Development of high efficient and energy saving greenhouse systems in the Netherlands

Horticulture Forum: "The High Efficiency and Energy Saving Production in Agriculture Greenhouse"
April 18th 2011, Taipei, Taiwan

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- The Netherlands and Taiwan are the same size

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Some facts and figures

- Population: 400 people/m^2
- Glasshouse area: 10.000 ha
- about 40% vegetables
- Number of enterprises: 5000
- Tendency towards large enterprises (>10 ha)
- Market-oriented production
  - High production levels
  - High quality
  - Exact timeline of production
- Average annual turnover: €45/m^2=NTS1800/m^2



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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



Research program “Kas als Energiebron”

- Energy: 20-30% of production costs
- 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



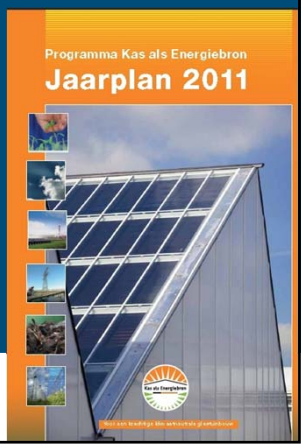
Research program “Kas als Energiebron”

- Research budget: 7 M€
- In 2010 more than 50 projects
- Financed by

Ministry of Economic Affairs, Agriculture and Innovation

Uw sector investeert in dit onderzoek via het Productschap Tuinbouw

- Participation of growers, industry, advisors, research



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Transitionpaths “Kas als Energiebron”

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Examples in pratice

- Co-generation: a lot of growers
- 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

sion

HYDRO HUISMAN
SPECIALIST IN HYDROCULTUUR

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

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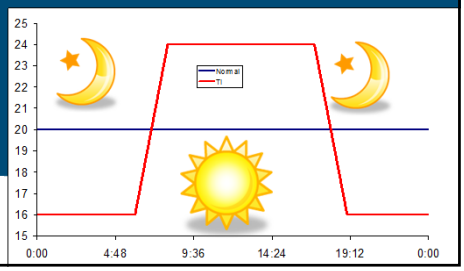
Energy saving = optimum crop growth = €

- Goal: Optimum crop growth
- What determines energy consumption in The Netherlands?
- Temperature = 75-90% of energy use (heating in NL)
  - → lowering heating temperature = production losses
  - → temperature integration saves energy
  - → greenhouse insulation (double covering, screen)



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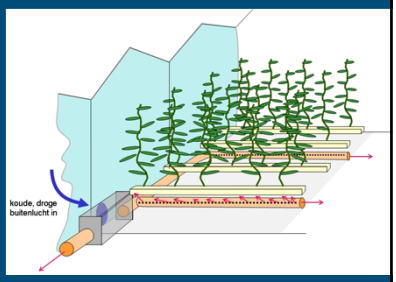
Energy saving = optimum crop growth = €



- What determines energy consumption in The Netherlands?
- Air humidity = 10-25% of energy use (dehumidification in NL)
  - → decrease crop transpiration
  - → increase humidity setpoint, fogging
  - → dehumidification by dry outside air

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The next generation of growing

Tomato: 60 kg/m^2 tomato with 27 m^3/m^2 gas
instead of 40 m^3/m^2 gas

Greenhouse system:

- Three energy screens (plastic film, transparent screen, aluminized screen)
- Heating maximum pipe temperature 48^{o}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

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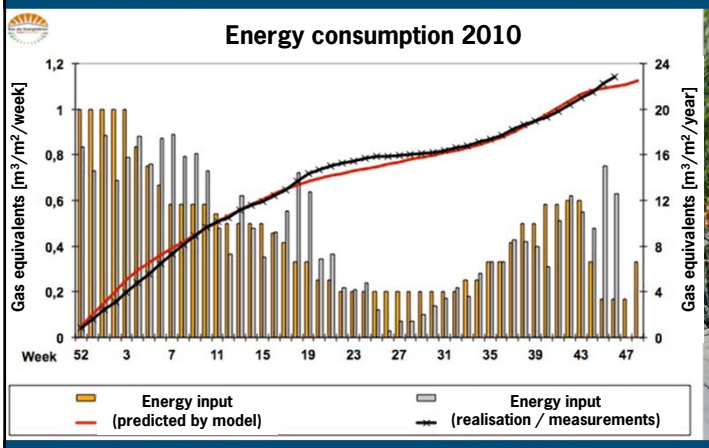
De Gelder, 2009

