

# New Developments in Biogas Upgrading (in Austria)

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<http://www.thvt.at>

**NEW:**

<http://www.virtuellesbiogas.at>

<http://bio.methan.at>



# Agenda

- Quality requirements of gas substitutes (biomethane) in Austria
- Biogas upgrading and grid injection
  - Projects in Austria
  - Projekt „Virtuelles Biogas“ Bruck/Leitha
- Bio-CNG fuel stations in Austria
  - Methapur fuel station Margarethen/Moos
- Economics
- Summary & Outlook



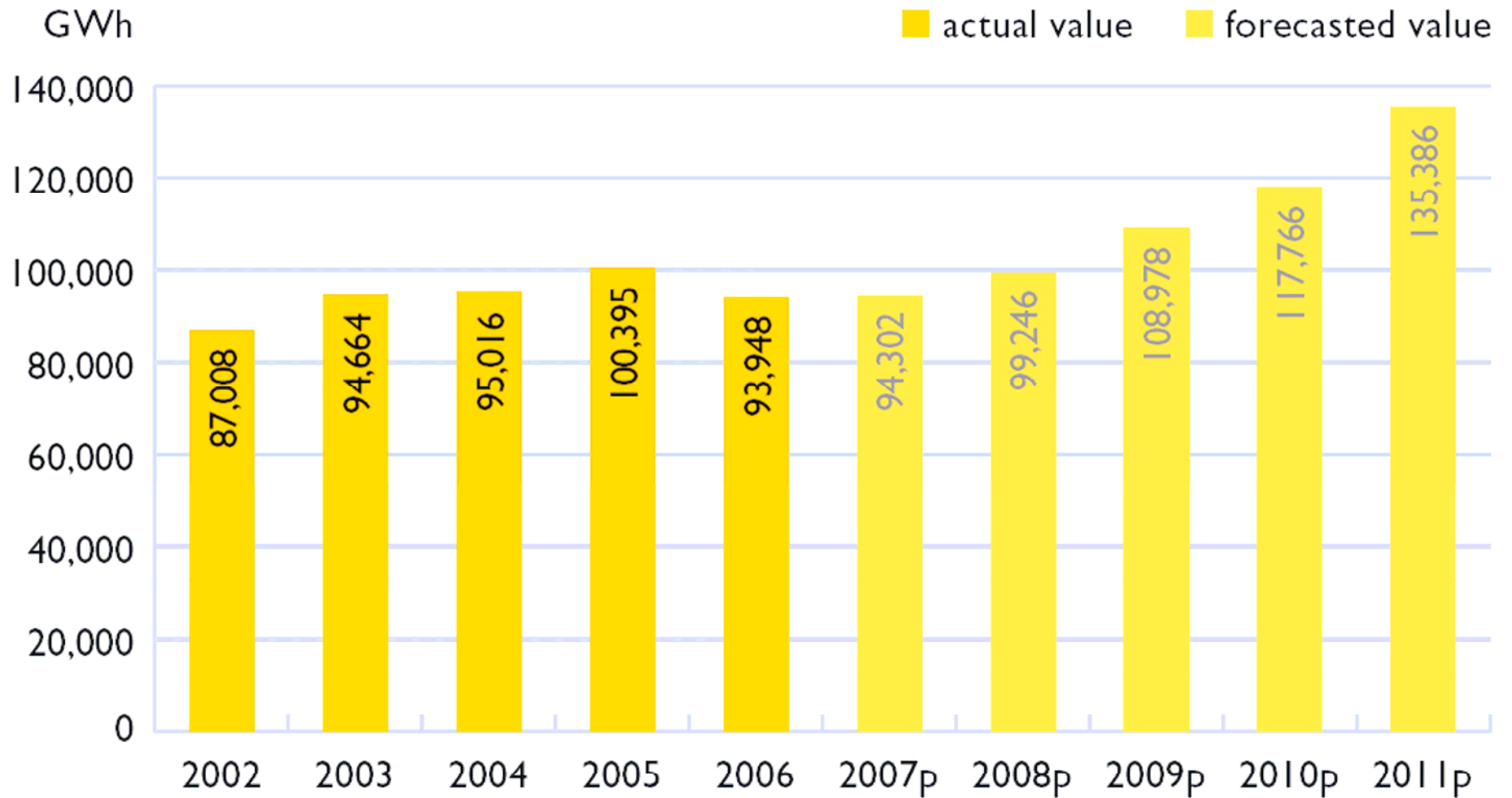
# Typical Biogas Composition compared to Austrian Natural Gas Grid Standards

