A Concentrator System for BI-CPV/T with Static Linear Fresnel Lenses

H.F. de Zwart, P.J. Sonneveld, G.L.A.M. Swinkels, B.A.J. van Tuijl, H.J.J. Janssen

Project

Challenge

- Greenhouses as solar collectors 10,000 ha in the Netherlands!
- Save 25 % of the energy consumption of Dutch greenhouses

Fig. 1 Impression of the Fresnel greenhouse

Fig. 2 Details inside the greenhouse Left: The CPV/T module. Right: Overview and cultivation area

Approach

Develop a new type of greenhouse

- Fresnel lens collect all direct radiation
- Diffuse light enter the greenhouse
- Innovative sun tracking system (Fig.2). Two motors keep the modules in position with steel cables
- Collecting energy with CPV/T-module
- Modules with monocrystalline CPV cells
- Electric power conversion to the grid

Concept

- A new greenhouse concept with a asymmetric covering
- A new Fresnel lens design with PMMA lenses between a double glass cover
- No direct radiation into the greenhouse
- No screens or white wash needed

Partner

- Bode Project- en Ingenieurs-bureau B.V. at De Lier, The Netherlands

Development

Raytracing simulations

The intensities near the focal line (Fig. 3) and the trajectories of the focal line (Fig. 4) are determined with raytracing simulation.

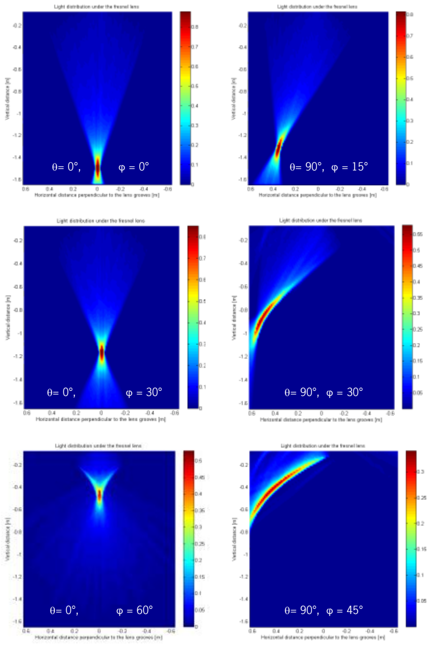

Fig. 3. Intensities at the focal area for different angles of incident φ and azimuth (θ=0 is in line with the groves of the lens) made with Raypro ray trace simulations.

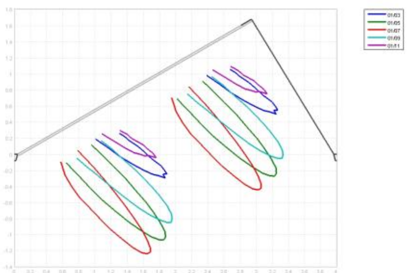

Fig. 4 Trajectories of the Focal line at different times during a year. Each loops span one day course.

Results - data

Energy Yield and Climate

- Peak power of 30 W/m^2 electrical.
- Thermal peak power of 250 W/m^2 at an illumination of 850 W/m^2.
- Average harvested thermal energy is 20% of the global radiation.
- Very stable light sum inside the greenhouse (Fig. 7).

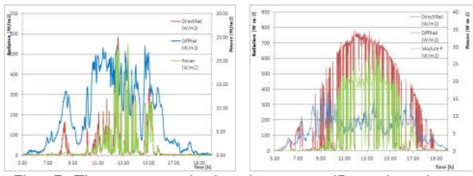

Fig. 5 The generated electric power (Power) and direct and diffuse radiation (Radiation) as a function of time on left: cloudy day August 6th, and right: bright day August 7th, 2011.

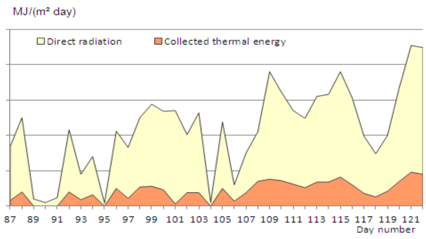

Fig. 6 Incident direct radiation and amount of collected thermal energy in 2011.

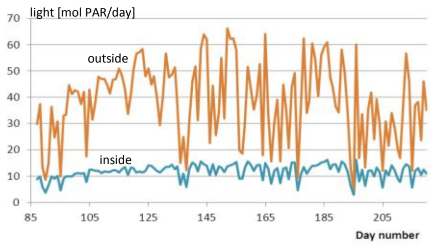

Fig. 7 Light sum in- and outside the greenhouse

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Wageningen UR Glastuinbouw
Droevendaalsesteeg 1, 6708 PB Wageningen
P.O. Box 644, 6700 AP Wageningen, The Netherlands
Tel.: +31(0)317 483 393
Fax: +31(0)317 423 110
E-mail: feije.dezwart@wur.nl
Internet: www.glastuinbouw.wur.nl