discharge the batteries to optimize economic value, and to address PV production intermittency. Stem's system doesn't require behavior changes or energy reductions to achieve results, allowing companies to focus on their core business. For PV installations, the Stem system serves as a resource that enables commercial customers to improve the value received from their solar investment.

Stem | www.stem.com
Booth 8346



PV installation testing

Seaward Solar has introduced a new, high-performance combination tester for fast and effective electrical testing of solar PV installations. The Seaward Solar PV150 is a dedicated, multi-function PV electrical tester, designed specifically for solar panel system installation. It performs open-circuit voltage measurements (Voc), short-circuit current measurements (Isc), ground continuity, insulation resistance, and operating current (via AC/DC current clamp) checks. Results can be recorded and stored in the tester for subsequent USB downloading to a PC. Furthermore, special wireless Solarlink connectivity between the PV150 and the Solar Survey 200R meter enables real-time irradiance and temperature to be displayed and measured at the same time as the electrical testing is being undertaken.

Seaward Group USA
www.seawardsolar.com/usa
Booth 8137

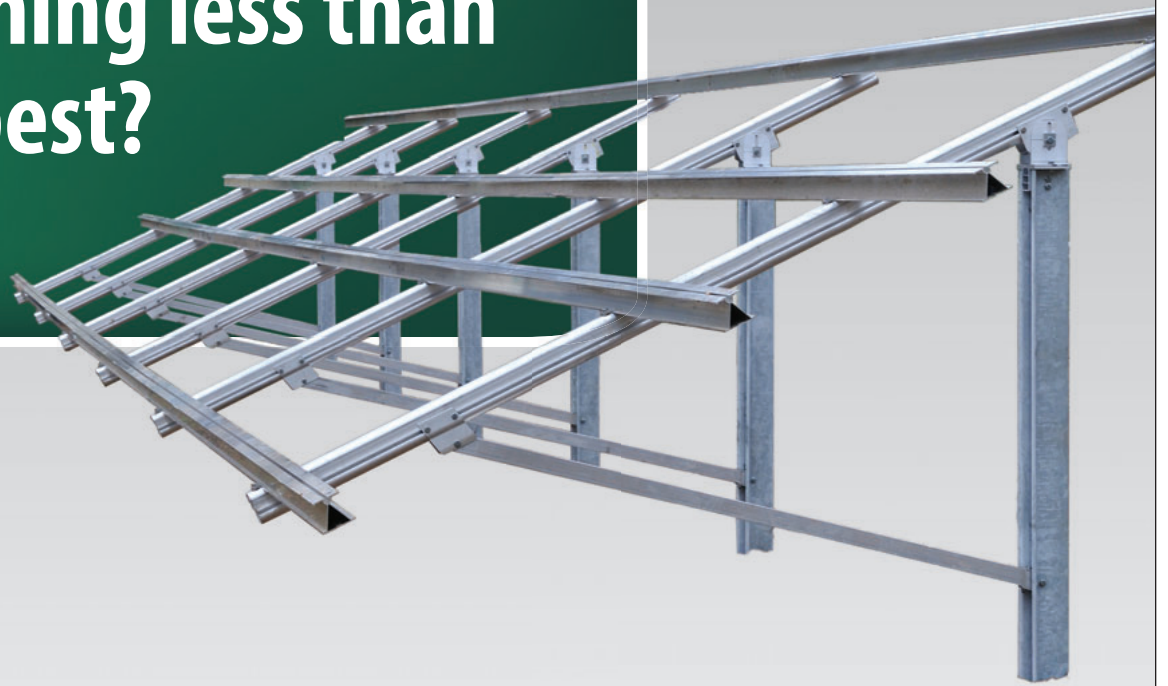


DC power contactors

Schaltbau North America presents their DC power contactors, which have been optimized for use with PV inverters. Manufactured to high-quality standards, the CT and CU series contactors are able to switch DC loads of up to 3,000 V and 800 A, while operating efficiently for many years in continuous operation. Also available are compact, power contactors in single- and multi-pole models. These compact power contactors are rated from 750 V to 1200 V, and from 40 A to 500 A.

Schaltbau North America | www.schaltbau-na.com
Booth 8133

Why place valuable modules on anything less than the best?



The World-Renowned FS System™

Companies invest a significant amount of time and money selecting the right PV module. So why would any less consideration go into selecting a mounting system, which is expected to safely secure module investments for decades to come?

Consider this: easy installation, superior quality, competitive pricing.

Time tests confirm that the FS System, from foundation to module, offers the fastest installation on the market.

Achieved in part through quality engineering, providing 70% preassembled components to the job site, and the use of high-quality, lightweight aluminum.

Backed by a team of engineers and the most sophisticated tools available, each FS System achieves the perfect balance of minimal material usage and structural integrity. The result is a competitively priced system designed to win.

System solutions for any terrain, ETL Certified to UL 2703, 100% IBC Code

compliance, PE stamped drawings, a standard 10-year warranty—these are a few of the expectations Schletter is proud to be known for.

Why place valuable modules in anything less than the best? Contact a Schletter team member to learn more about the FS System or to find where we will be offering *free assembly training* near you as part of the 2013 Solar Road Show.

Racking Simply Doesn't Get Any Better.



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Inverters & PV monitoring

Schneider Electric premieres its new, 1000-volt inverter. The Conext Core XC-NA series is a new line of central inverters, designed for high-efficiency and flexibility for any PV panel type and installation. The Conext Core XC-NA's flexibility allows the inverter to be configured with voltage and power outputs up to 680 kW. With the highest CEC and European Union efficiency ratings of any central inverter in its power range, it contains the latest grid management features to meet global utility requirements. Schneider Electric also offers monitoring solutions for PV power plants. Conext Control is designed to efficiently operate any PV plant by providing site technicians the means to make quick decisions, analyze long-term trends, and manage the life cycle performance of plant assets.

Schneider Electric | www.schneider-electric.com

Booth 8118



Energy storage system

BMZ provides systems and solutions for the intelligent mobile energy market. ION Storage is their new modular power storage system, which allows solar energy to be stored for future use. The surplus energy is stored in a lithium ion storage battery, and can be fed into a network for use at night or at times of low sunlight. With BMZ's ION Storage system, the solar energy user will have a light and space-saving module with up to 8,000 full cycles and a seven-year guarantee. The storage packs have a 97% efficiency rating, and a 90% depth of discharge. Depending on the desired storage capacity, the battery modules can be configured to meet a customer's specific needs.