The next generation of growing



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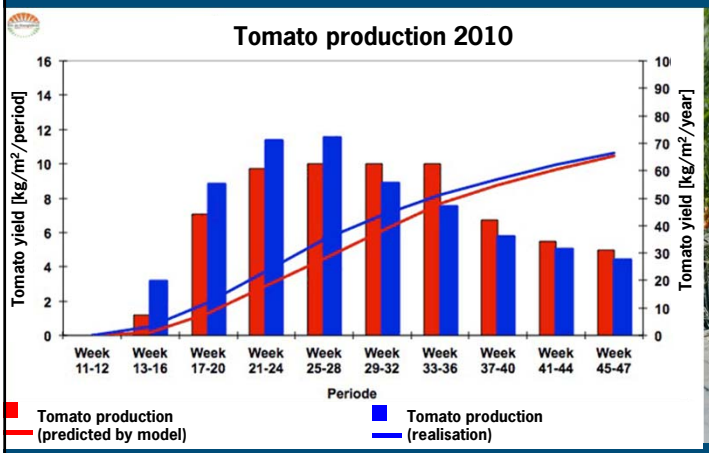
The next generation of growing



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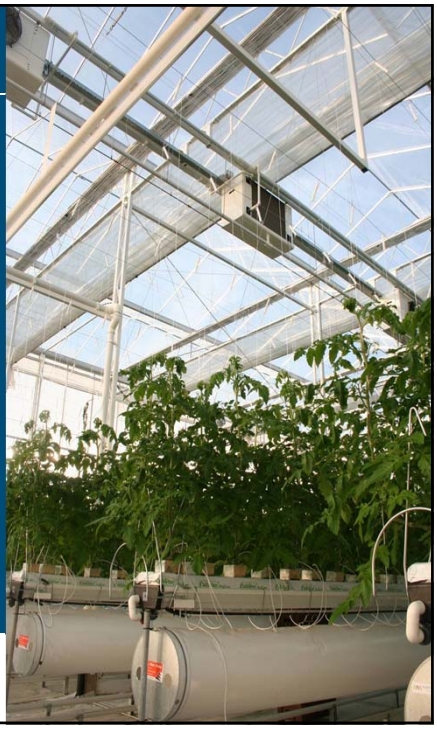
IDC – Sunergy greenhouse

A semi-closed greenhouse



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Sunergy greenhouse: system

Sunergy: Extraction of solar heat in summer

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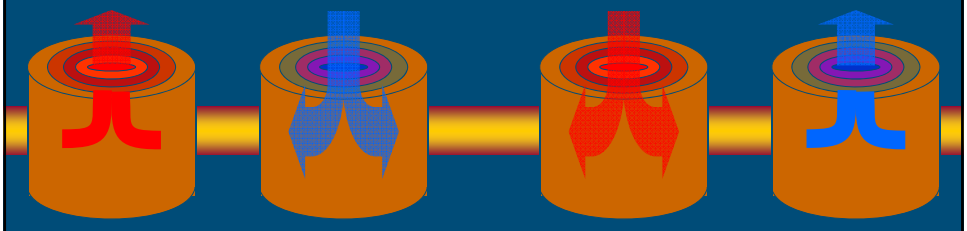
Sunergy: storage of heat

Seasonal storage in aquifers (80m depth)

Winter = discharging

Summer = charging



Daily/weekly storage in buffer tanks

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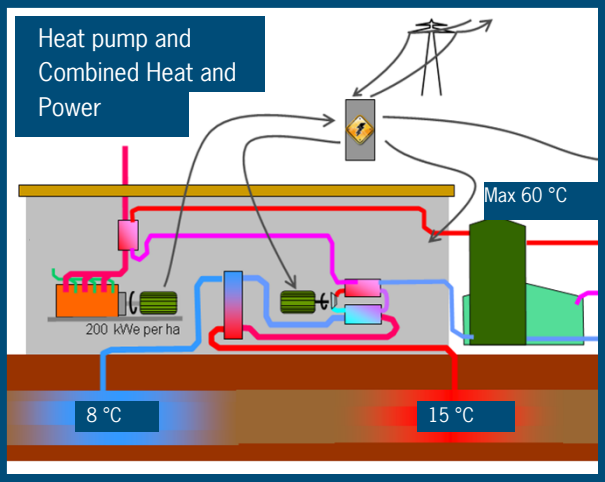
Sunergy: heat pump and co-generation CHP



