M12 solar cells are racing on to the market

Last year it was still believed that the next solar cell size standard in the industry would be M6. The much larger M12 was on the horizon, but it was not believed to arrive at mass production the market so soon. Just one year later the cell is available and some module producers have announced the mass production of modules made out of M12 cells by Q3 2020. This article will look at the possible layouts of these modules and the impact that it will have on module producers and the production equipment suppliers, with a focus on the module backend production equipment.

What should the next generation of module production equipment look like?

This is a big question for solar module producers and the solar manufacturing supply chain as well. One thing is clear: the manufacturing equipment will need to change to accommodate the newest module layouts.

In this article we will look at the changes in cell/ module sizes and the effect they will have on the module backend production. In the best case, it will be just upgrading existing equipment wherever possible, but for the latest large cell sizes, it will mean exchanging the older equipment.

The size of a solar cell was long a standard with an edge length of 156mm x 156mm (M0). It took nearly 10 years before the first cell size changes emerged, which by today go up to a size of M12 with an edge length of 210mm x 210mm, see figure 1. Each change in cell size increased the light trapping area, it started with minor changes in the range of a fraction of a millimeter, but has recently reached a gain of up to 81.2% when comparing the area of M0 to M12.

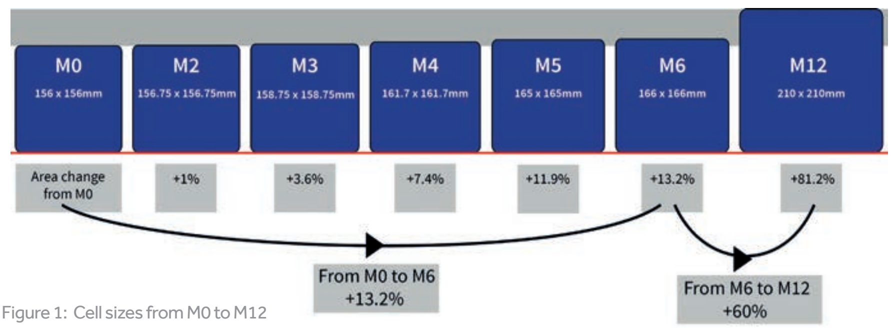

Figure 1: Cell sizes from M0 to M12

Figure 2: LED sun simulator with two LED units for the measurement of bifacial modules

The M6 cell size was long thought to be the new standard size to come, while going through a series of different sizes. The cell edge length of M6 is 166mm x 166mm and increases the light trapping area by ~13.2% compared to a M0 cell. The larger size directly increases the overall power per module. With the industries main goal, to increase the power per module, it seems the logical step to further expand the size of the silicon wafer.

Another way to increase the performance of cells and modules is to use new cell material combinations (PERC, HJT or TopCon) or new manufacturing technologies: using multiple busbars or intelligent wires, using bifaciality, shingles or paving. See figure 2 for an example of a bifacial LED sun simulator.

But increasing the cell area to improve power output could prove to be extremely cost-effective, even though it also calls for drastic changes to the production hardware.

A standard M0 module with 72 full cells has a dimension of ~1000mm x 2000mm, see figure 3. The green line indicates the direction of the busbars and the current flow through the module. How will that change for a M6 or M12 cell size-based module and what does it mean for the module dimension and hence the production equipment?

Before looking at the module dimension of an M6 or M12 cell size, it is necessary to show the benefits of the half-cut cell design. A very typical module layout is a module with 144 half–cut cells. Why are cells cut in half? The reduction of the cell area reduces the loss of power due to the reduction of the current flowing through the cell. This leads to a significantly lower series resistance, less power loss and to higher power output of the module.

Hence two smaller cells with the same area as one bigger cell produce more power. Additionally, the amount of electrical current carried through each bus bar in a half-cut cell is reduced as well. Using multiple bus bars, 6BB or even more, or using smart wires further reduce the resistance. At module level this again adds to the power output.

To avoid the high voltage, introduced by the higher number of cells, the layup for such a module usually has two separate groups of strings with an equal number of cells. In each group the cells and strings are connected in series, while the two groups are connected in parallel. This keeps the voltage of the module at a level the given infrastructure in a solar park can deal with. Cutting cells will be essential for M6 and larger cells to avoid series resistance and a loss in power.

Coming back to the original question regarding the module dimension of a M6 cell size-based module: The size of a M6 half cut cell is 83 x 166 mm. This led to a module length of about 2100 mm. With 24 cells along the modules long edge: 24 * 83mm +23 * 2mm, some space for the gap in the middle between the two string sets (30mm) and some for the interconnection along the sides (2x16mm).

The module width is 1040mm with 6 cells along the edge: 6 * 166mm + 5 *2mm, plus 2 * 17mm from the cells to the module edge, see figure 4.

