Larger Format Modules and Legacy Assumptions

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Problem Statement

The purpose of the article is to outline several engineering challenges created by the advent of large-format modules and recommendations for industry stakeholders to reduce the risk of large-format module breakage.

Targeted Audience

- Project Developers
- Engineering, Procurement & Construction (EPC) Companies
- Independent Engineering Firms (IE's)
- Standards Committees
- Insurance Companies
- Financiers
- Module Manufacturers
- Solar Racking Manufacturers

Benefits of Large-Format Modules

The advent of the 210mm cell incentivized the ubiquitous 72-cell format modules (2m x 1m) to grow to ~2.4m x ~1.13m (in some cases) to facilitate a higher power rating and often higher VOC.
(An approximate 55% area / power increase)

Higher module power and VOC have many benefits:

1. Lower number of electrical connections per MW (a major failure point)
2. Lower number of mechanical connections per MW (a major failure point)
3. Lower number of modules per MW
    1. Decreased material handling
    2. Decreased shipping
    3. Decreased installation labor (mechanical and electrical)

Challenges of Large-Format Modules

The larger size needs to maintain weight restrictions of reasonable material handling per OSHA guidelines. To maintain weight, <u>module glass thickness needed to decrease</u>.

<u>Frame heights decreased by approximately 40%</u>. This reduces the load-carrying capacity of the frame members significantly while the larger form factor increases the wind and snow loading on the frame.

Both of these challenges combined give LFM a "floppier" mechanical disposition. This challenge needs to be overcome in the mounting system handling of the LFM at the system-level.

Racking Design Challenges

Module loading is dependent on the structure on which it is mounted. Tilt angle, tilt direction, topography and other variables play a significant role in determining ultimate forces from wind and snow.

A SETO-funded research project being carried out through a joint venture of the Lawrence Berkeley National Lab and UC Berkeley has determined that vendors need to look at smaller effective wind areas than the spans between foundations (IE: Not "A" in Figure 1) when estimating individual module loading. PV modules can be broken if attributable areas as small as ¼ of the module are overloaded (individual fastener level loading – "D" in Figure 1) and this can be shown to occur at maximum project design conditions for many projects getting installed today. While the evaluation typically carried out is around a maximum design loading, the SETO-funded research team is currently exploring how a lower, **<u>uneven cyclical loading</u>** can lead to structural failures as well.

Module Datasheet Ambiguity

The current industry standards (UL 61730-2, IEC 61730, IEC 61215-2) all generally agree on mechanical load testing procedures. It is a huge achievement to have alignment. These standards typically assign a 1.5 safety factor between what a module is tested to and what a module is certified to handle in the field.

IE: If a module certification lab tests a LFM to 2,400Pa of back-side loading and the LFM passes, the loading which it is certified for in field loading is only 1,600Pa. If the LFM needs to handle 2,400Pa of back-side loading in the field, the test load needs to be increased 1.5x to 3,600Pa.

This ambiguity in the datasheet potentially misaligns stakeholders as to what the module capacity is rated to and certified for and whether the module warranty will hold given the project parameters, structural system requirements and testing.

