Modern technologies of biogas upgrading

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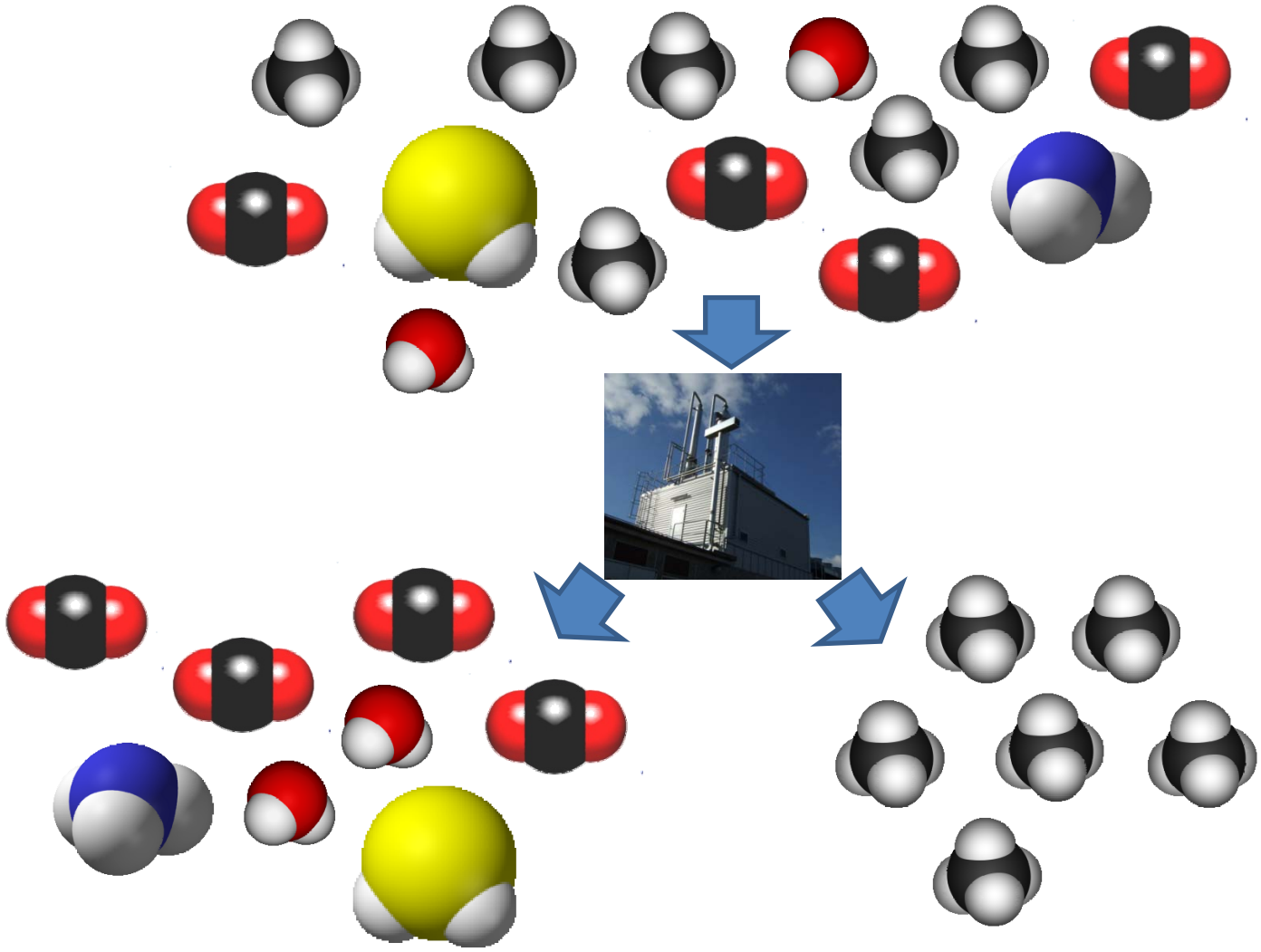
Biogas upgrading



