Calculating CO_2 footprint of the organic greenhouse horticulture

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Introduction

- Worldwide interest in GHG emissions of product
  - Wholesalers, supermarkets, consumer organization
- Calculation protocol CO_2 footprint: PAS 2050
  - Carbon Trust, DEFRA, British Standard Institute
- Calculation model CO_2 footprint
  - the Dutch Horticultural Board and the ministry of Agriculture, Nature and Food Quality

Dutch Greenhouse Horticulture

- Surface: 10.500 ha
  - Organic: ± 100 ha
- Firms: 3.500
- Main fuel: 95 % natural gas
- Average gas use: 45 m^3/m^2/year
- Heating system:
  - gas boiler: 95% area
  - co generation: 2.500 Mw_{el}: production: 10 TWh/year

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CO_2 footprint

- Calculation factors
  - Energy; gas and electricity,
  - Fertilizers
  - Pesticides
  - Plastics
  - Rock wool, peat, etc..
  - Transport to DC
  - Greenhouse material are not specified, but calculated in the overhead of 10 %.

CO_2 footprint co generation 1

- PAS 2050:
  1. System reduction,
  2. System expanding
  3. Economic allocation.
- PAS 2050:
  - Production of heat, electricity and CO_2 → System expanding
- System expanding: GHG emission
  - gas CHP ←→ avoided electricity production

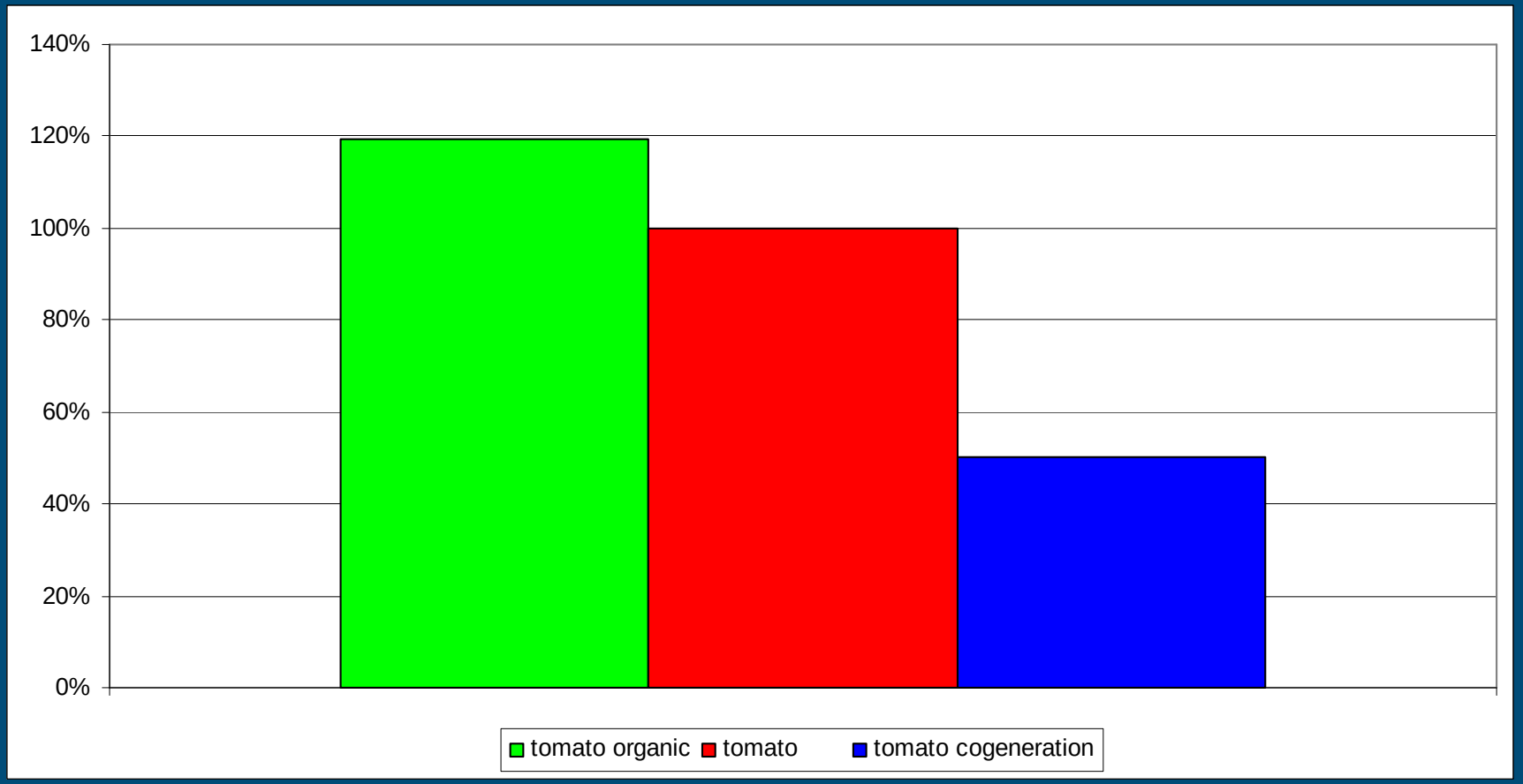
CO_2 footprint co generation 2

- System expanding: GHG emission
  - gas CHP ←→ avoided electricity production
- Avoided electricity production in NL
  - CHP runs at daytime → supply of CO_2
- Kind of electricity plant:
  - Weekdays → peak load: gas combustion
  - Weekend → base load: coal combustion
  - Avoided electricity: 2/7 coal 5/7 gas

