Energy optimization and the Closed Greenhouse in Dutch horticulture

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Dutch horticulture and innovation

1950/60s: CO_2; Venlo
1980s : substrate; computers
1990s : biological crop protection
1996 : GeslotenKas development at Ecofys

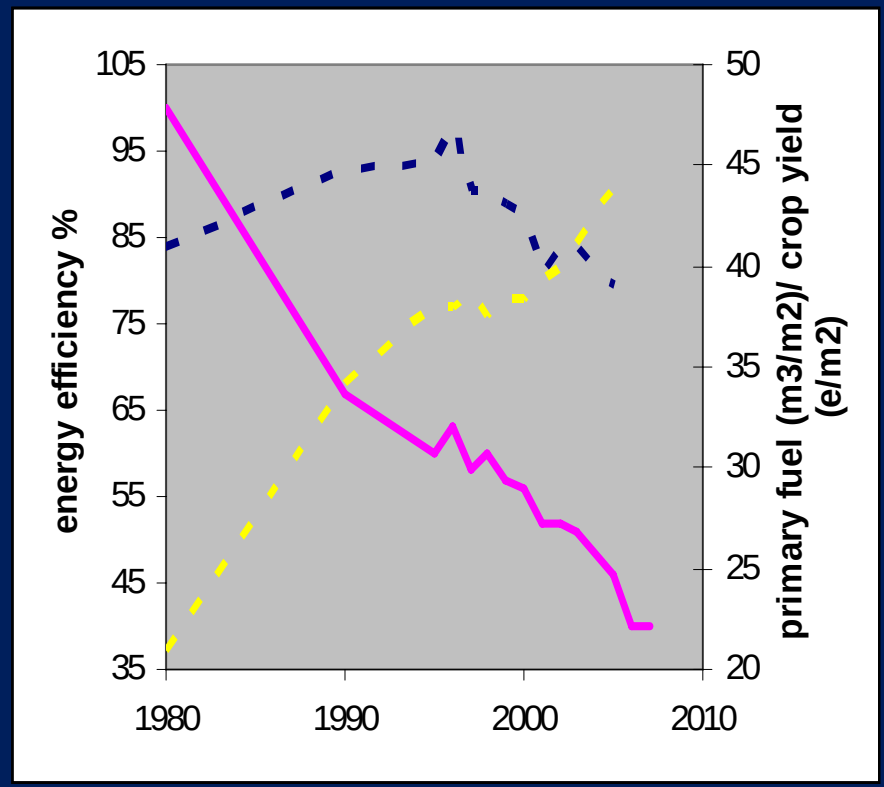
1998-2002 Kas van de Toekomst (ECN, TNO, WUR, Nuon, Ecofys) ⇒ Floriade
- New cover materials, heat pumps, fuel cells
- Closed Greenhouse presented results

Drivers for innovations in horticulture:
- Raising product production and quality
- Energy saving

Historical and future energy use: from energy efficiency .....

Long Term Agreement:
- energy efficiency to 35%
- 4% sustainable energy

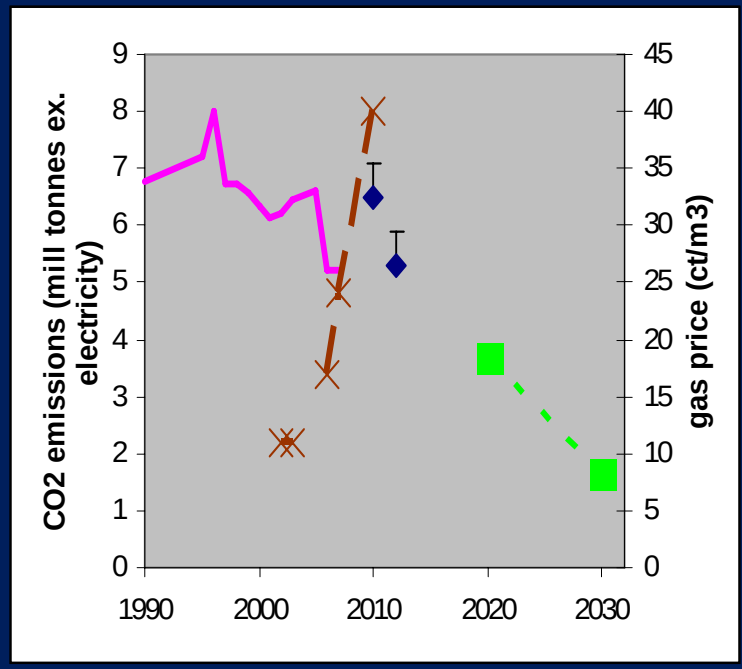
objectives may not be achieved:
- decrease in industrial heat
- More energy consuming processes
- Sustainable energy 2007 only 0.8%



to CO_2 reduction and emission trade

So is there an incentive for sustainability ???

