

cooling as possible by providing for air flow behind the module and minimizing effect of insulation. This is not an issue for amorphous silicon modules [45].

22.3.2.3 *Color of the cells and modules*

Solar cells are basically blue, dark blue or black after processing. Different colors are possible but these are not manufactured as standard. Some manufacturers sell tailor-made cells in special colors (e.g. gold, gray, green, red-orange and yellow). The cell color is varied by changing the thickness of various optical coatings on top of the cell, which changes their reflection. The blue color produces the highest efficiency solar cells. Current literature gives efficiencies for colored cells as 11.8% and 14.5% compared to optimized cell efficiency of 16.8% [46, 47], which corresponds to around 75% of the power of dark-blue cells [48].

Modules have several sections that can be colored. Besides the cells, the frame and the back sheet will also have a certain color. Older modules had natural aluminum frames and a white back sheet. The shape of the cell was very pronounced because of the contrasting color. However, modern modules have colors that are more in harmony: dark-blue cells with a dark back Tedlar® sheet and a dark-colored frame around the module, which produces a very uniform image. A roof or façade containing these uniform-colored modules will be seen as a single surface. The opposite effect is also possible by using modules in striking colors to attract attention and focus on the PV system.

22.3.2.4 *The architecture of modules*

Architects select modules based on their shape and composition possibilities. There is a big visual difference between framed and frameless modules.

Frameless modules look very similar to window glass. A surface with frameless modules with a “hidden” mounting system looks very uniform. The seams seem to be hidden and the individual module is hard to recognize. This smooth surface has a high aesthetic value.

Framed modules give a totally different effect. The frames can be heavy and therefore determine the total impression of the surface. The very visible frames divide the surface into modules and every individual module is very recognizable. This is not always the image envisaged by the architect.

To solve this problem, smaller frames in the same (dark or blue) color as the cells can be used and are less visible. The soldering between the cells is a small detail but is an important part of the image for very visible PV systems. In the older techniques the soldering was very visible and not very smooth. However, new techniques mean that the soldering is hidden better and new types of soldering, for example, ECN cells, can be expected in the future.

Modules vary significantly in size. Standard modules are less expensive than applications using tailor-made modules. However, almost every form, shape and dimension is possible with tailor-made modules. The glazing is available as single and double (insulating) glass. Thin-film modules allow greater freedom to select size and color than c-Si modules.