

## Current research on greenhouse constructions, materials and climate control

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## Dutch Greenhouse Horticulture

Some figures:

- Production area: >10.000 ha (45% vegetables)
- Number of companies: 5.600 (1.800 vegetables) ↓
- Energy consumption: 129 PJ (x4)
- Energy costs: 20-25% of production costs ↑
- Production value: € 1.300 miljoen vegetables (x60)



## Dutch Greenhouse Horticulture

- Increasing costs (energy and labour)
- Higher demands society and consumers (quality, year-round offer, special products)
- Increase of scale and international expansion
- Concentration (specific area's, multi-functional land-use)
- System integration



## Developments in Dutch greenhouse production

- |  |        |
|--|--------|
| 1. Increased production levels by high natural light and additional lighting | Market |
| 2. Mobile production systems with high grade of automation and robotics      | Labour |
| 3. Energy conservative and semi-closed (controlled environment) greenhouses  | Energy |
| 4. Optimal or multifunctional use of greenhouse area                         | Area   |

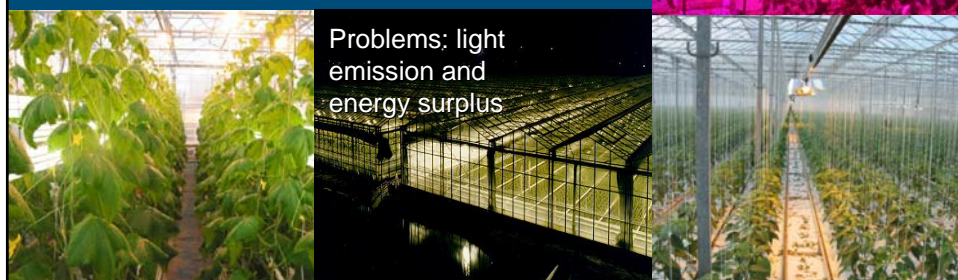
## High natural light and additional lighting

- Increased production levels by high natural light
- Light greenhouses: high light transmission, coated glass, diffuse glass, NIR reflection, new materials

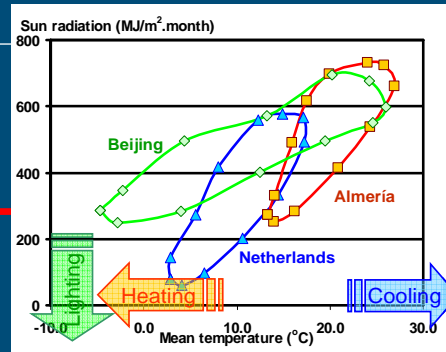


## High natural light and additional lighting

- Increased production levels by high additional lighting
- Artificial lighting: increasing areas, increasing light levels, LEDs, interlight



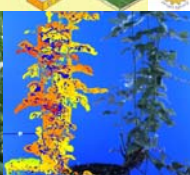
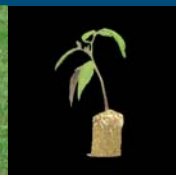
## Future perspectives



- Greenhouses are adapted to local conditions:
- Adaptive greenhouse for all climates
  - Social environment
  - Availability of resources
  - Legislation

## High grade of automation and robotics

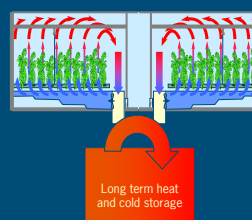
- Mobile production systems with high grade of automation and robotics ground -> individual plants
- Integrated growing systems (Mobysant, Mobyflowers...)
- Sorting technology (x-ray, 3Dscan, stereovision, NIR spectroscopy, fluorescent-technology...)
- Harvesting robots (apples & pears, roses, ...)
- Field-robots