Parameter	Biogas	Quality according to Austrian Standard OEVGW G31 / G33	Unit
Methane (CH <sub>4</sub> )	45 - 70	unspecified ( > 97.0)	mol%
Carbon dioxide (CO <sub>2</sub> )	30 - 45	≤ 2.0	mol%
Ammonia (NH <sub>3</sub> )	< 1,000	Technically free	mg/m <sup>3</sup> (STP)
Hydrogen sulphide (H <sub>2</sub> S)	< 2,000	≤ 5	mg/m <sup>3</sup> (STP)
Oxygen (O <sub>2</sub> )	< 2	≤ 0.5	mol%
Nitrogen (N <sub>2</sub> )	< 8	≤ 5	mol%
Water (H <sub>2</sub> O) - Dewpoint	< 37 @ 1bar	≤ - 8 @ 40bar	°C
<b>Upper Heating Value</b>	6.7 – 8.4	10.7 – 12.8	kWh/m <sup>3</sup> (STP)
<b>Wobbe-Index</b>	6.9 – 9.5	13.3 – 15.7	kWh/m <sup>3</sup> (STP)

- OEVGW G31 defines natural gas, OEVGW G33 specifies grid injection standards for biogeneous gases



# Natural gas consumption in Austria



Delivery to end users (exclusive of own consumption and errors of measurement)

[E-Control, AGGM (2007)]



# Biogas upgrading and grid injection in Austria

- **In Operation**

- Pucking (Upper Austria), PSA, 6 m<sup>3</sup>/h (since 2005)
- Bruck/Leitha (Lower Austria), Membranw, 100 m<sup>3</sup>/h (since 2007)
- Eugendorf (Salzburg), PSA, 40 m<sup>3</sup>/h (since 2008)

Source: AGGM  
Date  
31.08.2009

- **Planned or Start-up Phase**

- Waste water treatment plant Asten/St. Florian (Upper Austria), water scrubber(?)
- Leoben (Styria), amine scrubber
- Zell am See (Salzburg) PSA, water scrubber or membrane (?)

- **In discussion**

- Wiener Neustadt (Lower Austria)
- ...

