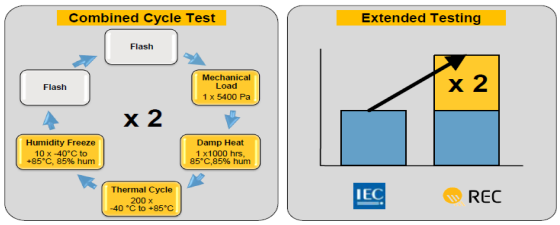
Rolling Reliability Test in REC Solar and Correlation Between Reliability Test and Field Degradation

Jia Ying Ye, Teck Cheng Tan, REC Solar, Singapore

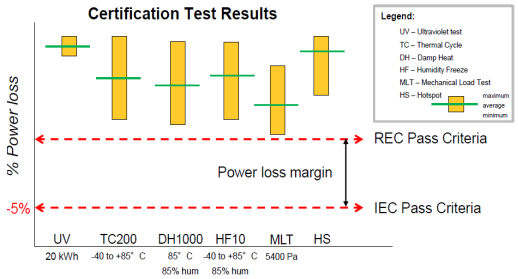
Introduction: REC internal "Rolling Reliability Test" (RRT) has been established to periodically and systematically monitor the production with extended accelerated aging tests, to ensure the constant quality and reliability. Results from the reliability tests are then compared with the real-life field-aged modules for correlation study. While the studies on the acceleration factor of reliability tests are calculated mainly based on the maximum power, the acceleration impact for various parameters vary significantly. In order to study the correlation between reliability test and field degradation, it might be necessary to determine the acceleration factors for individual parameters.

Stringent qualification and ongoing reliability tests in REC

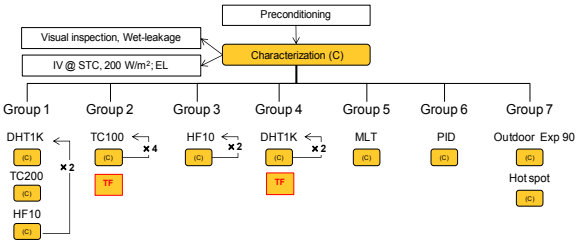
Extreme testing ensures performance in the most severe environments and increased reliability.



More stringent pass criteria than industry standards to ensure reliability



Rolling Reliability Test: Ongoing reliability monitoring



Failure Reporting, Analysis, and Corrective Action System (FRACAS) is established for continuous control of quality

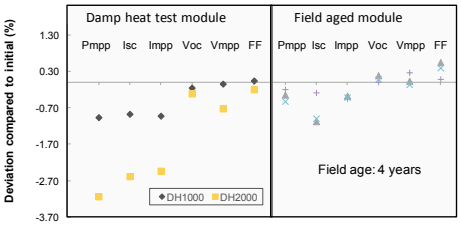
Lifetime and degradation simulation to correlate with real-life reliability

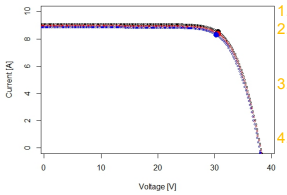
Arrhenius Relationship [1,2]

$$Rate \propto \exp\left[\frac{-E_a}{kT}\right] \qquad (*)$$

Correlation between field aged and test aged modules

Case 1: Damp heat aged module VS. modules from sub-tropical area (Germany, operating since December 2010)

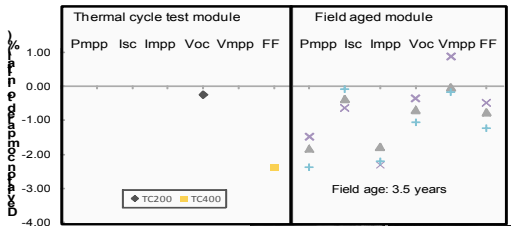


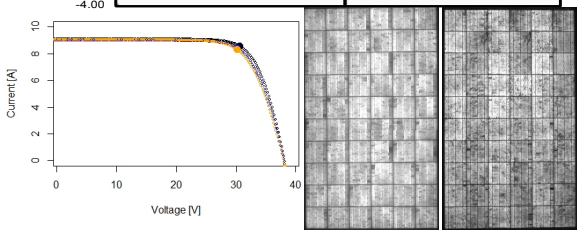


1. Acceleration factor of 30X based on (*)
2. Decrease in Isc is the main contributor to the power drop for both field aged and DH tested modules.
3. For field aged modules, the FF increase because the Isc decreases while the series resistance does not change significantly.
4. For modules after damp heat test, Isc decrease and series resistance increased due to corrosion of the interconnection. Thus FF remains or decreases.

➢ <u>The acceleration factor of damp heat to the Isc is approximately half of that to the series resistance.</u>

Case 2: Thermal cycling aged module VS. modules from arid area (Colorado, operating since July 2011)





1. Acceleration factor of 8X for Pmpp
2. For modules operating in arid climates, loss in FF is more evident. Increase in series resistance leads to significant decrease in Impp.
3. TC aged modules show additional decrease in Vmpp due to increased series resistance.
4. EL images show finger breaks in both thermal cycle aged modules and the field aged modules

➢ <u>Increase of series resistance is reflected from the decrease in both Impp and Vmpp.</u>

Summary:

1. The acceleration factor to different parameters (Pmpp, Isc, Voc, series resistance etc.) is different for a specific accelerated aging test.
2. In order to study the correlation between reliability test and field failure, it might be necessary to look into the acceleration factors for individual parameters, which will be further investigated with the RRT program in future.

[1] Kurtz et al, 34th IEEE Photovoltaic Specialists Conference, Philadelphia, Pennsylvania, June 7–12, 2009.
[2] Koehl et al, Solar Energy Materials & Solar Cells 99 (2012) 282-291.

This presentation contains no confidential information.