Industry and Research Join Forces on Reliability Testing of Collectors and Materials

*Speed*Coll

Solar thermal collectors and their components are commonly exposed to a wide range of climatic influences. Next to UV radiation, factors like humidity, wind, extremely high or low temperatures, salt, sand and other particles in the atmosphere affect the surfaces and performance of these products. Although these influences are decisive factors for the lifetime and long-term efficiency of solar thermal collectors, there are no validated or binding test procedures for reliability assessment over time or models that allow a location-specific service life prediction. The projects *Speed*Coll (2011-2015) and *Speed*Coll2 (2016-2020), funded by the German Federal Ministry for Economic Affairs and Energy / Project Management Jülich and the support of many leading industry partners, have started to fill these gaps by being the first initiatives to assess the durability of solar thermal collectors and their components with a global outdoor exposition campaign. This work is supported by the valuable input on quality assurance, reliability testing and also standardization and cost reduction efforts from projects of the IEA SHC, specifically Task 43: Solar Rating and Certification Procedures, Task 54: Price Reduction of Solar Thermal Systems and Task 57: Solar Standards and Certification.

▲ **Exposed solar thermal collectors in the Negev desert, Israel.**

Outdoor Exposure in Global Hot Spots

In the project *Speed*Coll, solar thermal collectors and samples of their components (glass, reflectors, absorbers, adhesives) were exposed at different outdoor exposition sites around the world. Each test stand was characterized by extreme climatic conditions and distinctive combinations of stress factors and monitored for more than three years. Starting with two reference test stands with moderate climatic conditions in Freiburg and Stuttgart, Germany, samples were exposed to four other climates 1) the island of Gran Canaria, a maritime climate with high UV loads and corrosive atmosphere, 2) the Negev desert in Israel, an arid climate with high temperature variations, soiling and sand loads, 3) the Zugspitze in the German Alps, an alpine climate with high irradiation and UV, and 4) in Kochi, India, a tropical climate characterized by high moisture loads and temperatures.

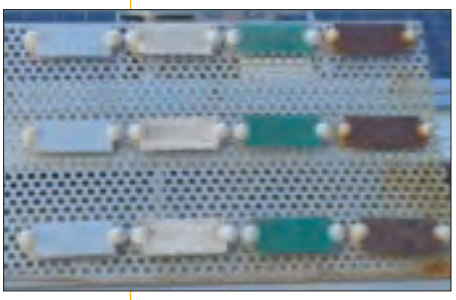
▲ **View from the alpine exposition test stand on the Zugspitze in the German Alps.**

Scientists from the Fraunhofer Institute for Solar Energy Systems ISE (coordination) and the Institute of Thermodynamics and Thermal Engineering (ITW) / Research and Test Centre for Solar Thermal Systems (TZS) of the University of Stuttgart measured the temperature, UV concentration, humidity, wind load, atmospheric corrosivity and irradiation at the sites and also monitored the resulting microclimate (i.e., the specific conditions in the flat plate collectors themselves). The measurements yielded valuable results, some of them not expected before the start of the project. "What astonished us," *Speed*Coll's project leader, Dr. Karl-Anders Weiss explains, "was the fact the highest absorber temperatures were in fact measured on the Zugspitze in the German Alps, the only test stand with snow loads for several months of the year." On Gran Canaria, on the other hand, insights were provided concerning other phenomena. At the test stand located about 100 meters next to the sea, salt aerosols in the atmosphere caused the highest corrosion rates measured in a global corrosion campaign. While corrosion was partly visible at the outside of the collectors their inside was nearly free of any influence. This shows the generally good quality of the collectors. How the

continued on page 24

Reliability Testing *from page 23*

climate would affect them beyond the three years is the crucial question and part of the follow-up project *Speed*Coll2.



▲ **Corrosion coupons as part of a global corrosivity campaign on Gran Canaria, Spain.**

On the Way to Standardized Durability Tests

For a future estimation of such long-term effects, the data was translated to accelerated aging tests where they were pushed to an extreme. "The most challenging part in defining aging tests is to find the right acceleration factor for each component to simulate aging without destroying the material too quickly", Weiss continues, "in *Speed*Coll, we worked with experienced researchers who carefully reviewed our outdoor exposition data and combined them to test routines for the factors UV, high temperatures and corrosion as groundwork for globally accepted standards for durability testing."

The possibility to introduce *Speed*Coll's test cycles to international standardization committees was given by a strong engagement of the project in relevant solar thermal standardization committees, such as the Solar Keymark Network, DIN, CEN, ISO and SHC Task 43: Solar Rating & Certification where the researchers are active members. As such, they were the perfect delegates to present the project and help it to international recognition. "*Speed*Coll is a good example for successful research and the parallel transfer and exploitation in the SHC framework," the project's supervisor at PTJ and member of the Executive Committee Dr. Peter Donat confirms. "SHC Tasks are the vehicles for bringing research results to the place where they have the biggest impact. This can be on a political level, in further research cooperation, or, as shown here, in standardization efforts."

Life Time Estimation and Cost Reduction Potential

As a continuation of the exchange on durability testing, the project's follow up is also strongly tied to the SHC Programme. *Speed*Coll2 supplements the work started in the previous project by developing numerical models that allow lifetime estimation for the tested samples. These will be directly brought in to SHC Task 57: Solar Standards and Certification and form part of SHC Task 54: Price Reduction of Solar Thermal Systems, where the economic potential of the project is the center of attention. A binding method for life time assessment of solar thermal collectors will allow a location specific and cost-effective manufacturing of tailored products, which will be crucial for reducing total costs of the solar thermal systems.

▲ **Tropical test stand in Kochi, India with solar thermal collectors and components.**

About the Projects

The *Speed*Coll "Development of Accelerated Aging Tests for Solar Thermal Collectors and Their Components" (2011-2015) was implemented by the Fraunhofer Institute for Solar Energy Systems ISE (Coordination) and the Institute of Thermodynamics and Thermal Engineering (ITW)/ Research and Test Centre for Solar Thermal Systems (TZS) of the University of Stuttgart with funding of the Federal Ministry for Economic Affairs and Energy / Project Management Jülich (Fkz.: 0325969) and the support of 15 industry partners. The developed test cycles and data entered several SHC Tasks as valuable groundwork for technological and economic research questions. (www.speedcoll.de)

*Speed*Coll2 "Durability Estimation of Solar Thermal Collectors and their Components" started in August 2016 and will run for four years. It is continuing the work started in *Speed*Coll by translating the results of the outdoor exposition and indoor testing cycles to numerical models for lifetime estimations. *Speed*Coll2 is strongly supported by the German Federal Ministry for Economic Affairs and Energy / Project Management Jülich (Fkz.: 0325865) and the support of 13 industry partners.

This article was contributed by Sandrin Saile, Fraunhofer ISE, Sandrin.saile@ise.fraunhofer.de and Karl-Anders Weiss, Fraunhofer ISE, karl-anders.weiss@ise.fraunhofer.de