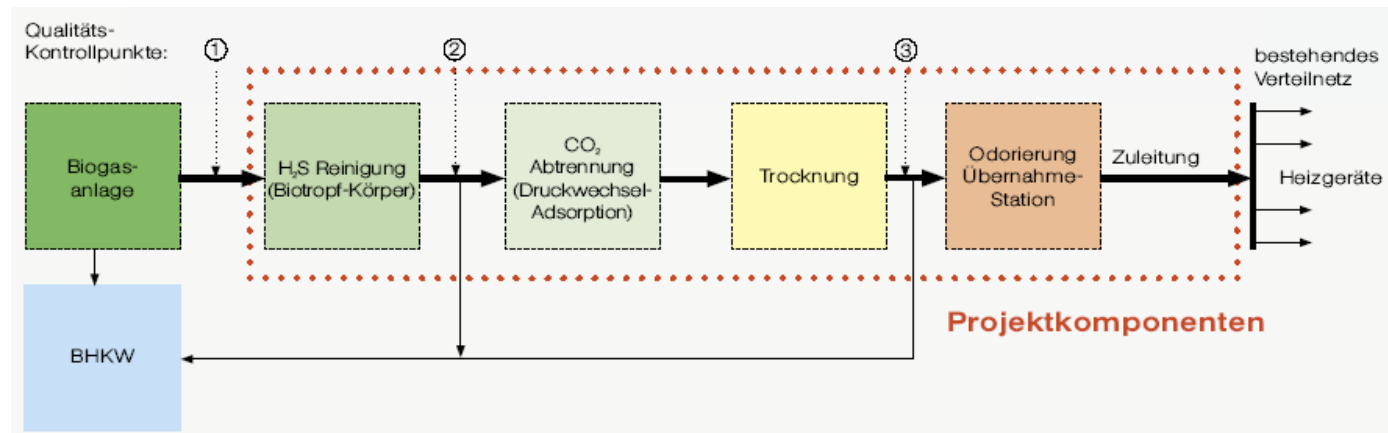
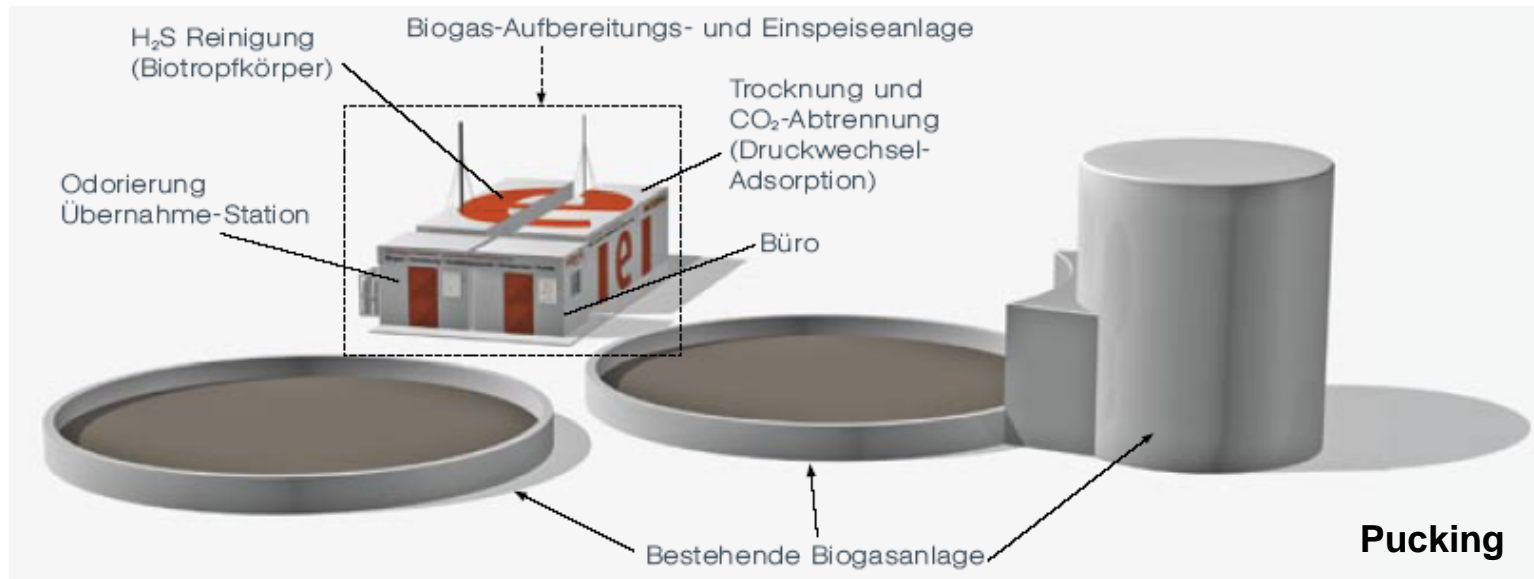


# Biogas Upgrading using Pressure Swing Adsorption

Betreiber: **erdgas öö.** sorgenfrei versorgt

Partnerunternehmen: Awite Bioenergie GbR, Johann Hochreiter GmbH, PROFACOR Produktionsforschungs GmbH, RÜTGERS CarboTech Engineering GmbH, Schmack Biogas AG

Projektpartner: Landwirtschaftskammer für Oberösterreich, **LAND OBERÖSTERREICH**



(Source: erdgas OÖ)



# Project Pucking

## Pressure Swing Adsorption (PSA)



(Photos: M.Harasek)



