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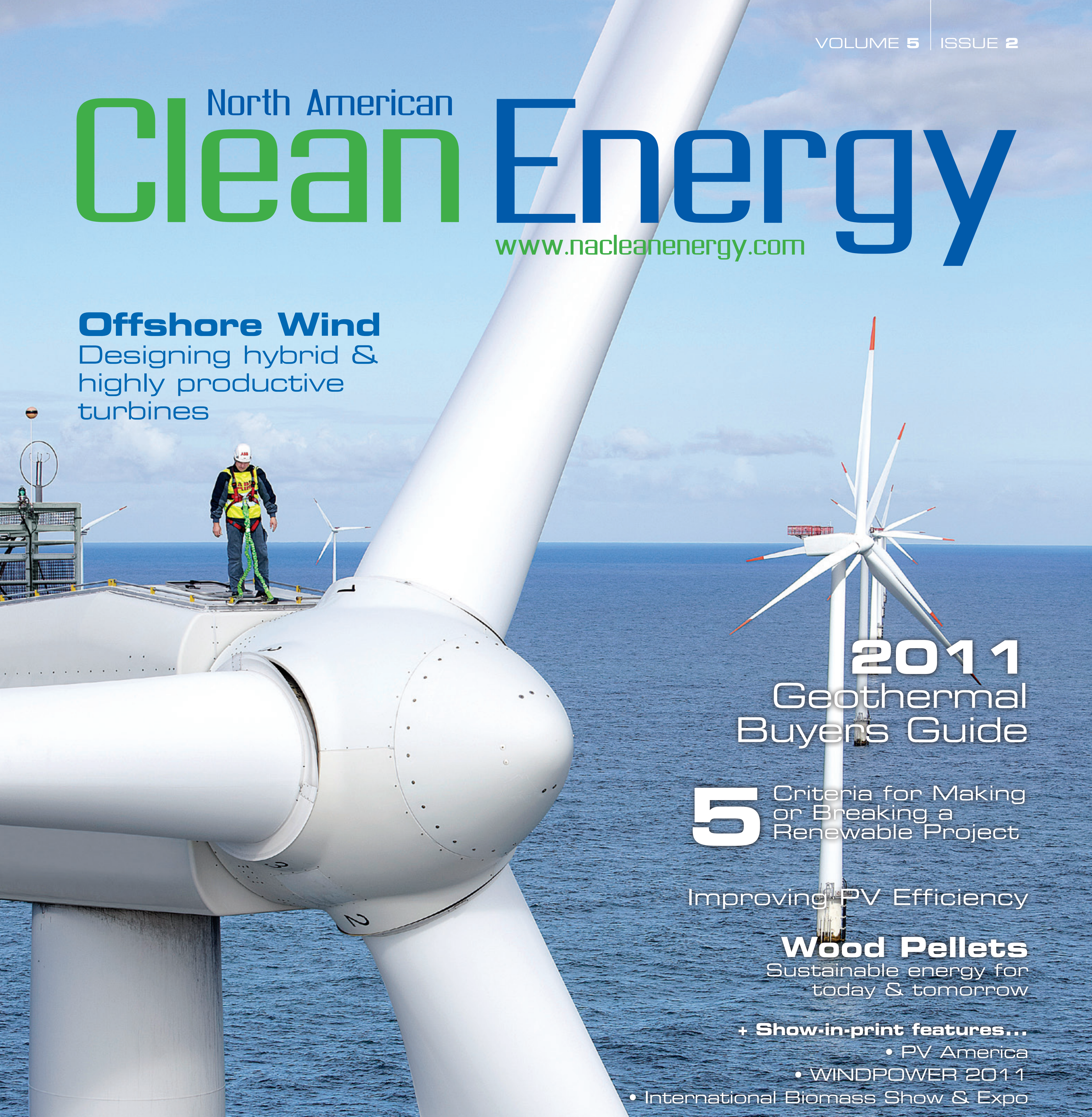

