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# Validation of assembly and deployment quality for a pre-fabricated PV array.

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5B, a company founded in Sydney in 2014, have developed a solar array structure known by its product name “Maverick”. Maverick is an engineered, pre-fabricated solar array, meaning that assembly of the array takes place in the relatively controlled conditions of a factory. Time spent on the actual installation site is reduced, as is uncontrolled handling of the modules on site. One expectation in designing this approach is that installation quality will be improved, but this expectation must be validated. This study describes an extended trial designed to quantify the risk of microcracking and performance loss during assembly and deployment of this new array structure. This quantification of risk is necessary for continual product improvement and to satisfy module manufacturers that they are not incurring an additional risk when they warranty their modules for use in 5B pre-assembled arrays. As the 5B approach is not a part of standard installation manuals, this special consideration is required of the manufacturers. The extended testing showed a very low risk of module damage during 5B deployment, with five major manufacturers now deploying modules in 5B products under their standard warranty conditions.

## Background

Despite the problem of poor solar module installation being well known, very little attention is given to the notion of installation quality [1]. A primary area of concern with poor installation quality is the generation of microcracking in modules. Microcracking is associated with poor manufacturing, module handling and module transportation practices [2,3]. It is generally assumed that existing methods of deployment provide reliable and consistent installation quality but this is not always the case. New deployment arrangements need to be properly tested, while existing ones need be held to account [4].

## Methodology

Cracking is primarily a probabilistic event [3] and the impact on module performance is also probabilistic, with the likelihood of performance loss increasing with the number and severity of cracks [5]. Although the industry attempts as much as possible to eliminate them, it is highly unlikely that one crack or some low number of cracks will significantly impact a module’s performance. The methodology of this test is designed in recognition of this fact. The 5B deployment approach is to pre-assemble the arrays (including panel to panel wiring) in a controlled factory process and then pack and transport them to site. On location the are deployed in a concertina-fashion using a telehandler / forklight as a high Ground Coverage Ratio (GCR) East-West array. An image of the final array is shown in Figure 1. The assembly and transportation processes, although unique in many regards, are comparable to standard approaches but with improved handling controls. The deployment process is more novel, as is the behaviour of the fielded modules in an array of this nature.

To test this aspect to its extreme, a set of modules were pre-assembled in 5B’s Sydney factory with panel level power conditioners and monitors on every module. The pre-assembled array was shipped to site and deployed and packed 100 times over the course of several weeks. This also served as the primary process development for the deployment process itself. After every 5-10 deployments, the panels were left in the field for some time to monitor the power and to check for any damage to the

modules. The intention of this methodology is not that any single array would ever be deployed 100 times, but simply to do an extreme stress test of the handling approach to look for fundamental problems and assess accurately the probability of harm coming to the modules. After the 100 deployments, the array was left in the field a little over a year, packed again and returned to the Sydney factory. Modules were removed from the array and then measured in EL / PL imaging using BT Imaging's prototype M1 Module scanning tool. Analysis was then done on the power stability through the deployment cycle, and EL / PL images of 24 modules were compared to EL images taken at the end of the manufacturing line. Although this approach cannot directly attribute all faults to all causal incidents, it does instead provide a very robust overall stress test of the deployment approach.

**Figure 1. Image of a deployed 5B array in South Australia**

## Results

Power stability was analysed and no power loss could be detected over the deployment cycles within a 2% sensitivity. From 24 module's examined, only 1-2 new cracks could be detected in 1728 cells (24 modules) over assembly, transport,100 redeployment cycles, 1 year in the field, disassembly and measurement. As the final images were being compared to images post manufacturing, the new cracks could have happened at many instances during transportation to 5B in the first instance. Nonetheless this does show a very low upper limit to the risk of cracking during deployment of the 5B preassembled array. The full paper and presentation will contain the statistical power stability analysis and the EL image analysis as well as more details on the assembly and deployment.

## Conclusions

The trial shows the very low risk of damage during pre-assembly and deployment of 5B's novel array structure. This low risk all occurred in the context of process development of the deployment process itself, and so substantial improvement is still expected. On-going work is underway to continue to assess these risks as new module types enter the market and as the deployment approach is developed.

## Disclosure of perceived conflicts

Dr Rhett Evans, the primary author has an employment link to the four entities involved in this study

- This trial was planned and first analysed independently for 5B, by Rhett Evans, as a paid consultant.
- Rhett Evans did the PL / EL imaging of the modules while an employee of BT Imaging.
- Rhett Evans did the final analysis and first authorship as a Postdoctoral Fellow at UNSW
- Subsequent to (and because of) this analysis Rhett has become a part time employee at 5B.

**References**

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