

# Sustainable greenhouse design for Turkey

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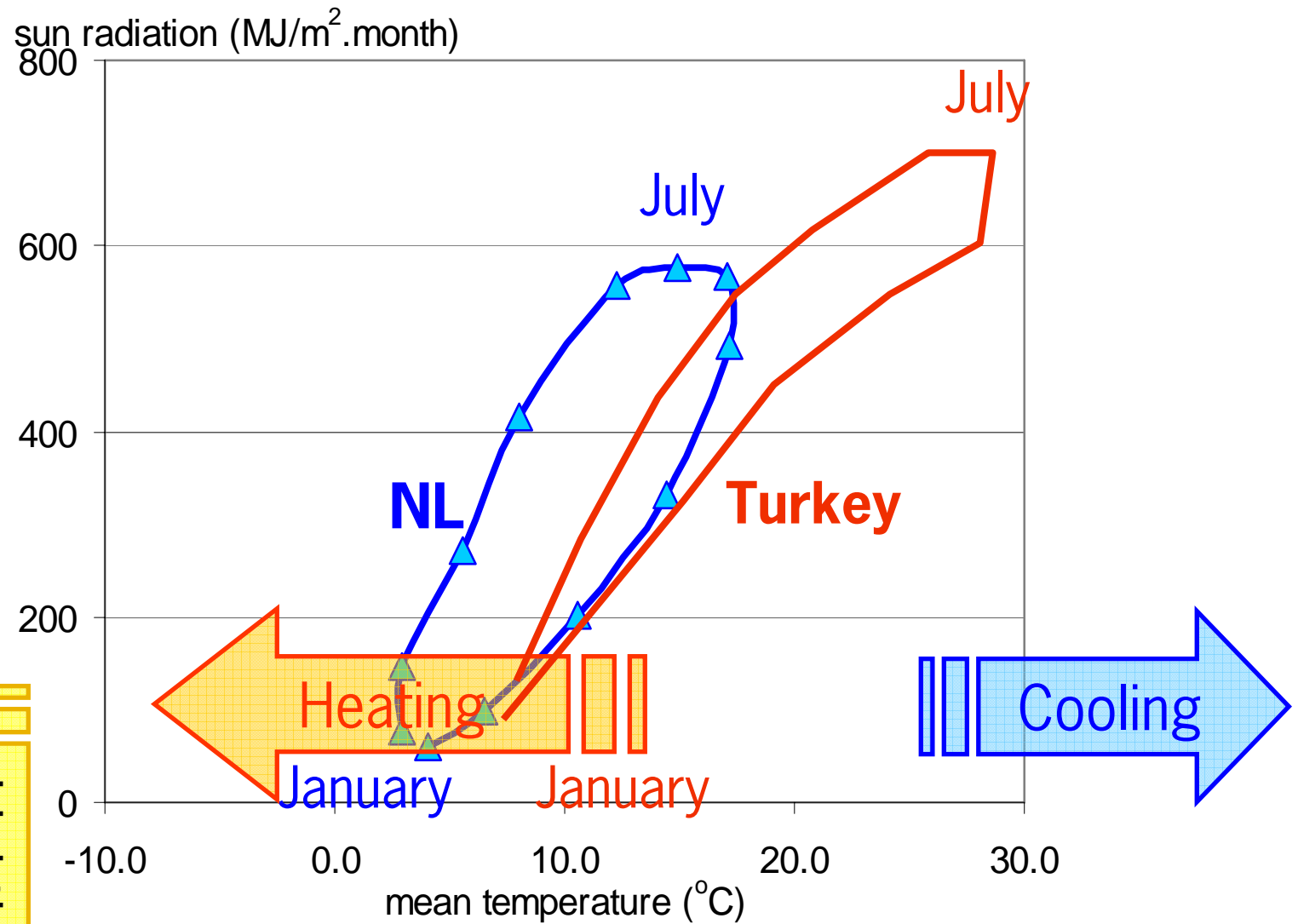
# Major challenge horticulture worldwide

- Design greenhouse systems which combine (economic) production efficiency with minimal input of energy, water and nutrients for different regions in the world:

**“Adaptive innovative greenhouses” → Turkey**



# Controlled environmental conditions



# Other design factors

- Design factors for greenhouse crop production systems\*:
- Market size and regional infrastructure
- Local climate
- Availability, type and costs of fuels and electric power
- Availability and quality of water
- Soil quality and topography
- Availability and cost of land, zoning restrictions
- Availability of capital
- The availability and cost of labour and the level of education
- The availability of materials, equipment and service level
- Legislation in terms of food safety, residuals of chemicals, the use and emission of chemicals to soil, water and air

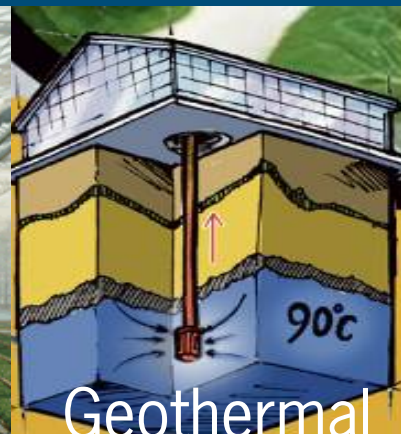
\*Hanan, 1998 and Van Heurn and Van der Post, 2004



# Challenge for sustainable greenhouses

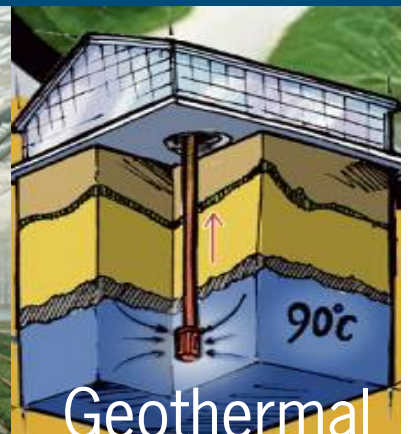
## Objectives for sustainable greenhouse production:

- Low energy input, use of sustainable energy
- High production and predictability
- High product quality and high prices
- High food safety
- High water use efficiency
- High ratio benefit – costs of the production system



# Challenge for sustainable greenhouses

- Objectives for sustainable greenhouse production:
- Low energy input, use of sustainable energy  
→ geothermal
- High production and predictability
- High product quality and high prices
- High food safety
- High water use efficiency
- High ratio benefit – costs of the production system



# Innovation greenhouse

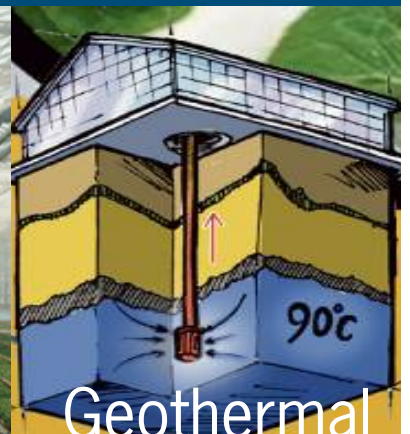


- ✘ Sustainable heat from geothermal energy
- ✘ Electricity from geothermal energy plant  
(+ yearround production possible, cooling possible, artificial lighting possible)
- ✘ CO<sub>2</sub> from geothermal energy plant  
(+ higher production possible)



