

# Biomethane as vehicle fuel

- Showcasing the Swedish development

Jörgen Held, PhD  
President Swedish Gas Centre

# Outline

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- What is biomethane?
- Technology routes
- Benefits with biomethane
- Energy supply - Sweden
- Driving forces
- Development in Sweden
- Examples of ongoing research
- Discussion and conclusions

# What is biomethane?

There is no clear definition of biomethane. In this presentation gases that mainly consists of methane and are produced from renewable resources are considered.

- Biogas through anaerobic digestion
- Landfill gas
- Biomethane through biomass gasification and methanation

Biogas is formed during microbial decomposition of organic material in an anaerob environment.



Bjuv, Sweden  
Foto: SGC

## Biogas

60-70 % methane

30-40 % carbon dioxide

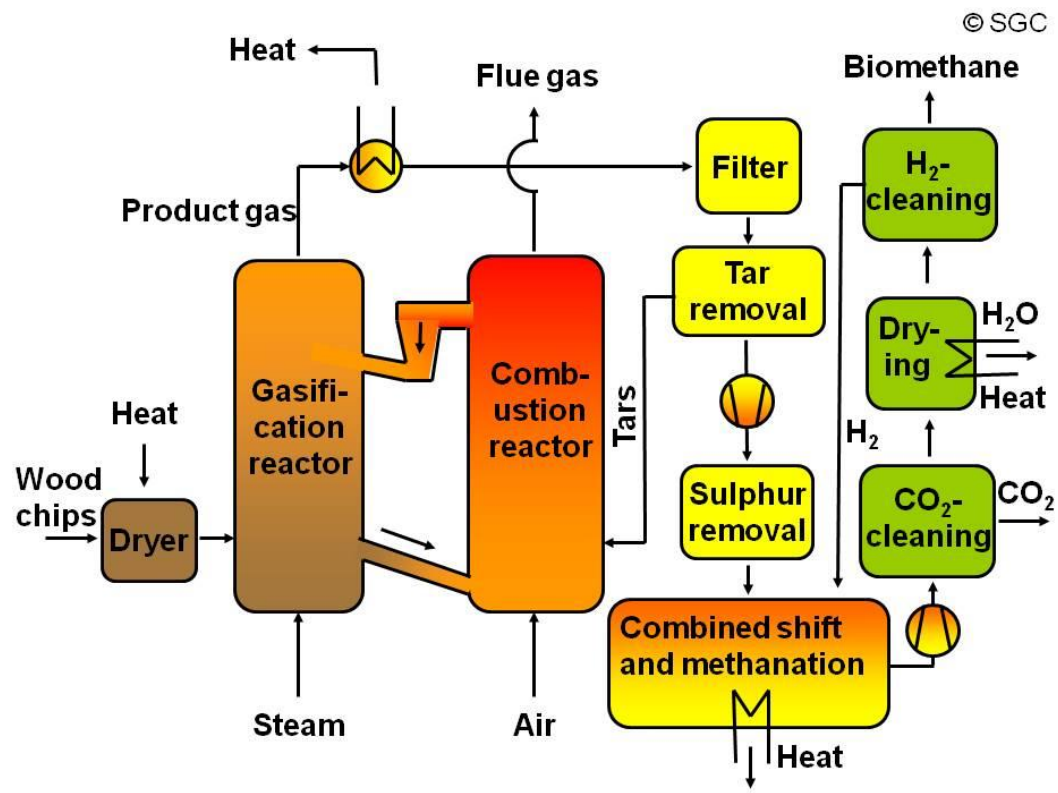
LHV 23 MJ/Nm<sup>3</sup>

## Upgrading (Sweden)

97 ± 2 % methane

LHV 35 MJ/Nm<sup>3</sup> (9,7 kWh/Nm<sup>3</sup>)

# Technology routes



$\text{CH}_4$ : balance (>94,5 %)
   
 $\text{H}_2$ : < 2%
   
 $\text{CO}_2$ : < .5%
   
 $\text{N}_2$ : < 2%
   
 $\text{CO}$ : < 1%
   
 Heating value and Wobbe index: as per H-gas

Repotec/CTU-process demonstrated in Güssing, Austria. The same gasification technology will be used in the worlds first industrial scale Bio-SNG plant (the GoBiGas-project), in Gothenburg, Sweden.