BMZ | www.bmz-usaUSA.com

Booth 8247

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Dual-Certified Solar Cables
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Power fuseholders

Mersen USGM-HEL Fuseholders are the latest addition to their popular line of UltraSafe Fuseholders. USGM-HEL Fuseholders are equipped with industry-proven and patented CAGE CLAMP technology. Mersen is the first manufacturer to offer this technology in a power fuseholder. This screw-less, spring pressure, wire termination technology has over 25 years of field experience and acceptance, reducing wire installation time and cost by up to 75%. CAGE CLAMP technology significantly improves system reliability by maintaining a very low contact resistance, easily withstanding corrosion, vibration, and temperature cycling. The technology also eliminates the need for routine torque maintenance required by standard screw-type terminations.

Mersen | <http://ep-us.mersen.com>

Booth 9116



Roll forming solutions

Roll Forming Corporation (RFC) is in the business of roll forming solutions for its customers' needs and concerns, utilizing design consultation to develop new solutions or improve existing shapes using FEA (Finite Element Analysis). Materials range from HRPO, CR, HSLA, aluminum, as well as pre-galvanized, post-dipped galvanized and powder-coated steel. As part of the world's largest custom roll forming group, RFC offers the latest technologies and innovations from around the world to transform any vision into reality. Consider the benefits of roll forming for solar mounting, and how a roll-formed solution can improve a bottom line, creating a stronger system.

Roll Forming Corporation

www.rfcorp.com

Booth 9235



Metering & control solutions

Connecting utility-scale solar and wind resources to the electric grid requires reliable metering, a Remote Intelligent Gateway (in California), and meteorological stations. These devices provide data required for accurate settlements and grid stability. Trimark Associates offers the integrated measurement and monitoring solution necessary to generate and sell renewable power in California. The components must be calibrated, tested, and approved by CAISO. Some situations demand complex metering solutions. Renewable resources in isolated areas often share transmission to reach a substation. These sites are at different distances from the interconnection point, resulting in different line losses. Trimark deploys metering schemes that enable proper accounting of payments and settlements, guiding clients through the steps required to generate income from their investment in renewable power.

Trimark Associates, Inc.

www.trimarkassoc.com

Booth 8041

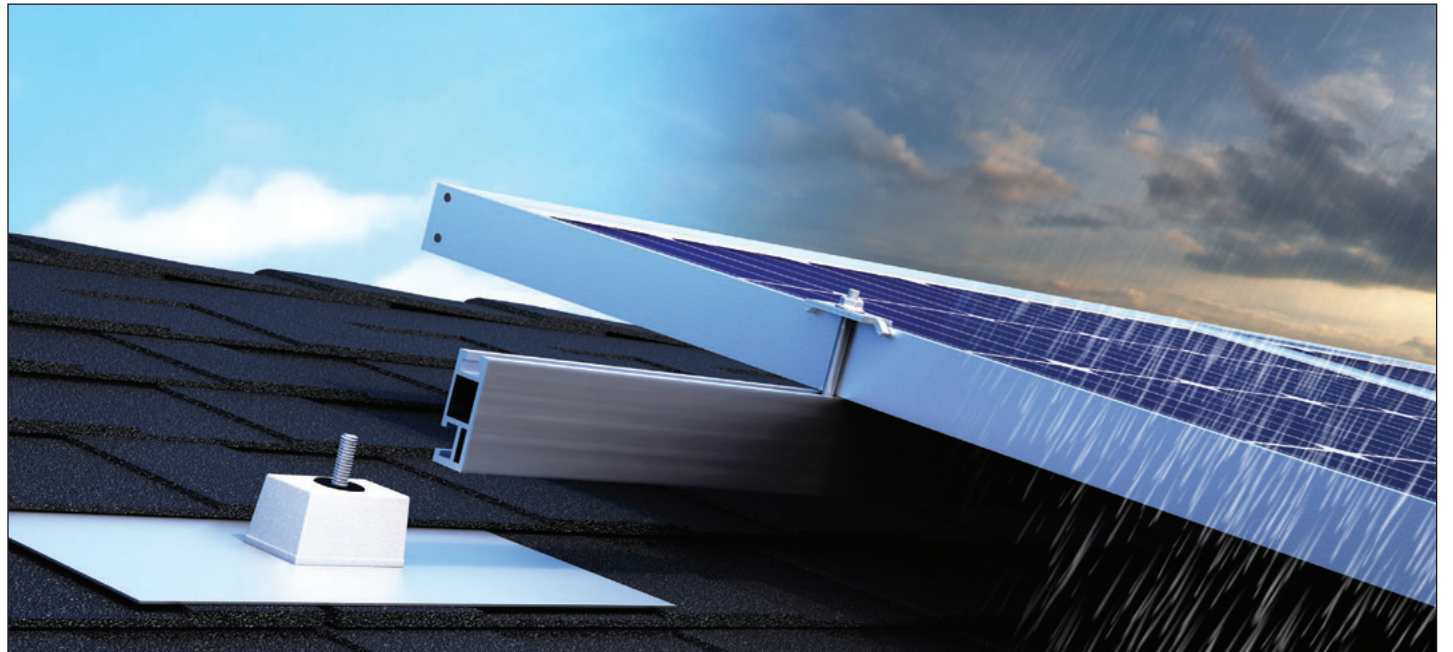


Solar modules & manufacturing

Talesun Solar, operating what's currently the world's largest, fully automated manufacturing facility, offers poly and mono 60- and 72-cell modules with 600 V and 1000 V certification. All modules are constructed with distinct Talesun quality for long-term reliability and durability. Talesun has also just launched their new frameless solar module, Twinkle.

Talesun Solar | www.talesunusa.com

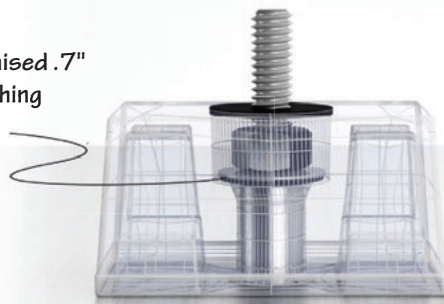
Booth 7621



What makes our Classic Comp Mount the industry's most trusted protection against roof leaks?

The QBlock Elevated Water Seal

Rubber seal raised .7" above the flashing and rainwater



Our patented QBlock technology encloses the EPDM rubber seal – the ultimate barrier between the rafter and the rain – inside a cast-aluminum block and raises it ⁷/₁₀ of an inch above the flashing where the rainwater flows. ***This completely protects the rubber seal from the elements for the life of the solar array.***

Don't risk disastrous roof leaks with inadequate solar mounting products and methods. Insist on Quick Mount PV and install it right – and **enjoy peace of mind for the full life of every PV system you install.**

See how our patented QBlock technology prevents future roof leaks at quickmountpv.com/noleaks

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Solar database & online assessment tools

GeoModel Solar is a technical consultant and developer of the SolarGIS database and online system. The company aims to increase efficiency and reduce uncertainty in solar energy projects by delivering bankable solar resource data and software services for planning, financing, monitoring, and forecasting solar energy. The SolarGIS on-line system is now available in the US, and has been independently recognized as one of the most reliable solar resource information tools available worldwide. SolarGIS database and online tools allow for better due diligence and asset management of solar power plants, helping to reduce the risks associated with solar energy investments.