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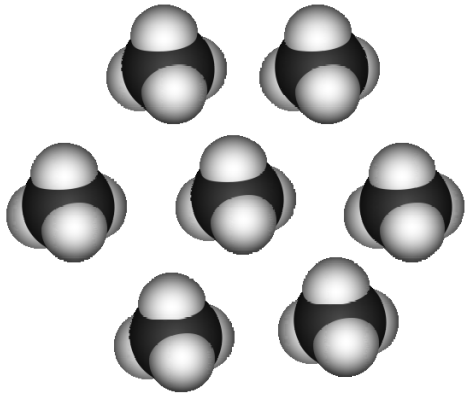
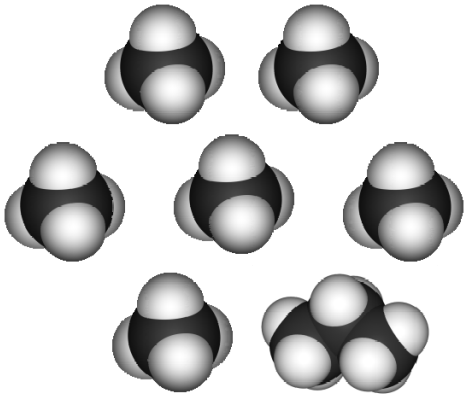
Utilization of upgraded biogas



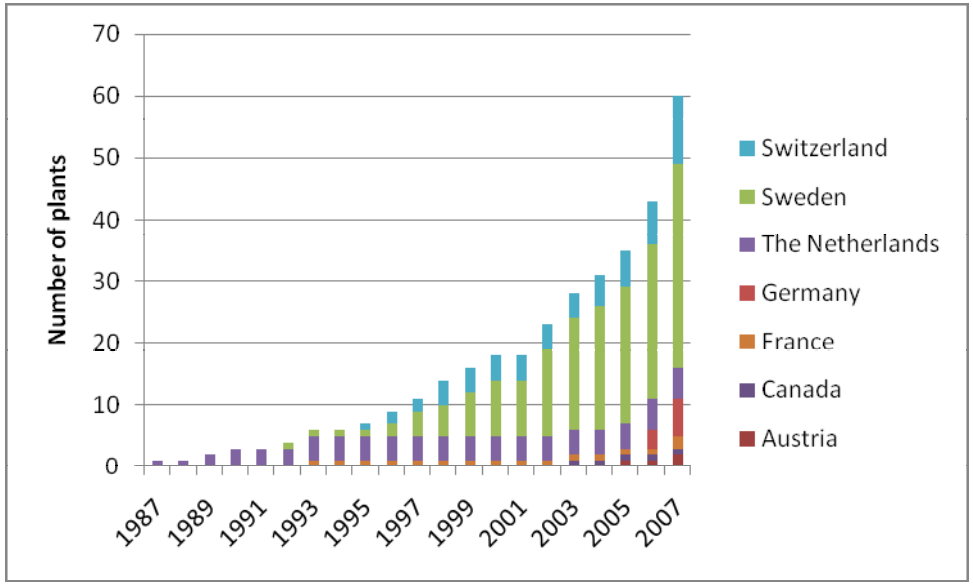


Environmental benefits – biogas as vehicle gas

- Biogas is renewable – low CO_2-emissions
- 25 % less CO_2-emissions for natural gas compared to petrol
- Lower emissions of: NO_x, SO_x, particles
- Simultaneous production of biogas and fertilizer
- Decreased methane emissions compared to traditional manure storage

Biogas upgrading

- Biogas upgrading plants in the Task 37 countries



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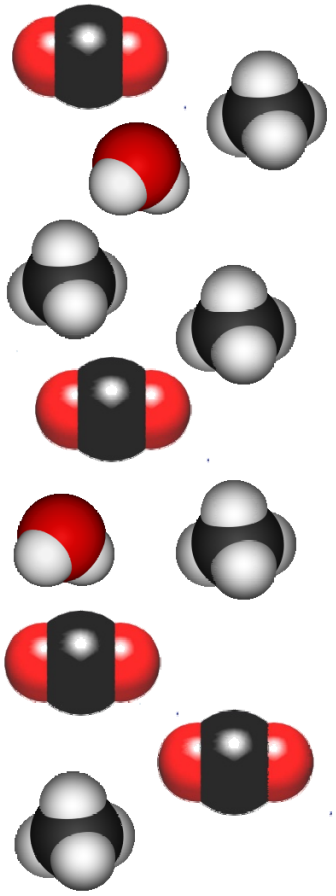
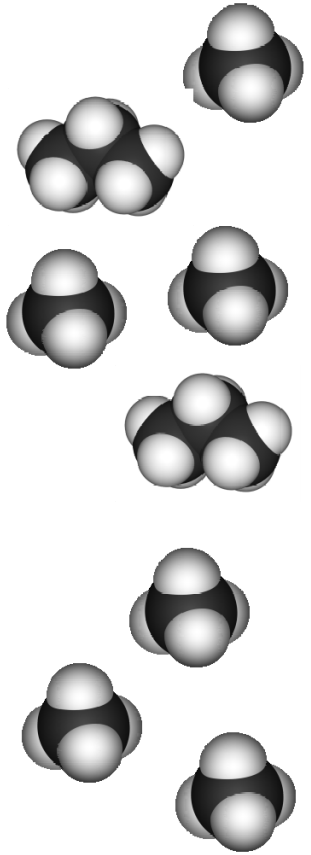
Gas composition