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Sunergy greenhouse: results

- Net heat delivery (2m^3/m^2/year)
- High production of cucumbers (>50kg/m^2 in half a year)
- High production of tomato
- (>70 kg/m^2 per year)

- → Demonstration of new crop strategies
- → Demonstration of “new” cooling techniques

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IDC – VenlowEnergy greenhouse

VenlowEnergy greenhouse: energy saving

- Double glass
  - Anti-reflection coating
  - Low-emission coating
  - Low u-value: 1.2 W/m^2/K
  - High light transmission: 79% hemispherical (si glass is 82%)
- Energy saving by:
  - Double covering, screen
  - No minimum heating pipe
  - Fogging
  - Dehumidification with heat regain

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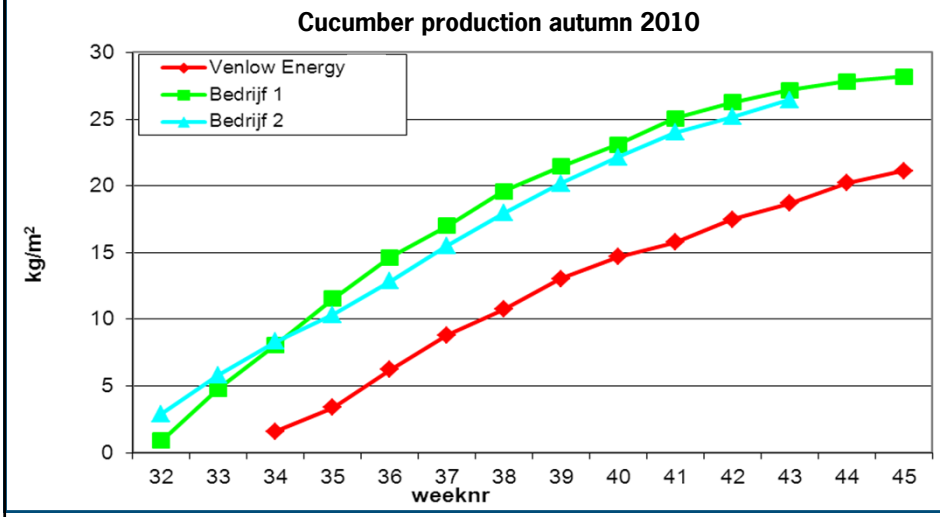
VenlowEnergy greenhouse: cucumber (Ranomi)



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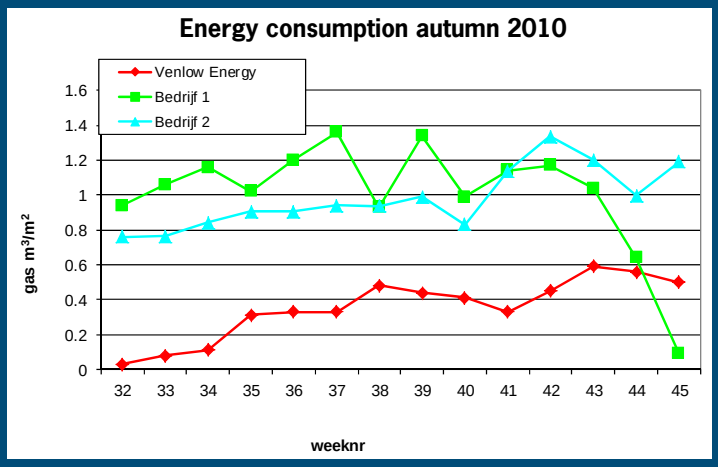
6 Aug – 15 Nov

21 kg per m^2

VenlowEnergy greenhouse: energy consumption



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6 Aug – 15 Nov

$5m^3$gas per m^2
goal: $15m^3m^2$/year

VenlowEnergy greenhouse: tomato (Komeet)

