Steinbeis-Transferzentrum
Dezentrale Regenerative
Energiesysteme

THU Technische Hochschule Ulm

Summary Test Results SunBrush mobil

Two reports on clarifying the mechanical load by a Photovoltaic cleaning system were made by Steinbeis-Transferzentrum Distributed Renewable Energy Systems in cooperation with the company SunBrush mobil.

Test 1- 2010: SunBrush mobil – Standard Cleaning

Evaluation Task:

Test of PV modules concerning power losses and wear due to possible mechanical abrasion and scratches. The mechanical loading is produced by a PV-cleaning unit from SunBrush mobil GmbH.
The brush of the cleaning system has cleaned the glass surface of the PV modules 4338 times without liquid additive. This simulates a load for about 20 years (manufacturer information Fa. SunBrush mobil GmbH). To analyze the power values before and after the cleaning process the modules are examined by means of a flasher at different irradiation levels. In addition the glass surface of the PV modules is visually examined with a microscope at defined measurement points according to the different purification steps.

Measuring devices:

- Flasher: PASAN Sun Simulator 3c, Serialnumber: PAA0325
- Microscope: ZEISS
- PV-cleaning unit: SunBrush mobil
- Power Meter Christ CLM1000-Professional+

Measurements performed:

Measurement 1: state of delivery

- Optical surface analysis, microscope at 16x and 25x magnification
- Performance measurement of PV-modules at an irradiation of 1000 W/m², 700 W/m², 400 W/m², 200 W/m².

Measurement 2: wet cleaning

- 50 cleaning cycles with wet surface
- Optical surface analysis, microscope at 16x and 25x magnification

Measurement 3: dry cleaning, 20-years simulation

- More than 4000 cleaning cycles with dry surface
- Optical surface analysis, microscope at 16x and 25x magnification
- Performance measurement of PV-modules at an irradiation of 1000 W/m², 700 W/m², 400 W/m², 200 W/m².

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Results

The solar power measurements of brand new modules compared with the measurements after more than 4000 cleaning cycles indicates no reduction in performance. Hence the cleaning brush caused no disturbance of the test modules within the 20 years simulation. It should be noted that the runs were carried out in the dry state corresponding to a higher mechanical load on the modules than in normal cleaning operation.