		Biogas	Landfill gas	Natural gas (Danish)
Compounds	Methane (vol-%)	60-70	35-65	89
	Other hydro carbons (vol-%)	0	0	9.4
	Hydrogen (vol-%)	0	0-3	0
	Carbon dioxide (vol-%)	30-40	15-50	0.67
	Nitrogen (vol-%)	~0.2	5-40	0.28
	Oxygen (vol-%)	0	0-5	0
	Hydrogen sulphide (ppm)	0-4000	0-100	2.9
	Ammonia (ppm)	~100	~5	0
	Lower heating value (kWh/Nm³)	6.5	4.4	11.0



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Swedish standard

- Particles < 1 μm
- Methane 97+/- 2 %
- Water < 32 mg/Nm^3
- CO_2, O_2, N_2 < 5%
- Oxygen < 1 vol %
- Sulphur < 23 mg/Nm^3
- N (except for N_2) expressed as NH_3 <20 mg/Nm^3
- Odorised
- Compressed to 200 bar

For grid injection: Addition of propane to reach the enegry content of the Dansih natural gas (around 7-9 vol% is added)

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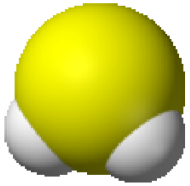
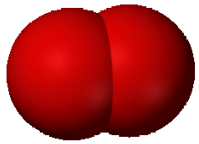
Cleaning

Water

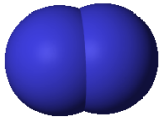


Hydrogen sulphide

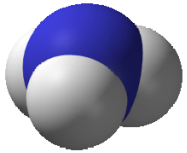
- Precipitation in digester
- Adsorption
- Absorption
- Biological treatment



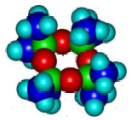
Oxygen



Nitrogen



Ammonia



Siloxanes

Particles

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Upgrading

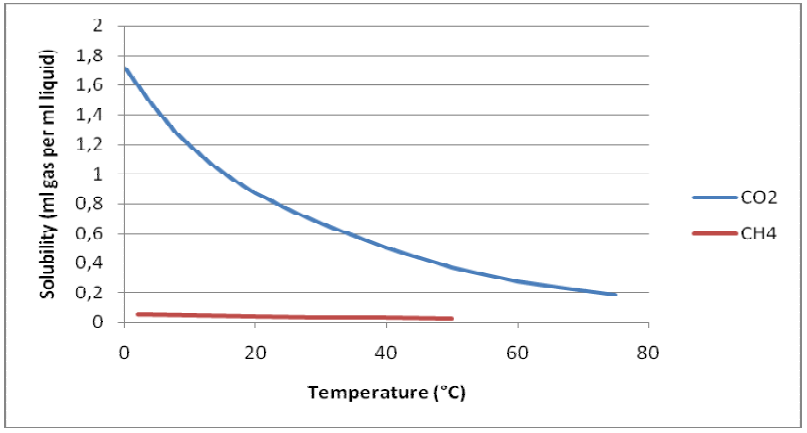
- PSA
- Water scrubbing
- Organic physical scrubbing
- Chemical scrubbing
- Cryogenic
- Membranes
- Technologies under development

PSA

- Pressure Swing Adsoption
- Activated carbon or zeolites
- Regeneration by decrease in pressure
- Several vessels in parallell