GeoModel Solar | <http://solargis.info>

Booth 7335

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InterSolar Booth 8041



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Campbell Scientific

www.campbellsci.com/solar1000

Booth 7436



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Booth 7021

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Booth 9247

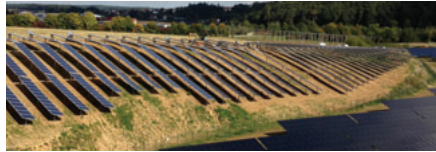


Rail mounting solution

DPW Solar presents their expanded POWER RAIL product family. The new LD and MD rails offer longer span and cantilever distances for commercial and industrial roof or open-structure PV solar mounting. Suitable for span lengths of up to 18 feet, the new rails minimize penetrations and the need for additional support structures. Similar to other POWER RAIL mounting solutions, installers will save time and cost with integrated grounding, single tool assembly, and the patent-pending RAD Lock-in-Place bolt with secure PV module clamping. Manufactured with high-strength, marine-grade aluminum, both rails include an integral wiring channel for securing cables, resulting in a professional appearance. In addition, a universal base bracket with integrated grounding clip easily mounts to structural members.

DPW Solar | www.dpwsolar.com

Booth 9401



Single-axis horizontal tracker

TerraFix is a specialist for individualized, ecological foundation solutions for free land solar plants, including framework structures. They present their new CONTOUR TRACK, a horizontal, single-axis tracker for solar modules that are suitable for all terrain types—no grading necessary. This innovation provides a high level of flexibility for plant design with a maximum of reliability and durability. Further benefits include minimized maintenance and reduced shading. Compared to fix-tilt, CONTOUR TRACK can achieve a 25% surplus.

TerraFix | www.terrafix.com

Booth 9724



Solar PV applications

DNV KEMA's experience includes utility-scale and commercial-scale applications of solar PV technologies. Their team of solar PV professionals has been supporting and actively involved in the solar industry for more than 20 years. DNV KEMA's solar energy segment specializes in providing technical consulting, project design, and independent engineering services to a wide range of solar industry clients, including: developers; utilities; operators; component manufacturers; investors; and government agencies.

DNV KEMA

www.dnvkema.com/solarenergy

Booth 7344

PV tracker

Unirac is a PV mounting supplier, offering some of the highest quality safety accreditations in the industry. They've recently introduced the Unirac GMT, a high-quality, low-maintenance, easy-to-assemble PV tracker solution. Unirac's bankable solar tracker provides one of the best values and currently the top warranty in the market, along with comprehensive service and support.

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Booth 9411



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Inverter solutions

AE Solar Energy showcases its two newest inverters: its utility-scale, one-megawatt inverter, the AE 1000NX; and the company's first three-phase string inverter, the AE 3TL. With these additions, the company offers one of the largest suites of inverter solutions on the market, offering customers a variety of choices for their solar project needs. The AE 3TL is AE Solar Energy's answer to market and customer demand for a distributed inverter that offers the same services and benefits as their central inverters: reliability, high efficiency, and customer support. The one-megawatt rated AE 1000NX inverter is AE Solar Energy's next step in utility- and large-scale solar power. AE Solar Energy designed the inverter to provide solar power plant owners with reduced cost and increased energy harvest for a lower LCOE, as well as advanced utility interactive controls to mitigate grid integration issues.

Advanced Energy Solar Energy

www.advanced-energy.com/solarenergy

Booth L209



Utility-scale inverters

Eaton's Power Xpert Solar 1500 kW inverter is engineered for utility-scale, solar applications. The Power Xpert Solar inverter converts direct current (DC) power into clean, alternating current (AC). Designed to improve plant levelized cost of energy (LCOE), Power Xpert Solar inverters maximize customers' energy harvest, operate reliably in harsh environments, and adhere to high safety standards. With a true megawatt inverter platform and unique transformer coupling approach, the Power Xpert Solar 1500 kW inverter enables a skid-less inverter station, reducing equipment requirements and installation costs, while improving plant uptime. It has been created with the intent of lowering electricity costs by addressing the gaps that designers and installers are currently facing in the solar utility-scale space. Customers will now be able to replace three small inverters with one larger one—expediting installation and facilitating operations and maintenance work.

Eaton | www.eaton.com

Booth 9611



Renewable energy law firm

Cleantech Law Partners (CLP) is a full-service law firm that caters to the unique legal and policy needs of renewable energy project developers and cleantech companies. Their attorneys have extensive knowledge of the clean technology industry and experience guiding clients through a variety of alternative energy projects, from solar and wind power to biogas and geothermal energy. Cleantech Law Partners helps developers, financiers, manufacturers, and entrepreneurs with the following services: obtaining permits; negotiating power purchase agreements; drafting key legal documents; securing intellectual property rights; accessing government funds; and managing financial transactions. CLP also serves as outside, in-house counsel for corporate clients. From concept to commercialization, their legal team is committed to helping clients navigate the rapidly changing regulatory landscape that governs the renewable energy and cleantech industries.

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Quick Mount PV

www.quickmountpv.com

Booth 9517



New Trend in GeoExchange for Inner Cities

By Simon Duck

Indoor drilling made possible with the right rig and proper precautions, making geexchange a potential energy saving solution for inner city buildings

ACCORDING TO THE CLINTON CLIMATE INITIATIVE*, American cities are home to more than half the world's population and account for 70% of global carbon emissions. In response to facts like this, New York City Council has asked for a feasibility study to develop geothermal energy to heat and cool buildings. New York City is not alone in its quest to reduce costs and emissions; many other cities in the United States either have plans in place or are currently working on them.

Even small advances are adding up for the successful support and future of geothermal energy. For instance, The Illinois General Assembly recently passed language sponsored by the Geothermal Exchange Organization (GEO) that removes impediments to the promotion and financing of geothermal heat pump (GHP) installations within the state.

Beyond language, however, technological advances are required that are put into action. One major step forward is geexchange. The inner cities present some unique challenges to this technology, which the industry is rising to meet.

Understanding geexchange

To know how geexchange can help, it's first important to understand the basics. Geexchange is not the hot rock geothermal from the earth's core used for electricity generation, but rather the warm soil technology from solar energy stored underground and used for heat. As solar energy warms the ground, this energy can be tapped and used to heat buildings via heat pumps. In a geexchange system, the ground temperatures in the summer are reduced by a pump's loop-field, drawing heat away from the earth. This, then, serves as a very efficient place to reject heat energy from the building—and, therefore, the name geexchange is more fitting than geothermal.

