GREEN CO_2 FROM BIOGAS TO GREENHOUSE

J. Hovland, T.W. Thomassen, SINTEF Tel-Tek
K.O. Furuseth, Greve Biogas, Multiconsult

What can we do with the CO_2?

- Biogas contains approximately 40% CO_2
- The CO_2 becomes a by-product during upgrading to biomethane
- Approximately 13 200 tonnes/year for a biogas plant producing 100 GWh/yr biomethane

Main uses of CO_2

- Urea fertiliser (150 mill tonnes/yr)
- Methanol
- Enhanced oil recovery
- Production of chemicals
- Carbonated drinks
- Fire extinguisher
- Greenhouses
- …

SINTEF

Main sources of CO_2

Fossil, biogenic sources – black CO_2

- Natural gas – CO_2 as by-product from ammonia and methanol production
- CO_2 from petrochemical production (plastics)
- Refineries
- CO_2 in natural gas
- …

Biogenic (present time) sources – green CO_2

- Ethanol fermentation
- Biogas plants
- In the future, bioenergy CHP plants

SINTEF

The Magic Factory, Greve Biogas

- Biogas produced from:
- Food waste (households and industry)
- Manure (cow and pig slurry manure)
- Planning for additional raw materials

- Excursion on Thursday for some of you

The Magic Factory – three products

- Biomethane (CBG and pipeline) for vehicle fuel and industrial use
  - 58 GWh in 2018, target 80 GWh in 2019
- Biofertiliser to farmers
  - 103 000 tonnes wet weight in 2018
- CO_2 – delivery to a demonstration greenhouse
  - Started late 2018, max 90 kg/h

The demonstration greenhouse

- Will only use a minor percentage of the CO_2 available, less than 10%.
  - 7 600 tonnes vented to air in 2018
- Will be a test center for the greenhouse technology and an educational center
- The greenhouse use soap foam, bubbles, within double walls to insulate and to shade for too strong sunlight
- https://www.bbbls.net/ - upscaling plans in preparation

CO_2 greenhouse quality – based on OCAP

(www.ocap.nl)

Compound	ppm
H_2O, moisture	40
NO, nitrogen oxide*	2,5
NO_2, nitrogen dioxide*	2,5
Total hydrocarbons	1200
CO, carbon monooxide*	750
H_2S, hydrogen sulphide	5
C_2H_4, ethylene (ethene)	1
HCN, hydrogen cyanide*	20

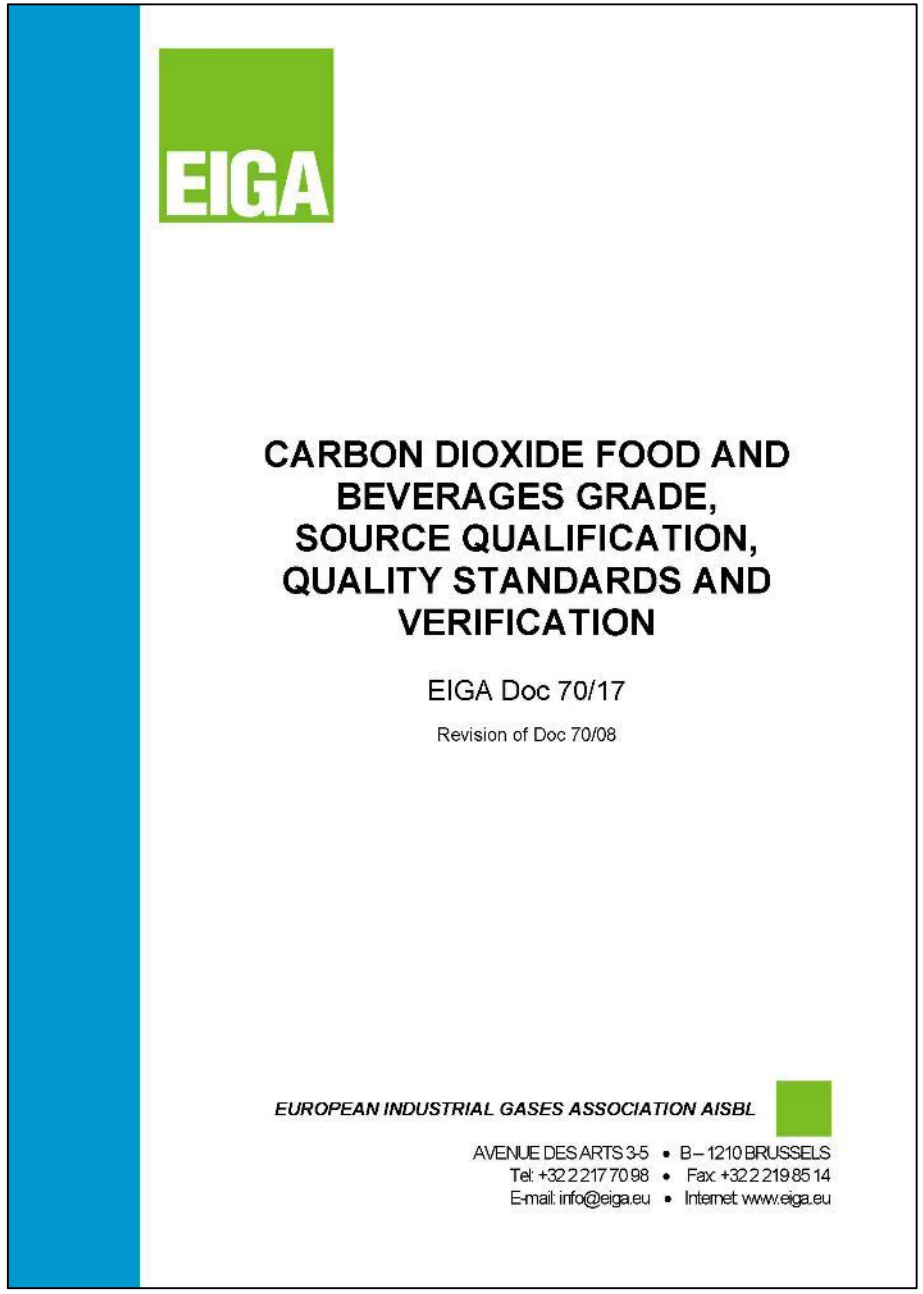
Note:
This specification is for greenhouses, there is also a specific Food and beverages grade

