



Outdoor weathering facilities:

- 1 on the Canary Islands.
- 2 in a desert climate.
- 3 at an alpine location (3000 m).

OUTDOOR WEATHERING IN DIFFERENT CLIMATES

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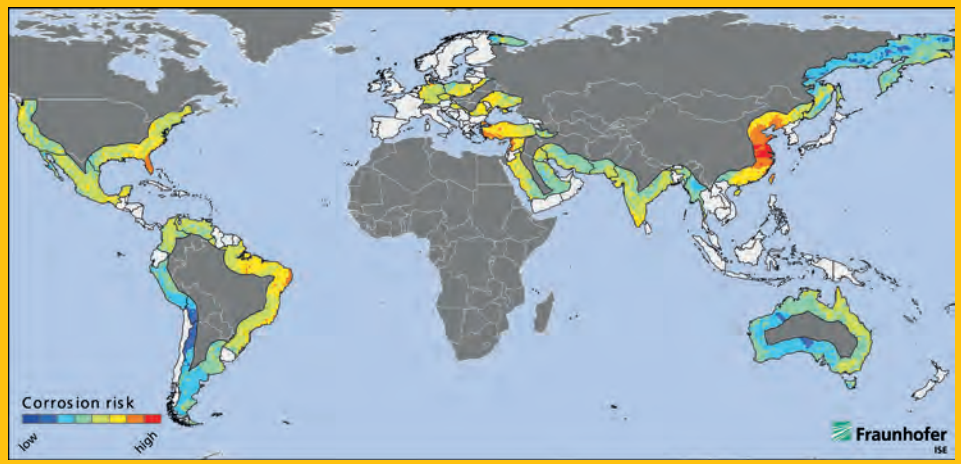
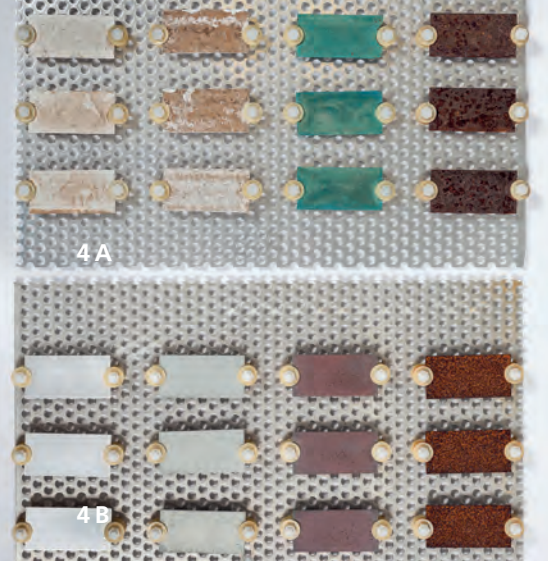
www.ise-reliability.org/pv

The climatic conditions affecting solar systems vary considerably from location to location, resulting in different requirements for materials and components of PV modules and thermal collectors. Fraunhofer ISE operates outdoor test sites in four different climates in order to assess the effects of different weathering conditions on the reliability of PV modules and thermal collectors:

- Freiburg, Germany – moderate climate
Central European reference site with moderate temperatures, humidity, UV radiation, and moderate snow and wind loads.
- Zugspitze, Germany – alpine climate
Location with a cold climate, wide temperature fluctuations, high UV radiation as well as high snow and wind loads.

- Sede Boqer – Negev desert;
Israel – arid climate
Desert climate with elevated operating temperatures, extreme temperature fluctuations, high global and UV radiation and soiling risk.
- Pozo Izquierdo – Gran Canaria;
Spain – maritime climate
Test site close to the sea with corrosive, saline atmosphere, Potential Induced Degradation (PID) and soiling.

We offer our clients the possibility to expose their PV modules, thermal collectors, materials and components at our outdoor test sites. We analyze their behaviour in different climates, also in comparison to our reference samples. In collaboration with our partner institutes, we offer additional outdoor tests in the USA and Saudi Arabia.