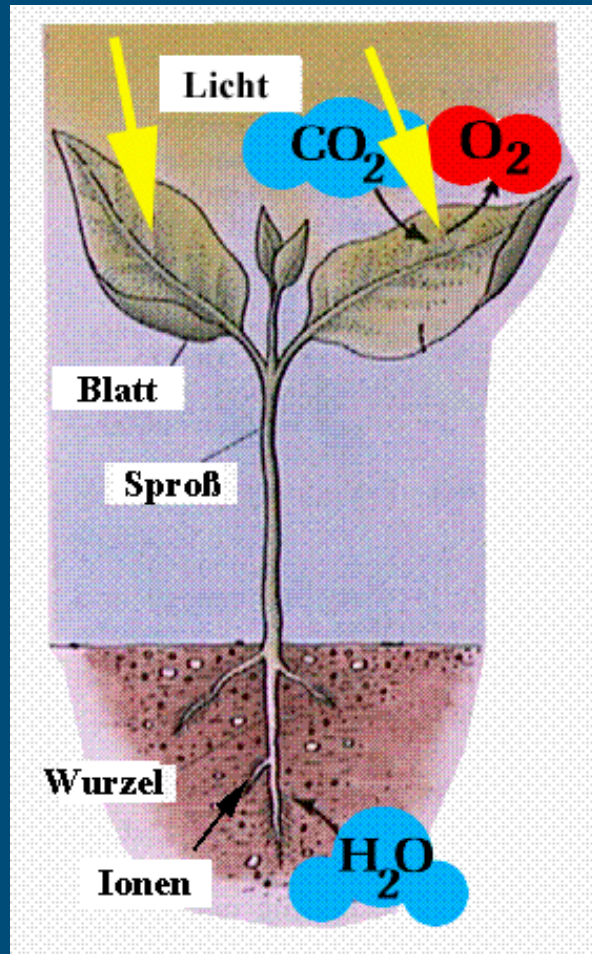
# Challenge for sustainable greenhouses

- Objectives for sustainable greenhouse production:
- Low energy input, use of sustainable energy
- High production and predictability
- High product quality and high prices
  - ➔ controlled temperature, CO<sub>2</sub>, humidity and light
- High food safety
- High water use efficiency
- High ratio benefit – costs of the production system



