

Reliability of large-area CuInS_2 solar modules – accelerated lifetime testing beyond IEC61646



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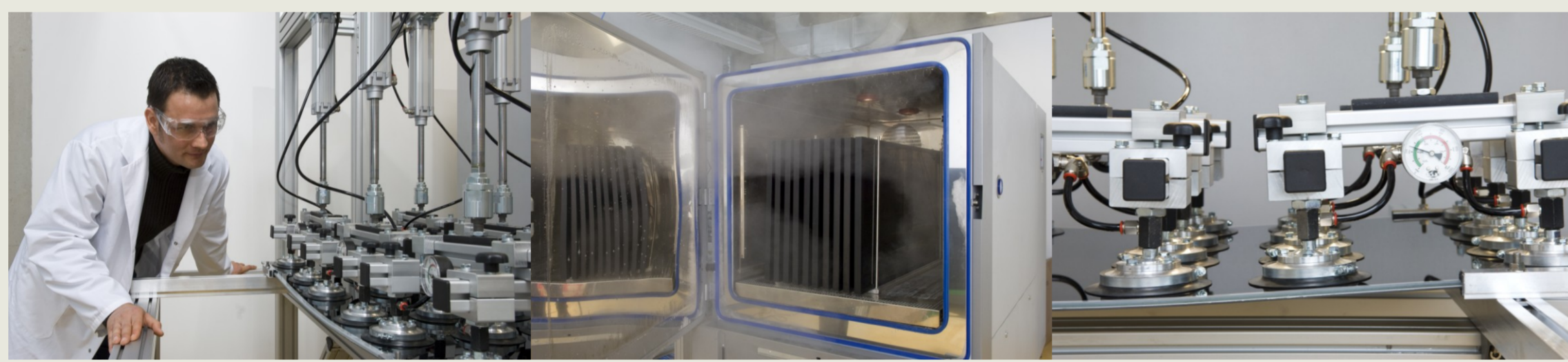
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Motivation

CuInS_2 based modules show excellent stability in accelerated life time tests in accordance to IEC61646. The whole product range of Sulfurcells CuInS_2 modules was certificated by TÜV Rheinland according to IEC61646 and IEC61730. In today markets these tests are considered a prerequisite for stable long term performance under outdoor conditions. However, laboratory test can never fully resemble the operation conditions of the module in the field. Therefore Sulfurcell has set up an internal test program which exceeds the IEC requirements in many ways aiming on more reliable predictions of outdoor performance and after all more reliable products.

The Sulfurcell test program

Our test program also includes combined tests, such as damp heat under module bias, mechanical load test of modules under torsion and UV radiation under damp heat conditions (planned). The test conditions of several other tests have been extended in order to cover operation conditions for specific climates, such as dry heat test at temperatures above 100°C or module stability under NH_3 exposure or salt spray. These tests are not part of the IEC61646 at all, however they become increasingly important for installation on agricultural buildings or close to the sea respectively. The table gives a short overview of our extended test program for accelerated life time tests.