Week	51	52	1	2	3	4	5	6	7	8	9	10
Date	20-dec	27-dec	3-jan	10-jan	17-jan	24-jan	31-jan	7-feb	14-feb	21-feb	28-feb	7-mrt
Gas consumption **real** per week	0.37	0.63	0.77	0.63	0.52	0.70	0.91	0.72	0.68	0.92	0.76	0.66
Gas consumption **calculated** per week (SEL2000)	0.59	0.57	0.63	0.59	0.67	0.72	0.65	0.68	0.63	0.64	0.54	0.54
Cumulative gas consumption **real**	0.4	1.0	1.8	2.4	2.9	3.6	4.5	5.3	5.9	6.9	7.6	8.3
Cumulative gas consumption **calculated** (SEL2000)	0.6	1.2	1.8	2.4	3.1	3.8	4.4	5.1	5.7	6.4	6.9	7.5

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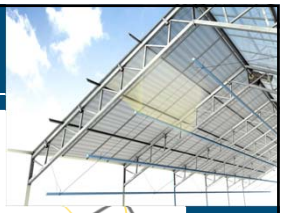
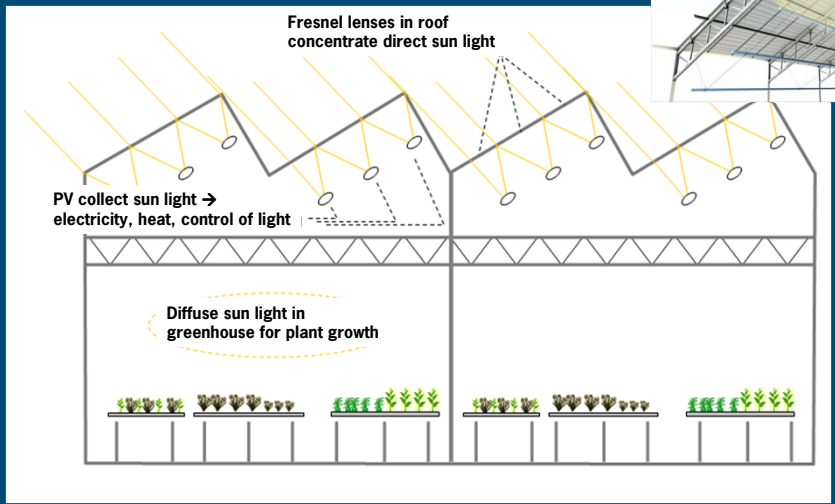
IDC – Fresnelgreenhouse: system





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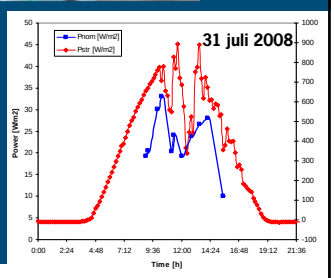
Fresnel greenhouse: first prototype







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Bedo

IDC - Fresnel greenhouse

Goal: 35 kWh/m^2/year electricity
& 210 kW/m^2/year heat energy

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TECHNOKAS

Bedo

Dutch orchid production: first stage young plants

Warm section: >26°C

Uniform light intensities: ca. 130 µmol m^{-2} s^{-1}

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Cold section: 18-20°C

Higher light intensities: ca. 220 (350) µmol m^{-2} s^{-1}

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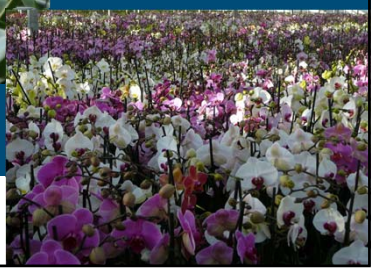
Dutch orchid production: last stage flowering