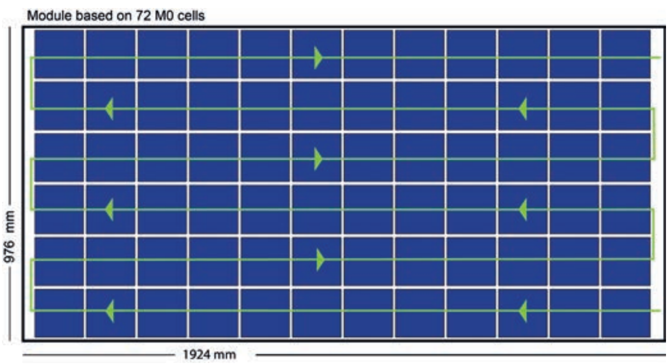

Figure 3: Standard M0 module with 72 full cells

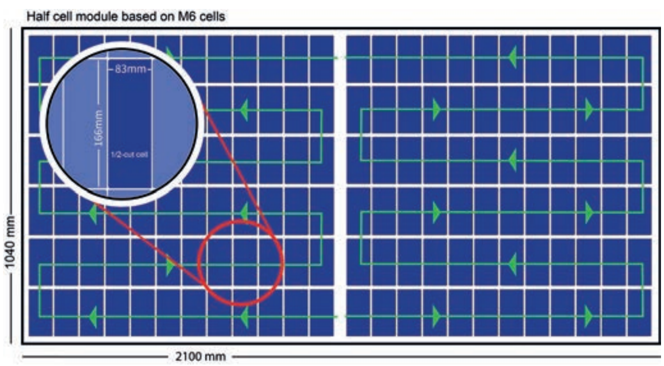

Figure 4: Module made of M6 half cut cells

'The future seems to go from M6 size cells directly to the next level, promising module power outputs of over 500W.'

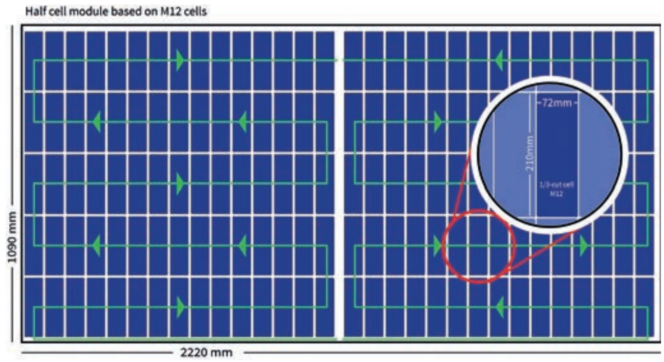

Figure 5: One possible layup for a module based on M12 cells

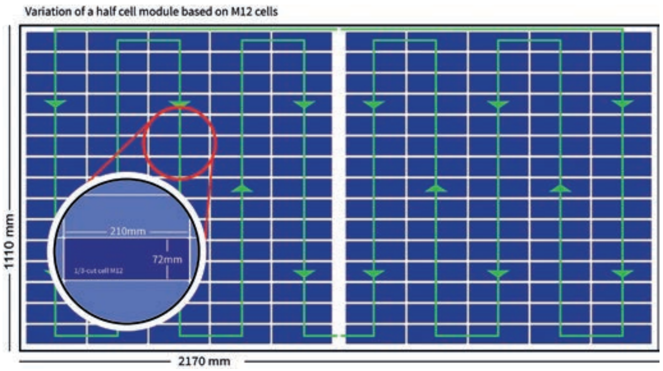

Figure 6: Possible variation of a layup with 1/3 cut cells from M12, bus bars 90 degree rotated and parallel to the short module side

The dimension of a M6 module already exceeds the standard module dimensions of 2000mm x 1000mm demanding changes to existing module production lines.

M12 size cells are already in production

With the first announcement of a M12 cell size factory in 2019 the change of cell sizing was not then believed to jump quickly from M6 to M12. Now, mid 2020, more than two module producers have announced mass production of modules made from M12 cells will be in place by Q3 of 2020.

MBJ Solutions has seen a noticeable increase in requests for equipment to handle module sizes up 2,300 mm which we interpret as a preamble to be ready for M12 cells. The future seems to go from M6 size cells directly to the next level, promising module power outputs of over 500W.

The M12 cell with an edge length of 210mm x 210mm offers a light trapping area 60% larger than that of an M6 cell and 81.2% larger compared to M0. The biggest plus point for the larger M12 cell is that the manufacturing costs per Wp is significantly lower than for the M6 cells. This enables manufactures to produce modules with higher nominal power without a significant increase in production costs.

The layout of a module with M12 cells is still not 100% clear. While some module producers already have their module layout ready, others still consider the general usage of the large cells and, the best possible module layout. The decision for a layout has to be based on the factors production cost, module efficiency, the number of cuts per cell: half cut or more cell parts, shingled cells, number of bus bars per cell, numbers of cells in one module and the fact that a module should still be manageable by two people when it comes to installation. Larger, heavier modules, in need of installation aids to place them, have not stayed long on the market in the past.