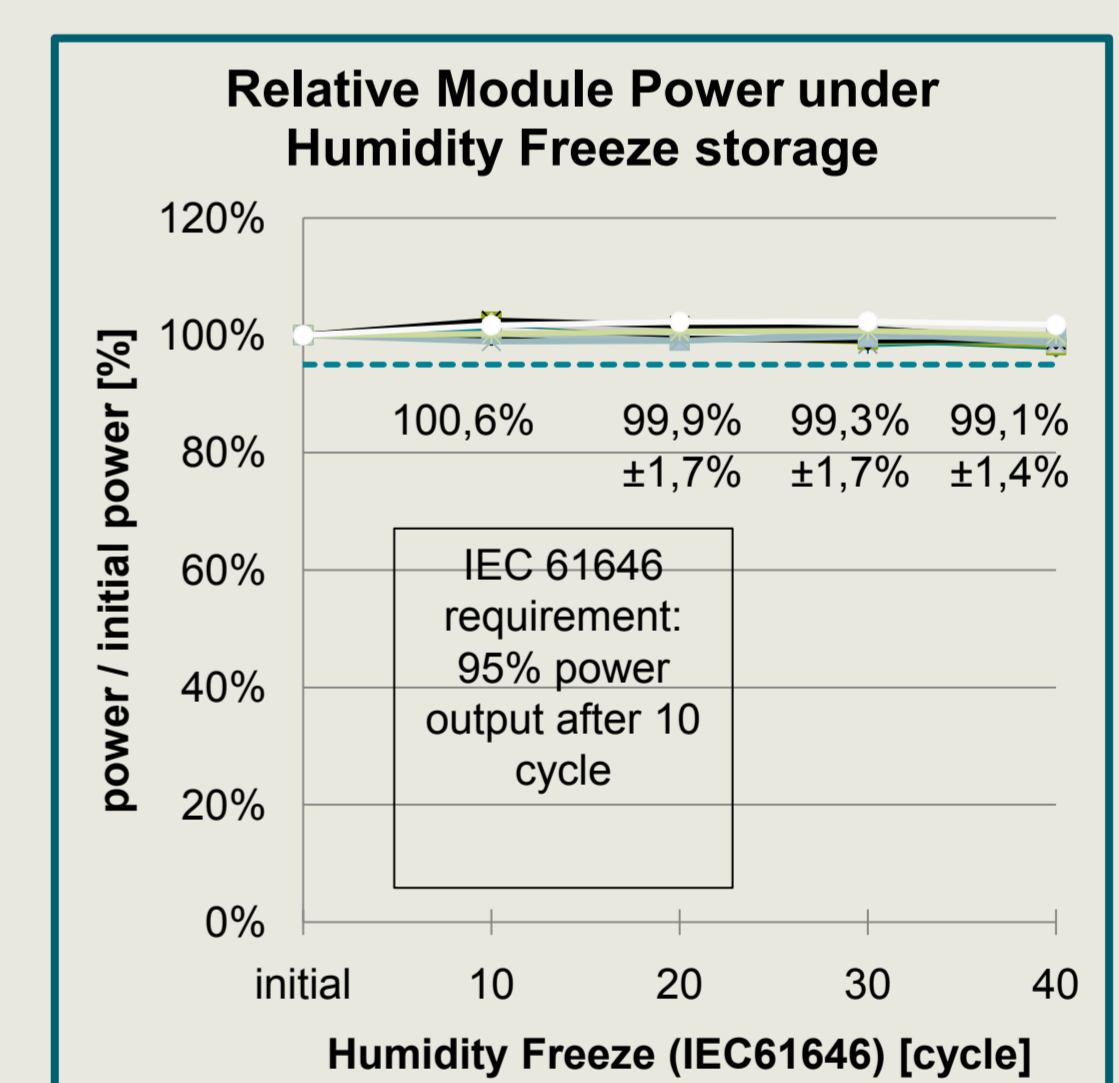
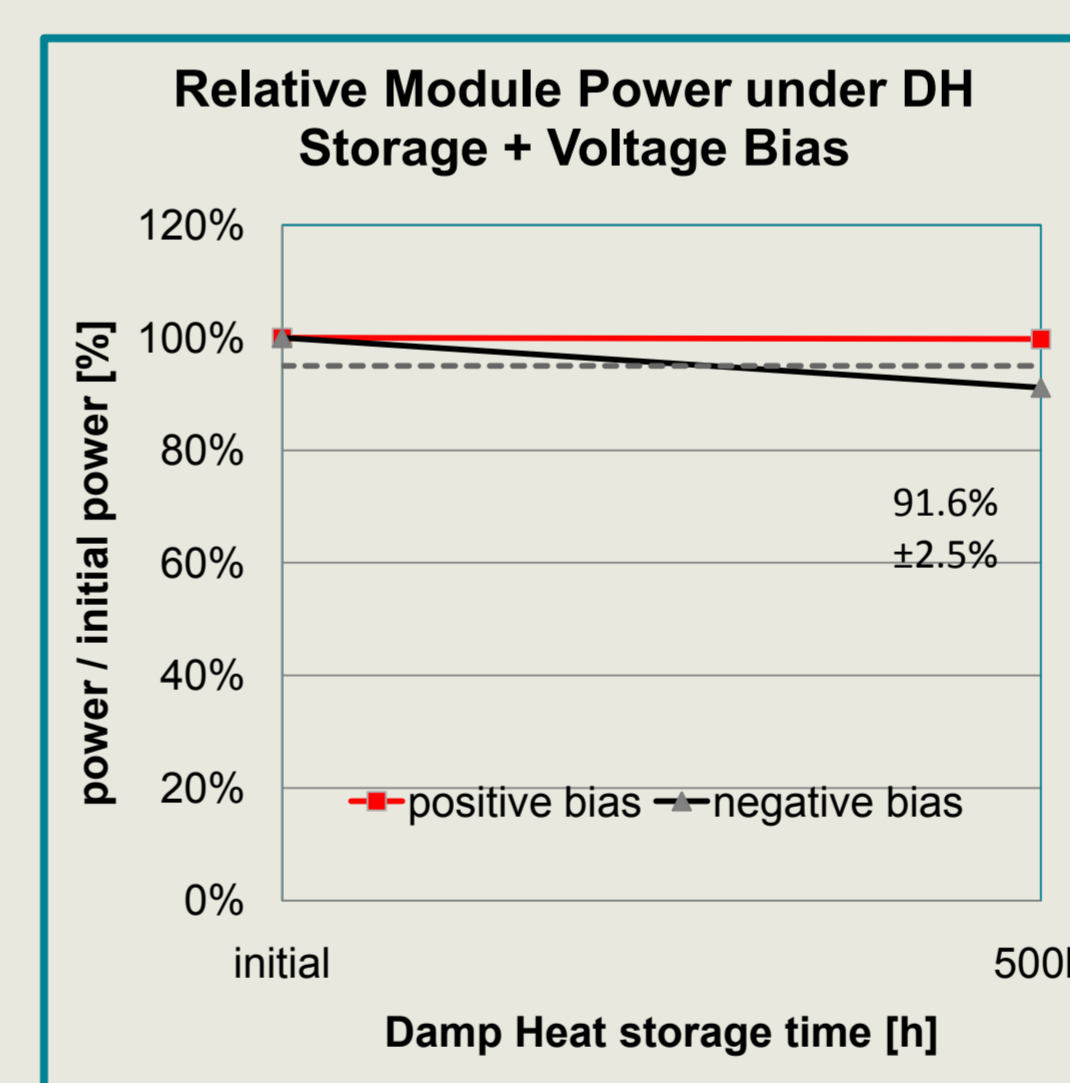