* Compounds associated with CO_2 from refinery and combustion

Food and beverage standard

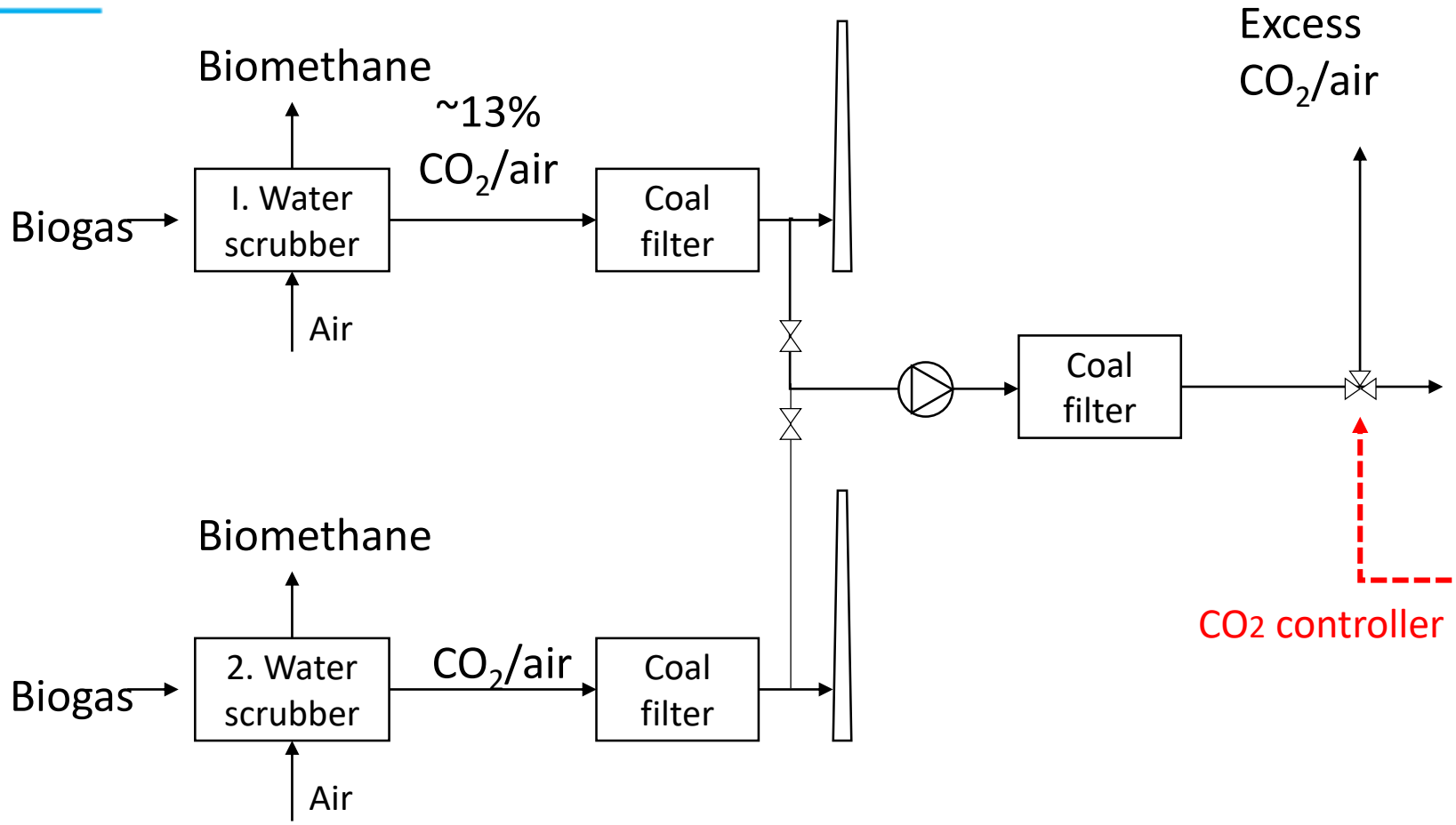
5.1.3.2 **Biogas** (methane) carbon dioxide sources