# Benefits with biomethane



- Sustainable
- Security of supply
- Job openings
- Regional development
- Climate change issues
- Environmental objectives
- Increased energy efficiency
- A versatile fuel
- Resource efficient

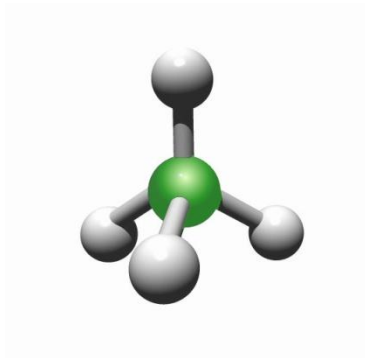
# Environmental benefits with biogas

- Reduced methane emissions
- Valuable fertilizer
  - recycling of nutrients
- Reduced eutrophication
- Improved soil structure
- Smell reduction
- Diverse cultivation



# Environmental benefits with biomethane

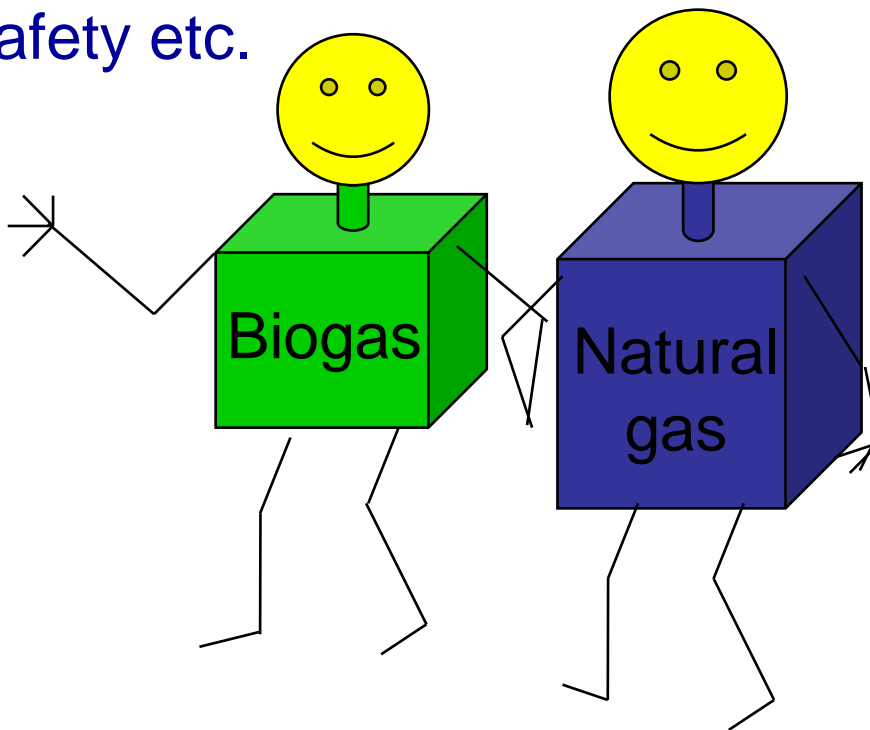
- High quality combustion
  - simple chemistry
  - clean fuel
  - gaseous state