One possible module layout using the M12 cell, is to cut the large cells in at least three parts and connect them to a string of 15 or more cells. To keep the module dimensions in the range of 2000 x 1000 mm two sets of strings, each set having 5 strings to it, could be placed in a parallel, see figure 5.

The module dimension of such a module with 5 x 30 M12 1/3 cut cells: 210mm by 70mm, would be around 1090mm by 2220 mm

This type of layout has already been announced by at least two module producers and is supposed to be in mass production in Q3 of 2020. A possible variation of the module layout is shown in figure 6.

Why change from half cut cells to 1/3-cut cell? The M6 half cut cell has an area of about 138 cm², the 1/3 cut M12 cell has an area of 147 cm². The area being close to the area of a M6 half cut cell will hold all the benefits already known from this cell size. Ideas for even smaller cuts, like 1/5-cut cells, where considered but the gain in power might contradicted a complex production process with a possible impact on the production yield, equalizing the cost saving gained from the additional power output.

Further consideration includes the number of bus bars to use. The trend seems to be 9BB/ 12BB or smart wire bus bars to reduce the series resistance. But so far, the 1/3 cut M12 cell seem to provide the best cost-efficiency ratio.

MBJ Solutions is ready to provide new system layouts

MBJ Solutions has three new standard products in their LED sun simulator family to cover for future module layouts: a standard setup for modules made from M0 to M6 size cells, a M12 setup and a new Max Setup for modules beyond M12 cell sizes.

The standard sun simulator setup for the modules with cells made up to M6 size cells is equipped with a matrix of 4 x 5 = 20 LED boards. One LED board is 480 x 320mm in size, the resulting LED area adds up to a dimension of 2400 x 1280mm. The homogeneous, active area, usable for the module measurement, is 2160 x 1040mm, which is 2 x 120mm less in each direction to avoid effects close to the side.

For the M12 setup, MBJ has changed the board orientation by 90 degrees to cover the M12 cell module layouts more effectively. The matrix of 3 x 8 = 24 LED boards will add up to an LED area of 2560 x 1440mm. The actual usable area being 2320 x 1200mm.

The Max Setup will use a matrix of 5 x 6 = 30 LED boards to cover modules going beyond the dimension known today. It covers an area of 2880 x 1600mm with an effectively usable area of 2660 x 1360mm. This leaves enough space for changes not clear today and can provide some reserve for the production of the future. See figure 7 for the three LED sun simulator setups available. The LED boards can be individually arranged to meet other measurement setups.

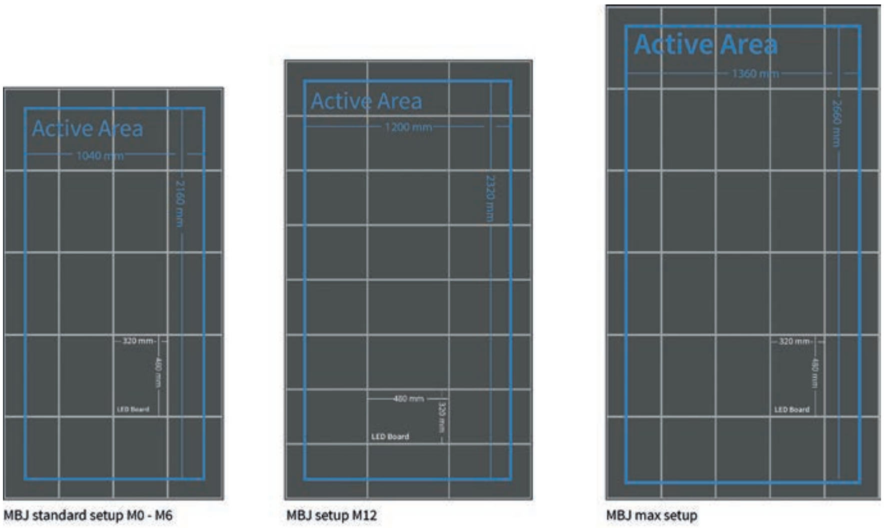

Figure 7: System setups for LED sun simulators from MBJ Solutions

From the layout variations mentioned above it is pretty obvious that nothing is clear in the industry at the moment. There is no standard for cell sizes, there is no agreement on module sizes, not on technologies to be used or cell material that will bring the best performance in the future. The market is very diverse in all directions and hard to predict. Only one thing seems clear: the market for solar modules is constantly growing worldwide.

In general, the module manufacturer will need to decide before ordering new equipment what type of module to produce in the future. It will be difficult to cater for more than one setup at a time. With our long experience in the solar business and our flexibility to build machines to your need we will stay a strong, innovative and reliable partner when the solar industry takes the next step in module evolution.

www.mbj-solutions.com

Figure 8: MBJ Solutions GmbH headquarters