

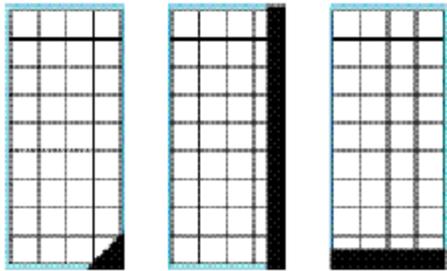
Winter brings many challenges for maintenance and operations personnel as they work to keep the product flowing. Solar power systems are pushed to their maximum. In an effort to maintain a healthy knowledge of the products we implement please read the following information from the Kyocera website - <http://www.kyocerasolar.com/solar/modules.html>.

### Solar Electric Modules - Shading:

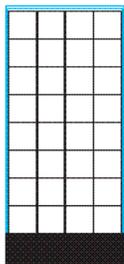
Photovoltaic (PV) modules are very sensitive to shading. Unlike a solar thermal panel which can tolerate some shading, many brands of PV modules cannot even be shaded by the branch of a leafless tree.

Shading obstructions can be defined as soft or hard sources. If a tree branch, roof vent, chimney or other item is shading from a distance, the shadow is diffuse or dispersed. These soft sources significantly reduce the amount of light reaching the cell(s) of a module. Hard sources are defined as those that stop light from reaching the cell(s), such as a blanket, tree branch, bird dropping, or the like, sitting directly on top of the glass. If even one full cell is hard shaded the voltage of that module will drop to half of its unshaded value in order to protect itself. If enough cells are hard shaded, the module will not convert any energy and will, in fact, become a tiny drain of energy on the entire system.

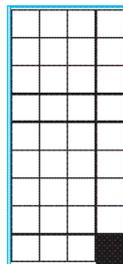
Partial-shading even one cell of a 36-cell module, such as the KC120, will reduce its power output. Because all cells are connected in a series string, the weakest cell will bring the others down to its reduced power level. Therefore, whether  $\frac{1}{2}$  of one cell is shaded, or  $\frac{1}{2}$  a row of cells is shaded as shown above, the power decrease will be the same and proportional to the percentage of area shaded, in this case 50%.



When a full cell is shaded, it can act as a consumer of energy produced by the remainder of the cells, and trigger the module to protect itself. The module will route the power around that series string. If even one full cell in a series string is shaded, as seen on the right, it will likely cause the module to reduce its power level to  $\frac{1}{2}$  of its full available value. If a row of cells at the bottom of a module is fully shaded the power output may drop to zero. The best way to avoid a drop in output power is to avoid shading whenever possible.



**Example of full-cell shading that can reduce PV module power to zero**



**Example of full-cell shading that can reduce PV module power by  $\frac{1}{2}$**