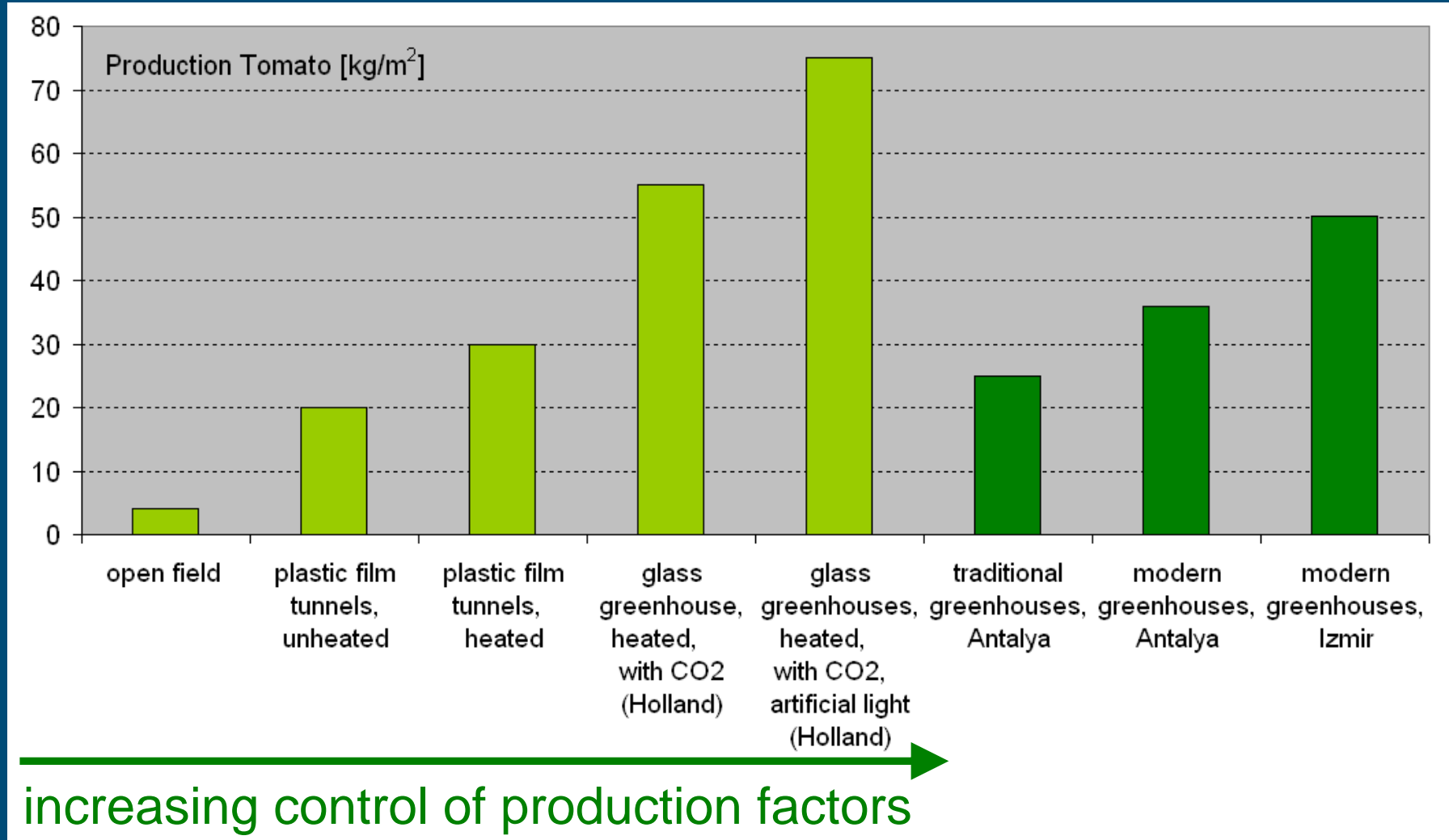


# Crop production and growth factors



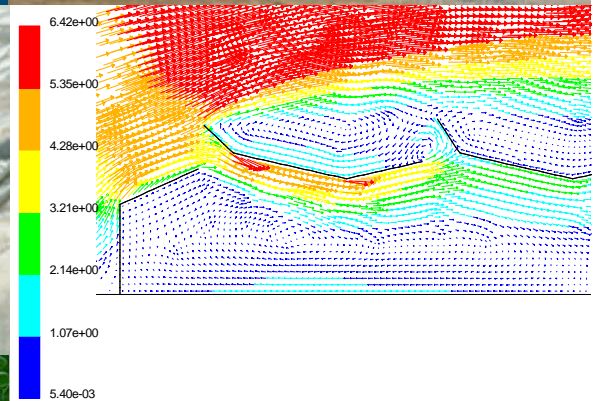
- $\text{CO}_2 + \text{water} + \text{light} \rightarrow \text{sugar} + \text{O}_2$
  - Sugars and nutrients are used for growth
  - Growth  $\rightarrow$  yield
  - Reactions are temperature dependent
- $\rightarrow$  control all growth factors
- $\rightarrow$  technology needed

# Relation technology and economics



# Innovation greenhouse

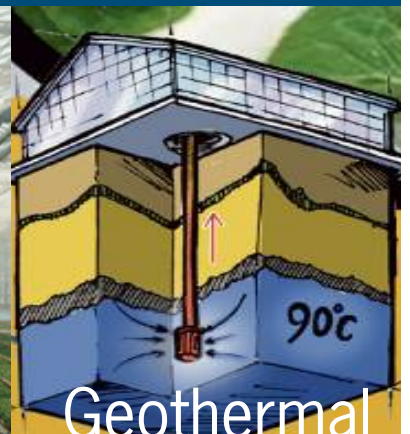
- Modern greenhouses
  - High-tech plastic or glass
  - High light transmission
  - High natural ventilation
  - Controlled environment (CO<sub>2</sub>, fogging)
  - Climate computer
- high production
- high quality