Geexchange can work particularly well in a city like New York, where there are numerous high-rise apartments and buildings. The heating and cooling cycles in high-rise buildings aren't like the seasonal cycles of residential single- to three-storey homes. Due to heat rising, the upper floors in taller buildings can warm up quickly, giving rise to an efficiency problem. In an attempt to even the temperature on each floor, a building can regularly be heated in the lower floors and cooled in the upper levels at the same time, which is an incredible waste of energy and money. All the excess heat is simply dumped through the cooling towers. Crazy, perhaps, but this process has been going on for decades.

A high-rise solution

There is a way to solve the high-rise dilemma that so often plagues downtown cores and inner cities. Rather than dumping and wasting excess heat from these buildings, this heat could be stored beneath the ground in an underground thermal energy storage (UTES) system. UTES systems use a borefield of closed, vertical loops to store heat transferred via heat pumps from a building to the ground, and vice versa. This system could help inner cities overcome a long-time challenge, replacing used heat energy that cannot be replenished by solar energy (because of neighboring buildings blocking the sunlight) to the loop-field.

Ideally, when and where possible, the logical solution is to use a building as the solar collector (the roof's of most high-rises might do just fine). In this case, if or when needed for heating, a geexchange borefield could simply use the stored solar heat, pumping it into the building. A borefield is generally divided into multiple areas, some used to heat the building and others to cool it. There is an obvious problem here, however, in that each borefield would have a limit on ground temperature and efficiency. The solution is a simple one: once the maximum or minimum temperature has been reached by one of the fields, it switches over to the other cycle—either heating or cooling as needed to maintain efficiency.

Saving space

Usually, a patch of open ground is required for the borefield and the thermal energy system. Of course, this ground is tough to find in the inner cities and would likely cost a fortune. To save on space and costs, drilling under the buildings could work. Thanks to advances in technology, drill rigs now have the capability to drill in low headroom, from

directly inside buildings. Drill rigs only 30 inches wide (760 mm) can work inside buildings with headroom as low as 7 feet 3 inches (2.2 m) to be exact. Furthermore, they can drill bores to 1500 feet (450 m) deep.

There are several additional challenges other than rig size that must be properly considered and solved for a rig to be permitted to drill inside a high-rise. For one, diesel power units must be left outside of a building, and an umbilical hose system would need to deliver power to the drill rig. This would ensure unwanted fumes remained outside. The drill cuttings would need to be carefully removed from a site, with minimal environmental contamination from either dust or large volumes of dirty water. Recycling the drilling medium through a separator would be an ideal solution. The drill cuttings can be contained inside specialized cleaning systems that separate the waste from the drilling medium, and that could be safely removed from the site.


Gone are the days of sites covered in clouds of dust, with workers knee-deep in mud. This safe drilling technology is proven, and has been available in other sectors of the industry for many years. By bringing it together with geexchange projects in the inner cities, and a major leap forward in energy savings and efficiency could take place.


**The Clinton Climate Initiative (CCI) builds on past President Bill Clinton's commitment to the environment, and is an initiative to reduce reliance on oil, while implementing programs that create and advance solutions to the root causes of climate change (www.clintonfoundation.org)*


Simon Duck is the CEO of RigKits LLC.

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The National Geothermal Data System

Transforming the discovery & access information for geothermal exploration

By Kim Pattern

RECENTLY, THE GEOTHERMAL ENERGY ASSOCIATION (GEA) released an Air Emissions Comparison and Externality Analysis showing geothermal energy provides significant benefits to public health and the environment as one of the least-polluting and most environmentally friendly forms of energy. The analysis found binary geothermal plants produce virtually no greenhouse gases (GHG), and that dry steam and flash geothermal plants put out only trace amounts of emissions. It estimates the public benefits from clean energy produced in California and Nevada alone are worth more than \$117 million annually.

Despite the environmental benefits, however, geothermal tends to be a slow-growing energy source, especially in comparison to solar and wind power. One of the largest barriers to the adoption of geothermal energy as one of the nation's leading renewable base-load energy provider is the upfront risks associated with the exploration and characterization of subsurface resources. Proving the location and viability of a geothermal region is often one of the most data-intensive and costly components of the overall exploration process.

To ensure maximum utility of often-limited monetary resources, providing a mechanism for cost-effective data discovery and access (particularly one that permits data analytics on multiple platforms) is critical to identifying active geothermal regions. Wider access to distributed data would certainly result in lower costs for geothermal development.

This knowledge is nothing new. Beginning in 2009, the US Department of Energy's Geothermal Technologies Office, through the American Recovery and Reinvestment Act, started doing something about it by funding the development and population of the National Geothermal Data System (NGDS). The NGDS is a distributed, interoperable network of data collected from state geological surveys across all 50 states, as well as the nation's leading academic geothermal centers. It will also include data

from recent federally funded geothermal exploration projects. NGDS is on track to become fully operational by 2014, and will serve as a platform for custom applications for accessing all geothermal data in the US and abroad.

Delivering data

The National Geothermal Data System is being built on the US Geoscience Information Network (USGIN) data integration framework to promote interoperability across the earth sciences community. The basic structure of the NGDS employs state-of-the-art informatics to advance geothermal knowledge. In addition, a software stack, deploying the Open Source CKAN data management system, will provide data consumers with a highly functional interface to access the system, and will ease the burden on data providers who wish to publish data in the system. CKAN holds the added benefit of being the system deployed by Data.gov, thereby increasing interoperability with external datasets (Data.gov increases the ability of the public to easily find, download, and use datasets that are generated and held by the Federal Government.)

It's important to note that this software package constitutes a reference implementation and that the NGDS architecture is based on open standards, which means other server software can make resources available, and other client applications can utilize NGDS data.

Geothermal data is currently being contributed by industry, academic, and national laboratory researchers, as well as by state and federal agencies. Although the focus is on domestic data critical to identifying geothermal potential and characterizing geothermal reservoirs, international data sources may be included, especially where such data and information can be utilized or benchmarked to help develop domestic geothermal resources.

A variety of information is required to ascertain whether a potential geothermal energy site should be developed for production, including: composition and hydrologic properties of materials hosting the thermal energy; proximity to existing power grids; and the quantity of thermal energy flowing from the interior of the earth are all primary considerations.

The goal of NGDS is to provide critical geothermal-related data that can be easily accessed to:

1. Help companies be more (cost and time) effective in exploration, development, and usage of geothermal energy;
2. Support a knowledge repository and archive for geothermal data, lessons learned, and reports;
3. Advance earth sciences by identifying gaps in knowledge and informing new geographic areas of the United States;
4. Provide a reliable base-load energy source of knowledge; and
5. Increase public awareness of geothermal energy.