Measurement Technology

We developed a unique PV monitoring system for long-term recording of current-voltage (IV) curves which is used at our test sites and at customer sites. The measurement frequency and speed can be individually adapted for each sample. A big advantage of this technology is the possibility to measure and compare samples simultaneously under identical conditions. Additionally, samples can be equipped with sensors for temperature measurements of the modules, the absorbers or the adhesive joints. Because of revised building codes in some countries (e.g. Germany) the adhesive joints are of particular interest. With the help of climate monitoring and several pyranometers we can specify the

actual local stresses (global and UV radiation, temperature, temperature fluctuation, humidity, wind speed and wind direction) as well as the soiling risk and the corrosivity at these locations (Fig. 6). We achieve a precise characterization of the radiation by using special spectrometers. Moreover, each test site is equipped with high quality Fraunhofer ISE outdoor reference cells.

Geographic Information Systems (GIS)

The combination of monitoring samples and climate data in these various climates enables us to correlate the influences of environmental factors with the observed material changes. These results and findings are included in our simulation models. The combination of adapted satellite-based climate data together with our own mea-

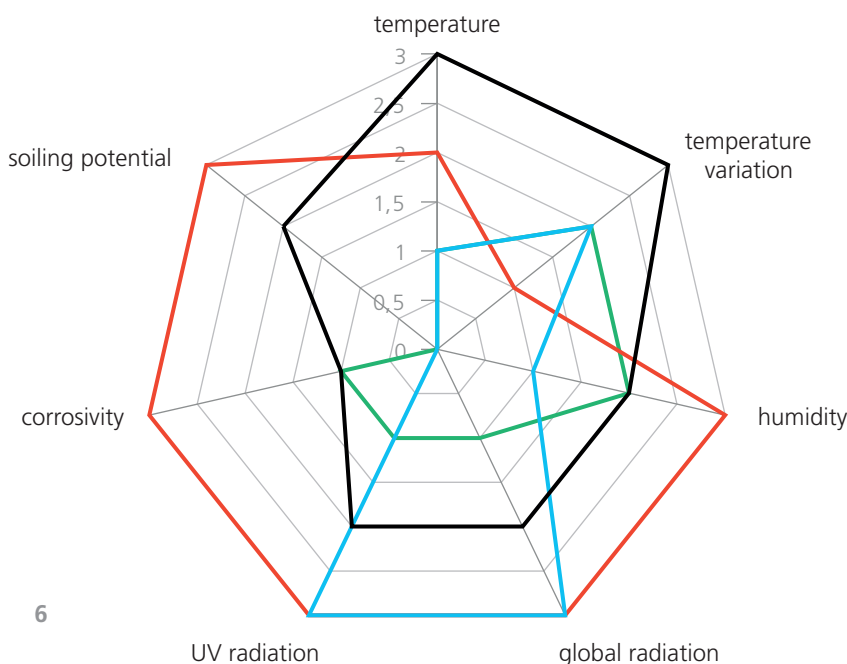
surement data, processed with the help of Geographic Information Systems (GIS), allows us to predict environmental impacts and thus durability requirements for solar system components worldwide.

Analytics

Comprehensive analytical characterization in our laboratories enables us to investigate chemical and physical degradation processes of materials during their exposition at outdoor test sites and during corresponding accelerated aging tests.

Accelerated Aging Tests

In our TestLab PV Modules, which is ISO 17025 accredited, we perform customized accelerated aging tests that simulate real stress conditions in a short testing time.



- Freiburg (Germany)
- Canary Islands (maritime climate)
- Zugspitze (alpine climate)
- Negev Desert (desert climate)

4 A / B Samples of different metals (Al, Cu, Fe, Zn) for measuring atmospheric corrosion at different locations.

5 Mapping the global corrosion potential.

6 "Climatic fingerprint": climatic loads of our outdoor test sites.