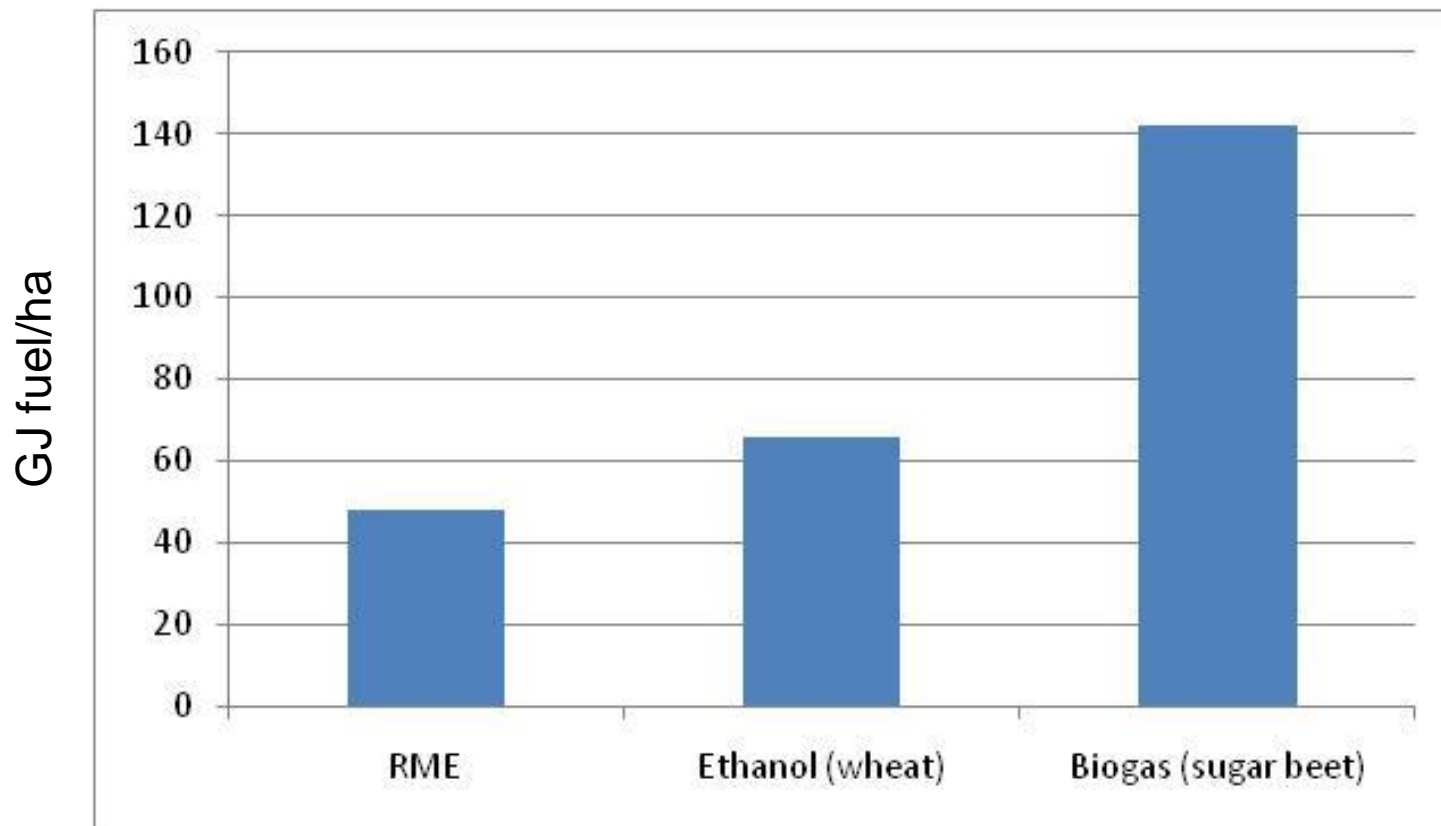


# Environmental benefits with biomethane

- Grid distribution possible!
  - Efficient. Less emissions, traffic, accidents and contamination. Improved health and safety etc.