However, these goals can only be accomplished if the National Geothermal Data System provides a quality user experience, and is widely adopted by the geothermal community. There are three targeted

user communities for NGDS, and each user group has different goals, needs, and tasks when interacting with NGDS as follows:

- **Data providers:** Expose information to NGDS through standardized, Internet-accessible interfaces and formats;
- **End users or data consumers:** Utilize NGDS to access data to support their work in geothermal energy exploration and development; and
- **Application developers:** Build applications that utilize the data in NGDS, and make it easier for end-users to interact with the system.

With the assistance of geothermal domain experts, applicable metadata (data about the data), and interoperable data exchange formats are currently in production mode. Current development in progress is focused on the implementation of the portal application for searching all NGDS resources, as well as for easing contributions to the system by data providers.

Denoting success

The ultimate indicator of success will be known when the NGDS system goes live in early 2014, and real-world usage patterns emerge. Although it should be noted that the design approach taken is an agile approach, and so beta applications are operational and currently accessible to the public. This usage, in turn, is also serving to inform the current design process. Once completed, a greater geothermal community of practice will hopefully emerge as data needs are addressed and the value of an interoperable network is demonstrated.

The National Geothermal Data System will, ultimately, serve as a platform for sharing consistent, reliable geothermal-relevant technical data with users of all types, supplying tools for geothermal-related work. As aggregated data supports new scientific findings, this content-rich linked data should act to broaden the pool of knowledge available, to fuel discovery and the continued development of commercial-scale geothermal energy production.

This article is based on research presented at the Stanford Geothermal Reservoir Engineering Conference, which took place earlier this year. Full papers discussing the geothermal data and metadata community needs, the application of CKAN within the system, the user interface development, and a mechanism for data contributors through the Geothermal Data Repository, are available at the Stanford Geothermal Workshop site.

National Geothermal Data System

<http://geothermaldata.org>

The Arizona Geological Survey

www.azgs.az.gov



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Algae Harvesting Technology Optimized (AHTO) Dissolved Air-flotation system in operation at UC San Diego - Scripps Algae-biodiesel Research Facility in the Sonoran Desert

Harvesting Algae for Biodiesel Research

By Jim McMahon

THE SEARCH FOR NEW FORMS OF ALTERNATIVE, environmentally friendly fuel sources is an ongoing one. Alga (or, algae per its plural form) caught the eyes of scientists some years ago, and has been a popular host of biofuel research ever since. Algae don't only grow naturally all over the world, but they also grow in abundance—presenting as a readily available potential resource to biofuel researchers. Under optimal conditions, algae can be grown in massive, almost limitless, amounts.

Since 2008, the San Diego Center for Algal Biotechnology (SD-CAB) has been conducting research into algal applications for biofuel. A joint collaboration between several departments of the University of California/San Diego faculty and students—including the University's Scripps Institution of Oceanography, the Scripps Research Institute, as well as non-academic industrial corporate participants—SD-CAB moved beyond its campus-oriented research facility in San Diego in 2011, to a field laboratory in the Imperial Valley of California. About 100 miles east in the Sonoran Desert, one-acre algae ponds were made available for hands-on research testing.

The field location gave SD-CAB the opportunity to considerably expand its algae growing volume from simple, in-laboratory vats. The ponds used were massive in comparison, and provided the largest field laboratory of any academic institution in North America for the growing research of algae for use as a biofuel.

Accumulating algae

Algae thrive in fresh water and seawater, including all types of water up to a salinity of about 0.5% (50% higher than seawater). They can grow in desert ponds, employing high-saline water from aquifers that cannot otherwise be used. Growth isn't dependent on a particular season; algae can proliferate wherever there are nutrients and light.

Approximately half of algae's composition, at least by weight, is lipid oil. It is this oil that researchers have been studying for its ability to convert to biodiesel. Algae biofuel burns cleaner and more efficiently than petroleum.

Having performed much prior in-lab research with the processing of smaller quantities of algae, the San Diego Center for Algae Biotechnology was well versed and outfitted with the necessary knowledge and equipment for properly:

- Growing algae;
- Handling the drying of the biomass on racks, so as to remove 90% of the water;
- Extracting the oil with a screw press;
- Purifying it in a centrifuge; and
- Converting this oil to biodiesel, using the traditional open-processing reaction method.

The algae were first tested to determine the levels of free fatty acids and moisture content, so as to establish the exact mixture of chemistry needed. Balancing the methanol and sodium hydroxide is required to effect the desired reaction. This process wasn't a problem, but SD-CAB had little experience with how to actually harvest algae from the one-acre ponds—which posed a considerable obstacle for the group.

"We knew, starting off, that the biggest challenge would be the harvest," says Kristian Gustavson, part of the UCSD student-led, algae-based biodiesel research study. "We could grow the algae all day long, and once we had the dry biomass, we could turn it into fuel... but, it was the matter of harvesting. We experimented with several methods that were not very successful."

Algae harvesting

After some trial and error, and upon careful review, a unique, dissolved air-flotation system was eventually selected to help with the matter of harvesting. The Algae Harvesting Technology Optimized (AHTO) Dissolved Air-flotation System (DAF) is specifically equipped for the yielding of algae from water, and proved to be an efficient and compact treatment method.

Continued on page 74.

...continued from page 73.

AHTO involves pond water being pumped into the DAF, where suspended solids in the form of algae are separated from the water. This is accomplished by the process of dissolving air into the water under pressure, thanks to the addition of a polyacrylamide flocculent. Upon release of that pressure, micro-bubbles form. These micro-bubbles interact with the algae particles, attaching to the biomass surface and affecting the particle density so that they float to the surface of the DAF. They are then skimmed with a chain and flight mechanism to a sieved product, known as Thickening Beach.

Thickening Beach allows free water to be drained, thereby thickening the algae particles and achieving an efficient liquids and biomass separation. A patented, air dissolving technology is also utilized to create the robust whitewater in the AHTO system, which saturates the effluent pond water entering the DAF with atmospheric air.

As part of this process, heavy sand and grit particles settle to the bottom, where a timer function controls the removal. Clean water is continuously removed from the DAF and piped back into the ponds, allowing new pond water laden with algae to enter for separation.

“We got the chemistry set and were able to harvest continually from the ponds,” explains B. Greg Mitchell PhD, research biologist and senior lecturer at Scripps Institution of Oceanography, UC San Diego, and associate director of SD-CAB. “We added fertilizer to the ponds as it was being harvested to keep it at a steady state where it was still growing in a nutrient-rich environment, to help maximize the lipid content.”

The AHTO process proved to be a highly efficient system for separating algae from liquids. The technology can achieve biomass removal efficiencies exceeding traditional DAF performance. Up to 9,000 gallons of algae-laden water can be processed per minute, at a 95% capture rate, yielding up to 20% algae concentrations.

Algae biofuels

When processed properly, biodiesel runs cleaner and more efficiently than petroleum-based diesel, and provides needed lubricity to petroleum-based diesel. According to the Department of Energy, use of biodiesel in a conventional diesel engine results in a substantial reduction of unburned hydrocarbons, carbon monoxide, and carbon dioxide emissions, as well as particulate matter.

