



**Experience geothermal energy in
the greenhouse business:
a global roadshow of possibilities**

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Delft NL
Wednesday June 15th 2022



Geothermal Greenhouses | Agenda



1. Renewables in heating and cooling for greenhouses
2. Showcases of the use of geothermal in greenhouses
- 3. Relations to Crop & Water management**
4. Roadmaps for individual projects and configurations
5. Market developments



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Renewables in heating and cooling for greenhouses

Source	Conversion	Greenhouse system
Wind	POWER (Hydrogen)	Fans Lights AC / Air treatment units Heat pumps
Solar		
Nuclear		
Biomass	HEAT	Heating pipes/tubes
Waste heat	HEAT	
Geothermal	HEAT COOL + storage	Heating pipes/tubes AC / Air treatment units Primal energy for heat pumps

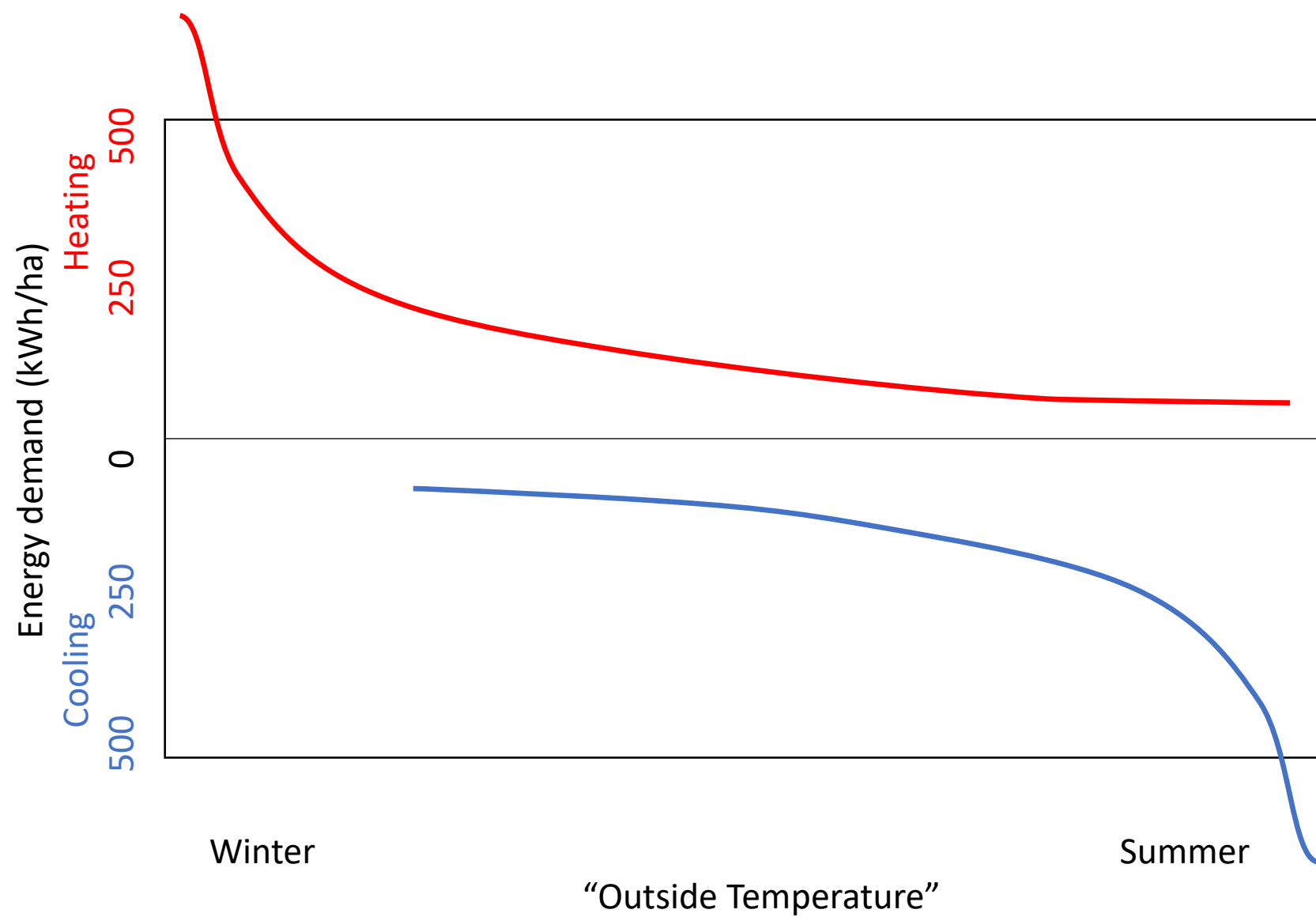
Related to:

- Local climate conditions
- Crop need
- Indoor climate strategy
- Technology level & intensity
- Local energy grids

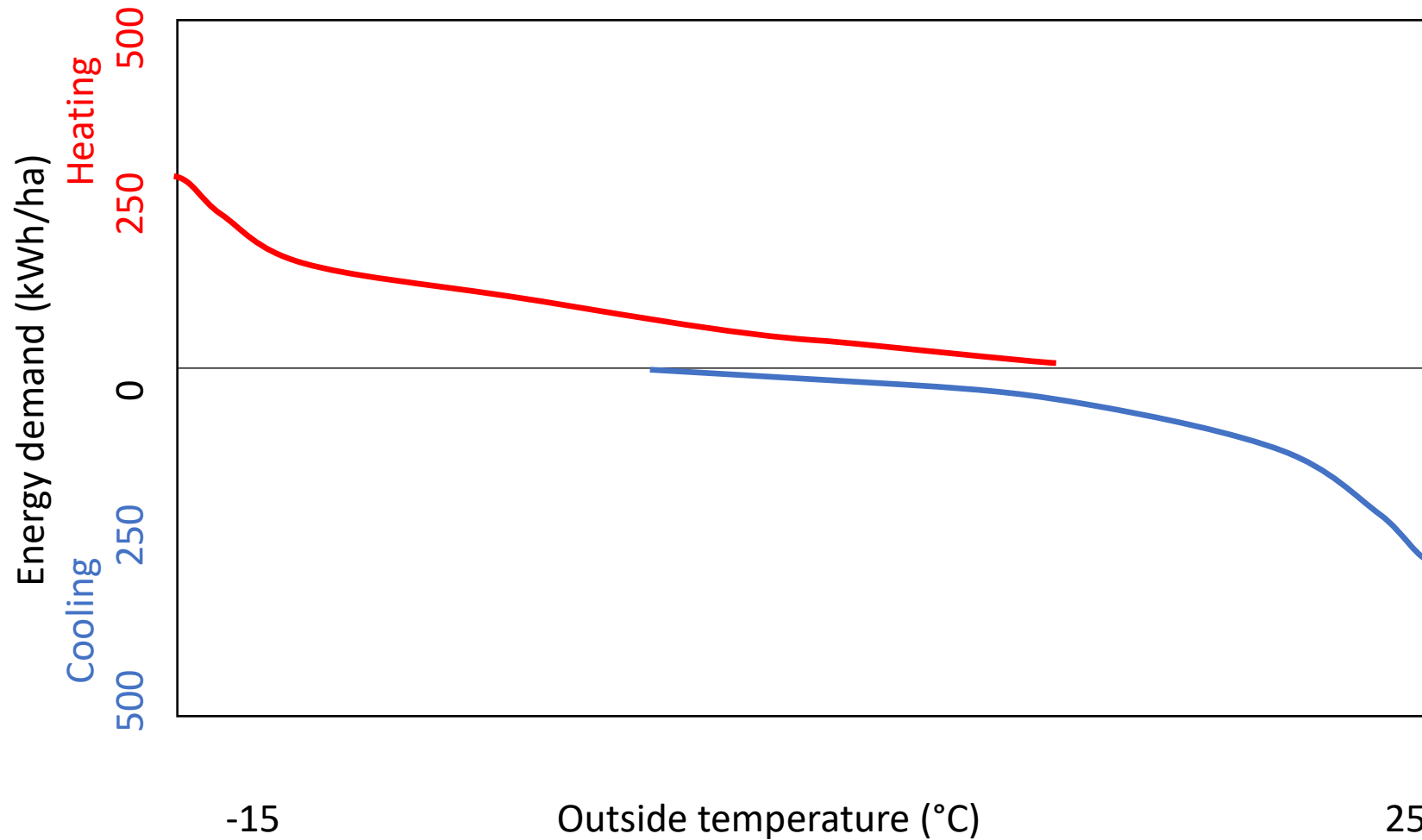
GENERAL CONCLUSION:

We need all possible options
to lower CO2 footprint

Heating and cooling demand – seasonal



Heating and cooling demand – 24 hours



Showcases of the use of geothermal in greenhouses

1. NL Deep geothermal
(1000 – 3000 m)
production 40 – 100 °C
2. UTES = underground thermal energy storage
(50 – 500 m)
cold production summer (5 °C)
heat production winter (25 °C)
3. Innovations:
Combination Deep Geothermal and UTES
Seasonal storage 45 – 85 °C



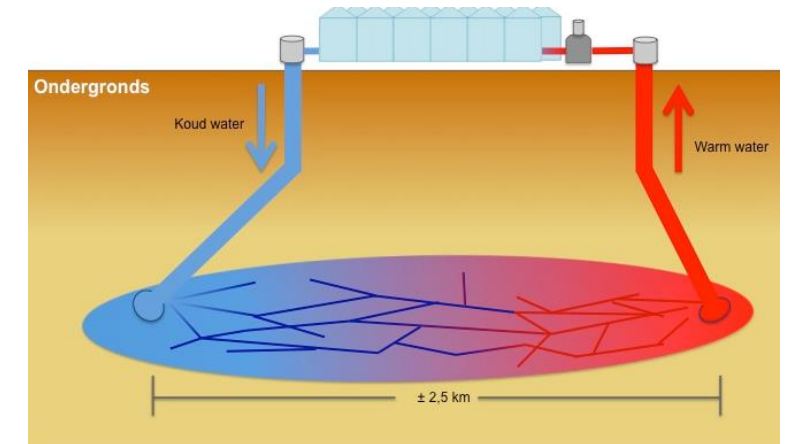
1. “Deep”geothermal doublet for greenhouses

NL 2021:

24 locations = 6,4 PJ

342.000 tonnes CO₂ = 181 M m³ natural gas

1. Geothermal heat production 40 – 100 °C
2. Heating installation to cool down in delta T 20 – 60 °
3. High capacities 10 – 30 MW th per installation
4. NL: 20 – 200 ha greenhouse per doublet
5. 100 kW – 1000 kW / ha heating capacity
6. Combination with other heating installations (fossile)



2. UTES Heating & Cooling

Aquifer Thermal Energy Storage = ATES

Borehole Thermal Energy Storage = BTES

Summer: cooling crop and harvesting heat

Winter: heating crop and harvesting coolness

Fit greenhouses and ATES in size

Balancing heat/cool over years for long lasting success

Manageability & Scalability

Example 10 ha greenhouse:

Delta T summer/winter = 20 °

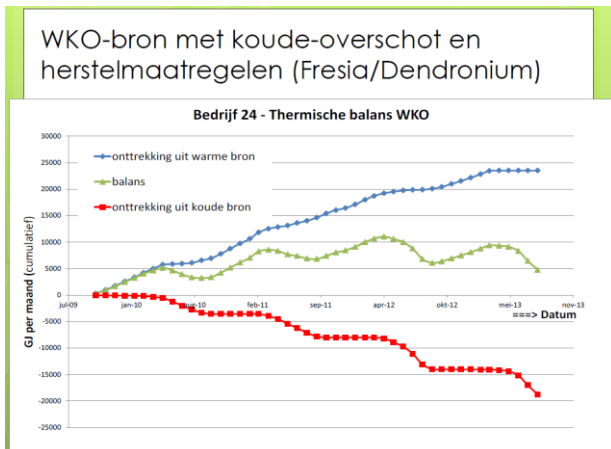
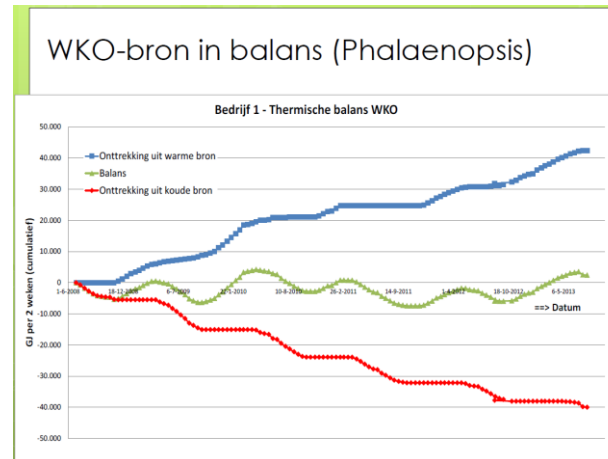
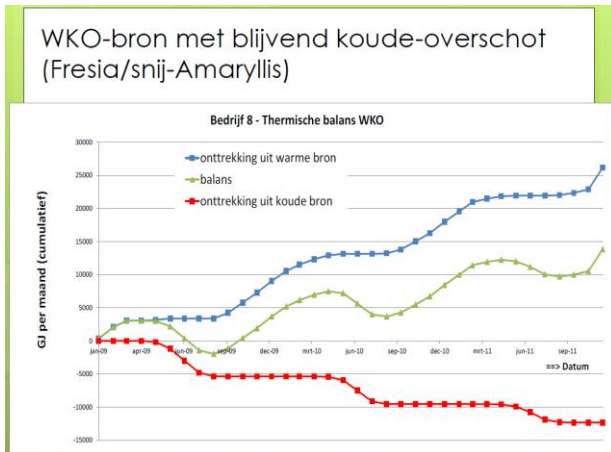
100 m³/h = 2,3 MWh