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Next-generation Urban Integrated Solar Technologies

By Peter Le Lievre

IF YOU ASK A PERSON off the street what "solar technology" means, he or she will likely point you to an array of panels on a roof. Silicon Photovoltaic (PV) modules have come a long way since first introduced by Bell Labs in 1954, and are now a common sight in many cities. Aside from the energy produced, these modules are easy to live with (no noise or emissions) and can retrofit on vernacular architecture. Over 20GW of panels have been reported as installed in 2010. Government incentives have played a large part in this spectacular growth and, looking beyond PV modules to the next generation of rooftop solar technologies, incentives and new research will continue to play an important part.

One area of interest is in the gradual rise of hybrid PV research, which not only aims to increase solar-to-electrical efficiencies but simultaneously looks at harvesting waste heat, as well. "Normal" silicon PV modules produce valuable electricity with efficiencies from about 10% up to 20%. However, these efficiencies mean that 80% to 90% of the sun's energy is wasted as heat. This thermal energy loss is unavoidable—even "ideal" monocrystalline silicon cannot exceed 29% efficiency (ie. 71% "inefficient"). To solve this problem, hybrid PV systems aim to capture the lost heat while still providing equal or better electrical output as PV. Typical total hybrid (electric/thermal) collection efficiencies can range from 50% to 75%. These efficiencies provide more usable energy from a rooftop than "normal PV," and research in the area has been strong.

In California, hybrid research is being partially stimulated by the Solar Thermal Handbook, which is funded by the California Solar Initiative (CSI). The "million roofs" program initially supported PV module installation by subsidizing rooftop installations at up to $3.25 per Watt. However, response was strong and the PV program has now stepped down to far lower subsidy levels. Since then, the thermal component of CSI has been launched at $12.80 per therm (100,000 BTU), which is attractive not only to traditional solar hot water installers but to Hybrid PV system developers, as well. Next-generation Hybrid PV modules producing electricity and hot water can benefit from this renewed CSI support, and are expected to increase their market share over the coming period.

But what are these technologies and what do they look like? In simple terms, there

Figure 1: *ANU CHAPS (left), Absolicon covered Parabolic Trough Hybrid (center), and Heliodynamics Fresnel Reflector (right)*

Figure 2: *Wiosun water-cooled PV modules (right), and PVT air-cooled PV modules (left)*

Figure 3: *Brightphase (left) and Chromasun MCT (right)*

are three main types: concentrating hybrid, flat plate hybrid, and flat panel hybrid. Here's a look at each one...

Concentrating Hybrid systems are essentially utility scale solar collectors that have been adapted for rooftop service. An example of this technology has been installed by the Australian National University, in their CHAPS demonstration in Canberra. The CHAPS system is based on a classic parabolic trough concentrator design, adapted for rooftop installation. The custom hybrid receiver contains PV cells for electric generation and a water pipe to extract hot water for the building's domestic hot system. Another example is Absolicon, a Swedish company that is currently commercializing a similar parabolic trough-based hybrid technology. In addition to parabolic trough, linear Fresnel concentrating systems have also been developed in rooftop hybrid format such as those constructed by Heliodynamics and Entech.

Common problems with concentrating hybrid systems is they are fairly bulky, have externally moving parts, and are hard to mount on the roof. However, these systems demonstrate excellent system efficiencies, as well as the ability to produce higher temperature heat (up to 100°C).

Flat Plate Hybrid offers a simpler, alternative approach that "cools" traditional PV modules with air or water. These hybrid modules are far easier to mount on the rooftop, and can be stacked much closer together than concentrating systems for greater rooftop density. Several versions of this type of technology are in the marketplace today.

Air-cooled modules are marketed by PVT Solar; whereby, hot air trapped behind the PV module is gathered up in a heat exchanger that, then, generates hot water. Alternative direct water-cooled modules are also available from Wiosun, which route water pipes behind the PV module and capture

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hot water directly. Water-cooled systems have the advantage in that they can mount on standard PV racking—but they do require proprietary modules. Air-cooled systems do mount on proprietary racking, but at least accept standard modules.

