Solar Flashers: Solar Module Options

by Joseph Wise

One of the key components in a solar-powered traffic system is the solar electric module. Solar modules are constructed of multiple solar cells electrically connected to each other and mechanically encapsulated. Modules come in a variety of sizes and shapes to allow project designers flexibility of space and cost effectiveness.

Manufacturers construct modules sized around the physical dimensions of the individual solar cells. In the most common technologies, typical cell sizes are 4 inches and 6 inches.

Over the past 25 years, three types of solar materials have become commercially viable, are mass produced and in wide use for traffic control systems. These technologies use crystalline, polycrystalline or amorphous silicon as the base material. Each has its pros and cons.

Crystalline solar modules

Crystalline solar cell technology uses silicon's crystal properties, and because of the crystal structure's uniformity, produces the most highly-efficient cell. Of the three types of cell materials, it is the most expensive to produce.

The cell material is created by inserting a seed crystal into a crucible of silicon. A round cylinder of crystalline silicon is drawn from the crucible and once cooled, the silicon is cut into wafers. For every cell cut from the cylinder, a cell is wasted in the cutting process. This drives up the price of the overall material and adds to production time.

Cells are further processed to give them the desired electrical characteristics, then sorted by electrical output. They are then electrically connected into strings, placed between glass and encapsulating polymers and formed into the finished module.

Crystalline solar modules are the most expensive to produce yet have some of the best efficiencies in converting light to electricity. The end result is a smaller overall module for the rated output power. Shell Solar's SM55 module is an example.

Polycrystalline solar cell technology

Polycrystalline silicon material is processed by pouring molten silicon into a mold and allowing the crystals to form randomly as it cools. These forms must also be cut into cells with the resultant waste. The individual cells go through additional processing, then are sorted by output. Finished cells are encapsulated into solar modules in the same manner as crystalline cells.

Polycrystalline module efficiency is slightly less than crystalline material. These modules are less expensive to produce than the crystalline yet have nearly the same footprint as the crystalline modules, since the conversion efficiency is nearly equal.

Both module technologies are available in various sizes to fit specifier's needs. Each type is mechanically mounted in a similar manner: under a specialized high strength glass with ethylene vinyl acetate encapsulant and an aluminum framework around the module. Considering most units are mounted on pole tops, energy density is important. Crystalline and polycrystalline offer high-energy densities which help minimize wind loading issues in their applications. Crystalline and polycrystalline modules will operate for approximately 20 years. Their warranties back their power output for 20 years, and longer.

The major concern in most applications using crystalline and polycrystalline: durability to vandalism. The glass used in these modules is capable of withstanding a 1-inch piece of hail at 52mph. These technologies are also not tolerant to shading of the cells. If one entire cell is shaded, it can block most or all of the output from the remaining cells. It's critical that sites without obstacles, such as trees or buildings, be selected for the application.

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Thin Film Modules

Another technology on the market today is thin film or amorphous. Again, silicon is the base material used for this type of cell. However, the cell's manufacturing process is different; it uses vaporized silicon deposited onto either a stainless steel or glass substrate.

Cells made on the stainless steel back sheet have gained popularity, since they are not as fragile as those deposited on glass. The production method has also been highly mechanized resulting in an inexpensive product. These cells are configured into various sized modules, covered with a clear Teflon encapsulant and placed in an aluminum frame for mechanical support.

Durability is a major feature of thin-film technology. This module is highly vandal-resistant as the cells are built on a stainless steel substrate and covered with Teflon, which is lighter and tougher than glass, and thereby appealing for a number of applications. Thin film withstands impacts from rocks and bottles while sustaining little damage. The manufacturer even claims these modules can resist gun shots and continue to function for an extended period before total failure.

Some versions of these modules have shown a tolerance to partial shading. Even with partial shade on the module, much of the output power is still available. This is in sharp contrast to the crystalline and polycrystalline when shading of a single cell causes the module to virtually stop producing an output. Thin-film modules have a fairly good warranty on power production: ten years in some cases.

The major drawback is lower efficiency in converting sunlight to electricity. Thin film technologies typically deliver about half the efficiency of a polycrystalline module, translating to a large surface area for the rated watts. For example, compare the Uni-Solar US32 (32W) solar module with a footprint of 53 inches x 15 inches (5.52 sq. ft.), with a Shell Solar SM55 (55W) solar module with a footprint of 13 inches x 51 inches (4.6 sq. ft). When more power is required by the system or mechanical constraints from wind loading become an issue, it may be impractical to use a thin film module due to its larger footprint. Another consideration is thin-film's Teflon coating: as a polymer material, it will eventually suffer UV degradation and cloud over, thus limiting the useful life of the module.

Alternative technologies present many potential solutions to our problems. However, the pros and cons must be weighed carefully to determine their suitability. When specifying a solar power system for a project the module cell type, physical size, and its durability should be examined to make the best possible choice for the money and the application. **I M S A**

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