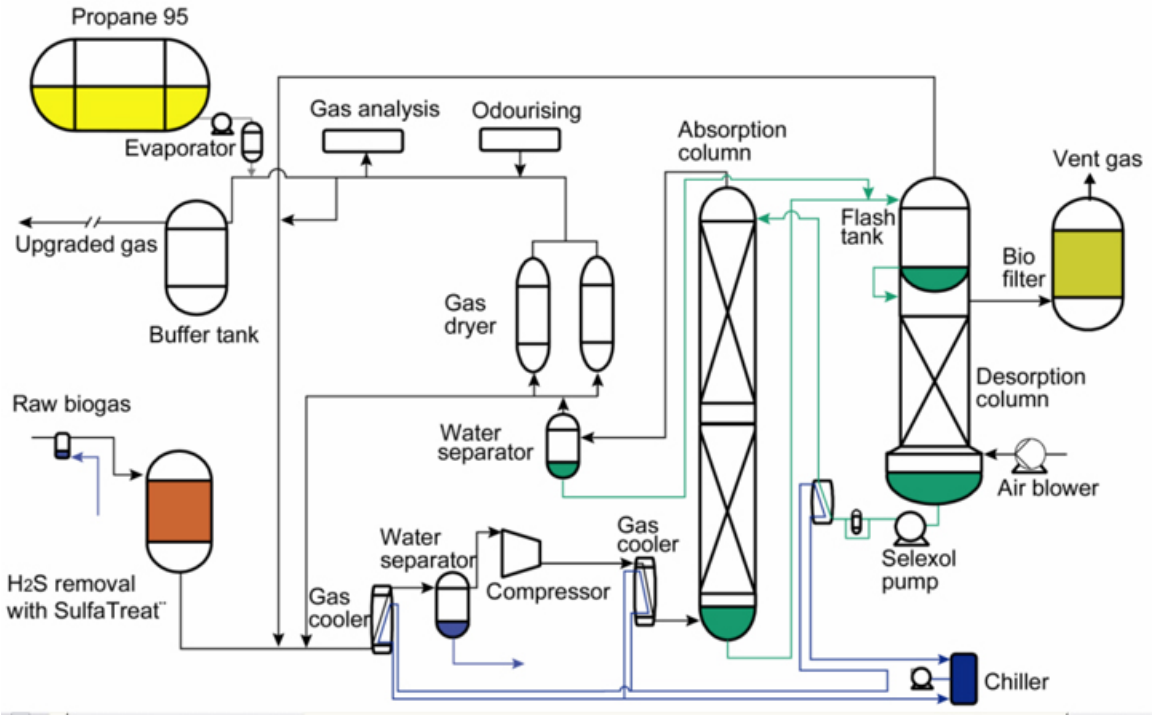
Water scrubbing

- Carbon dioxide dissolves in water
- Methane dissolves to a much lower extent
- Dissolved methane recovered in flash tank
- Water regenerated in desorption column



Organic physical scrubbing

- Similair to water scrubbing, but carbon dioxide is absorbed in an organic solvent such as polyethylene glycol instead of water.

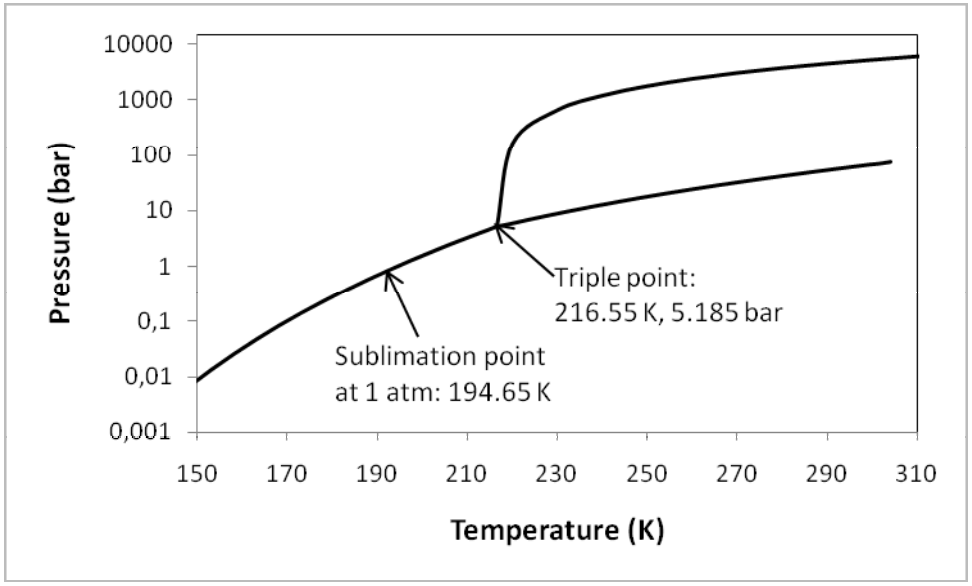


Chemical scrubbing

- Carbon dioxide binds chemically
- Selective reaction
- Low methane losses
- MEA or ETA in the liquid
- Regeneration by heating