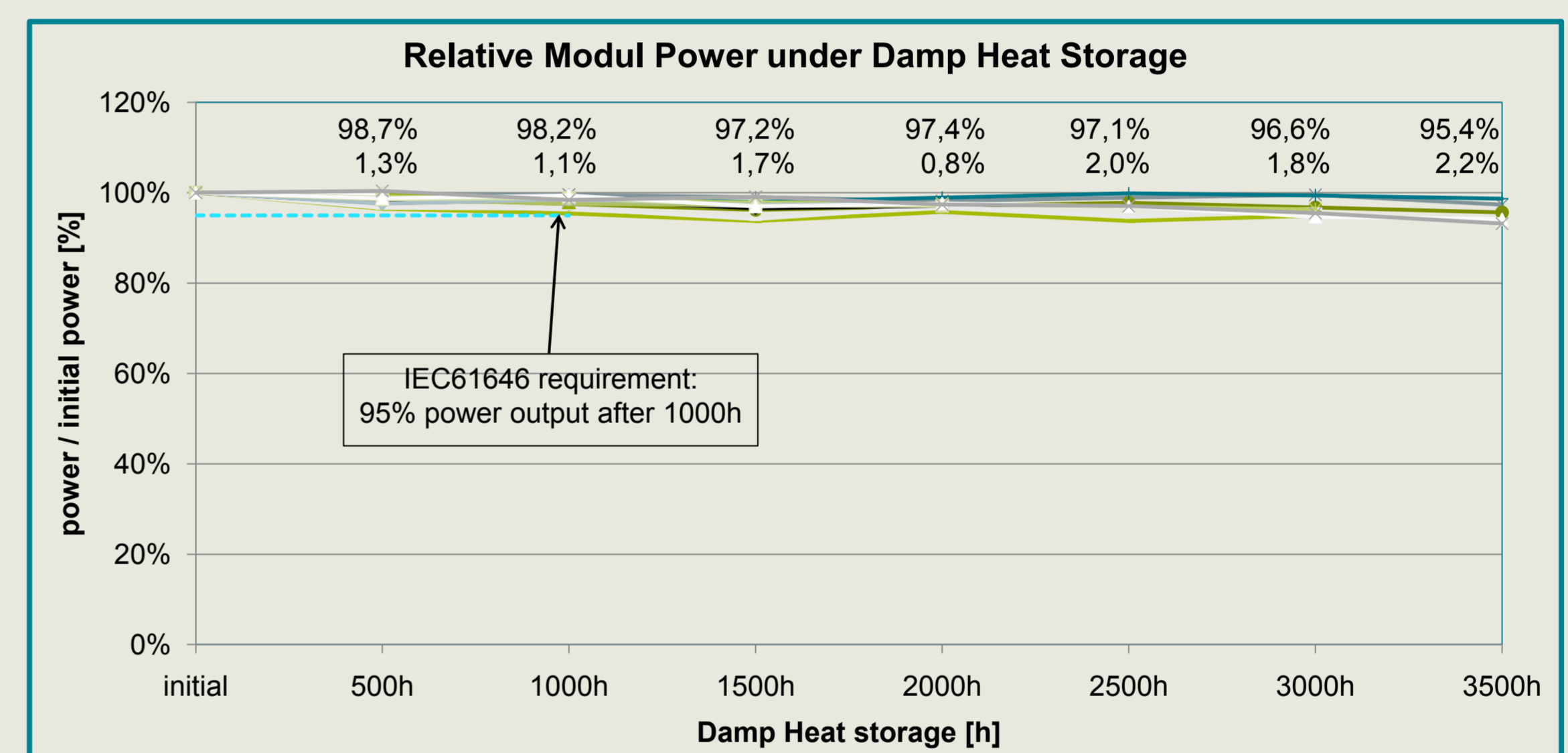