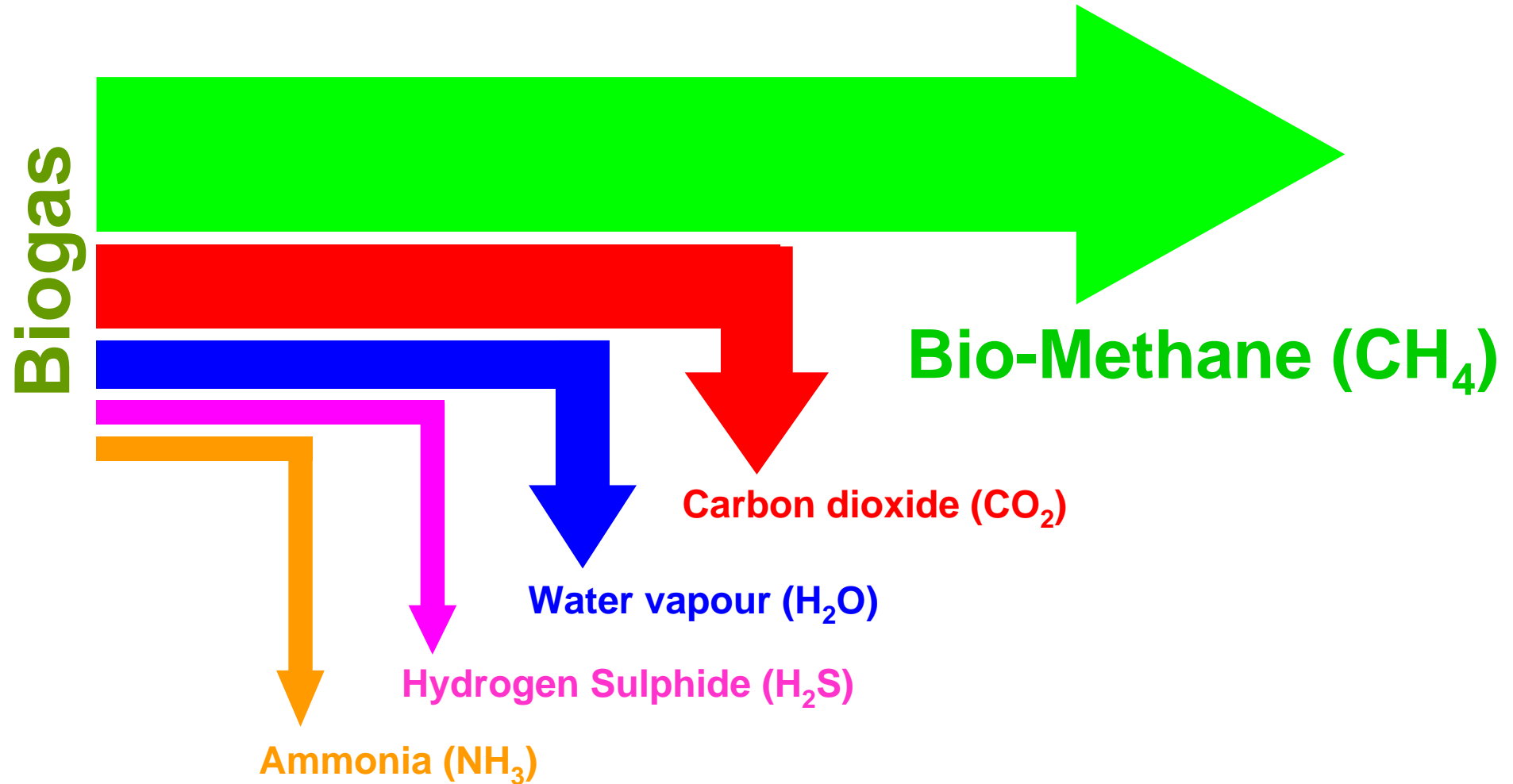
# Biogas upgrading plant Bruck/Leitha

- **2-stage gas permeation** plant producing 100m<sup>3</sup>(STP)/h corresponding to about 180m<sup>3</sup>(STP)/h raw biogas
- **100% compatible natural gas substitute** according to Austrian laws ÖVGW G31 and G33
- **Supply to local gas grid** (3bar) and transported to city
- During summer additionally **high-pressure compression** (60bar) and supply to regional gas grid (up to 50m<sup>3</sup>/h)
- **Optimized process integration** into the existing biogas plant resulting in **zero-emission-operation** for methane
- Highly compact: whole plant fits into 30'-container
- **Opening mid 2007**, normal operation since 01/2008