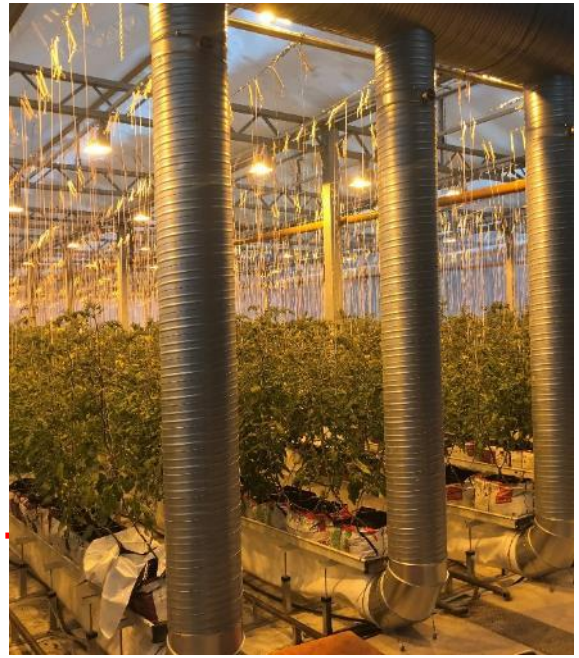
This type of source is acceptable but requires particular care in evaluation as a source of carbon dioxide for use in foods and beverages. CO_2 from a biogas plant that uses waste, or a mixture of waste and energy crops, requires greater care than for energy crops in evaluation as a potential source of carbon dioxide for use in food and beverages.