Rising energy prices in 2008 have fallen again



New agreement (2008):

- Goal: climate neutral and insensitive for rising energy prizes
- Vision: greenhouse is a solar collector to harvest energy

Future:

- Clustering
- (semi-) closed greenhouse (HP with CHP) 700 ha in 2011
- Geothermal heat
- External CO_2, green electricity

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What is the Closed Greenhouse

Improves major growth factors T, RH, CO_2 by keeping greenhouse (semi)closed

Summer:

- Storage of surplus of heat in summer
- Active cooling with stored winter cold

Winter:

- Use of summer heat in winter
- Storage of generated cold

Results in higher production & energy saving

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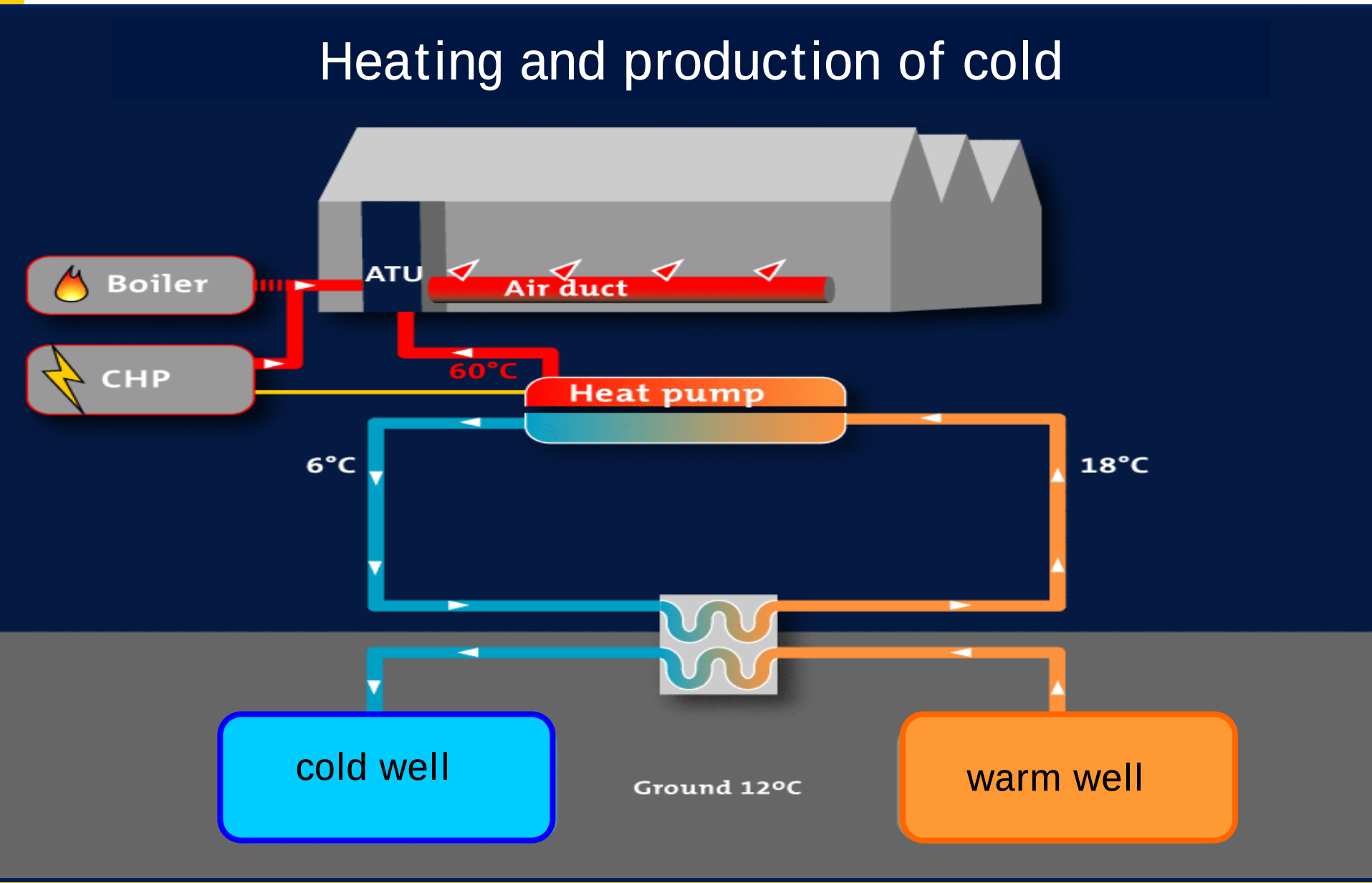
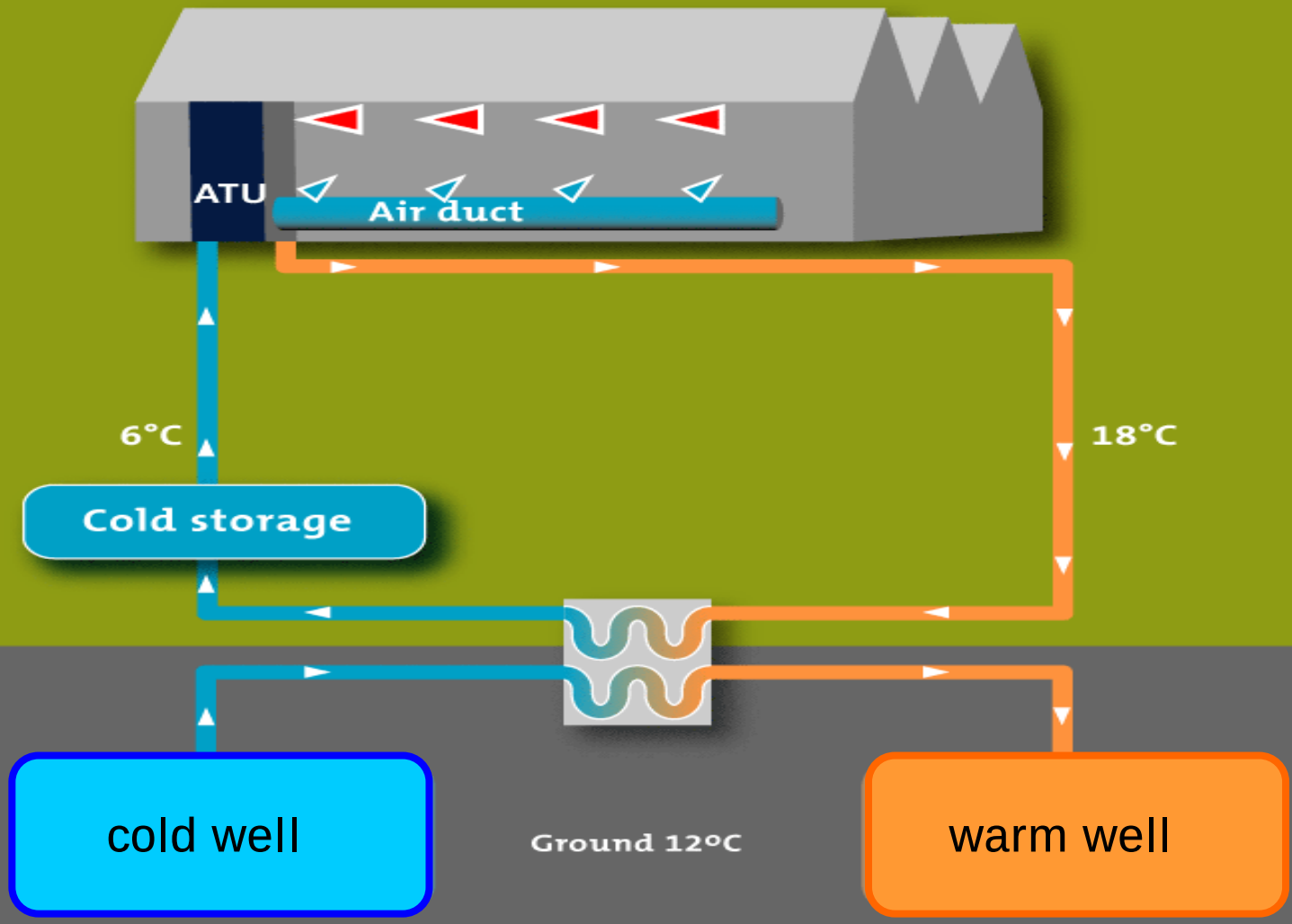
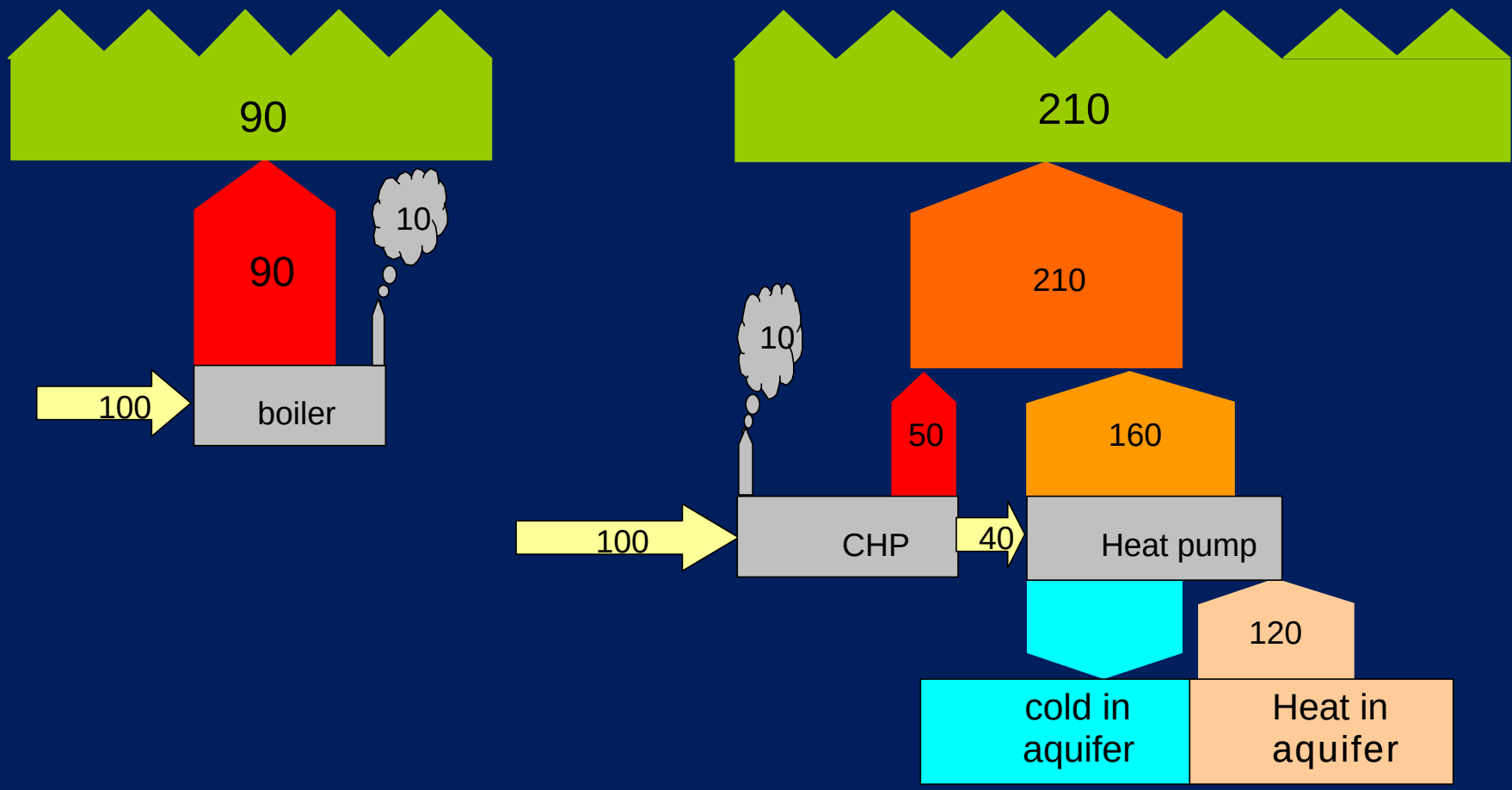
Heating and production of cold



