# Energy Saving Research 2011

Visit Norwegian group June 2011, Wageningen, NL

Silke Hemming
Wageningen UR Greenhouse Horticulture, NL

WAGENINGEN UR For quality of life

Productschap Tuinbouw Voor een bloeiende zaak

Ministerie van Landbouw, Natuur en Voedselkwaliteit

## Some facts and figures

| | 2000 | 2008 |
|---|---|---|
| Gas use $m^3$ ($1m^3$=31.5 MJ) equals 10% of national use | $3,6\ 10^9$ | $4,0\ 10^9$ |
| For crop production | $3,4\ 10^9$ | $2,9\ 10^9$ |
| Net Electricity production (kWh) 6% | $1,3\ 10^9$ | $4,8\ 10^9$ |
| Energy efficiency (1980 =100%) Energy/ unit product | 45 | 30 |

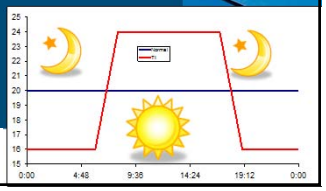
## Goals of Dutch horticultural sector

- Targets Greenhouse sector in the Netherlands for 2020:
- -48% $CO_2$ emission compared to 1990 (-3.3 Mt)
- 2% higher energy efficiency every year
- Greenhouse sector uses 20% sustainable energy
- Economic feasible greenhouse concepts


## Problem

- 75-90% of the energy is used for temperature control/heating purposes
- → make use of free solar energy
- → greenhouse insulation (screen, double covering)
- → temperature integration

*e.g. Bot 2001; Hemming et al. 2009; Zhang et al. 1996; Bakker et al., 2008; de Gelder et al, 2010...*

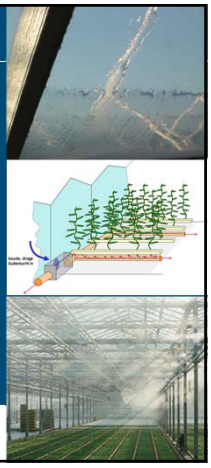



WAGENINGEN UR For quality of life

## Problem

- 10-25% of the energy is used for dehumidification purposes
- → decrease crop transpiration
- → dehumidification with outside air
- → increase humidity setpoint, fogging

*e.g. Bakker, 2008; de Gelder et al., 2010; Li & Stanghellini, 2004; Campen, 2009...*



WAGENINGEN UR For quality of life

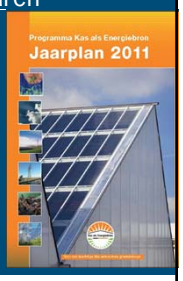
## Goals of Dutch energy saving research

Ministry of Economic Affairs, Agriculture and Innovation

Uw sector investeert in dit onderzoek via het Productschap Tuinbouw

In total more than 50 projects

Total budget 7 MEURO




## Examples in pratice

- Co-generation: a lot of growers
- OCAP $CO_2$: growers in the Western part

- Semi-closed greenhouses: Prominent (Westland), De Grevelingen (Sirjansland), Tas (Zevenhuizen), Van der Lans (Rilland), Themato (Berkel en Rodenrijs), Sion Orchids (de Lier), Rozen van der Weiden (Nieuwveen) ..... → diverse cooling systems and strategies
- Greenportkas: Joep Ramakers (Venlo) → energy delivery to house of eldery people ....

HYDRO HUISMAN

Greenportkas Venlo

## Examples in pratice

- Geothermie: Rik van den Bosch (Bleiswijk) → greenhouse on geothermal energy
- Bio-WKK: Jaap Vink (Beegtum), RijnPlant (Westland), Hartman (Sexbierum) → 1,1 MWe on biogas from french fries production, Nico Karsten (Hooghoud) → 2 x 330 kWe on biogas from bulbs and manure, Jaap Vink (Beegtum) on wood
- BiJo: Biologisch Jonker → bioler with bio-oil, green electricity, heat storage

WAGENINGEN UR

## The next generation of growing

Tomato: 60 kg/m² tomato with 27 m³/m² gas instead of 40 m³/m² gas

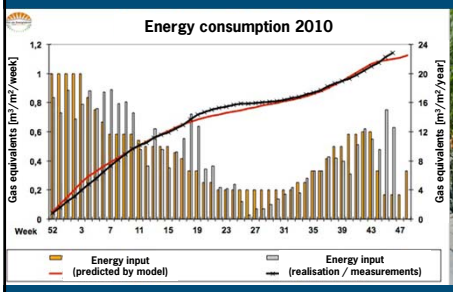
Greenhouse system:
- Three energy screens (plastic film, transparent screen, aluminized screen)
- Heating maximum pipe temperature 48°C
- Temperatureintegration, -flexibility
- Dehumidification by blowing in dry outside air
- Increasing humidity setpoint >85%

Use sun energy to heat up greenhouse, control greenhouse climate depending on outside climate