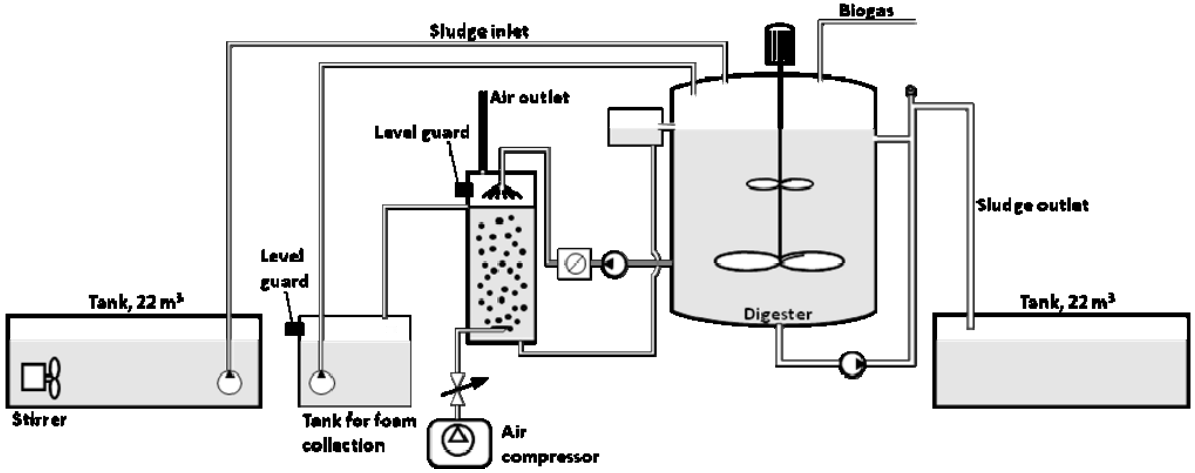
Cryogenic

- Seperation by cooling
- Carbon dioxide removed as solid or liquid
- If cooled further liquid methane gas is formed



Other upgrading technologies

- Membranes
- Technologies under development
  - *In situ* methane enrichment
  - Ecological lung



Schematic view of *in-situ* methane enrichment research plant. (Courtesy of Åke Nordberg, SLU, Sweden).

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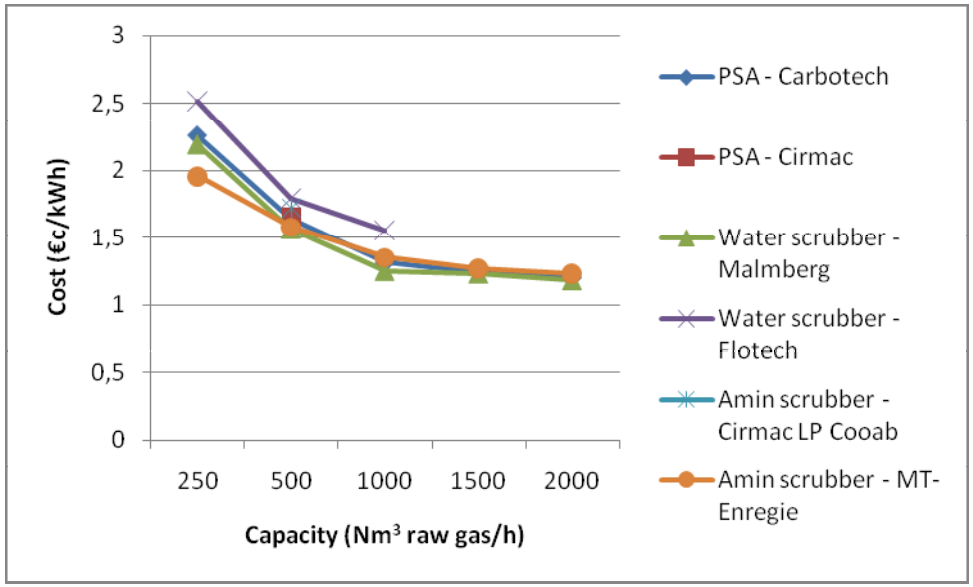
Upgrading - cost



Urban W, Girod K, Lohmann H. Technologien und Kosten der Biogasaufbereitung und Einspeisung in das Erdgasnetz. Ergebnisse der Markterhebung 2007-2008. Fraunhofer UMSICHT. 2008