Flat panel hybrid systems are especially appealing in residential applications where domestic hot water (55C) loads are a significant part of the energy requirement. However, in commercial and industrial applications, hotter water is often required and hybrid systems are unable to meet these demands.

Flat Panel Hybrid are a new breed of hybrid solar collectors that retain the ease of mounting shown by flat plate systems, but also incorporate concentrating optics that allow the higher operating temperatures and greater system efficiencies of concentrating hybrid systems. BrightPhase Energy introduced a pioneering version of a Flat Panel Hybrid in 2006 and, more recently, Chromasun has unveiled the development of a hybrid product in partnership with The Australian National University.

Flat panel hybrid technologies already demonstrate collection efficiencies of around 65%, and operating temperatures exceed 100°C. These temperatures are expected to increase as research and development teams look for ways to maintain the electrical efficiency of PV cells at higher temperatures. Or, alternatively, harness the infra-red radiation before it reaches the PV.

With so many advantages, it's not surprising rooftop-mounted hybrid technologies are one space to watch in the next generation of urban integrated solar. It is fortunate in states like California, regulatory and policy support already exists to stimulate this emerging segment as products reach the marketplace. A small segment, for sure, but one with some definite advantages on the rooftop.

Peter Le Lievre was originally the co-founder and CEO of utility scale solar company, Ausra, and is now the founder and CEO of Chromasun.

Chromasun | www. chromasun.com

PV ion implant system

Varian's Solion PV ion implant system offers solar panel manufacturers better cell efficiency and reduced production costs. Based on the production-proven VIISta semiconductor implant family and its installed base of over 1200 units, the Solion platform is an ideal tool for advanced junction engineering. It also offers far better uniformity and cleanliness than the PV sector's traditional diffusion doping process, while eliminating several process steps. Solion can also handle both doping and patterning in a single step, with proprietary Precision Patterned Implant (PPI) technology. Early users have responded enthusiastically to Solion, using it to achieve cell efficiencies of over 19%. In the longer term, Solion offers a clear roadmap to manufacturable 22% efficiency.

Solion | www.vsea.com

Optical inspection & measurement of solar modules

The KUKA String Test is particularly recommended for automated production, where it can enhance the quality and output of the modules produced. A camera system is used to measure the strings, check the position of the bus bars, and give the cells a final inspection. This ensures that the robot positions the string optimally, and that faulty parts are segregated for manual reworking. An optional EL (electroluminescence) test reveals cracks (known as micro cracks) and functionally inefficient areas of the solar cells. The procedure takes between eight and 20 seconds, depending on the scope of the test and the string size, at the end of which a clear quality analysis is available. In cell strings that have passed the test, the connecting strands are cut-to-size for the relevant deposition position in readiness for the subsequent process step, cross-soldering.

Kuka Systems | www.kuka-systems.com

PV monitoring solution with wirelessly communication

SMA's Sunny WebBox monitoring system is now capable of wireless operation via integrated Bluetooth technology. In addition to continuously gathering PV array data, the Sunny WebBox with Bluetooth gives solar system owners the freedom to install or house the device in a variety of flexible configurations. The Sunny WebBox with Bluetooth wirelessly receives, stores, and transmits data from up to 50 solar inverters to the SMA Sunny Portal, where users can then access this information remotely from any web-enabled PC in the world. The Sunny Portal can also be configured to send email or text message alerts to the system owner if a power deviation is detected by the Sunny WebBox. For more detailed performance analysis, users can also add the SMA Sunny SensorBox to collect irradiance data at the PV array. The Sunny WebBox with Bluetooth can withstand ambient temperatures of minus 4°F to more than 149°F, and can be mounted on DIN rail, wall-mounted indoors, or used as a tabletop device.

The SMA Group | www.sma-america.com