

UPOT: the Utrecht Photovoltaic Outdoor Test facility

Universiteit Utrecht

W.G.J.H.M. van Sark¹, A. Louwen¹, A.C. de Waal^{1,2}, B. Elsinga¹, R.E.I. Schropp²

¹Utrecht University, Copernicus Institute, Budapestlaan 6, 3584 CD Utrecht, the Netherlands ²Utrecht University, Debye Institute for Nanomaterials Science, Physics of Devices, High Tech Campus 5, 5656 AE Eindhoven, The Netherlands

Introduction

Construction

Outlook

The test facility will be operational in October 2012. From then on, data will be acquired from Si modules (single and multi crystalline), thin film silicon (single and triple junction) modules, c-Si/a-Si heterojunction modules, and CdTe and CIS modules. A wealth of spectral and performance data will be analyzed, and effects of Dutch spectral changes on module performance will be presented in the coming months and years.

Multi-GW growth of production capacity and deployment is going hand in hand with efficiency improvements in PV system components, both PV modules and inverters.

System performance is improving as well: the so-called performance ratio approached 0.9 in many systems [1].

Energy performance of photovoltaic (PV) cells or modules presently is usually estimated using:

- + module data specifications manufacturers
- + meteorological data
- + PV model (irradiation, temperature)
- parameters derived from experimental data, indoors and/or outdoors

However, spectral effects often neglected, or indirectly assessed.

Test facility

To assess yield data for different present-day and future generation PV technologies an outdoor test facility is designed and constructed. In addition, power will be fed into the university campus grid, thereby peakshaving the load.





Webcam image



Measurement set-up

- + Current-voltage (I-V) characteristics of 24 commercially available modules
- + Individual power optimizers for each module
- + 12 modules per inverter
- + Total system power 4 kWp
- Solar irradiance, global and in-plane, direct and diffuse
- + Time interval 1 sec 1 min 1 hour
- + System tilt 37 degrees, south
- + Spectroradiometer for in plane spectra
- Meteorological parameters (wind, ambient temperature, rain)
- + Sky camera (cloud imaging)
- + On top of 8-storey high UU building





Labview interface



Acknowledgements

We would like to thank Remco van Tessel, Frits Verdam, Randoplh Meekes, Michiel Scherrenburg for their help in realising this structure in a university environment. Also we gratefully acknowledge the generous support from Erik Lysen and some manufacturers in supplying some of the solar PV panels.



Financial support is acknowledged from Nuffic, kfHeinfonds, and the STW-Perspectief 2010 programme FLASH (FundamentaLs and Application of Silicon Heterojunction solar cells).

References

[1] N.H. Reich, B. Mueller, A. Armbruster, W.G.J.H.M. van Sark, K. Kiefer, Ch. Reise, *Performance Ratio revisited: Are PR* >90% realistic?, Progress in Photovoltaics 20 (2012) 717-726

faculty of **Geosciences**