AVERAGE YEARLY DEGRADATION OF HANWHA Q CELLS MODULES

Hanwha Q CELLS continually tests and monitors modules in numerous test fields around the world. Using data from R&D test site in Thalheim, Germany, average yearly degradation of 0.3 % has been observed – much lower than the warrantied level of 0.6 %/ year.

HANWHA Q CELLS TEST SITES

With a 12 year product warranty and 25 year performance guaranty it is important to fully understand the effect of long term outside exposure on Hanwha Q CELLS modules. Along with accelerated testing and detailed modelling Hanwha Q CELLS operates a number of test sites and reference installations around the world in order to effectively assess the long term performance of its modules.

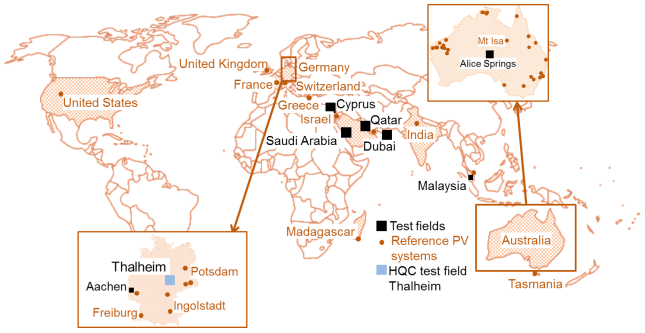

Figure 1: Hanwha Q CELLS global test fields and reference installations

DATA FOR DEGRADATION ANALYSIS

Hanwha Q CELLS operates a large outdoor test field near the Headquarters for Technology and Innovation in Thalheim, Germany. The main purpose of this test facility is to generate high quality experimental data under real field conditions. Typically the results are used for characterisation of products, components and as a data basis for simulations.

In 2010 a system of 12 polycrystalline modules was installed as one of the first installations on Hanwha Q CELLS test facility in Thalheim, Germany. These modules continue to operate and have been monitored continually since installation. The system is monitored individually with key electronic characteristic being recorded every 10 seconds. Alongside this meteorological data such as humidity, pressure, ambient temperature, precipitation and irradiation is also captured.

CALCULATION OF YEARLY DEGRADATION

Modules perform differently in different light conditions, typically termed low light performance, also the incident angle of the light falling on the module affects how much light is transmitted through the glass, affecting the power. To exclude these effects and other erroneous points only data for times when the environmental factors were close to Standard Test Conditions (STC) were considered to be valid. STC is defined as:

- Illumination of 1000 W/m²
- Ambient temperature of 25 °C
- Spectrum of 1.5 atmospheres (AM 1.5G)

Valid data points are then further adjusted in terms of temperature and irradiation using the equation below, with TC_{Pmpp} referring to the temperature coefficient of the module and G_{Plane} referring to the global irradiation in the plane of the module:

$$P_{STC} = \frac{P_{DC}}{1+TC_{PMPP} \times (T_{MOD} - 25)} \times \frac{1000}{G_{Plane}}$$

After removing such unfit data a few minor uncertainty factors remain. Therefore, a linear regression is performed on the remaining data points, with the first month being taken as the 100 % mark.

RESULTS OF DEGRADATION MEASUREMENTS

From this dataset of Q CELLS modules an annual degradation rate of 0.3 % has been observed over the 6 years of data – well below Q CELLS linear performance warranty of 0.6 % per year.

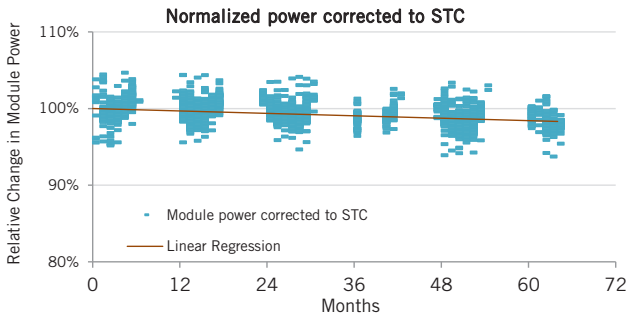

Figure 2: Yearly Degradation in Hanwha Q CELLS modules

Modules in the Thalheim test field experience snow covering of up to 30 cm along with wind speeds up to 30 m/s. These conditions are not extreme, however they are equal to or tougher than the climate conditions in the majority of PV installation locations, making this a reasonable analogue to many installation environments.

(Note) This whitepaper is a summary of the results presented in the paper "Long term record of PV modules: Results from Hanwha Q CELLS test fields and reference installations around the world" – D. Buß, et al. published in 2015 and available through EUPVSEC

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