Cooling, dehumidifaction and heat collection

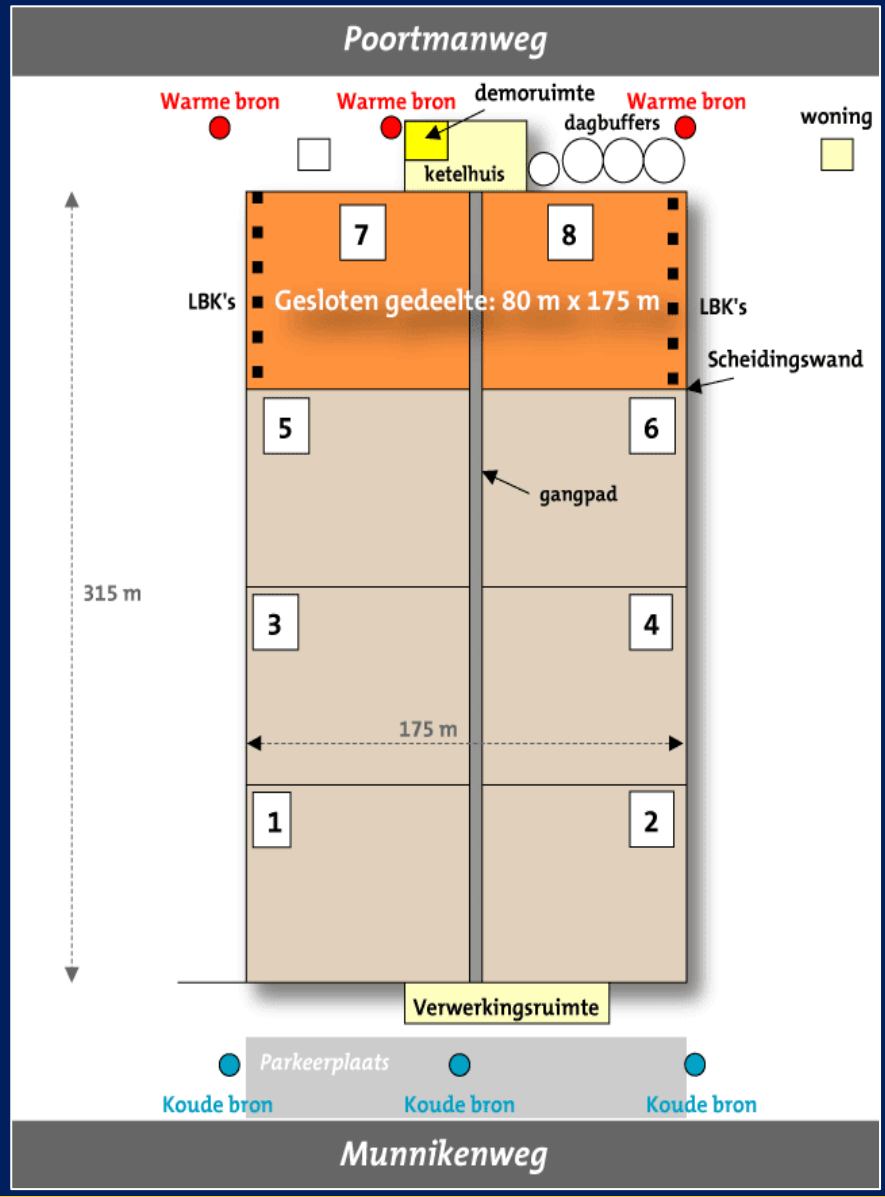


Sustainable energy production at Themato (first project build 2003)



Themato

1.4 ha “closed greenhouse”
Excess heating to “open” 4 ha
6 wells (3 cold + 3 warm)
CHP, heat pump
100 air treatment units
100 air socks (27,000 ft)
Result: 35% energy saving; 20% higher production



Sustainable cooling / heating

After the success of Themato sustainable cooling and heating got more common in horticulture in several crops and with different systems, because of the benefits (crop and energy):

- Semi/fully closed
- Different air treatment units on different places in greenhouse
- Air ducts / no ducts
- Different types of heat pumps

Depending on demand of crop or type of greenhouse

Innogrow (subsidiary of Econcern) designs Closed Greenhouse projects (since 2003)

HP specs in several Innnogrow projects

	Power HP	Refr.	COP (H/E)	Temp. out	installation
	kWe			C	
Themato	525	R134a	4.0	54	heat HP in HT buffer
Tas	90	R134a	4.2	45	Condenser in series met CHP 40->90C to buffer
Prominent	626	R134a	5.0	47	heat HP in HT buffer via diffusers
Delta	375	R134a	3.9	53	no aquifer but day buffer
BiJo	460	R134a	6	35	100% sustainable

Choice HP

general:

- reliability
- Fit in project (temperature, power)
- High COP
- Investment

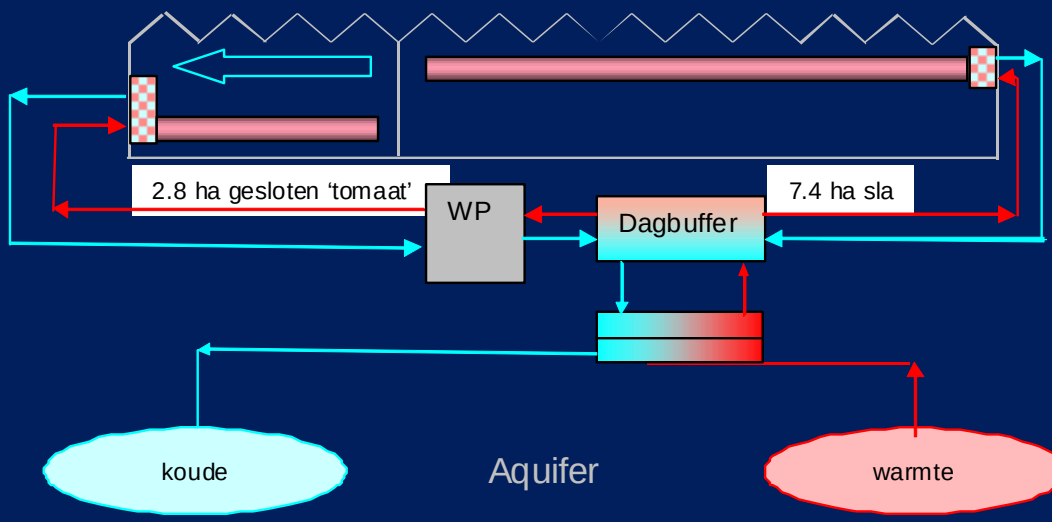
choice for supplier:

- interface module for communication between internal control unit and greenhouse climate computer
- Maintenance for horticultural sector
- Time to deliver

Energy management

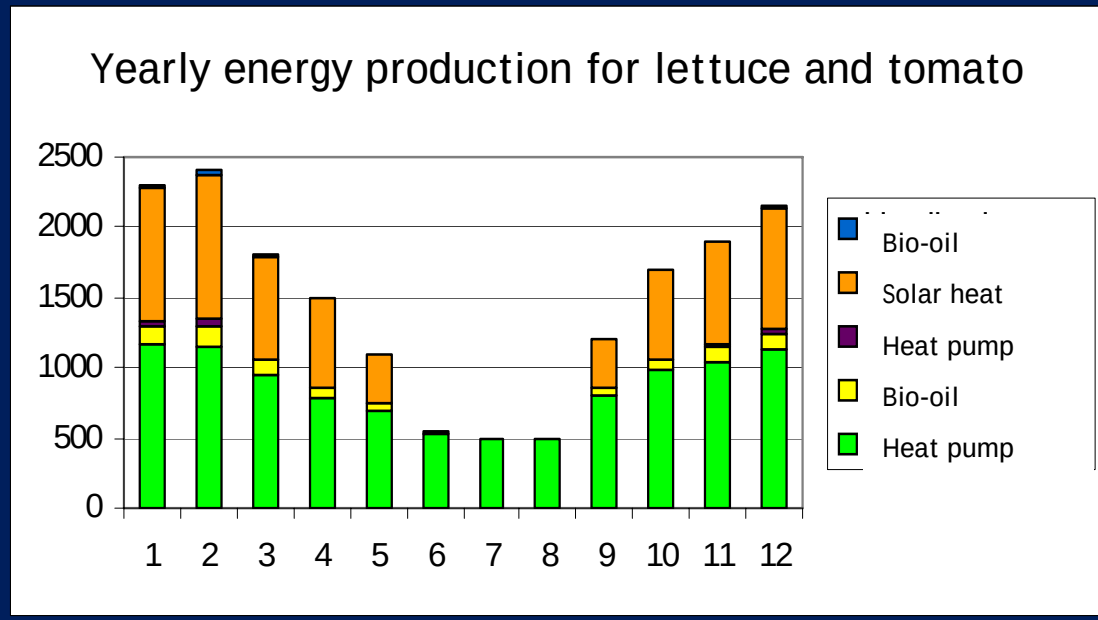
- Monitoring GeslotenKas neccesary because of seasonal buffering (think ahead) : cold need of greenhouse in summer is produced in winter time
- Greenhouses are used to high temperature pipes; with HP you want high COP so low temperature and low E consumption
- Installation with buffering to uncouple heat, cold, electicity use and production

Our 100% sustainable GeslotenKas



Summer: cooling and harvesting solar heat (tomato)

Winter: direct heating with stored solar heat (new: air heating in lettuce)



Challenge for a green greenhouse in Holland: innovate !