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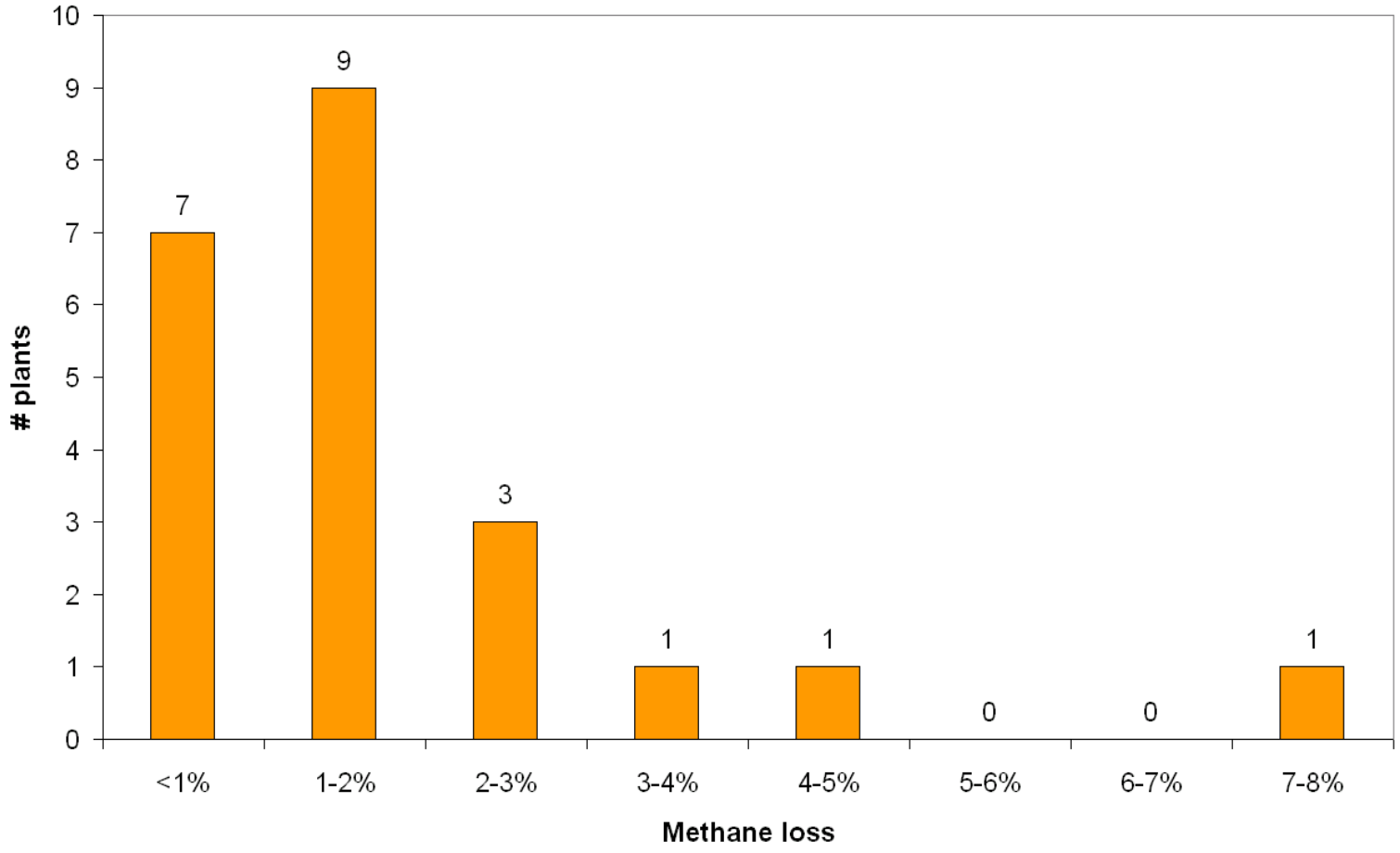
Methane losses



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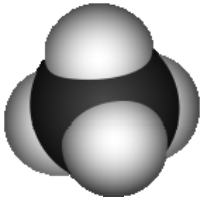
Conclusions



- Biogas is upgraded for utilization as a sustitute to natural gas or as a vehicle fuel
- The treatment of the biogas can be divided into cleaning and upgrading
- Upgrading technologies
  - PSA
  - Water scrubber
  - Organic physical scrubbing
  - Chemical scrubbing
  - Cryogenic
  - Membranes
- Other technologies in research phase
- Many aspects, such as economical and environmental, have to be considered when plants are evaluated, or new plants are under planning

Thank you for your attention!

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