ILLUMINATION HOMOGENEITY OF BIFACIAL SYSTEMS – OUTDOOR MEASUREMENTS WITH SYSTEMATICALLY VARIED INSTALLATION CONDITIONS

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Motivation and Approach

Bifacial technology
• Bifacial technology is currently in the focus to increase PV yield
• More complex conditions for bifacial installations compared to standard, monofacial ones
• Difficult conditional effects from backside illumination (albedo, shading, …)
• Limited predictability of the output by simulation or by comparison with similar systems
• Optimized mounting conditions (height, tilt angle, …) are vague
• Actual benefit due to bifaciality unclear → possible investors are deterred

Approach
• Nine bifacial modules installed on BIFOROT (Bifacial Outdoor Rotor Tester) test array
• Measurement at twelve different tilt angles per minute with permanently revolving modules
• Shading effects considered
• Uniformity of incoming module irradiance measured on front and backside
• Provide systematic data to test and improve simulation algorithms
• Find optimised tilt angle for the specific installation conditions

Specifications
• Azimuth angle: 0° (north-south orientation)
• Axis height: 0.75 m (from ground to axis centre)
• Axial spacing: 2.86 m (from the centre of the axis to the centre of the axis)
• Tilt angles: 0°, 10°, 15°, 18°, 21°, 25°, 30°, 35°, 40°, 45°, 60°, 90°
• Ground albedo: 0.51 (measured at axis height)
• Axial spacing: 2.86 m (from the centre of the axis to the centre of the axis)
• Module height: lower edge depending on tilt angle (Figure 6), module centre always at axis height (0.75 m)
• Module 1 (M1): frontside covered for I SC,front measurement
• Module 2 (M2): IV curve measurement (I SC,bifacial)
• Module 3 (M3): backside covered for I SC,back measurement

Long time measurements
• Data acquisition from 5th of October 2016 until 27th of March 2017

Results, Conclusions and Outlook

Results and Conclusions
• Maximal energy yield for measurement period (winter season) and given setup achieved at 40° tilt angle (Figure 3)
• Backside illumination sum (\(\Sigma I_{SC,back}\) (M1)) over the measurement period nearly constant for all tilt angles (Figure 4)
• The relative contribution of the backside to the total illumination was measured between 0.15 (45°) and 0.35 (0°) dependent on the tilt angle (Figure 4)
• The minimal irradiation on the backside of the module limits the bifacial gain, compare red line in Figure 4 (Bc) and Figure 5 (minimal value)

Outlook
• Extend and optimize the measuring device and carry out further measurements
• Further work on an energy yield simulation model in cooperation with ISC Konstanz

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