A Fresnel Lenses based Concentrated PV system integrated in a Greenhouse

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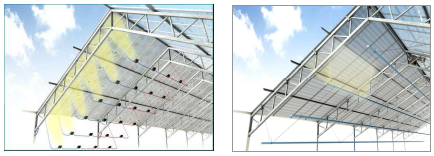
Background

- The greenhouses in the Netherlands are basically a solar collector of 10,000 ha.
- The incident solar energy is much more than necessary for the required energy consumption.
- For the most pot plants direct radiation is not only unnecessary but even unwanted



Figuur 1: Impression of a greenhouse hood with a. Normal Fresnellenses and TPV module b. Lineair Fresnellenses and TPV modules The lenses are integrated between double glass (Drawing Bode Project and Engineering).

Approach

The scope of this investigation is the development and testing of a new type of greenhouse with an integrated linear Fresnel lens, receiver module and an innovative tracking system for exploiting all direct radiation in a solar energy system. The basic idea of this horticultural application is to develop a greenhouse for pot plants (typical shadow plants) who don't like direct radiation. Removing all direct radiation will drastically reduce the need for cooling under summer conditions and the need for screens or lime coating on the glass to reflect or block a large part of the radiation.

Experiments:

The experimental greenhouse (Fig.2) with a size of 36m^2 is built in Wageningen and was ready in June 2008. For the conversion monocrystalline Si- cells are laminated to a module with a size of 1500 x 30 mm, placed in the focal point of the linear Fresnel lens (concentration factor of about 80x). The modules are mounted and suspended with thin steel cables.

Fig. 2. The Fresnel greenhouse at real size.

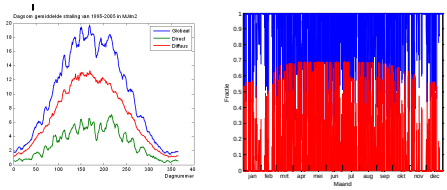


Fig. 3 a. Daily average global radiation in the Netherlands divided into diffuse and direct part . b. Diffuse and direct radiation in the Netherlands as determined from hourly means. (red = fraction direct radiation, blue = fraction diffuse radiation)

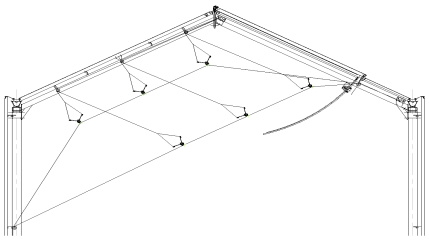


Fig. 4 Cross section of the hood with details of the suspension and steering construction of the solar cell modules, with the lowest and highest position of the modules is shown

These cables are excited by two electric powered steel shafts. This structure enables the modules in the right position for large surfaces (1,000-10,000m^2) with only two electric motors

Results

An overview of the energy yield for Dutch climate conditions is given in Fig. 6. The

Fig. 5 Inside the greenhouse a. Details of the PV module b. The three collectors of the system

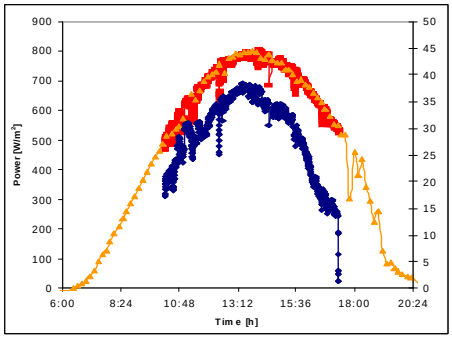


Fig. 6 The generated electric power (Pnom ——— scale right) en irradiation (Prad ——— scale left) and Haarweg (Prad ——— scale left) as a function of time on August 5, 2009

conversion of all radiation leads to a maximal screening factor of 79% (Dutch climate circumstances). A peak power of approximately 60 W/m^2 electrical and thermal peak power of 250 W/m^2 is expected at an illumination of 900 W/m^2. This will result in a sustainable energy supply of maximal 50 kWh/m^2 per year Si-cell based modules or 100 kWh/m^2 per year with triple junction cells based modules.

Partner:

Bode Project- en Ingenieursbureau B.V. in De Lier The Netherlands is a partner in this project.

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