SINTEF

Supply system at Greve





Target 1200 ppm CO_2
Estimated max 90 kg/h

SINTEF

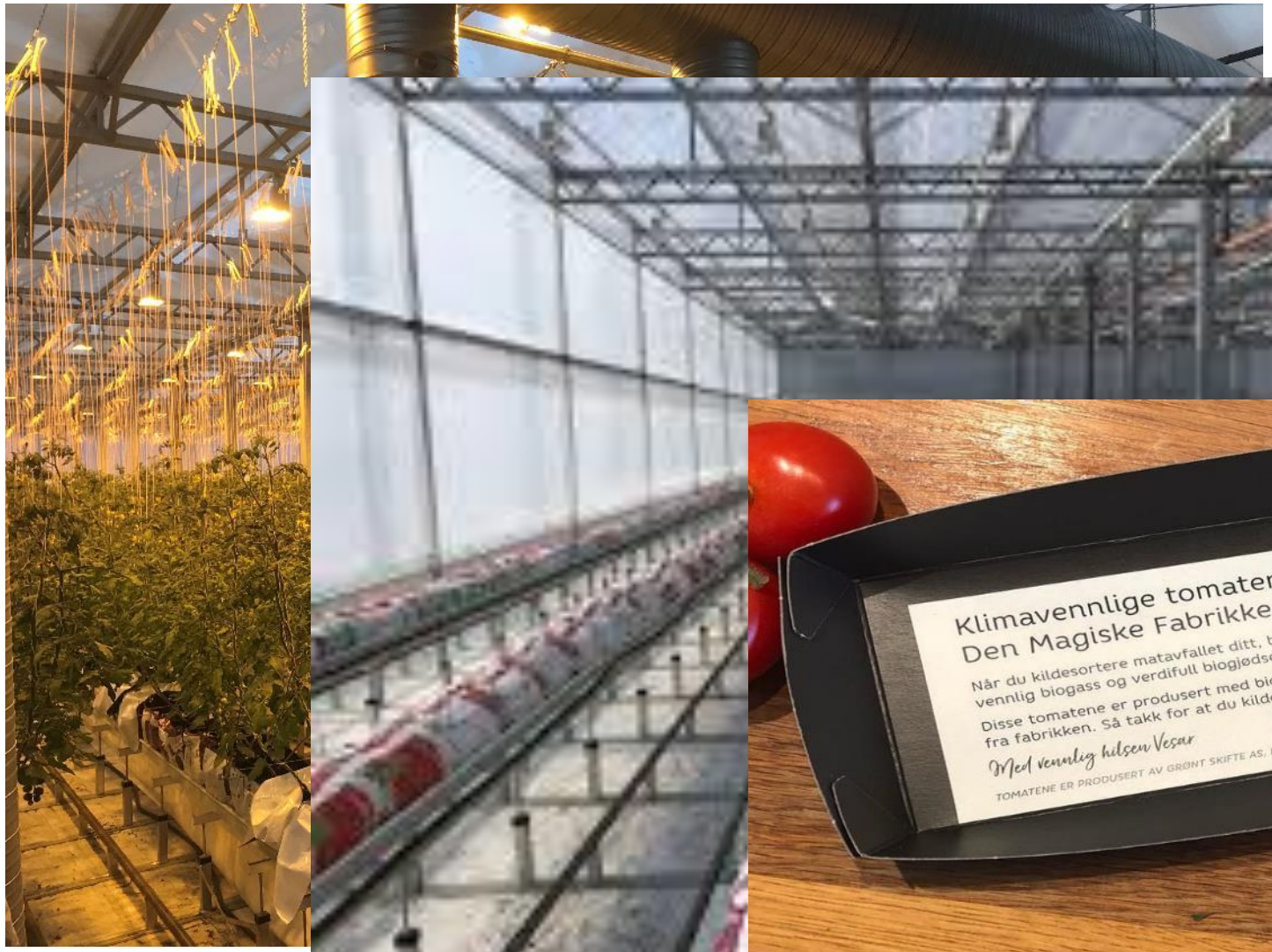
Risk evaluation

- Methane slip from the water scrubber units
  - Fire risk – not toxic to humans or plants
  - The scrubber has an internal detector, stop at 25% LEL in offgas
  - Detector also inside the greenhouse
- H_2S produced in the biogas reactor
  - Very toxic – main concern is the effect on plants, not humans
  - Low levels as Fe is added to the digestors, online H_2S detector on CO_2 supply
- Ethylene – a plant hormone
  - Is it formed in the biogas process? Continuously or sporadic formation?
  - So far not detected in the CO_2

The first crop was harvested this year

- Green CO_2 from biogas
- Grown in vermicompost from digestate and green waste compost (no peat)
- Biofertiliser – digestate from the biogas production

- Sustainable production and circular economy!



CO_2 added to air circulation manifold

Growth medium is compost, no peat used

SINTEF

What about other uses than greenhouse?

- For non-local use CO_2 are delivered as liquid CO_2, cooled (-35 to -15 °C) and pressurised (12 – 25 bar)
- There are commercial suppliers of small scale CO_2 liquefaction plants

SINTEF

Opportunity in the circular economy

- There will be a business opportunity for green CO_2
- "Sustainable buyers" will pay a premium price for green CO_2
- In the long run green will have to replace black CO_2

SINTEF

Reducing atmospheric CO_2?

- Negative CO_2 emission by carbon capture and storage?

ADM Ethanol Facility (Decatur, IL) – Began Operations 2017

- Built and operated by Archer Daniels Midland (ADM) at their existing biofuel plant located in Decatur, IL
- **1 million metric tons of CO_2** as a by-product of the ethanol biofuels production process and store it in a deep saline reservoir
- First ever CCS project to use the EPA Underground Injection Class VI well permit in the United States that is specifically designed for CO_2 storage

SINTEF

Teknologi for et bedre samfunn