# Challenge for sustainable greenhouses

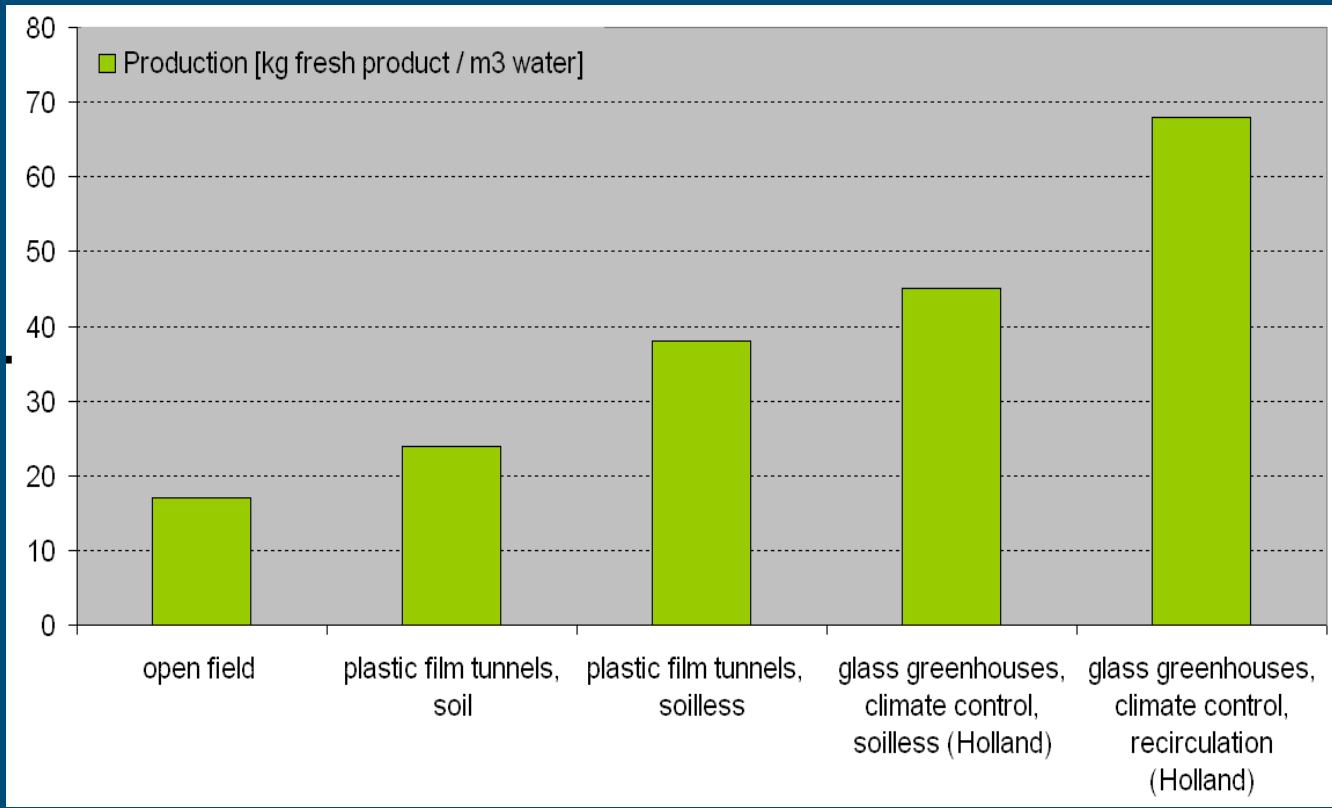
- Objectives for sustainable greenhouse production:
- Low energy input, use of sustainable energy
- High production and predictability
- High product quality and high prices
- High food safety
- High water use efficiency  
→ soilless growing system
- High ratio benefit – costs of the production system





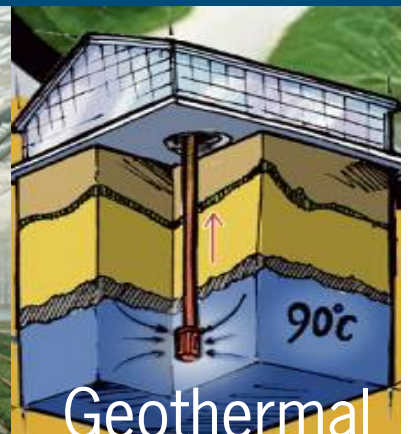
# Innovation greenhouse

- Independent from soil quality
- → High water use efficiency
- Saving nutrients, saving costs



# Challenge for sustainable greenhouses

- Objectives for sustainable greenhouse production:
- Low energy input, use of sustainable energy
- High production and predictability
- High product quality and high prices
- High food safety
  - integrated pest control, biological control
- High water use efficiency
- High ratio benefit – costs of the production system



