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Calculating CO_2 footprint of greenhouse crops produced with co generation

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Problem

In the Netherlands greenhouse horticulture has 3.000 MW on electric power cogeneration (CHP).The electricity horticulture production is 10 TWh yearly of which the main part is being delivered to the national network. What to do with CO_2 emission?

Reasons cogeneration horticulture

- Energy costs
- Extra CO_2 for the crop
- Artificial lighting
- Energy saving

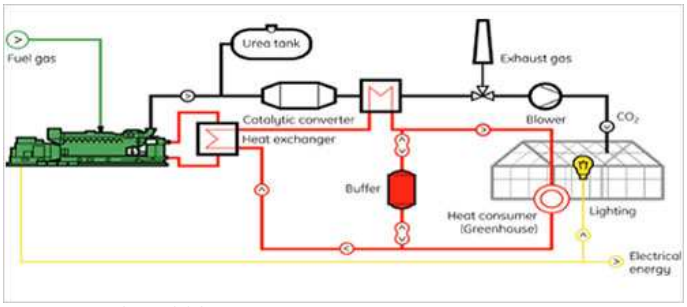

Figure 1: CHP: CO2 converter, heat and electricity production and use.

CO_2 footprint

Allocation methods PAS 2050:

- system reduction based at energetic allocation
  - 1 $kWh_{el} \approx 0{,}28\ m^3$ gas,
  - Electricity 40/90 * 0.3 = 0.126 m^3 gas/kWh
  - depending of the efficiency of the cogeneration
- system expanding based on avoided CO_2 emission
  - depend on production time and method, different by country
- economic allocation based on economic returns
  - depending electric market and product prices

The case

Tomato crop in Holland:
Planting begin of December
Crop finished end of November
Compare CO_2 footprint with and without use CHP.

Allocation method to use: System expanding.
Avoided CO_2 emission:

- 2/7 base time electricity production: coal heated
- 5/7 peak time electricity production: gas heated

Table 1. Input data tomato crop

		No CHP	CHP
Production	kg/m^2/year	58.5	58.5
CHP	MW_{el}/ha		0.5
CHP	hours/year		3565
Natural gas boiler	m^3/m^2/year	43.4	15.0
Natural gas CHP	m^3/m^2/year		49.7
Electricity	kWh/m^2/year	10	10
Electricity prod.	kWh/m^2/year		178

(Kwantitatieve Informatie voor de Glastuinbouw 2008)

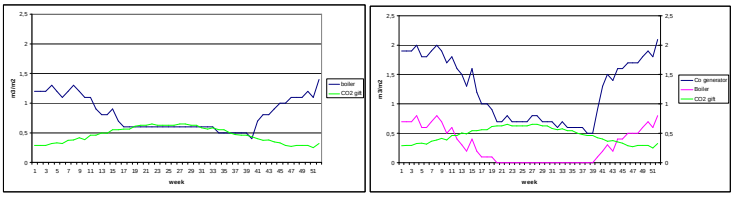

Figure 2: Tomato crop: Use of natural gas by the boiler and co generator accumulated and the CO_2 gift converted in combusted natural gas (1.8 kg CO_2 /m^3 gas)

Table 2. CO_2 emission of electricity production in the Netherlands

	g CO_2 / kWh Excl. pre combustion
Nuclear	0
Natural gas average	450
Oil	660
Coal	870
Import in Holland 2006	586
Production av. Holland 2006	543

The results:

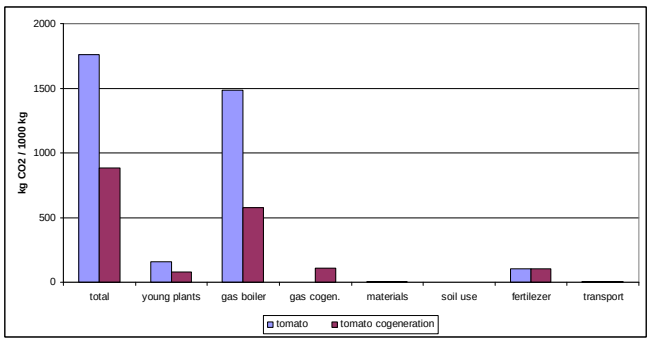

Figure 3: Tomato crop: CO_2 emission (kg CO_2/ ton) of a crop with and without heating with a co generator.

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