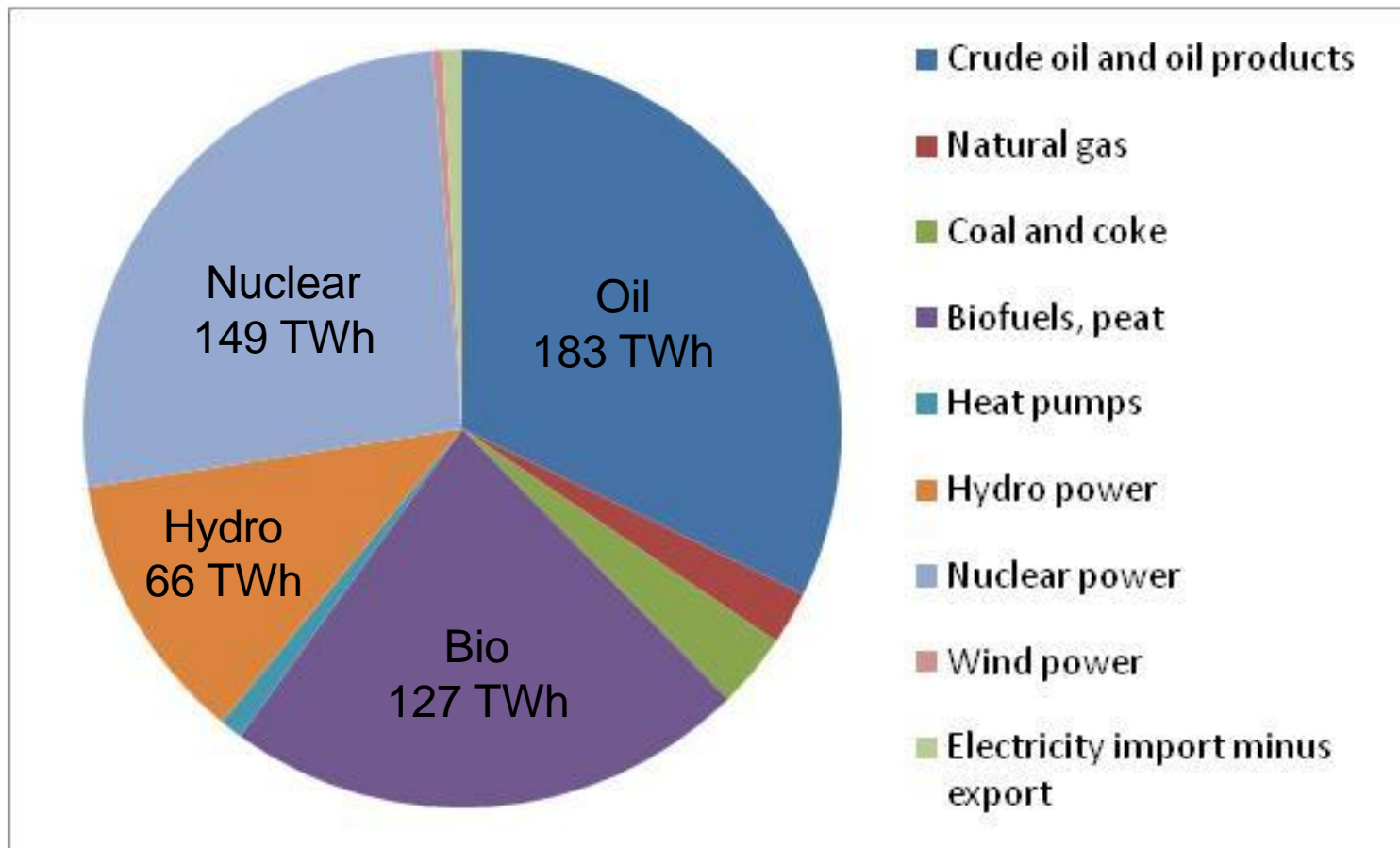


# Resource efficiency – yield/ha

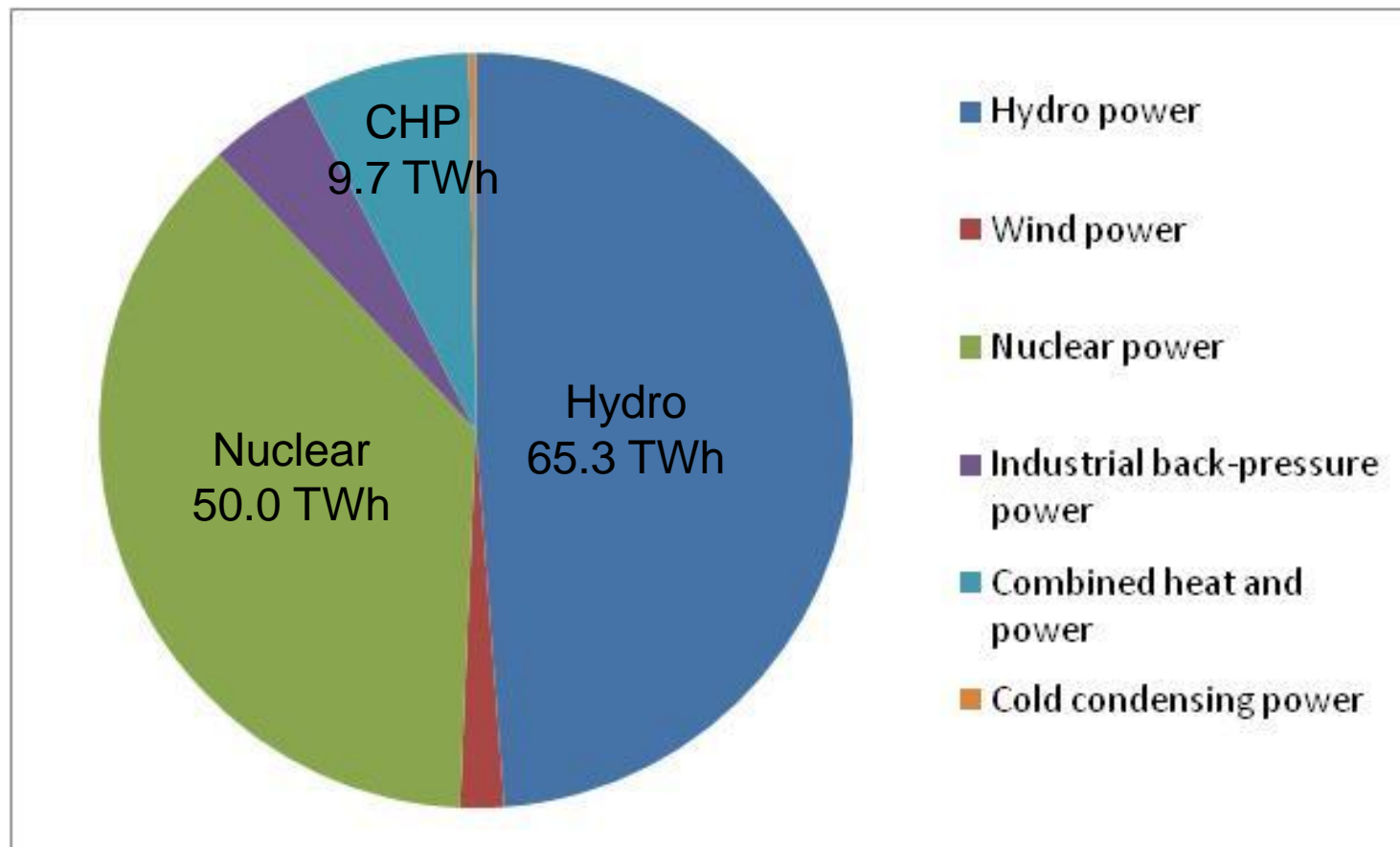


Source: Pål Börjesson et al. Livscykelanalys av svenska drivmedel. SGC rapport 217 (in Swedish). Swedish Gas Centre, 2010.

