Making Sense of Ultra-large PV Modules

Technical Brief

Major manufacturers of crystalline silicon PV modules have recently been developing and launching *ultra-large* modules for utility-scale applications. These modules are based on wafer sizes which **have increased** from the current standard **158 or 166 mm to** either **182 or 210 mm**. This represents an increase in wafer size **of up to 75 %**.

These new modules bring some obvious benefits to utility-scale systems such as potentially lower installation costs and more power per string, but they also carry with them a number of more challenging changes and risks – some which are linked to the larger size, and some which are not.

New Manufacturing Challenges

None of the large or ultra-large modules are in mass production as of today (October 2020), but manufacturers are actively promoting these modules for projects in 2021 and beyond. Certification processes have already been completed in some cases; in others they are still running. No larger modules have completed extended duration testing.

Some manufacturers may struggle to introduce the new modules in mass production given the need to make potentially significant investments in new production equipment. The manufacturers who have already invested will be keen to use the new modules to their competitive advantage.

The large and ultra-large modules may help manufacturers reduce unit production costs. The cost of key module components, such as frames and junction boxes can now be spread over a larger size module. However, the larger wafers themselves are more fragile and one broken wafer will mean throwing away more watts of power than smaller wafers. So close attention to handling of the cells before they are fully encapsulated in a module will be important.

New Technologies

The introduction of cells and modules based on larger wafers has been coupled with the introduction of other new technologies and designs that are important to consider.

Cutting cells into more pieces

Standard cells today are typically cut into half, whereas some cells based on the large 210 mm wafers are now being cut into thirds. This is based on the need to keep the current and voltage of the module within reasonable limits.

Using new cell inter-connect technologies

The number of busbars required per cell has increased. This has led some manufacturers to introduce more novel inter-connect methods such as using thin wires (rather than flat tabs) and/or *shingling* the cells to reduce gaps between the cells.

Configuring cell strings in new ways

Depending on the size of the new wafer, manufacturers are using anywhere from 110 to 156 half-cut cells and from 150 to 240 third-cut cells in a single module. This creates the need for new module layup methods and string-interconnection designs.

Mixing encapsulants in double glass modules

Some manufacturers of bifacial modules are switching to using two different types of encapsulants within a single module – most often a mix of EVA (in front of the cells) and POE (behind the cells). This presents several major challenges regarding material compatibility – both in terms of manufacturing and long-term durability.

Junction box redesigns

Junction box designs also need to be adapted to ensure sufficient internal spacing for electrical isolation and heat dissipation due to the higher currents that need to be carried (and potentially routed through the bypass diodes).

Key Product Features

The introduction of larger modules has increased the available power per module coupled with changes in other key product features.

More power

The higher power per module is clearly the biggest advantage of the new modules.

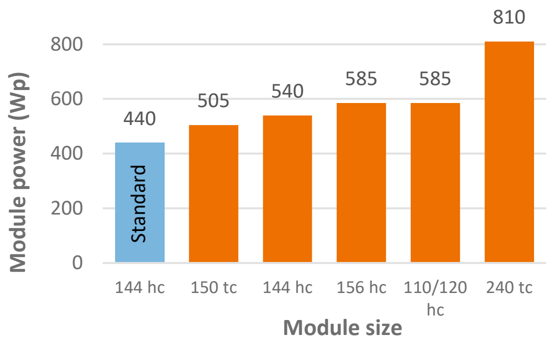

Figure 1: Max. Module Power (hc: half-cut; tc: third-cut cell)

Physically larger

The increase in wafer size and module power may introduce challenges in packaging, transportation, handling and installation of the new modules. Module area is increasing by anywhere between 11 and 81 % compared to today's standard modules. Widths are increasing by up to 73 %. This results in modules increasing in width in some cases from 1 m (3') to just over 1.75 m (5.3') making them physically more difficult to lift and handle.

Larger modules may not be able to withstand the same high wind and snow loads as the current standard modules. The thinner 2.0 mm glass used on the front-side of by bifacial modules may also have a higher risk of suffering from hail-related damage.

Increased current

The majority of new modules see an increase in current from around 11 A to 12 - 14 A – an increase of up to 25 %. Inverters may need to be modified to handle the higher currents and cabling increased in size to avoid higher resistance losses.

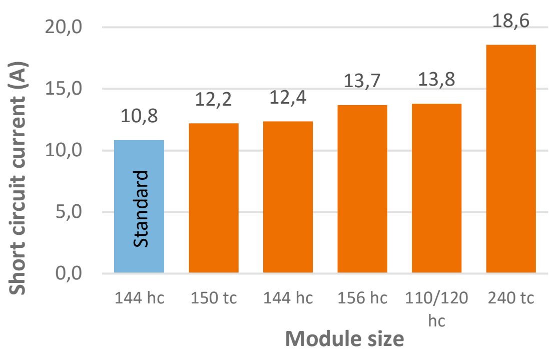

Figure 2: Module current (hc: half-cut; tc: third-cut cell)

Getting heavier

The weight of mono-facial modules is increasing on average by around 25 % because of the overall larger size. Bifacial modules are increasing in weight less - on average around 15 %. Some of the highest power modules based on 210 mm sized wafers are increasing in weight by as much as 150 % to 68 kg (150 lbs) per module. The most typical increase is from 25 to 30 kg (55 to 66 lbs) per module.

Recommendations

PI Berlin makes the following recommendations to buyers and investors considering using large or ultra-large modules.

Conduct independent extended testing

Attention should be paid to mechanical load testing due to the larger size and junction box testing due to the larger current. UV testing should be included for double glass modules due to the use of mixed encapsulants. Extended hail testing should be included for modules that will be located in the hail belt in the U.S. Each unique bill of material combination to be used should also be tested.

Generate new PAN files

Modules should be third-party performance tested to generate validated PAN files. This will ensure accu–rate performance forecasting when using the new modules.

Undertake a thorough structural evaluation of the mounting system

This is necessary to ensure that the larger area and weight of the modules can be handled by the mounting structure, and that suitable ways of mounting the large modules are designed.

Pay close attention to the electrical configuration of the system

Matching of the inverter electrical characteristics to the electrical output of the module strings is critical. Wire sizing should be appropriate to the higher currents being carried.

Review the packaging, transportation, and handling of the modules

The packaging of the larger modules should be reviewed and tested to ensure it is suitable for long-distance shipping and will avoid damage such as cracked cells. Handling procedures at the install site should be reviewed to ensure the modules can be handled safely.

Conduct an independent audit of the factory

An independent factory audit will verify that the changes in manufacturing systems implemented to assemble and handle the larger modules has been successfully carried out and all major bugs removed. Particularly close attention should be paid to cell stringing and lamination processes. Any audit findings should be corrected by the manufacturer before production offtake and third-party quality assurance undertaken during builds for specific projects.

TBS – Ultra-large Panels – IN- 2020-11v3