# Innovation greenhouse

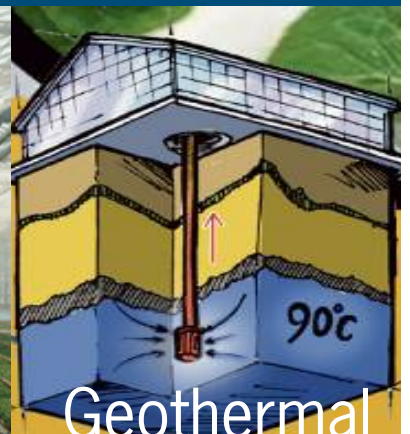
- Control of pest and diseases
  - Hygiene
  - Integrated pest and disease control
  - Biological pest control - beneficials
- Using pollinators





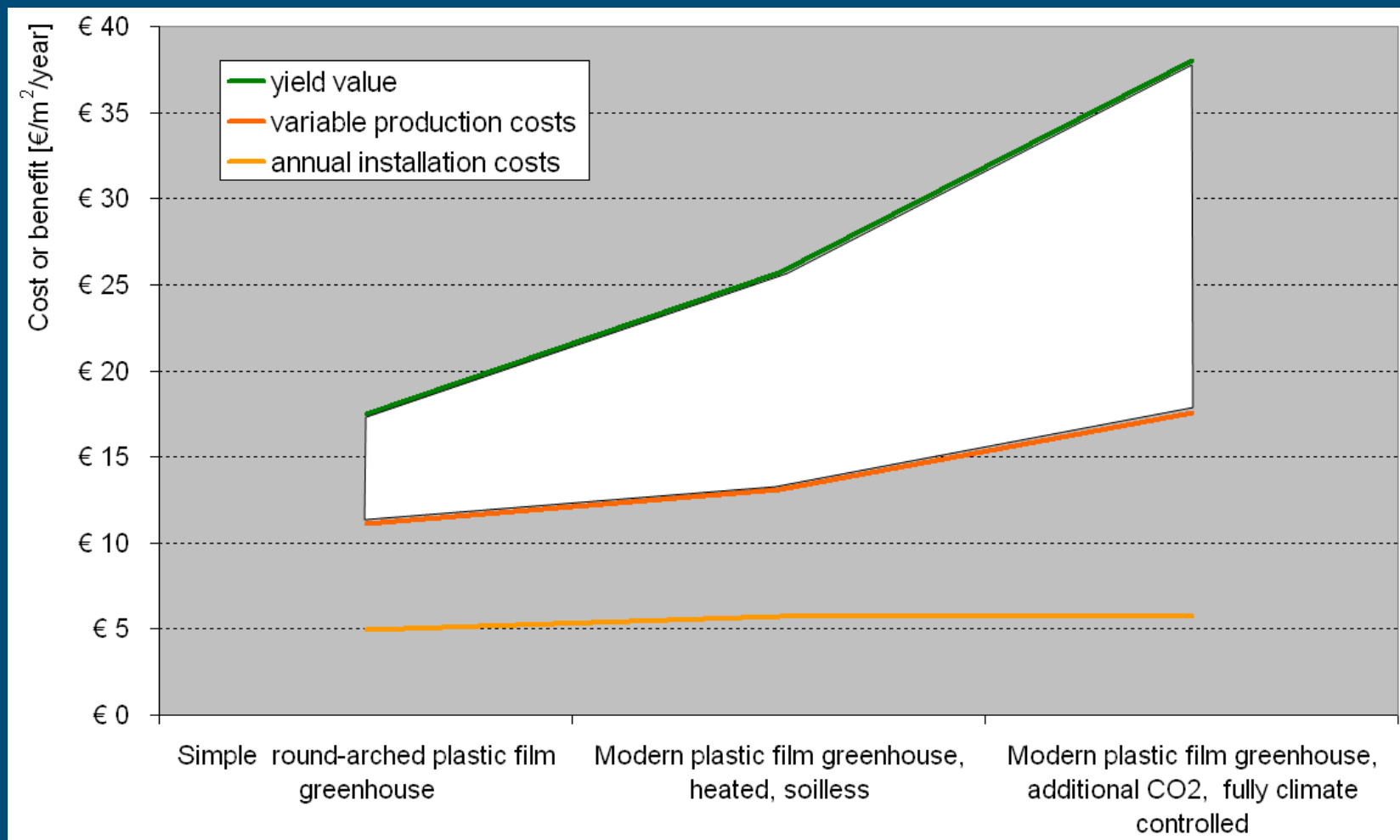
# Challenge for sustainable greenhouses

- Objectives for sustainable greenhouse production:
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# Cost - benefit



