ASIA-PACIFIC
SOLAR RESEARCH CONFERENCE

Qualification testing of a new light-weight polymer based photovoltaic modules

Rhett Evans[1,2], Zhengrong Shi[3]

[1]*School of Photovoltaic and Renewable Energy Engineering, UNSW, Sydney, Australia*
[2]*Solinno Pty Ltd, Towradgi, NSW, Australia*
[3]*Sunman Energy, Sydney, NSW, Australia*
E-mail: rhett.evans@unsw.edu.au

Glass-based PV modules have dominated the PV market for its entire life. Consequentially, a great deal of understanding exists as to the fielded performance of standard glass-EVA-TPT or glass-glass modules. There are market opportunities for bringing other PV module products to market, but this requires thorough and detailed testing of module reliability in order to build confience in the fielded durability of any new approach. This study analyses IEC test data and extended qualification test data on a new, light weight, polymer-based PV module developed by Sunman Energy. By benchmarking these results against standard modules, we discuss how these results can be used to build confidence in the reliability of this new approach, and to identify areas of further and more rigourous testing.

Background

There is a significant market niche for light weight modules in the commercial solar market as many buildings that would otherwise be suitable for PV installations are not engineered to take the high weight load of conventional glass-base modules [1]. Polymer-based modules also provide easy opportunity for variation is installation method, size and aesthetics [1]. The new module in this study has been developed by Sunman Energy and is sold under the product name “eArch”. It is in mass production with over 50MW installed globally, including a recently-commission 235kW flagship installation on the Australian Maritime Museum in Sydney Australia. Any new module design needs to undergo extensive testing to build confidence in the reliability of its field performance, especially in comparison to the well-known performance of the conventional product. The IEC 61215 testing protocol is designed to do just this. It is an extensive test regime of 19 tests [2], born out of extensive development and review of durability test regimes [3]. However, despite some attempts [4,5], there has been limited success in precisely relating outcomes in IEC testing to specific fielded product lifetimes. Perhaps partly because of this, some concerns exist in relation to the rigour of IEC testing. In some cases these concerns are justified, although it remains the opinion of this author that the concerns relate more to sampling and manufacturing consistency than the rigour of the IEC tests themselves. Nonetheless, various extended or sequential tests regimes [6] have been developed. In some cases these address specific well known failure modes such as backsheet reliability [7], well known deficiencies in the IEC test protocol such as insufficient UV exposure, or just extended testing times to highlight weak points and more easily differentiate module performance [8].

Methodology

This study reviews IEC test data results and additional extended exposure test results from a new lightweight module product. To address the lack of explicit relationships between test outcome and specific field life, the results from the IEC tests are benchmarked against outcomes from standard modules [8-11]. Changes in power that are recorded during exposure tests are examined in terms of specific changes in voltage and current at maximum power as these imply particular degradation mode – changes in current mostly being related to optical effects and changes in voltage (at maximum power) being related to resistance effects.

Results

Performance change after the individual IEC tests are shown in Figure 1. These can be seen to be well below the degradation limit. Of significance interest is that most (80%) of the degradation is in the Imp, implying optical effects dominate. This is in contrast with expected performance from standard modules, particularly in tests such as mechanical loading (ML) which would be expected to affect Vmp only. While this does suggests a high stability of series resistance, it does create some concerns around measurement consistency for Imp. This will be explored more fully in the full submission, together with specific benchmarking against standard modules.