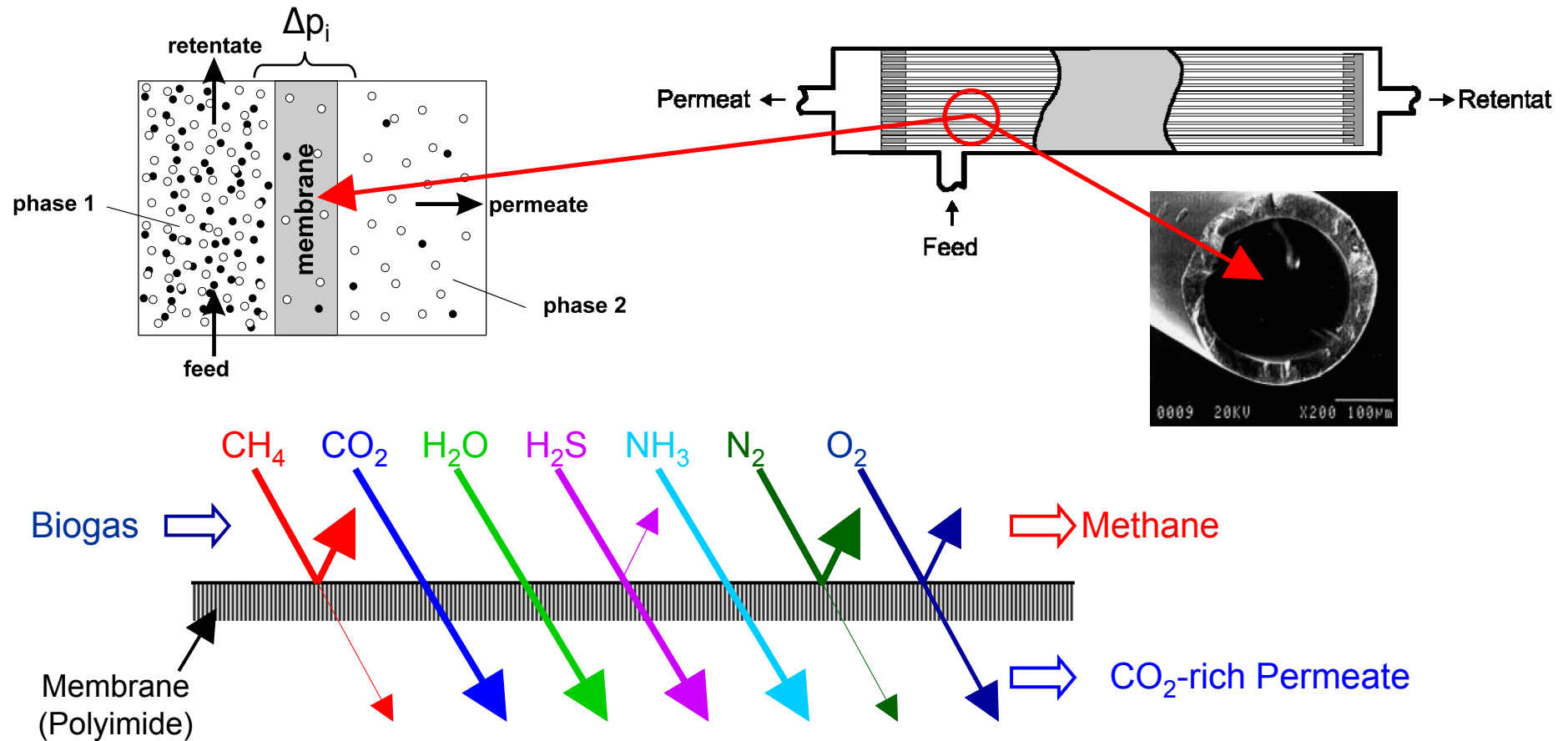




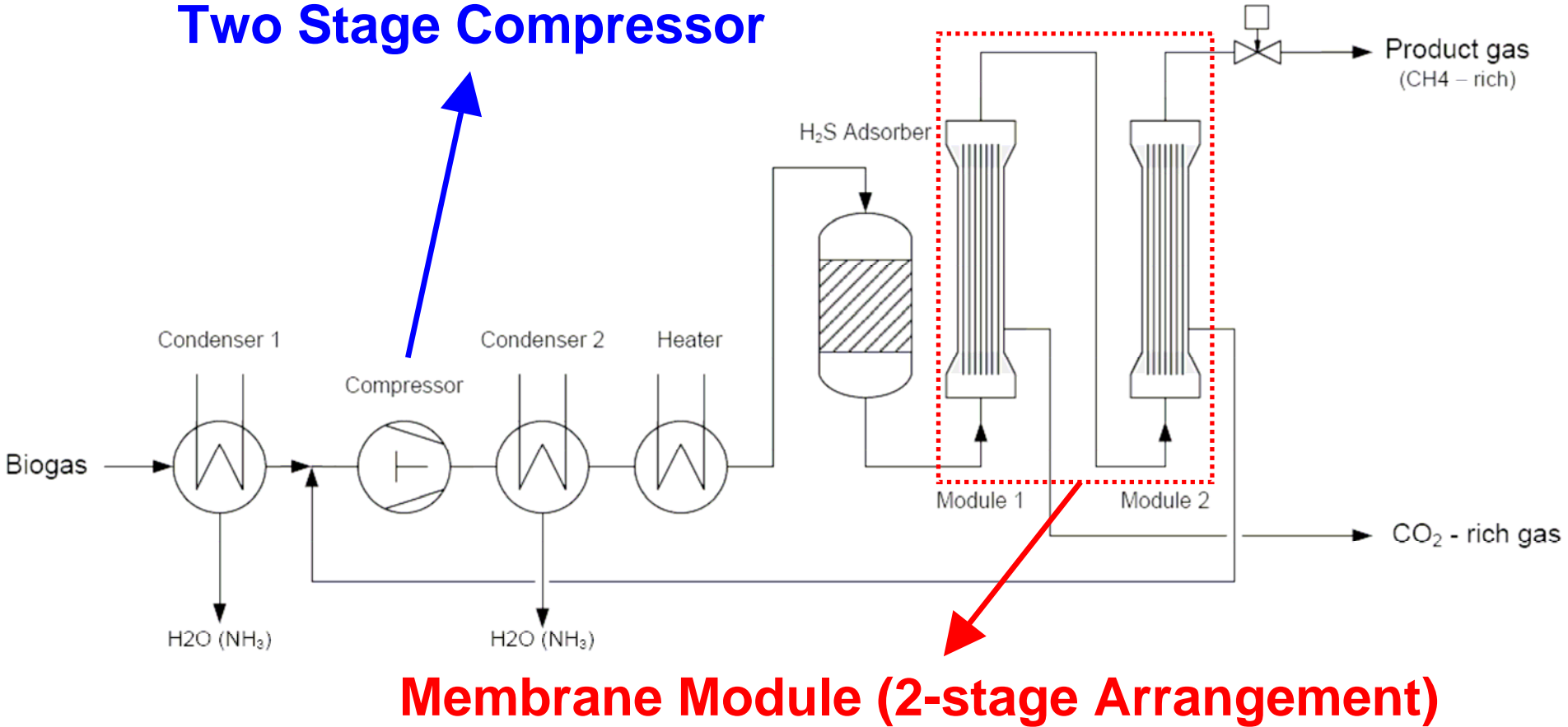
# Biogas Upgrading – A Separation Problem



