The Engineering Consultant

"Excellence in Engineering"

Scheeser Buckley Mayfield LLC

Issue 2

February 2011

Solar Power & Photovoltaic Cell Technology

by James E. Eckman, PE, LC, LEED AP, CBCP

The last issue of The Engineering Consultant discussed the following items:

- Alternative and renewable energy definitions
- Net metering
- Tax incentives, grants and rebates
- Renewable energy credits (REC's)

The first alternative energy source to be discussed is solar or photovoltaic (PV). This source has several advantages over the other alternative energy sources. These include no moving parts as well as probably the most advanced technology when compared to either wind or fuel cells. Solar also is the lest expensive alternative energy source from an initial installation cost per kwh produced and from an ongoing operational standpoint. Solar tends to be the most predicable at least as compared to wind power.

System Components:

Solar systems consist of three major components. These include the Photovoltaic (PV) modules, inverters and mounting structure.

PV Modules

A PV module typically consist of approximately (104) 5"x5" cells. Modules are then arranged in arrays depending on the system design and voltage requirements. There are currently two types of PV modules available. These include crystalline modules and thin film modules. The older technology and most common module type is the crystalline module. This type of module has an efficiency of approximately 15%. Due to its construction it is heavier and more expensive than the thin film module and require mounting structures to support their weight. Crystalline modules can withstand hail up to 1" diameter.

Thin film modules as their name eludes are flexible, lightweight sheets of PV material that are less expensive than the crystalline modules. Unfortunately the downside of the thin film modules are that they are less efficient than the crystalline (approximately 8% vs 15%) and slightly more difficult to wire since they don't require mounting structures that can also double as wiring troughs. The lower efficiency means that nearly twice as much area is required for the thin film modules to equal the same output as the crystalline. Thin film modules are more shade tolerant than the crystalline which offsets the lower efficiency if shading is an issue.

Inverter

The inverter is simply the device that converts the DC power produced by the PV arrays to AC power. These devices come in various DC inputs, wattages and AC outputs depending on the system design. Inverters are available from 190 watt micro inverter to 1 megawatt with output voltages of 120 volt AC to 480 volt AC.

Mounting Systems

Mounting systems consist of ground mount, pole mount and roof mount systems. Mounting angles are critical as there is an optimum angle depending on the site location. Regardless of your site location the system and mounting angle are based on summer sun. Systems are available that adjust the mounting angle based on the time of day and time of year but these are very expensive. Roof mounted systems create obvious issue with roof systems as do any roof mounted equipment. Non roof penetrating systems that consist of concrete block or other ballast are available. If a non penetrating system is anticipated for a new building, the roof load capacity must be designed to accommodate this added weight. If this type of system is anticipated for an existing building the existing structure must also be evaluated for the additional weight of the solar system itself and the anticipated ballast. It is highly possible that the non penetrating system might not be feasible for an existing structure.

Solar system design rule of thumb:

The following design rules of thumb are useful for quick solar system calculations.

10 watts/square foot of solar array surface area.

1.1 kwh per year per watt installed.

80% overall system efficiency

$6.00 to $8.00 per watt

Special points of interest:

- PV System Components
- PV System Design Rules of Thumb
- Design Guides
- Payback Example

Look for upcoming issues:

- Wind Power Technology
- Fuel Cell Technology
- Geothermal Technology

Scheeser Buckley Mayfield LLC

Scheeser Buckley Mayfield LLC
1540 Corporate Woods Parkway
Uniontown, OH 44685
Phone: 330-896-4664
Fax: 330-896-9180

300 Marconi Blvd., Suite 306
Columbus, OH 43215
Phone: 614-448-1498
Fax: 614-448-14998

E-mail: jeckman@sbmce.com

Mechanical, Electrical, Site/Civil,
Telecommunications Engineering
Commissioning Services

We're on the Web!
www.sbmce.com

SBM Completes First Major 100% BIM Project

SBM recently completed the mechanical, electrical, plumbing and telecommunications (MEPT) design for a new 100,000 square foot dormitory for Marietta College. The architectural design was completed by Design Group of Columbus and the project represents the first major 100% building information management (BIM) project completed by SBM. The project involved the modeling of all major MEPT systems and interfaced the project model with the architectural and structural elements for coordination purposes. The project was completed using AutoDesk REVIT MEP 2010.

SBM Commissioning Services

SBM has been expanding it's commissioning services throughout Ohio and West Virginia. SBM has three Certified Building Commissioning Professionals (CBCP) leading the companies commissioning projects. Commissioning is the systematic process of ensuring that building systems are designed, built, and operated as intended. Today's buildings are extremely sophisticated and complicated. Computerized controls can operate many systems in a building automatically without human intervention. If these controls are not set up properly and verified to work as intended, a building could have serious temperature control problems at worst and could use much more energy than necessary. The commissioning process is a team effort and requires the Owner, the design professionals, the contractors, and the commissioning agent to work in concert with each other to obtain a well commissioned building. Many times the design professionals view the commissioning agent as competition which can put up barriers for a commissioning agent. The professionals at SBM utilize their extensive design experience to bring all of the participants in a project together and lead the way to communicate the necessary information required to get a building on-line and operating as designed. SBM has completed commissioning projects in Ohio and West Virginia and is currently actively commissioning a project at the Ohio State University, Kent State University and Aultman Hospital.

Solar Power & Photovoltaic Cell Technology Continued ....

installed depending on system complexity.

Solar system Design Guides:

Solar system designs cannot be accurately completed without the use of design guides and tools. These include solar charts and shading applications.

Solar charts can be found on-line at www.NREL.gov/gis/solar.html.

Solmetric is just one vendor of shading application software.

Solar System design example:

Assume 10kw 120/240 volt single phase load. 95% shade free area available.

System installed in NE Ohio with approximately 4.1 sun hours per day average

Simple ground mounted system will be provided.

Solar array square foot required:

10,000 watts x 1 square foot/10 watts = 1000 square feet array surface.

Energy generated per year:

1.1kwh/watt x 10,000 watts = 11,000 kwh per year.

Solar system cost

$6.00/watt x 10,000 watts = $60,000.00

Solar system financial analysis

10,000 watt simple system

$60,000 estimated cost

$18,000 federal grant (30%)

$30,000 state rebate (50%)

Final cost $12,000.00

Solar system payback

At 7 cents per kwh

11,000 kwh generated per year

$770.00 per year savings

Payback: $12,000.00/$770.00 per year = 15.6 years

Hats off....

Congratulations to Joseph Ross, Electrical Engineer, Joe has passed his PE exam. Joe has been with SBM since 2005.

Congratulations to Lan Li, Mechanical Engineer, Lan passed the LEED AP exam. Lan has been with SBM since 1999.

SBM Continues to grow...

Scheeser Buckley Mayfield continues to grow with the addition of Jason Wilson, Mechanical Engineer, to our Columbus office. Jason attended Wright State University where he received his Bachelor of Science in Mechanical Engineering.

Caleb Kuzman has joined our Akron office. Caleb attend the University of Akron where he received his Bachelor of Science in electrical Engineering in 2010.