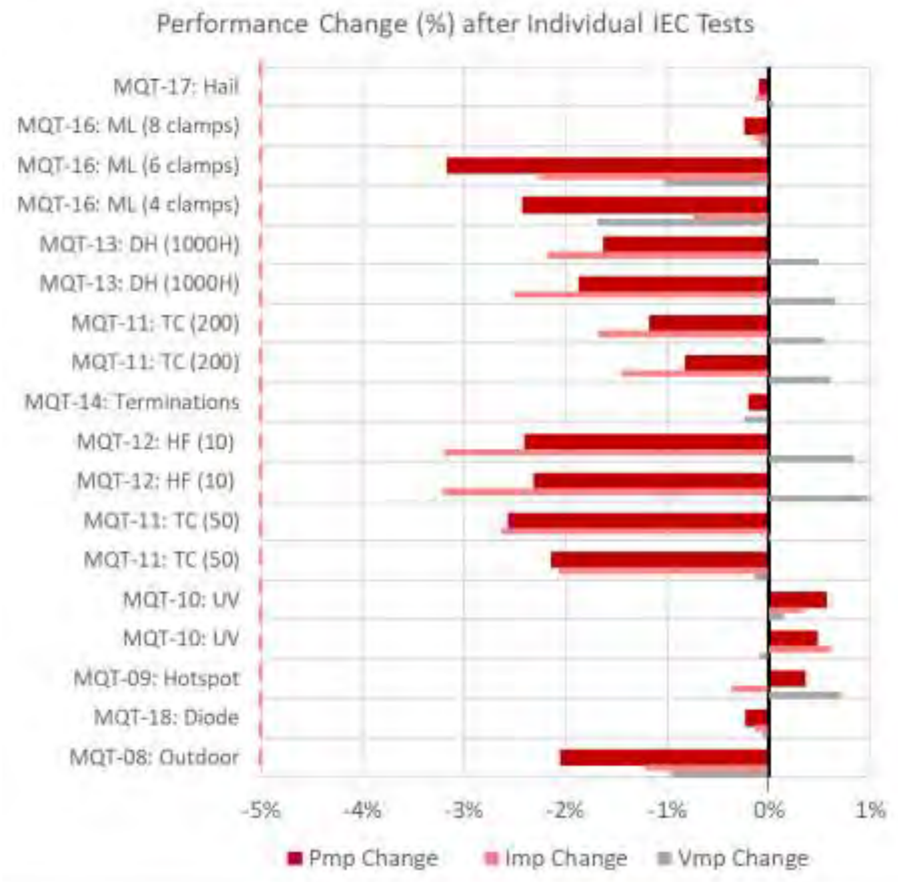

Figure 1. Performance change in IEC testing, compared to the performance degradation threshold. See [2] for further information on individual tests. Note that some tests, such as MQT-11:TC (50) are done in a sequence after other tests.

IEC 61215 testing has also shown to be insufficient in regards to UV exposure. Internal Sunman testing and independent 3rd party extended UV testing has shown good results approaching 10 years equivalent of UV exposure. These results will also be discussed more fully in the final submission

Conclusions

Despite some areas of inadequacy, passing IEC testing and other important extended testing by a comfortable margin demonstrates a good basis for expectation of reliable field performance. Further ongoing and extended testing will no doubt be required to continue to build market confidence and further develop product durability.

References

[1] Martins, A. C., Chapuis, V., Virtuani, A. and Ballif, C. 2019, "Robust Glass-Free Lightweight Photovoltaic Modules With Improved Resistance to Mecahnical Loads and Impact", IEEE Journal of PV, Vol 9, No. 1.

[2] IEC61215, 2016 "Terrestrial photovoltaic (PV) modules – Design qualification and type approval", Ed 1.0 2016.

[3] Osterwald, C. R. and McMahon, T. J., 2009, "History of Accelerated and Qualification Testing of Terrestiral Photovoltaic Modules: A Literature Review", Progress in Photovoltaics, Voc 17, p11-33

[4] Subramaniyan, A. B., Pan, R., Kuitche, J. and TamizhMani, G., 2018 "Prediction of Acceleration Factor for Accelerated Testing of Photovoltaic Modules Installed Around the World" IEEE Reliability and Maintainability (RAMS) Annual Symposium

[5] Kempe, M. D., 2014 "Evaluation of the Uncertainty in Accelerated Stress Testing", IEEE 40th Photovoltaic Specialist Conference.

[6] Jarnason, S. 2012 "A Decade of Photovoltaic Module Accelerated Testing and Warranty Returns", *InterPV Accelerated Testing and Warranty Symposium 2012*.

[7] Gambogi, W., Heta, Y., Hashimoto, K., Kopchick, J., Felder, T., MacMaster, S., Bradley, A., Hamzavytehrany, B., Felix, V., Aoki, T., Stika, K., Garreau-Illes, L. & Trout, T.J. 2013, "Weathering and durability of PV backsheets and impact on PV module performance", *Proceedings of SPIE - The International Society for Optical Engineering,* Vol 8825.

[8] Doyle, T., Desharnais, R., Erion-Lorico, T., 2019, "PV Module Reliability Scorecard", PV Evolution Labs.

[9] Zhu, J. et. al. 2016 "Changes of solar cell parameters during damp-heat exposure", Progress in Photovoltaics, Vol 24, p1346

[10] Koehl, M., Hoffmann, S. and Wiesmeier, S. 2016, "Evaluation of damp-heat testing of photovoltaic Modules", Progress in Photovoltaics, Vol 25, p175

[11] Gonzalez, O. et. al. 2016, "Forensic Analysis of Si-based PV Module Micro-cracking Due to Standard IEC Thermal and Mechanical Testing Procedures", IEEE 42nd Photovoltaic Specialists Conference.