Warm section: ca. 23-25°C

Uniform light intensities: ca. 100-150 µmol m^{-2} s^{-1}



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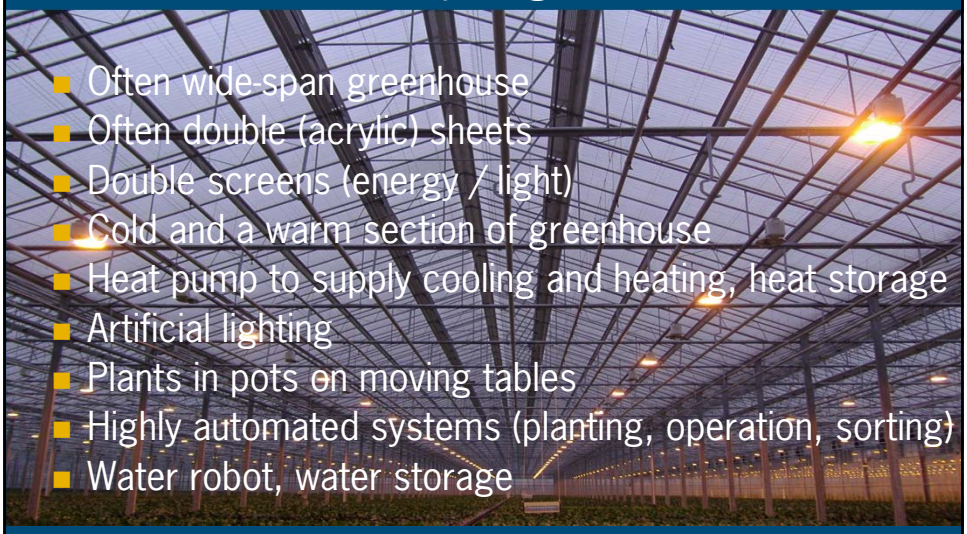
Installation at Phalonopsis growers in Holland



- Often wide-span greenhouse
- Often double (acrylic) sheets
- Double screens (energy / light)
- Cold and a warm section of greenhouse
- Heat pump to supply cooling and heating, heat storage
- Artificial lighting
- Plants in pots on moving tables
- Highly automated systems (planting, operation, sorting)
- Water robot, water storage

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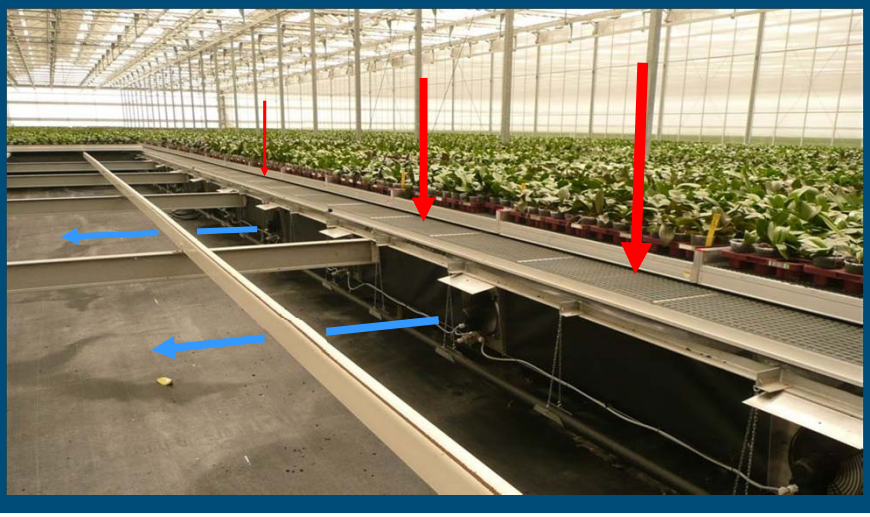
Orchid production: Cooling below the tables (1)



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Orchid production: cooling below the tables (2)

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Orchid production: cooling above

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Orchid production: water system

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Orchid production: mobile benches, multi-layer

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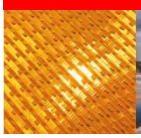
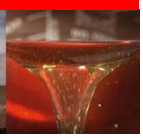
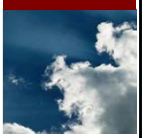
Transitionpaths "Kas als Energiebron"

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

Energy saving		Sustainable Energy Sources			Efficient use of fossil energy	Others
						
Growing strategy	Light	Solar energy	Geothermal heat	Biofuels	Sustainable electricity	Sustainable CO_2

VenlowEnergy greenhouse: 60% saving by insulation

Sunergy greenhouse: almost climate neutral, high production

Co-generation: 30% saving

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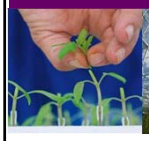
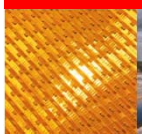
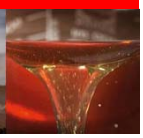
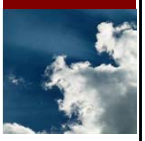
Research program “Kas als Energiebron”

Co-operation growers, industry, advisors, research

Energy saving		Sustainable Energy Sources			Efficient use of fossile energy	Others
						
Growing strategy	Light	Solar energy	Geothermal heat	Biofuels	Sustainable electricity	Sustainable CO_2

CROP

ENERGY

TECHNOLOGY

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KNOWLEDGE

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