UNIRAC®
Bright Thinking in Solar

Supporting Your Systems:

Mounting Structures Evolve With The Solar Marketplace

Architects and designers are pushing the envelope for more exotic and challenging designs, necessitating more advanced mounting technology.

"There they are," my wife said. "Over there." We were looking at a bank of solar modules gleaming in the sun, proudly producing electricity. When she saw the solar photovoltaic installation, the solar modules - large and clearly visible - caught her eye. She didn't give much thought to what was supporting the modules - the PV mounting structure. That wasn't surprising. After all, she didn't give much thought to the studs and roof trusses that supported our house until there was an earthquake. Luckily, our house didn't fall. But following that disaster, she was keenly interested in what structural elements protected our home.

Similarly, owners and installers of solar systems should be aware of what elements comprise good PV mounting structure design. In-depth knowledge is not needed, but owners and installers should learn enough about mounting technology and techniques to provide confidence in the final installation.

Most simply, the purpose of a PV mounting structure is to support and hold the solar modules under the expected weather conditions for the installation site. Depending on the geography of the installation, the PV mounting structure will have to withstand snow, high winds and earthquakes.

Many factors must be considered, including:

- the desired mounting location (on a roof, on the ground, on a pole),
- if on a building, the location on the roof or side of the building,
- the number of attachments allowed,
- the required tilt angle of the solar modules, and
- the type of structure used to hold the solar modules.

Mounting advancements

As the solar PV industry has grown, mounting-structure strategies and technology have improved. In the mid 1990s, when the PV mounting structure industry was a marginal component of the solar industry, mounting structures were largely built from a one-size-fits-all perspective - a do-it-yourself approach that employed all types of materials, from wood to metal framing.

But the industry has become much more mainstream, growing from annual U.S production of 34 MW in 2002 to an estimated 200 MW in 2007. More sophisticated mounting structures are now required to meet the higher demands of the market. Today, PV mounting technology has become an integral component of the industry.

Architects and designers are pushing the envelope for more exotic and challenging designs. Strategies used by large manufacturers in other industries for improving products - engineering, testing and quality control - are becoming prevalent. Highly skilled engineering and product management teams are being used to bring new products to market.

In the last decade, professionally engineered aluminum frames have replaced simple wood structures, mounting structures have become subject to rigorous testing to ensure safety and durability in the most challenging of circumstances and advanced computer modeling has emerged to assist the mounting process. These sophisticated design techniques are vital toward ensuring that a PV mounting structure meets the requirements of each installation.

Likewise, with the growth of the PV solar market, the number of different PV mounting structures has also grown. Residential systems, typically mounted flush to the roof, have long been built with standard mounting structures. However, many customers wanted more aesthetically pleasing structures, and the manufacturers responded.

With the advent of favorable tax breaks, the market for commercial systems grew. Now, commercial systems have many variations: flat roof structures with attachments; flat roof structures with minimal penetrations; ballasts to replace attachments; tilted structures; structures mounted to standing seam roofs; ground-mounted, pole mounts, and open-field arrays; some featuring sophisticated tracking systems.

Building code

In order to handle high winds, engineers know that PV mounting structures must be designed according to American Society of Civil Engineers (ASCE) Standard 7-05, Minimum Design Loads for Buildings and Other Structures.

Unfortunately, these guidelines do not specifically address PV mounting structures, nor do they address even the type of structures used in mounting PV panels. These deficiencies make a system designer's job more difficult.

For example, ASCE 7-05 specifies the loads that are acceptable on open building rooftops with slopes up to 45 degrees. What if the installation is greater than 45 degrees? Or what if you are designing a structure that mounts on a pole and tilts at 60 degrees? What if the PV installation will be mounted with a tilt close to the edges of the roof?

These conditions are unique, and ASCE 7-05 provides no specific answers. Therefore, an engineer designing PV mounting structures must know the intricacies of each wind load category and apply good, conservative practices to determine the correct calculations and assumptions.

Also, manufacturers that sell PV mounting structures in more than one state must stay abreast of code changes, as well as to the various implementation schedules of the different states. New versions of the ASCE standard are issued every three years and are adopted by the International Building Code (IBC) approximately six months after that. However, the states adopt the IBC at varying times.

For instance, the 2003 version of the IBC was adopted in January 2004 by Colorado, Connecticut, South Carolina and Tennessee. Oregon adopted it in October 2004, and Ohio did so in March 2005, while California never adopted the standard. The 2006 IBC was adopted by various states in February, April, July and October of 2007, but not until January 2008 by California - which jumped from the 2000 California Building Code directly to the 2006 IBC, bypassing the 2003 IBC completely.

Following the IBC is also a concern of local jurisdictions, which are becoming more and more involved as the number of solar installations increases. The building inspectors for these jurisdictions are required to approve any new solar system installation, and they are concerned with both the electrical and mechanical safety of the equipment.

While the National Electric Code - via Article 690 - does a good job in providing guidelines for the electrical safety of a solar system, there currently isn't an equivalent guide for the structural safety of the installation. The IBC comes closest, but it does not specifically include the structures used in mounting solar equipment. As a result, the local inspector may insist that the structure design be stamped by a professional structural engineer.

Frequently, the manufacturer of the PV mounting structure will have already obtained certification of its components and design methodologies by a professional engineer, and this certification will be enough to satisfy the inspector. If not, the inspector may require another engineer to sign off on the design. This engineer, in turn, may request that the manufacturer of the structure verify its components through various calculations, internal testing or independent third-party testing.

Because system designers and installers would prefer not to be burdened by all of these issues, it is incumbent on manufacturers to simplify the selection of the appropriate support structures. Such structures should be correctly engineered; tested and validated; and easy to size, price, order and install. These are hallmarks of well-engineered products which should give users confidence that their installation won't fail during severe weather conditions.

Douglas J. C. King

(AUTHOR NOTE) Douglas J. C. King is the director of engineering and product development for Albuquerque, N.M.-based UniRac Inc., which specializes in PV mounting technology. He can be contacted at (505) 242-6411.