

Challenges for Bifacial solar cell and module measurements

Authors

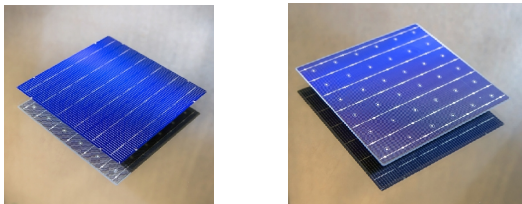
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Bifacial solar cells

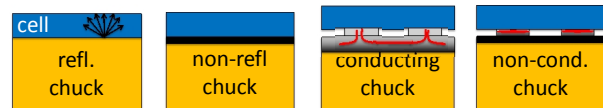
Cells can collect light from both sides

- Open metallization pattern on front and rear
- Light can be collected from both sides
- How do we compare results?



Bifacial cell measurements: influence of chuck

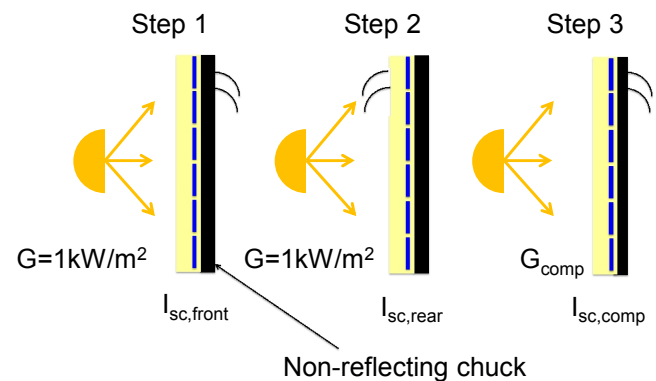
- Reflecting chuck: mimic monofacial /bifacial cells with reflecting foil application- > reflections differ between chucks
- Non-reflecting-chuck: monofacial illumination (no rear side illumination), to determine bifaciality (ratio front to rear response)
- Conducting chuck: short-cutting fingers, so $FF_{measured}$ too high
- *Results of different institutes/companies cannot be compared!*



Efficiency of bifacial cells and modules: approach 1

- Not yet an IEC standard but is under development (IEC 600904-1-2).
- Proposal:
 - Measure $I_{sc,front}$ under standard test conditions
 - Measure $I_{sc,rear}$ under standard test conditions
 - Determine the bifaciality ratio = $I_{sc,rear}/I_{sc,front}$
 - Calculate the compensated I_{sc} :

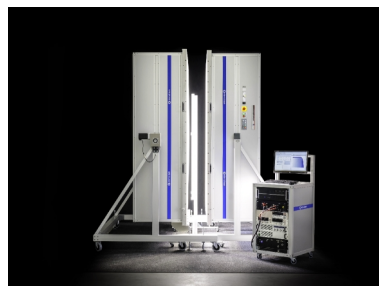
$$I_{sc,comp} = (1 + 0.2 \times \text{bifaciality ratio}) \times I_{sc,front} = G_{comp} \times I_{sc,front}$$
 - Measure cell under G_{comp} to determine bifacial efficiency
 - Factor 0.2 is initial estimate for rear side irradiance relative to front side. Other factors are under consideration. Depends on albedo of background.



Taken from <https://pvpmc.sandia.gov/>

Efficiency of bifacial cells and modules: approach 2

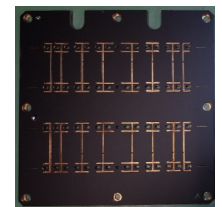
- Simultaneous illumination from 2 sides
- Front side 1000W/m²
- Rear side 200W/m²



- Picture: Eternal Sun system

Adapting solar simulator for bifacial measurements

- Chuck reflection: black non-reflecting sticker film on our standard temperature controlled chucks.
- Check if the black sticker film is not influencing the temperature during measurement
- Adapt lamp irradiance for G_{comp} , typically about $1.18 \times 1kW/m^2$
 - Check if lamp spectrum does not change with increasing irradiance -> if so current needs to be adapted for spectral mismatch



Conclusion

- Bifacial cell and module measurements need to take into account front and rear side illumination
- Two standards are being developed; ECN is adapting the measurement setups and procedures to comply with these proposed standards

References

- PV Quality Assurance Task Force: <http://www.pvqat.org/>
Bifacial workshop: <http://bifipv-workshop.com/>
PV performance and modelling collaborative: <https://pvpmc.sandia.gov/pv-research/bifacial-pv-project/>