2500 hours / year for summer and winter = 5.800 MWh/year



Ad 2. Balancing ATEs in greenhouses

1. Example



Cooling

Heating

Semi closed greenhouse concepts
Dehumidification greenhouse climates

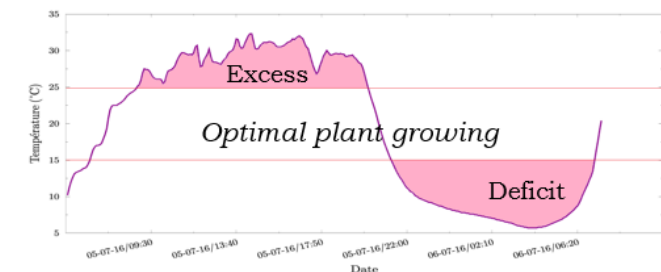
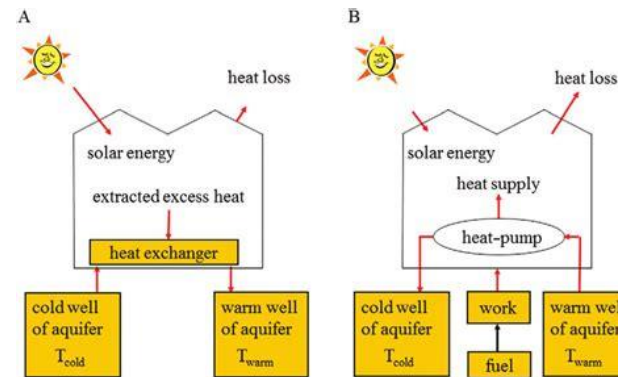
3. Innovations in configuration systems

Energy systems with geothermal

- Solar heat to store in ATES
- Heat pump in summer and winter mode

Greenhouse systems combinations

- Stand alone systems
- Isolation = screening
- Semi-closed
 - Dehumidification
 - Cooling
 - Less ventilation
- Vertical farming
 - Cooling need !
 - Usage of waste heat



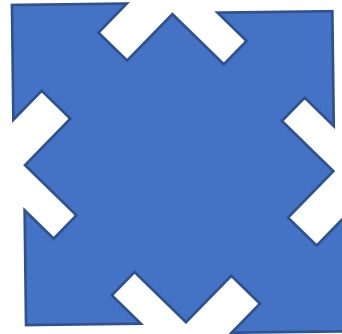
Relations to crop and water management

Climate developments

- More screening
- Less ventilation
- Cooling
- Dehumidification

Indirect climate developments

- “Humidity” management
- Evaporation influences
- CO2 management
- Homogeneity T, RH, air movement