# Energy supply, Sweden 2009, 586 TWh



# Electricity production, Sweden 2009

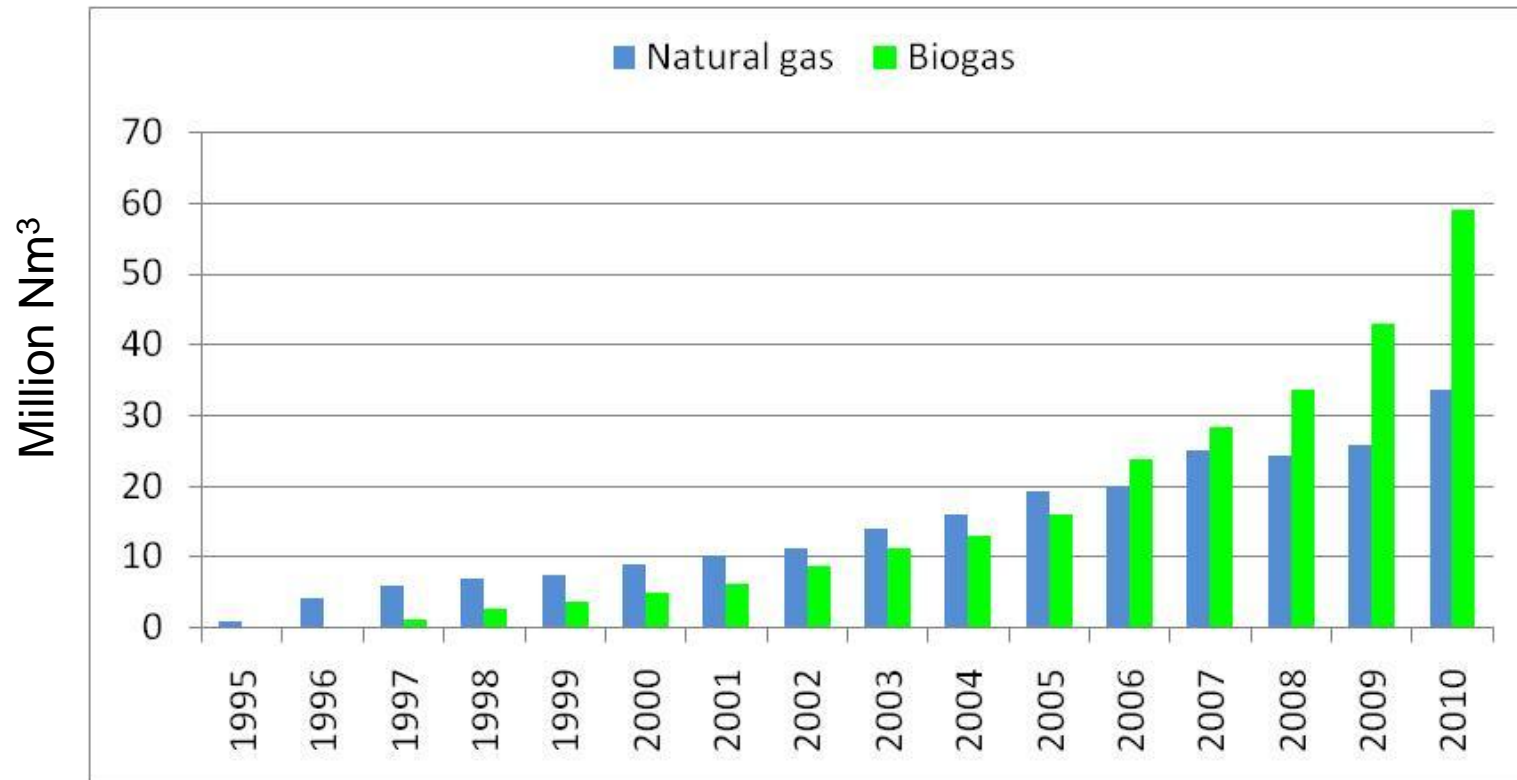


# Driving forces and incentives

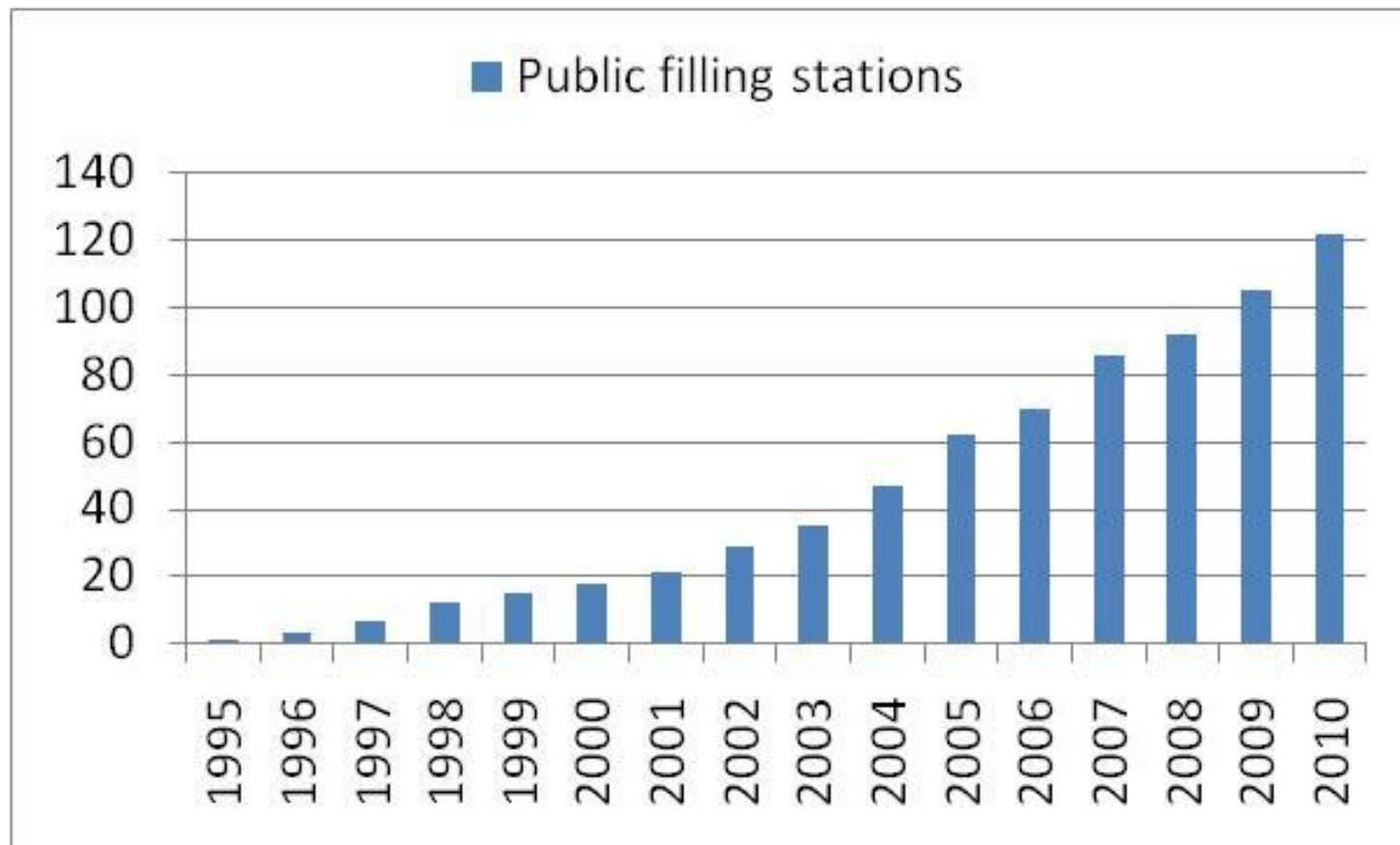
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- No energy tax on biomethane and natural gas used as vehicle fuel
- No carbon dioxide tax on biomethane
- Reduced tax level for CNG company car
- Different types of governmental support regarding R&D and investment in production, upgrading and infrastructure