Tomato case input data

		Organic estimated	Regular [1)]	Regular [1)] with CHP
Production	kg/m^2/year	50	58.5	58.5
Electric power co generator	MW/ha			0.5
Cogeneration	hours/year			3565
Natural gas boiler	m^3/m^2/year	43.2	43.4	15.0
Natural gas co generator	m^3/m^2/year			49.7
Electricity	kWh/m^2/year	10	10	10
Electricity production	kWh/m^2/year			178
PE/PVC/PS	kg/ha/year	436	927	927
Pesticides	kg/ha/year		8	8

Tomato case CO_2 footprint 1



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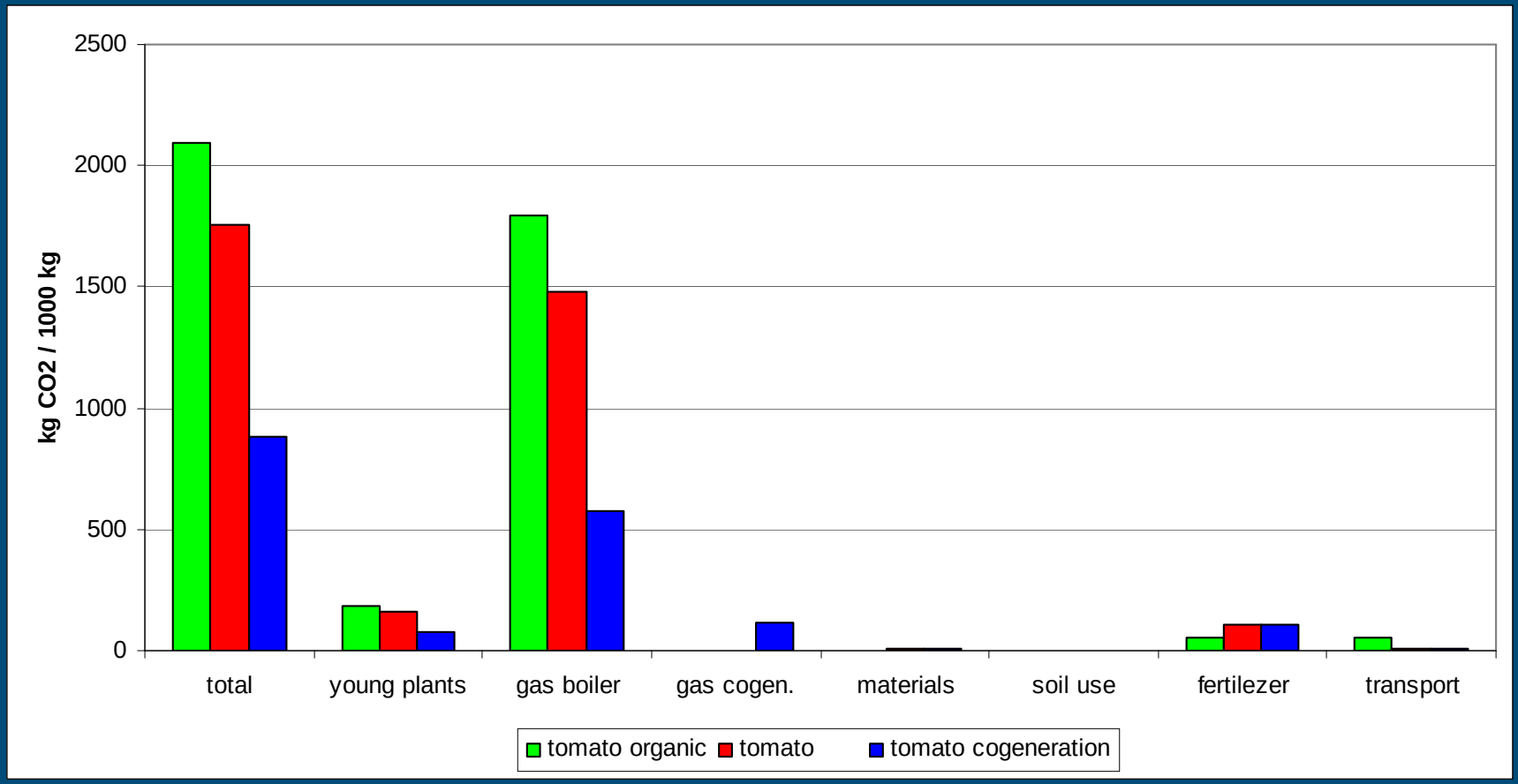
Tomato case CO_2 footprint 2



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Discussion 1

- Innovations conventional growers
  - Heat delivery by greenhouse growers to
    - other companies,
    - other no greenhouse partners, such as schools, swimming pools, etc.
  - CO_2 delivery by electricity or industrial plants to greenhouses
  - Use of geothermal heat,
  - Bio energy
  - Fermentation
- Are the organic growers able and allowed to follow?
- Yes!

Discussion 2

- Use CHP at greenhouse plant:
  - Results based on at the heat and CO_2 demand of the crop → less waste of heat
  - High electricity prices in compare costs gas CHP
    - → longer runtime CHP → more profit → more waste of heat
    - More avoided electricity production electricity plants → less GHG
  - Low electricity prices in compare costs gas CHP
    - → shorter runtime CHP → less profit → no waste of heat
    - Less avoided electricity production electricity plants → more GHG
- The CHP use as result of the economic influence the CO_2 footprint!

Discussion 3

- Will be the CO_2 footprint the right method?
- Toxicity: pesticides and fertilizers
- Biodiversity
- Soil healthy
- ....

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Innovations for and with the greenhouse horticulture

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