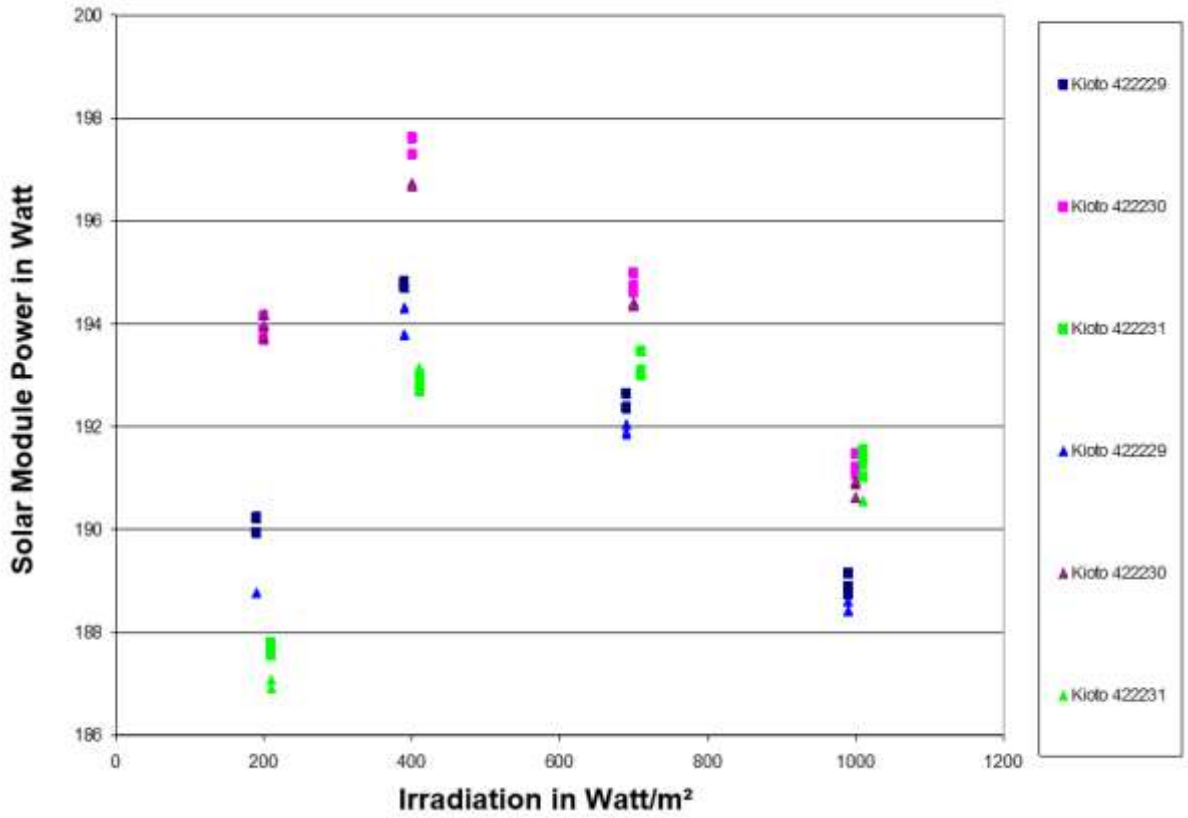

Figure 1: Results of the module power measurement at different irradiation levels before and after the 4338 cleaning cycles.

The square mark shows the three modules before the test run. The triangle mark shows the power measurements after to the test run. Three power measurements were carried out at each irradiation and each module. The difference between the measurements before and after the test run was +0.1 to -0.3%.

The absolute accuracy of power measurement is +/- 3%. The accuracy of the repeated measurement is 0.25-0.5% of the measured value.

The results of performance measurements were confirmed by the optical surface analysis of the modules.

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Conclusion

The simulation of the 20-year dry-cleaning process (Measurement 2) shows no scratches on the glass surface of the PV modules and no decrease in the electrical characteristics.

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Test 2 – 2015: SunBrush mobil – Soiling with Sand

Evaluation Task

Test of Photovoltaic modules concerning power losses and wear due to possible mechanical abrasion and scratches. The mechanical loading is performed by a Photovoltaic-cleaning unit from the company SunBrush mobil GmbH. The brush cleaning system has cleaned the glass surface of the PV modules 1002 times under dry conditions with an addition of a defined amount of quartz sand per cleaning cycle.

Figure 2: Dry cleaning process with the SunBrush mobil cleaning unit.

The following measurements were carried out before and after the cleaning process to analyze the impact on the solar modules:

- Performance measurements determining the U / I characteristics with a flasher at different irradiation levels
- Electroluminescence measurement with the EL camera
- Optical surface analysis of the glass surface of the Photovoltaic modules with a microscope at defined measurement points

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Measuring devices

- Solar modules Kioto Solar serial nr. : 422229, 422230, 422231(AR coated)
- Flasher: PASAN Sun Simulator 3c, Serialnumber: PAA0325
- EL-Kamera, Cool Samba HR-830
- microscope, Auflicht-Digital-Zoom-Microskop Di-Li 2001
- Solar cleaning unit SunBrush mobil
- Soiling additive Quartz sand (particle size 0,3…0,8 mm)

Measurements performed

Measurement 1: initial state

- Optical surface analysis, microscope at 20x and 40x magnification
- Performance measurement of PV-modules at an irradiation of 1000 W/m², 900 W/m², 800 W/m²,700 W/m², 400 W/m², 200 W/m².
- electroluminescence measurement

Measurement 2: dry cleaning, quartz sand

- More than 1000 cleaning cycles with dry surface with an addition of ca.140g of quartz sand per cleaning cycle
- Optical surface analysis, microscope at 20x and 40x magnification
- Performance measurement of PV-modules at an irradiation level of 1000 W/m², 900 W/m², 800 W/m², 700 W/m², 400 W/m², 200 W/m².
- electroluminescence measurement
- determination of energy consumption

Results

The comparison of solar power measurements of various modules with the measurements after 1002 dry cleaning passages shows no reduction in performance compared to initial state. Also there were no changes detected using the electroluminescence measurement.

Summary Test Results SunBrush mobil

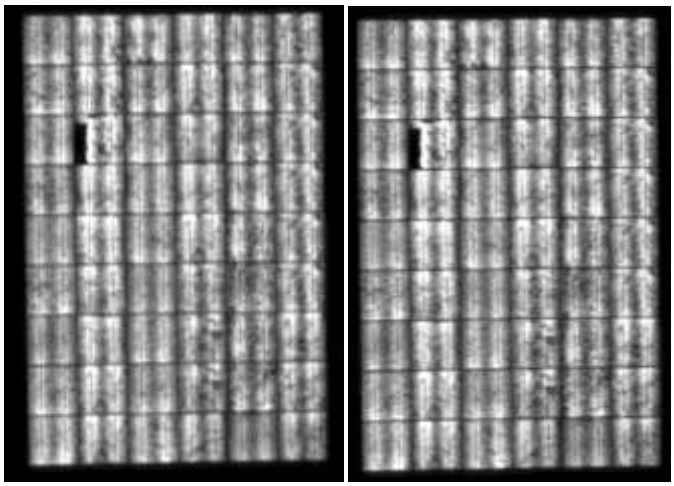

Figure 3: Picture of Kioto Solar Seriennr. : 422229 before (left) and after (right) the test uptake by the EL camera.