Comparison of IEC and internal test program requirements (list is not complete)

	Requirements IEC61646	Sulfurcell Solartechnik GmbH Internal requirements
DampHeat (85°C, 85% rH)	1000h (Pmp >95%)	2000h (Pmp >95%)
DampHeat+bias (1000V between frame and short-circuited contacts)	-----	1000h (Pmp >95%)
Humidity Freeze test (-40°C / 85°C)	10 cycle (no glass breakage, Pmp >95%)	40 cycle (no glass breakage, Pmp >95%)
NH₃-test (DIN 50916:1985 T2)	-----	Pmp >95% no corrosion or damage at the module
Salt spray test (IEC 61701)	-----	Pmp >95% no corrosion or damage at the module
Mechanical load test	2400Pa without torsion	2400Pa with torsion for frameless modules
Dry Heat test	Annealing at 85°C until stabilization of performance $\pm 2\%$	Annealing at 100° until stabilization of performance $\pm 2\%$

Climatic testing

There is an ongoing discussion about the corresponding outdoor lifetime of a module with respect to the 1000 hours under damp heat conditions (85°C, 85% rel. humidity). Of course, this time strongly depends on the climatic conditions of the specific location and there is general agreement that the 1000 hours corresponds well to moderate climates such as in Central Europe. In order to cover more humid climates the minimum exposure times of our climate tests are significantly longer, e.g. 2000 hours damp heat instead of 1000 hours and 40 humidity freeze cycles instead of 10. Figure 1 shows the relative degradation of STC performance of a batch of CuInS_2 modules under damp heat conditions. As can be seen in the figure even after 3500h the performance of these modules still exceeds the IEC criterion of 95% of initial performance.



The degradation of module power under damp conditions depends strongly on the voltage bias of the thin film circuit wrt. to ground. Stable module power under damp heat can be assured for positive bias. Therefore Sulfurcell recommends to ground the negative pole of PV generators with CIS based thin film modules.

About Sulfurcell

Sulfurcell has been running a pilot production for thin-film solar modules using CuInS_2 -chalcopyrite (CIS) as absorber material since 2004. The construction of a new, highly automated production facility has been completed end of 2009 and first modules from the new fab have been shipped in Q1/2010. The new factory will have a final capacity of 75 MW. Sulfurcell currently qualifies a new Cu(In,Ga)Se_2 (CIGSe) based product line which will be introduced into the market end of 2010. Sulfurcells CIGSe modules reach power values of 84 W (confirmed by TÜV Rheinland) which corresponds to a total area efficiency of 10.3 %.