# Cost – benefits (examples)

	Simple round-arched plastic film greenhouse	Modern plastic film greenhouse, heated, soilless	Modern plastic film greenhouse, additional CO <sub>2</sub> , fully climate controlled	Glass greenhouse , heated, soilless	Glass greenhouse additional CO <sub>2</sub> , fully climate controlled
<b>investment 1 ha kas</b>	€ 292,000	€ 542,500	€ 547,700	€ 592,500	€ 597,700
production [kg/m <sup>2</sup> /year]	25.0	36.7	54.4	36.0	53.3
price tomato [€/kg]	0.7	0.7	0.7	0.7	0.7
<b>income production [€/m<sup>2</sup>/year]</b>	€ 17.50	€ 25.70	€ 38.05	€ 25.20	€ 37.30
energy (& CO <sub>2</sub> )	€ 3.50	€ 5.20	€ 8.60	€ 3.50	€ 7.00
labour	€ 2.08	€ 2.08	€ 3.13	€ 2.08	€ 3.07
water & nutrients	€ 1.27	€ 1.27	€ 1.27	€ 1.27	€ 1.27
others (chemicals, substrate, packaging etc.)	€ 4.27	€ 4.55	€ 4.54	€ 4.38	€ 4.52
<b>total variable costs (energy, water etc.) [€/m<sup>2</sup>/year]</b>	€ 11.12	€ 13.10	€ 17.54	€ 11.23	€ 15.86
greenhouse construction & covering	€ 18.00	€ 26.50	€ 26.50	€ 38.00	€ 38.00
change covering	€ 6.50	€ 6.50	€ 6.50	€ -	€ -
other installation costs (heating, CO <sub>2</sub> , climate control, soilless system etc.	€ 11.20	€ 21.25	€ 21.77	€ 21.25	€ 21.77
<b>total installation costs incl. depreciation, maintenance, interest [€/m<sup>2</sup>/year]</b>	€ 4.93	€ 5.70	€ 5.75	€ 6.22	€ 6.28
<b>netto income [€/m<sup>2</sup>]</b>	€ 1.45	€ 7.00	€ 14.76	€ 7.75	€ 15.16
<b>return of investment [years]</b>	5.6	4.3	2.7	4.2	2.8

*Cost en benefit for 1 ha or 1m2, based on total area of 2 ha greenhouses*

# Goal Innovation greenhouse

- Build a **Sustainable Innovation Greenhouse Centre** in the scope of SeraCulture in Turkey together with Turkish investors
- → **economic feasible** horticultural production with Dutch technology (high production, best quality)
- → **sustainable** production by using Turkish resources (geothermal, CO<sub>2</sub>)
- → collaboration of **Dutch science & industry** and **Turkish investors (& growers)**

# Why in Izmir/Aydın region?



- Climate advantageous for greenhouse production
- Geothermal energy plant (**sustainable**)
- Region is developing fast, several modern greenhouse production (**innovation**)
- Focus of large investors (**commitment**)



# How does it look like?



- Greenhouse (optimum design) of 1-10 ha depending on Turkish partner
- Economic feasible production with Dutch technology
- Dutch farm manager (for 3 years)
- Monitoring greenhouse performance (crop, energy, sustainability, economics)
- Publishing results in workshops, seminars, website etc. – transparency for Turkish interested parties (showroom)
- Challenges: sharing risk, financing, marketing & export

# Future activities

## ■ Innovationcentre:

- Further discussion on greenhouse design until May
- Negotiations with potential Turkish partners in May (SeraCulture, WUR, Bank, Trade/Auction)

## ■ Trainingcentre:

- Feasibility study together with Turkish parties (growers, province, KvK) (EVD project)
- Pilot of training 1 week at SeraBir in June

# Wageningen UR Glastuinbouw

## Innovaties vóór en mét de glastuinbouw

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