As the popularity of alternative fuels gain momentum, biodiesel—and, specifically, algal-based biofuel—continues to strengthen its position as an attractive option to offset petroleum-based diesel usage. The introduction of non-commodity feedstocks such as algae, along with attractive US Federal and State subsidies for both biodiesel production and consumption, are inciting equipment manufacturers to develop better processing systems that are faster, safer, and more efficient.

Compared to crops used to produce vegetable oil for biofuels, algae are far more productive, generating up to 50 times the yield of oil per acre. The San Diego Center for Algae Biotechnology scientists plan to make sustainable algae-based fuel production a reality within the next five to 10 years. Its goal is to create a facility that provides a national and global model for the commercialization of algae fuel.

The San Diego Center for Algae Biotechnology was established in 2008 as a consortium of researchers. The center collaborates with non-academic organizations to apply its algal laboratory discoveries to industry through research and development in biology, chemistry, and engineering.

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The San Diego Center for Algae Biotechnology, Division of Biological Sciences

www.algae.ucsd.edu

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www.worldwaterworks.com



Metering-surge bin

The Model MSB6-20-O Metering-Surge Bin from Warren & Baerg is the latest generation for biomass and waste energy industries, allowing users to load fibrous materials with a front-end loader. The Metering-Surge Bin provides a consistent, positive, and even flow of material. It also offers cost-effective metering of shredded or ground woods, stover, grasses, paper, cardboard, plastics, and other similar materials from low rates to well over 100 tph. Either built with straight sidewalls or with flared front and back walls for additional capacity (the flared back is gusseted and supported), The Metering-Surge Bin has two doffers up front and a V-Level rake before the top doffer. Depending on the out flow tonnage required, the floor drive motors are two horsepower or less and 7.5 hp or less on each doffer. The differences between this bin and existing models is that it's open for loading with a front-end loader, flared sides for more capacity and loading room, as well as higher discharge flow rates.

Warren & Baerg Manufacturing, Inc.

www.warrenbaerg.com



Waste-to-energy system

The Saturn Grizzly M Series by Granutech-Saturn Systems is a size-reduction system utilizing a single rotor design. This durable machine is easy to maintain and provides high-quality fuel feedstock, or clean rubber and separated steel when processing tires. The Grizzly's unique rotor construction and proprietary blade material allow the greatest size reduction for materials, while minimizing blade wear and maintenance downtime.

Successful in waste-to-energy processing for a wide variety of combustible materials, the Grizzly M-Series can be configured through adjustments in screen size to create product in 1/2" minus, 3/4" minus, and one-inch minus (or even larger sizes). The Grizzly's rotor is 34" in diameter, supported by double-row spherical roller bearings that are mounted external to the grinding area where they can't be contaminated. The system is available with a 300 hp or 400 hp drive motor, coupled to a heavy-duty gear reducer. Cutting chambers are available in widths of 80", 96", or 120", and all models utilize rotary and stationary cutting knives with a proprietary staggered-knife design.

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The energy potential of grass silage or whole plant silage (WPS) is very high. But, often times, bacteria aren't capable of completely processing carbohydrates and proteins to biogas as a result of their long, smooth surfaces. WELTEC BIOPOWER has developed a rugged liquid input system, MULTIMix, which prevents outages, safeguarding the technical stability of AD systems. With MULTIMix, fibrous and sticky input materials, including grass silage, solid manure, or co-substrates, are comminuted, increasing their surface so it's suitable for bacteria. In addition, MULTIMix separates foreign matters, such as rocks or metals prior to input, decreasing the risk of the pumps and agitation systems incurring damage because of build-up in the fermenter or in the pipelines. Productivity is also increased due to the possibility of flexibly mixing the input materials as an alternative to using expensive maize silages.

WELTEC BIOPOWER

www.weltec-biopower.com



Biofuel production drum

Suitable for everything from large, land-clearing jobs to green-waste recycling, the Vermeer Tier 4i (Stage IIIB) HG6000 and HG6000TX horizontal grinder offers a number of features that make it ideal for a wide array of operators. Its all-new chip drum allows the grinder to produce a consistently sized chip necessary for applications, including biofuel chip production. One of the premier enhancements is its ability to modify chip sizes. Operators can add or remove spacers to achieve the desired size, which ranges from 0.125 to 1.50 inches (0.3 cm to 3.8 cm) with 0.125-inch (0.3 cm) increment adjustments. From fuel chips to playground base to fuel pellets, the drum design creates a more useful, higher quality chip. Moreover, a number of the high-wear areas of the drum are protected by hardened steel parts, which provide a longer life. The hardened steel parts are replaceable via threaded fasteners to reduce labor costs and minimize downtime.

Vermeer | www.vermeer.com



Dry chemical feed system

Sodimate, Inc. engineers and manufactures turnkey feed systems for heavy metal removal. Typical chemicals handled with Sodimate equipment include lime, soda ash, Trona, urea, and powdered activated carbon (PAC). Sodimate systems feature a mechanical unloader, designed to fully unload storage containers (such as silos, hoppers, and big bags) without bridging, jamming, or compaction of the product.

Sodimate, Inc. | www.sodimate-inc.com



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320-548-3586 www.rotochopper.com



Cast iron flange block & pillow block assemblies

Metallized Carbon Corporation cast iron pillow blocks and flange blocks, with self-lubricating, carbon-graphite bearing inserts, are ideal for applications where oil/grease lubrication cannot be used. These bearing assemblies provide low friction and long, maintenance-free, wear life in high-temperature applications where oil/grease lubricants would melt, volatilize, or carbonize. Applications include hot air dampers and butterfly valves for power plant boilers. These bearings are also ideal for high-temperature conveyors for drying, heat treating, baking, and annealing. They're also excellent for ash drag-out conveyors, kiln car wheel bearings, and stoker bearings.

Rugged cast iron housings are used to hold steel encased, carbon-graphite bushings. Desirable features include self-alignment to five degrees from center-line, a replaceable bearing cartridge, and two standard lengths to accommodate a normal load or high load. These bearings are also interchangeable with most standard ball bearing pillow blocks and flange blocks, and can be modified to carry thrust loads.

Metallized Carbon Corporation | www.metcar.com





Filter-based IR analyzers

Currently, Methods D7371 and EN 14078 require FTIR spectrometers for biodiesel blend analysis. Placing expensive equipment at a loading dock to ensure biodiesel blend accuracy isn't a preferred choice of most terminal operators. In addition to the cost associated with FTIR spectrometers, the level of technical knowledge required to operate them presents another issue. Filter-based infrared analyzers, such as the Wilks InfraCal Biodiesel Blend Analyzer and InfraSpec VFA-IR Spectrometer, offer a rugged, compact solution, and are better suited for the environment where fuels are blended.