## Energy conservative and semi-closed greenhouses

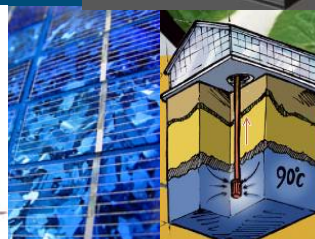
- Conditioned greenhouses, energy delivering greenhouses, electricity delivering greenhouses, energy webs

Benefits: energy saving, production increase, higher production due to better climate control (more CO<sub>2</sub>, uniform temperatures)



## Energy conservative and semi-closed greenhouses

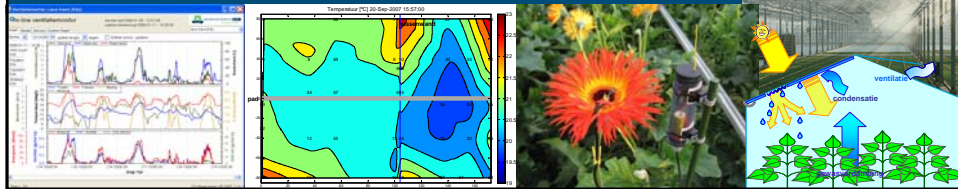
- Sustainable energy sources
- Global radiation as energy source & heat pumps, geothermal, Kas zonder gas, photovoltaic, power generation with green energy sources





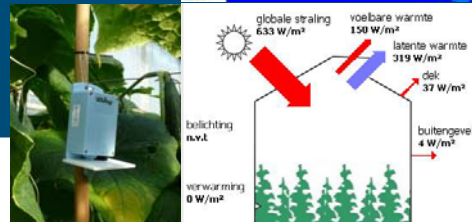
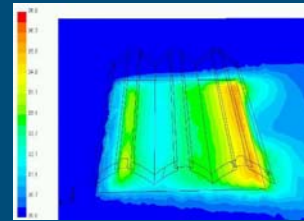
## Energy conservative and semi-closed greenhouses

- Greenhouse climate control
- Natural growing – interaction plantphysiology / climate
- Air circulation (ventilators)
- CO<sub>2</sub> dosing by power generation, OCAP, CO<sub>2</sub> viewer
- Mechanical dehumidification, condensation behaviour of coverings, humidifiers
- Optimum control
- Soft-sensors for climate observation
- Micro-climate



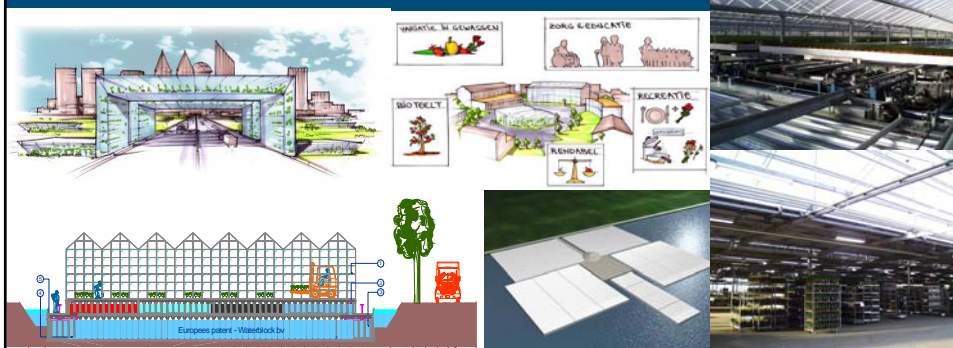
## Energy conservative and semi-closed greenhouses

- Research tools:
- Virtual greenhouse -KASPRO
- CFD of ventilation and cooling systems
- Wireless sensors
- Kijk in de kas
- Synergiekompas



## Optimal or multifunctional use of greenhouse area

- Combining plant production with logistics (Bunnik plants)
- Combining greenhouse production with water storage, floating greenhouses
- Greenhouses in the city
- Greenhouse and fish production (Zeeuwse Tong)
- Agroparks



## Wageningen UR Glastuinbouw Innovaties vóór en mét de glastuinbouw

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