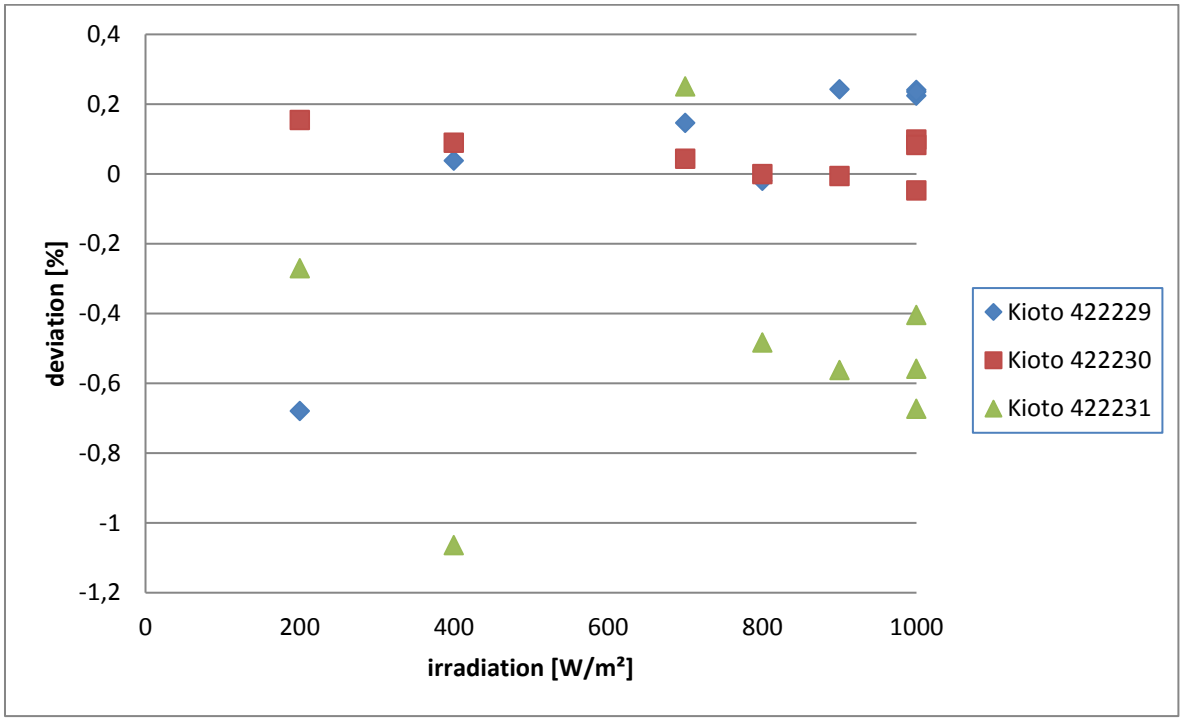

Figure 4: The results of the performance measurements of the three test modules before and after 1002 passes at different irradiations. Two modules show a performance increase of about 0.1%. The third show a performance decrease of about -0.5%.

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Figure 4 presents the deviations in percentage before and after 1002 dry cleaning runs on the solar modules. The deviations of the measurements of the three solar modules at the six different irradiations were at +0.25 to -1.1%. The absolute accuracy of power measurement is +/- 3%. A temperature change of 1 ° already causes a change in power output of 0.5%! The performance measurements were carried out at the solar modules immediately after the cleaning cycles.

Conclusion

It can be seen that no reduction in performance of the solar modules can be measured after the 1002 dry cleaning cycles with the SunBrush mobil cleaning system with the addition of 140g of quartz sand before each cleaning cycle. Also the electroluminescence analysis and control of solar modules with a microscope shows no changes to the solar modules.

The Kyoto modules examined in the cleaning process were already used in the first test without quartz sand in 2010 with 4338 cleaning cycles with the cleaning brush from SunBrush mobil GmbH.

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