The InfraCal Biodiesel Blend Analyzer is a specific-analysis, fixed-filter infrared analyzer, reading out directly in percent-biodiesel, and can easily be operated by personnel having little or no knowledge of infrared analytical techniques. The InfraSpec VFA-IR Spectrometer is a spectral range analyzer, which contains a linear variable filter and a detector array covering the wavelength range of 5.4-10.8 μm (1850-925 cm^{-1}). This provides the capability to not only measure biodiesel in diesel, but also ethanol in gasoline or water in ethanol. Wilks Enterprise has also championed an ASTM method, which provides a fast and inexpensive infrared method for measuring biodiesel (FAME-Fatty Acid Methyl Esters) in biodiesel. This ASTM Method is in the process of full committee voting, and should be approved before the end of 2013.



Wilks Enterprise, Inc. | www.wilksir.com

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Centrifugal pumps

With the arrival of the latest generation of KSB's Movitec pumps, KSB Canada has widened its portfolio of small size centrifugal pumps. Geared to the commercial market, Movitec vertical, multi-stage pumps are available with a range of material and seal options, making them more versatile than ever. With seal variants rated for temperatures from -30°C to $+140^{\circ}\text{C}$ (-22°F to 284°F), these standardized centrifugal pumps are designed to handle a huge variety of media, ranging from water (including acidic and alkaline solutions), alcohol, and vegetable oils, to condensates, liquid CO_2 , and more. The pumps come in different sizes (up to 90 mm pipe diameter). Inlet and outlet nozzles are the same size, and in line, so the pumps are easy to install in piping systems. Movitec pumps are designed to be easy to service; when equipped with Easy Access or cartridge seals, seal replacement can be done without removing the motor. They're rated for volumes of up to $113\text{ m}^3/\text{h}$ (498 gpm) and discharge pressure of up to 2,496 kPa (362 psi).

KSB | www.ksbcanada.com



Biomass microchipper

Morbark, Inc. has re-designed their 40/36 Whole Tree MicroChipper. The 40/36 Whole Tree Drum Chipper was first introduced as a compact, affordable biomass chipper, and later upgraded with the addition of the Advantage 3 high-performance chipping drum, which significantly improved chip quality. The latest model includes an enhanced drum set with 16 knives utilizing standard hardware, an operator-friendly slide-in forestry grate system to reduce oversized chips, and a mechanically driven chip accelerator to fully load vans with the microchips.

With an average fuel consumption of 2.25 tons of microchips produced per gallon of fuel used, the Morbark 40/36 MicroChipper allows owners to reduce costs and maximize profits. In customer tests, 95% to 98% of the microchips produced passed through a half-inch grate, and 72% to 74% passed through a quarter-inch grate. These microchips are vital for pellet mills, eliminating the need to regrind the wood fiber prior to pelletizing.

Morbark, Inc. | www.morbark.com

Setting up a Successful Corporate Sustainability Plan

By Jay Zoellner & Bruce McLeish

ACCORDING TO THE UNITED NATIONS COMMISSION on Sustainable Development, sustainability is defined as: “meeting the needs of the present without compromising the ability of future generations to meet their own needs.” The online Merriam-Webster dictionary defines it as either “of or relating to, or being a method of harvesting or using a resource, so that the resource is not depleted or permanently damaged;” or “of or relating to a lifestyle involving the use of sustainable methods.”

With the threat of global warming and a potential world energy crises on our hands, sustainable methods are, perhaps, more important than ever before. Efforts to conserve energy and reduce, re-use, and recycle aren’t just happening in many homes and residences to lower electricity bills and to help better the environment, but are also becoming commonplace in many workplaces.

Commercial and industrial organizations, however, often face challenges when formulating and implementing a corporate sustainability plan of their own. These challenges can include cultural, informational, and resource barriers. Proven best practices, such as large-scale enterprise energy management systems, can help to overcome these obstacles and support the effective implementation of organization-wide sustainability plans.

Cultural barriers

Large-scale organizations already stretched thin on time and resources can experience conflicts between corporate and plant-level objectives. At the management level, increasing energy efficiency, reducing greenhouse gas emissions, complying with regulations, and measuring and reporting to approved standards may very well be priorities. Conversely, at the plant level, where maintaining production schedules and quality are paramount, the additional time and resources often required to meet sustainability objectives can present a dilemma.

To overcome these challenges, top performing companies understand the importance of focus, culture, and organization with regard to implementing sustainability programs, and they take specific steps to address them.

Companies formulating a sustainability action plan can benefit from implementing the following measures...

- **Communicate wisely.** If energy is to be viewed as a vital resource, one that’s to be managed for a return on investment, this message of sustainability needs to be a clear one—so everyone in the company is well-versed and on the same page.
- **Goal set.** To ensure efficient use of energy and resources remain a priority, successful companies make it a core business strategy, establishing realistic, quantifiable goals.
- **Develop a plan.** Involving both parties (headquarters and plant-level personnel) in the development of a Corporate Sustainability Plan, allows for the alignment of objectives from both sides.
- **Allow for differences.** It’s important to understand that goals must be set up individually for different plants as formalized metrics, with sustainability tied to performance and operations objectives at all levels.
- **Track progress.** Include a common measurement metric that’s understood throughout the organization, and that ties back to the bottom line (such as energy cost-per-unit or production).
- **Reward success.** Not only should a system for consistent monitoring be implemented, but also one that acknowledges progress and rewards success.

Informational challenges

Comparable to any corporate-wide initiative, a sustainability plan requires careful and thorough planning to be executed effectively. Creating a good plan that delivers significant and ongoing energy reductions requires a solid knowledge base, as well as:

- A centralized view of energy usage, enterprise-wide, down to the sub-system level;
- Upfront financial data on what efficiency projects will cost, and the projected return on investment (ROI);
- An automated structure to measure, track, and maintain energy savings; and
- An ability to quantify payback.

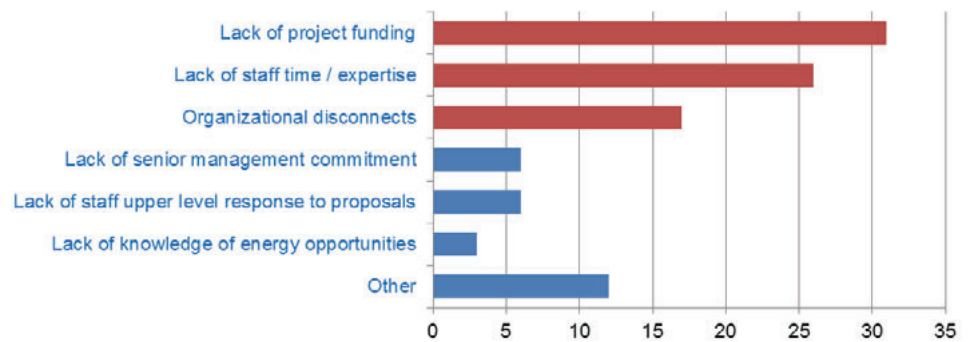


Figure 1. A survey of manufacturers demonstrates the greatest challenges to implementing energy efficiency strategies (Source: Pew Center on Global Climate Change; www.pewtrusts.org | www.c2es.org)

Companies should already be collecting and auditing the available data on their utility bills. However, the typical data contained in these bills doesn’t help with quantifying energy usage at the sub-system level, or in real-time. Even basic information systems, tied to individual rooms or pieces of equipment at a plant, don’t usually provide enough information to properly calculate a company’s bottom line.