WAGENINGEN UR

De Gelder, 2010

## The next generation of growing




WAGENINGEN UR

De Gelder, 2010

## Optimize natural light

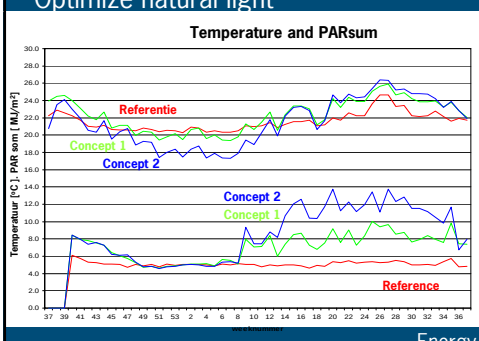
New growing strategies potplants
**→ more light, temperature integration**

| | Reference (9.06) | Concept 1 (9.07) | Concept 2 (9.08) |
|---|---|---|---|
| Light | 5 mol/m²/day | | |
| Screen closed | 300 W/m² | 500 W/m² | 500 W/m² |
| Screen | LS 16, 50% white wash | LS 10, Diafragma, 25% white wash | LS 10, Diafragma |
| Temperature | 19/21 to 23 | 17.5 to 28 | 15 to 28 |
| RV (fogging) | Min. 40% | Fogging: 60% | Fogging: 80% |

WAGENINGEN UR

Van Noort et al., 2010

## Optimize natural light




Energy saving > 70%

WAGENINGEN UR

Van Noort et al., 2010

## Diffuse light

- Diffuse light is positive because…
  - Changed light penetration in crop
  - Diffuse light is absorbed more by middle leaf layers of cucumber
  - Higher photosynthesis in those leaf layers
  - Higher yield (up to 10%)
  - Milder greenhouse climate on sunny days
  - Lower head temperature during high irradiation

Hemming et al., 2007
Dueck et al., 2009

## LED compared to SON-T


Dueck et al., 2010

## Innovation and Demonstration Centre

- Greenhouse concepts
  - Sunergy Greenhouse
  - FlowDeck Greenhouse
  - Sun Wind Greenhouse
- Ca. 500m² each greenhouse


De Zwart, 2010

## IDC - Sunergy greenhouse = Closed greenhouse


## IDC - Sunergy greenhouse

- Net heat delivery (2m³/m²/year)
- High production of cucumbers (>50kg/m² in half a year)
- High production of tomato
- (>70 kg/m² per year)
- Economic feasibility depending on spark spread

De Zwart, 2010

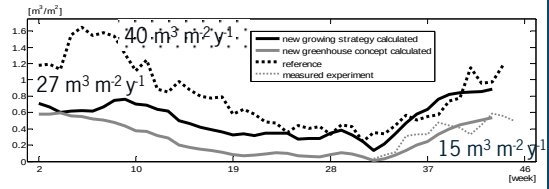
## IDC - VenlowEnergy energy saving


- Double glass
  - Anti-reflection coating
  - Low-emission coating
  - Low u-value: 1.2 W/m²/K
  - High light transmission: 79% hemispherical
- Energy saving by:
  - Double covering, screen
  - No minimum heating pipe
  - Fogging
  - Dehumidification with heat regain

Kempkes et al., 2011

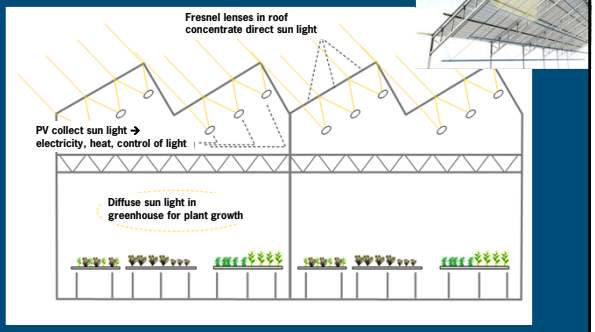
## IDC – VenlowEnergy: energy consumption

- Calculated (year-round) and realised (week 32 until 45) energy consumption




Energy saving ca. 50-60%

## IDC – Fresnelgreenhouse




De Zwart et al., 2011

## IDC - Fresnel greenhouse

Ca. 16 kWh/m²/year electricity &
Ca. 400MJ/year heat energy

De Zwart et al., 2011

## Transitionpaths "Kas als Energiebron"

20-40% saving of heating energy by The new generation of growing

Sun light energy is for free

Fresnel greenhouse: electricity producing

Waste $CO_2$ from Shell industry


VenlowEnergy greenhouse: 50-60% saving by insulation

Semi-closed greenhouses: ca. 40% energy saving

Co-generation: 30% saving

## Wageningen UR Greenhouse Horticulture

Innovations for and together with the greenhouse sector



Productschap Tuinbouw

Ministerie van Landbouw, Natuur en Voedselkwaliteit