Effective Wind Area (EWA) Overview

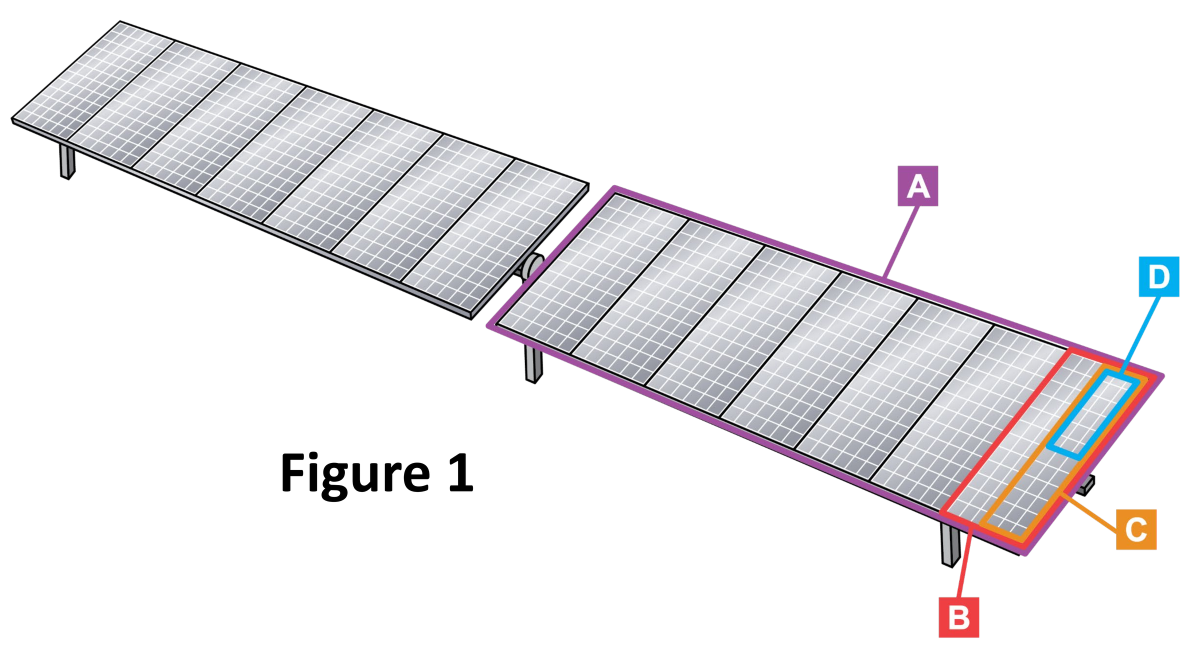


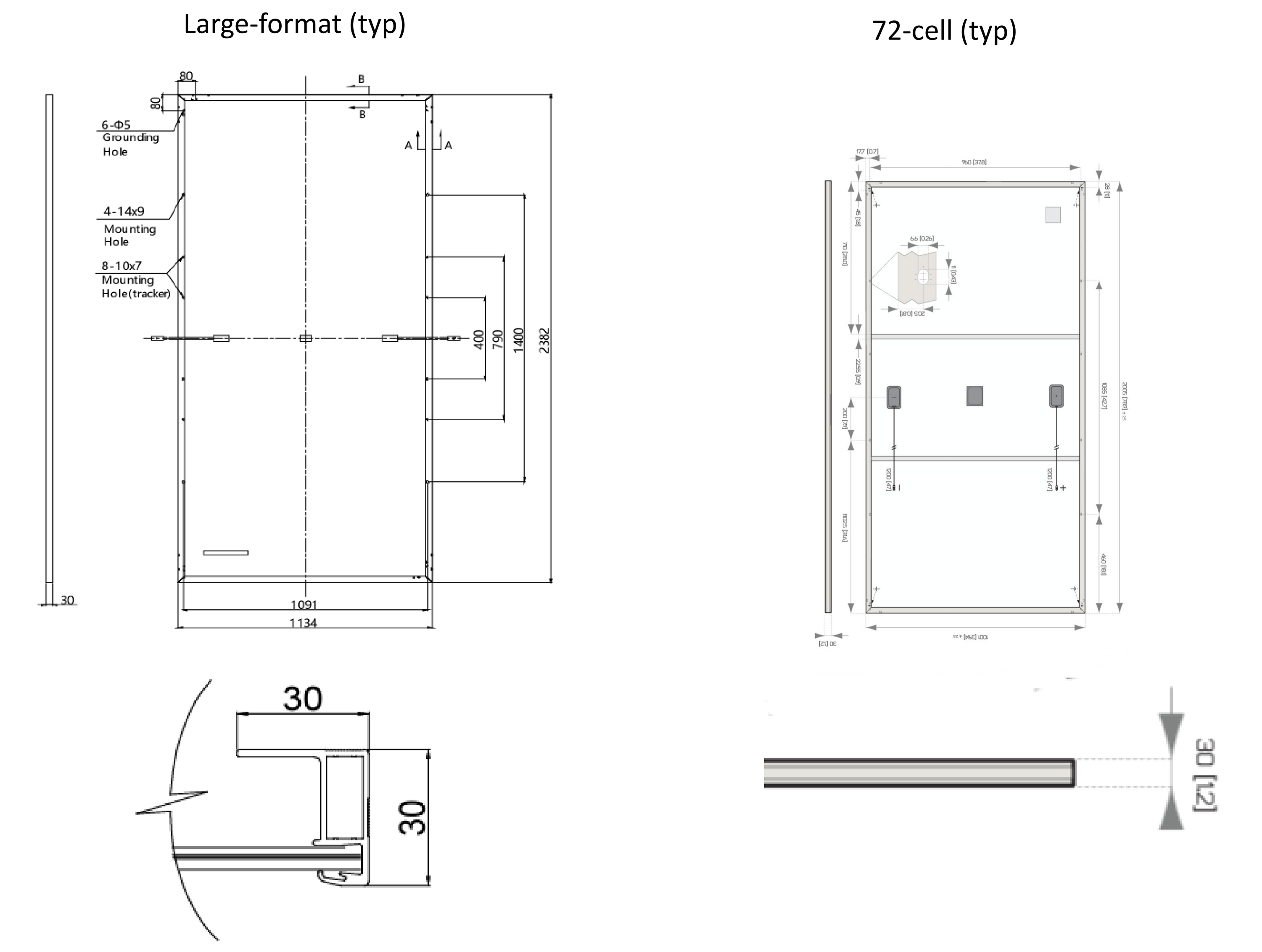
Figure 1

A – Average Row Area (last 5-7 modules is typical)
B – Average Module Area
C – Average Rail Area
D – Clip & Bolt Loads

See the wind tunnel coefficients for more details

All locations are typical highest locations for loading and can apply to tracker or fixed tilt systems. They should be checked on a project-by-project basis.

Approximate Size Differences



The smaller height frames that pass certification on large-format are now being adopted onto new 72-cell format modules.

Recommendations

- Check that module certification loading does not include the 1.5 safety factor that certification standards require.
- Check that the module frame and attachments are designed to withstand the governing loading case (typically area "D" in Figure 1).
- Check that the module rails are designed around the governing loading case (typically either area "C" (highest half-module loading) or the adjacent, 2nd module rail (highest full module loading).
- Check that the module itself is designed to the worst-case "B" loading.

More Information

Resources:

Oudheusden, Frank, and Chris Needham. "Large-Format Solar Modules and Legacy Assumptions." *PV Magazine International*, 15 Feb. 2024, www.pv-magazine.com/2024/02/15/large-format-solar-modules-and-legacy-assumptions/.

Oudheusden, Frank, and Chris Needham. "Large-Format Solar Modules and Legacy Assumptions." *PV Magazine USA*, 14 Feb. 2024, pv-magazine-usa.com/2024/02/14/large-format-solar-modules-and-legacy-assumptions/.

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BUILDING TECHNOLOGIES & URBAN SYSTEMS DIVISION

Funded by:
SOLAR ENERGY TECHNOLOGIES OFFICE
U.S. Department Of Energy

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