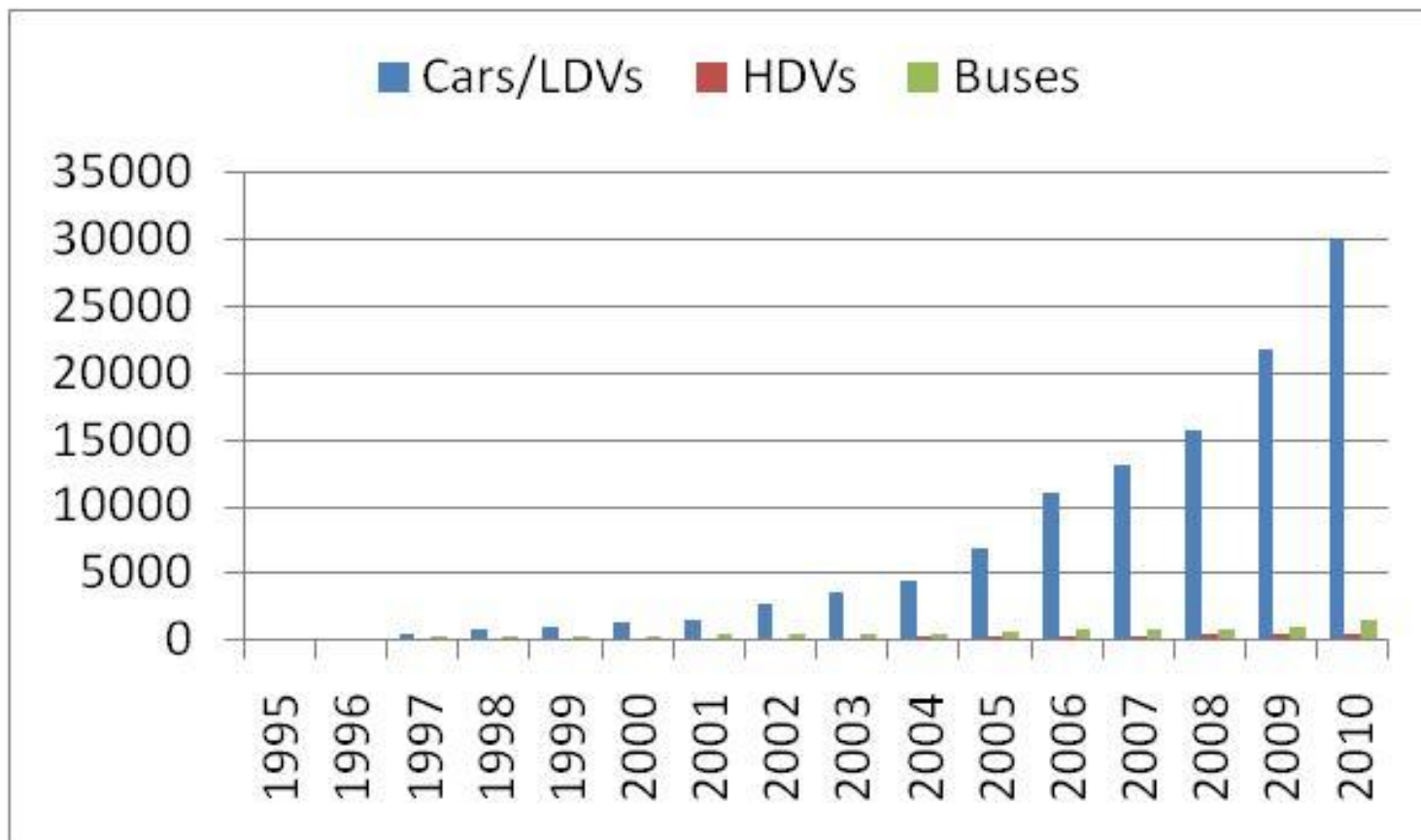
# CNG development



# Nr of public filling stations



# Nr of CNG vehicles





# Ongoing research

- Biomethane through gasification/methanation
  - Competence Centre Gasification
  - Chalmers, pilotplant Bio-SNG
- Biogas upgrading
  - Small scale upgrading
    - In-situ methane enrichment
    - Ecological lung
    - Biosling (sling pump)
    - Carbonatisation of biomass ash
- Gas engine development
  - Competence Centre Combustion Processes
  - Improved HD NG-engine efficiency

