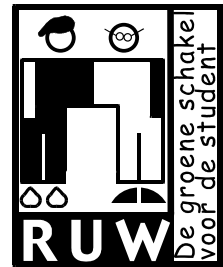


Energy *Producing* Greenhouse

by Gabriëlle Rossing

Horticulture consumes a lot of energy. In the Netherlands it consumes ten percent of the domestic natural gas demand! So the energy demand is very high and therefore new technological innovations are needed.

The RUW Foundation went with its audience (mainly students from Wageningen UR) on excursion to Bergerden (the Netherlands). In this ultramodern horticultural region an energy producing greenhouse is situated, where horticultural entrepreneurs are the owners of an energy plant and infrastructure. Theo Eeuwes and Piet Sonneveld will explain what it is and why it works (it does!).



Theo Eeuwes (representative of Kwekerij Stef Huisman BV) introduces the energy producing greenhouse (Energy Greenhouse, EGH): the EGH is owned by hydro culture pot plant company Kwekerij Stef Huisman BV. Together with Wageningen UR they do research on alternative ways of producing energy. They not only want to know technical aspects of an EGH, but also climate and pest aspects of plants and economical feasibility of such a greenhouse.

The EGH has a surface of 2700m² pilot area and a similar one not producing energy which functions as a reference for the research.

Capturing heat from sunlight

In the Netherlands the energy supply from the sun is 3.8 GJ/M² during the day and in summer. The demand for (fossil) energy for nursery of pot plants is 1.6 GJ/m² during the night and in winter. We see supply of energy in summer exceeds its demand. In summer a greenhouse needs to be ventilated for cooling. Running a ventilator demands extra energy in summer while the sun also provides a surplus of energy. Fact: sun heat equals 100m³ gas/m². So it would be logic if it is possible to make use of the surplus of energy from the sun. Well, new technology is able to make use of it: Fiwhex heat exchangers can harvest heat in the summer and release it in the greenhouse in winter. Those heat exchangers have hundreds of meters extremely thin wires from copper (0,1 mm) braided around small tubes with a diameter of 1,7 mm. Water flows through the tubes and the copper wire conducts heat in between air and water in an extremely efficient manner. A highly energy efficient engine in a ventilator passes air through the heat exchanger to cool or warm the greenhouse.

Heating and cooling

In summer the EGH harvests energy, heating up cold ground water with the heat exchangers to cool the greenhouse. The energy will be transported and stored in a hot-ground-water-well in aquifers. In winter the 'hot' ground water will pass the heat exchanger again. It will heat up the cold air in the greenhouse, the water will cool down and will be pumped into the cold well.

Aquifers are a layer of sand and ground water at a depth of 35-70 meters. They are in between non permeable layers of clay. Those aquifers happen to be there naturally. The ground water from these aquifers will only be *used* for heating and cooling the greenhouse, so it won't be consumed. Not consuming it prevents contamination of both the greenhouse

and the ground water. By permit Kwekerij Stef Huisman BV can legally make use of the water with a maximum of 45.000 m³ water per year, or 100 m³ water per hour. Aquifers with warm water (storing the heat of the sun in summer) and cold water (to absorb the heat of the sun) can be separated maximum 250 meters. The temperature of the ground water in the hot well can be at maximum 18-19 °C. Above these temperatures iron in the ground can oxidize, bacteria will grow and minerals will dematerialize.

The energy obtained from the heat exchanger is of low quality (around 60 kWh/m²) and reduces on 25.000 m² 0.5-1 m³ natural gas.

In greenhouses the high energy demand is not the only topic of concern. Also climate and growing conditions like CO₂ level and humidity, are very important to grow plants. So reduction and improvements on energy usage is interesting, but not the only focus.

The EGH has an isolating roof top and the heat exchangers in both directions (heating and cooling) are very efficient. The greenhouse roof top is covered by a special zigzag-shaped roof and covering cloth. It isolates and captures sunlight. The roofs are closed when harvesting energy. This generates a more homogeneous climate in the greenhouse, and besides that less pesticides and insecticides needs to be used. Also temperature and humidity can be regulated more precisely resulting in higher production and better quality of the plants.

Zig Zag® roof sheets

Mister Piet Sonneveld from Wageningen UR invented the Zig Zag® roof sheets. Because of the shape and the angle the sheets have, light gets a second change to enter the greenhouse. It only works efficiently when the light is direct and not diffuse. The direct light will be converted into diffuse light in the greenhouse.

The sheets are made of polycarbonate which ensures more transmission. The light transmission is higher than flat sheets. It saves energy for 20% up to 45% compared to single glass and it functions as a UV filter. The sheets captures heat, because a twin wall sheet provides isolation. And it is safe: it is hail resistant, unbreakable and cannot burn.

PV cells or the Fresnel lens: electricity delivery

At the moment we are able to produce electricity from sun light using PV cells. But PV cells and horticulture both using PAR (Photosynthetically Active Radiation; the wavelengths of light used by plants in photosynthesis). So will it be useful to make transparent PV cells? It will be more efficient to produce electricity with the Fresnel lens. This type of lens concentrates radiation, resulting in 30 -100 times less light losses. The Fresnel lens has a spectral selective film which can separate NIR (Near Infrared Radiation, heat) and PAR. NIR radiation can be converted into (high worthy) electrical energy, resulting in less heat surplus during summer. And the PAR will remain available for the plants to grow. An asymmetrical covering will result in extra surface on the southern direction and therefore increase the energy yield. Greenhouses covered with such a rooftop are called Fresnel lens greenhouses (not in Bergerden), which are also invented by mister Sonneveld.

More advantages are similar to the solution with the Fiwihex heat exchangers: climate circumstances in the greenhouse will be improved and supply and demand of energy flows during the year are more in equilibrium. And besides that, heat will be available for the aquifer, so in winter the greenhouse can be heated. Both greenhouses (with heat exchangers and Fresnel lens rooftops) make use of solar energy more complete.

Energy production

More heat is harvested in summer than used for heating the greenhouse in winter. So there will be a surplus of heat produced by the EGH. The EGH delivers hot water of 40°C to anyone who wants to use it, like districts for example. The EGH has an energy surplus of 283 MJ/m².

(Dis-) advantages

High investments in such a system, practical experiences of only a few years and still a need for fossil fuels (the small engine in the heat exchanger) can be seen as disadvantages. But with those systems less fossil based gas will be used, there is a net production of 'renewable' energy (heat and electricity) and the production and quality of the plants will be higher. At the moment businesses and industry make use of the hype about climate change and sustainable development. Having an energy producing greenhouse contributes to the positive image of the company.

When we went to the EGH in Bergerden it felt like a day in summer, although it was still spring. There was a lot of sunshine and it was warm. From experience we can say: the Fiwihex heat exchanger works! In the EGH the climate was very pleasant and the temperature was lower than the temperature outside.

Extra information on websites:

www.kasalsenergiebron.nl (website in Dutch only)

www.energiek2020.nu/ (website in Dutch only)