Crop response and effects

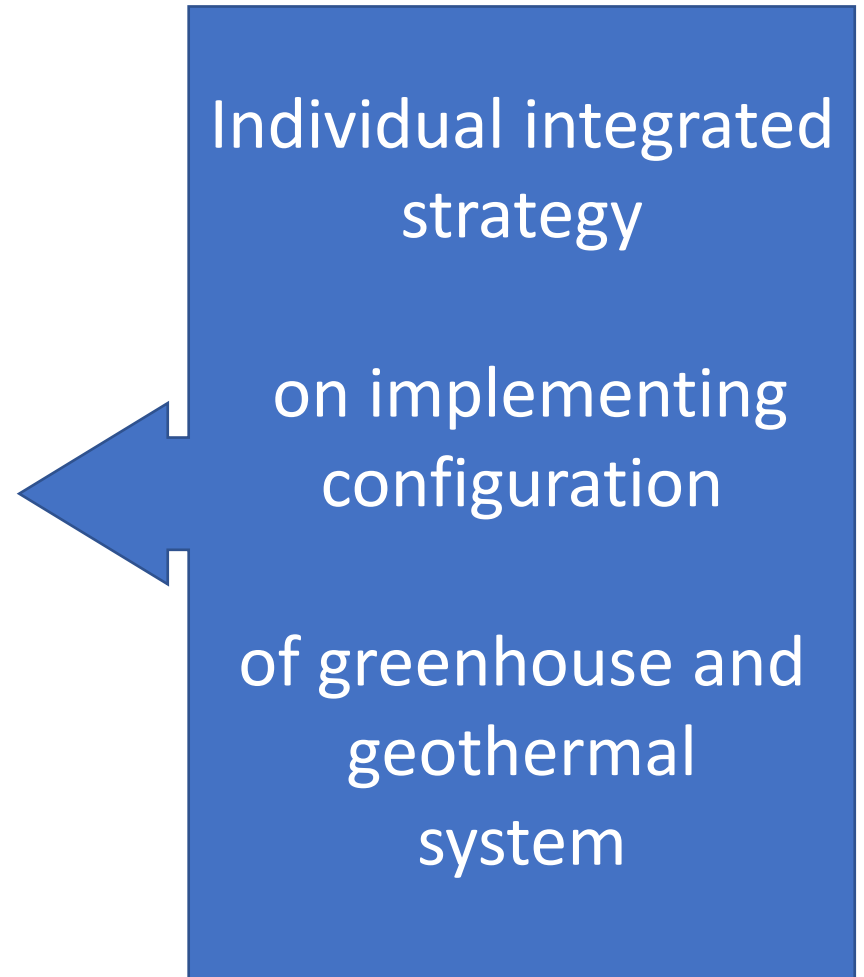
- Leaf Area Indexes
- Vegetative / generative
- Energy input to manageable evaporation

Water management

- Effect on cc/Joule
- EC to drip
- Needed drain amounts
- Start – stop time
- Substrate volumes

Roadmaps for individual projects and configurations

1. Crop
2. Climate
3. Greenhouse climate
 - Lights
 - Screening
 - Heating installations
 - Cooling/dehumidification installations
4. Heating and Cooling demand
5. Options for peak load and backup
6. Possibilities aquifers and geology
7. Legislation and licences
8. Prototyping configurations
 1. Peak demands over all seasons
 2. Flex demand over days



Market developments

Integration greenhouse energy system by multiple focus

- Technical: possibilities greenhouse system and geology
- Business / Economic: forecast energy costs / m² over years
- Social context: policies, legislation, taxes and subsidies

Triple helix = policy makers, academia and market players

- Connection on local level
- Inspiration on global experiences

ACCELERATING GEOTHERMAL

JOIN
US

REenergize the Greenhouse Sector

Save the date

September 26 & 27, 2022
The Hague, The Netherlands

What will you get?

- Learn from the experts in greenhouse climate and geothermal energy.
- Join us on guided afternoon field excursions.
- Network with global professionals during our dinner & drinks.

**For more information, you can
contact the IGA at:**

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First program confirmations:

Introductions by:

- TNO
- Wageningen Economic Research
- Shell Geothermal

Specialists for:

- Geological potential
- Contract management heating and cooling
- Stakeholder engagement
- Aquifer Thermal Energy Storage (ATES)

Excursions to:

- Trias Westland
- ECW Netwerk Middenmeer
- ATES for greenhouse

<https://www.lovegeothermal.org/portfolio-item/accelerating-geothermal-reenergize-the-greenhouse-sector/>