Three keys for overcoming informational barriers are to: 1) Develop a common corporate energy language as part of a Corporate Sustainability Plan; 2) Know where energy is used across the entire enterprise; and 3) Understand how to calculate or translate it into the corporate energy language.

Implementing these best practices include:

- The use of an automated energy data collection system to provide visibility throughout the enterprise, enabling users to easily compare usage across systems and plants;
- Automated data collection that strengthens continuous monitoring capabilities, allowing companies to maintain and enhance their energy efficiency and savings programs over time; and
- The use of tools within an energy and carbon management system, such as dashboards, alerts, event management, and analytics is another common practice. These features permit organizations to understand and act on critical information to reduce energy usage and carbon emissions in real time.

A quality, enterprise-wide energy management system goes beyond just information. It provides “Energy Intelligence,” by transforming a broad spectrum of data into targeted, functional information. It further offers a real-time view into energy usage, cost, and carbon emissions during different production shifts at different times and days, across the enterprise, and down to the sub-system level. With the right information, companies can impact process relationships, more optimally allocate resources, and make better energy management decisions to achieve maximum efficiency—and achieve their sustainability goals.

Resource management

Many companies cite a lack of funding for projects as the greatest challenge they face when attempting to implement energy efficiency measures. Almost as prevalent is the lack of time or expertise within the organization to develop projects.

One solution is to outsource this process. A third-party provider can provide a macro-level or targeted understanding of monthly energy costs and usage, as well as recommendations for conservation. Additionally, they should be able to offer a number of additional services, such as bill payment, budgeting, accrual reporting, utilities-based carbon reporting, and technical solutions.

Installing automated energy and carbon management systems is also a means of tracking energy consumption, greatly reducing the amount of time required to oversee and implement sustainability programs. Intelligence energy solution can even identify the projects with the highest potential of energy savings, quantifying the ROI and payback period for these projects.

From addressing cultural and informational barriers to finding and allocating resources for proper energy management, ultimately, a combination of practices and solutions are required to develop a successful sustainability plan—especially one that everyone in a company buys in to. From the perspective of the environment and future generations, however, it would seem such efforts are well worth the time and resources.

Jay Zoellner and Bruce McLeish are responsible for Enterprise Energy Management services at Ameresco, Inc. Enterprise Energy Management comprises demand- and supply-side services, enabling commercial and industrial customers to meet their sustainability goals.

Ameresco, Inc. | www.ameresco.com

JULY

- 09-10 AWEA Wind Power on Capitol Hill**
Hyatt Regency Washington—Washington, DC; www.awea.org/events
- 09-11 Intersolar North America**
Moscone Center—San Francisco, California; www.intersolar.us
- 28-30 Pellet Fuels Institute Annual Conference**
The Grove Park Inn—Asheville, North Carolina; <http://pelletheat.org/events>

AUGUST

- 07-08 National Geothermal Summit**
Hyatt Regency, Sacramento—Sacramento, California; <http://geo-energy.org/events>

SEPTEMBER

- 03-06 International Conference on Thermochemical Biomass Conversion Science**
Sheraton Chicago Hotel & Towers—Chicago, Illinois; www.gastechnology.org/tcbiomass2013
- 09-10 AWEA Finance & Investment Seminar**
New York, New York; www.awea.org/events
- 10-12 Energy Storage North America**
San Jose Convention Center—San Jose, California; www.esnaexpo.com
- 23-24 5th Concentrated Photovoltaic Summit USA 2013**
Hyatt Place San Jose/Downtown—San Jose, California; www.pv-insider.com/cpv
- 24-25 Optimizing Wind Power O&M**
The Mid-America Club—Chicago, Illinois; www.greenpowerconferences.com
- 24-26 6th Annual Utility Scale Solar Summit 2013**
Rancho Bernardo Inn—San Diego, California; www.infocast.com/events
- 24-26 6th Annual Utility Scale Solar Summit 2013**
Rancho Bernardo Inn—San Diego, California; www.infocast.com/events
- 29-02 GEA Geothermal Energy Expo 2013 & GRC Annual Meeting**
MGM Grand—Las Vegas, Nevada; <http://geo-energy.org/events>

OCTOBER

- 02-03 ALL-ENERGY CANADA 2013**
Direct Energy Centre—Toronto, Ontario; www.all-energy.ca
- 03-13 US Department of Energy Solar Decathlon**
Orange County Great Park—Irvine, California; www.solardecathlon.gov
- 07-10 CanWEA 2013**
Metro Toronto Convention Centre—Toronto, Ontario; www.canwea2013.ca
- 17-18 5th Annual OPIS RFS2, RINs & Biodiesel Forum**
Hyatt Regency McCormick Place—Chicago, Illinois; www.opisnet.com/events/rfs2rins/index.html
- 21-23 Solar Power International 2013**
McCormick Place—Chicago, Illinois; www.solarpowerinternational.com
- 22-23 AWEA Offshore WINDPOWER Conference & Exhibition**
The Rhode Island Convention Center—Providence, Rhode Island; www.offshorewindexpo.org
- 29-30 World Bio Markets USA**
Parc 55 Hotel—San Francisco, California; www.greenpowerconferences.com

NOVEMBER

- 03-07 ISES Solar World Congress 2013**
Cancún Center—Cancún, Mexico; www.swc2013.org
- 06-08 AWEA Wind Energy Fall Symposium**
The Broadmoor—Colorado Springs, Colorado; www.awea.org/events
- 12-14 POWER-GEN**
Orange County Convention Center—Orlando, Florida; www.power-gen.com
- 13-15 6th Annual Nebraska Wind Conference & Exhibition**
Cornhusker Marriott Hotel—Lincoln, Nebraska; <http://nebraskawindconference.com>
- 19-21 Geothermal Energy: The 3-Day MBA**
New York; www.greenpowerconferences.com

DECEMBER

- 03-04 26th Annual Industry Growth Forum**
Denver, Colorado; www.nrel.gov/technologytransfer/events.html
- 09-10 SOLAR CANADA 2013**
Metro Toronto Convention Centre—Toronto, Ontario; www.cansia.ca/solar-conferences/solar-canada

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