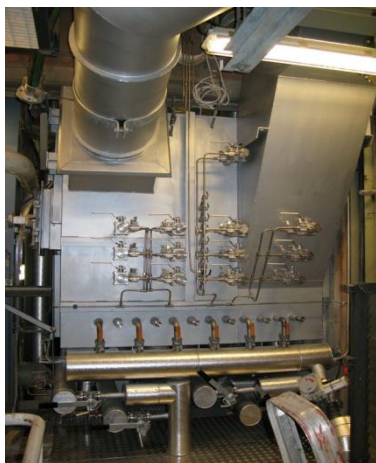
# Biomethane through gasification – R&D

Source: Prof. Henrik Thunman,  
Chalmers University of Technology

Chalmers  
lab-scale reactor



Chalmers  
2-4 MW  
pilot plant



GoBiGas phase 1  
20 MW SNG  
Demonstration plant  
Gothenburg Energy/E.ON



GoBiGas phase 2  
80 MW SNG  
Commercial plant  
Gothenburg  
Energy/E.ON



2008

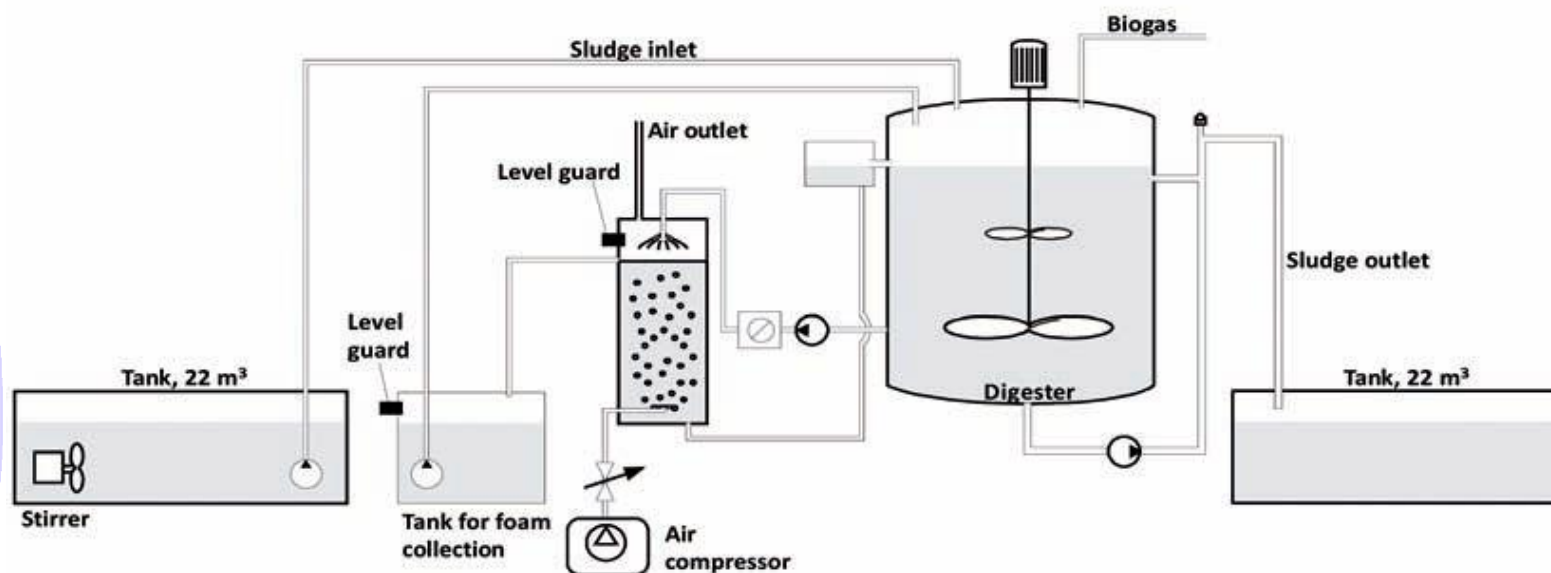
2012

2016



# In-situ methane enrichment

CO<sub>2</sub> is absorbed in the liquid phase of the digester and removed in a desorption vessel by pumping air through the sludge. Methane levels of 95% have been reached.



Courtesy of Åke Nordberg, Swedish University of Agricultural Sciences.

The enzyme carboanhydrase is able to catalyse the carbon dioxide that is formed during the metabolism in our cells by following reaction:



The dissolved  $\text{CO}_2$ , in the form of carbonate, is then transported to our lungs where the same enzyme catalyses the reverse reaction.

The enzyme can be used to remove  $\text{CO}_2$  from raw biogas. Methane levels of 99% have been shown<sup>1</sup>.

Source: Petersson A. and Wellinger A. Biogas upgrading technologies – developments and innovations. IEA Bioenergy, 2009.

1) Prof. Mattiasson B. Dept. of Biotechnology, Lund University, 2011.

# Improved HD NG-engine efficiency

Diesel -> Natural gas/biogas

+: emission reduction, engine operation

-: high throttle losses, lower efficiency and power level

High EGR rate combined with a variable geometry turbocharger, high turbulence piston and closed-loop dilution limit control resulted in up to 10 % lower fuel consumption.



Source: Kaiadi M. Diluted Operation of a Heavy-duty Natural Gas Engine. PhD-thesis. Dept. of Energy Sciences, Lund University, 2011.

# Discussion and conclusions

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- Many benefits with biomethane
- Natural gas and biomethane are excellent alternatives to petrol and diesel
- Many options to produce electricity (and heat) from renewable resources but just a few in the transportation sector
- Biomethane is more resource efficient (yield/ha and conversion efficiency) compared to RME and ethanol.
- Grid distribution is a huge advantage
  - Efficient, less emissions, traffic, accidents and contamination. Improved health and safety etc.

**Thank You for Your  
attention!**

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