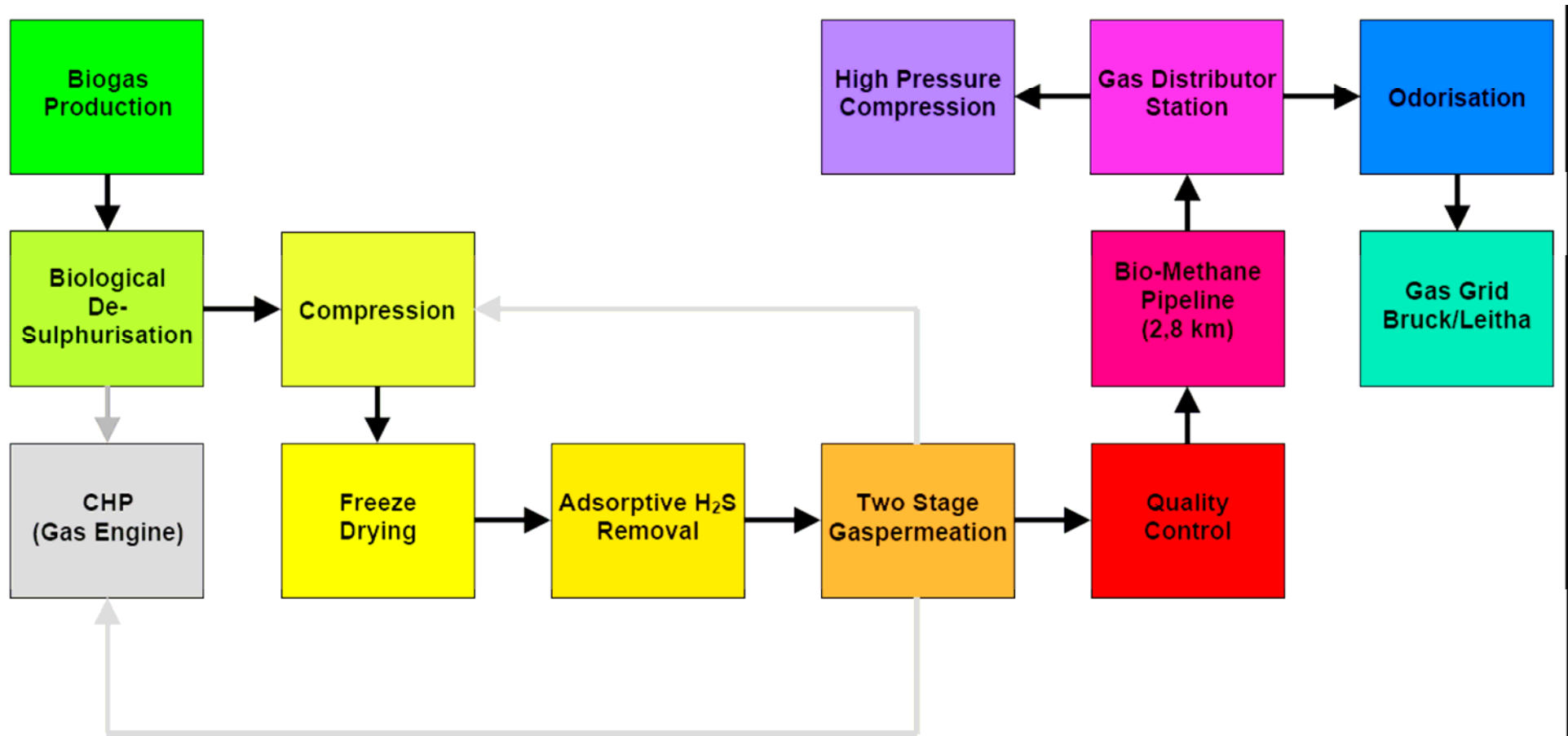
# Separation principle of gas permeation (GP)



# Process Concept



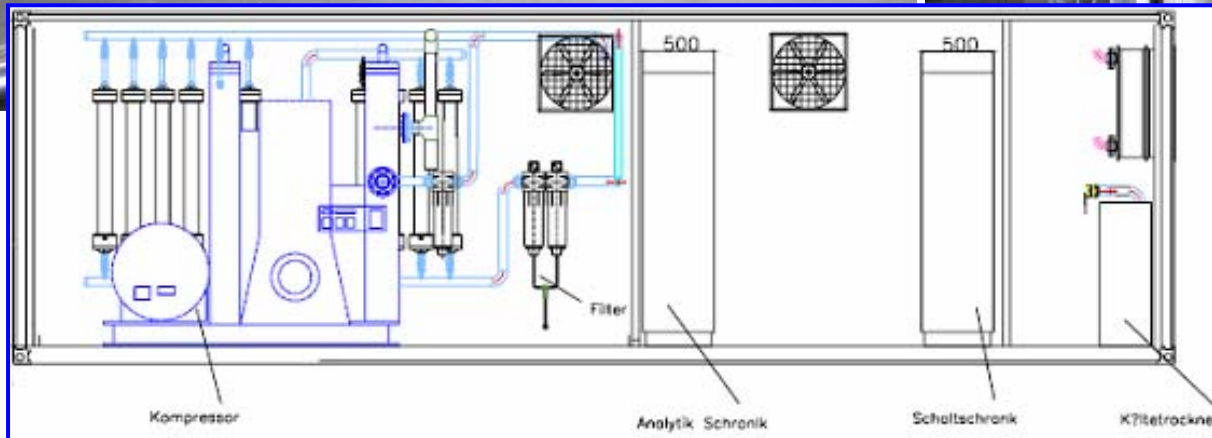
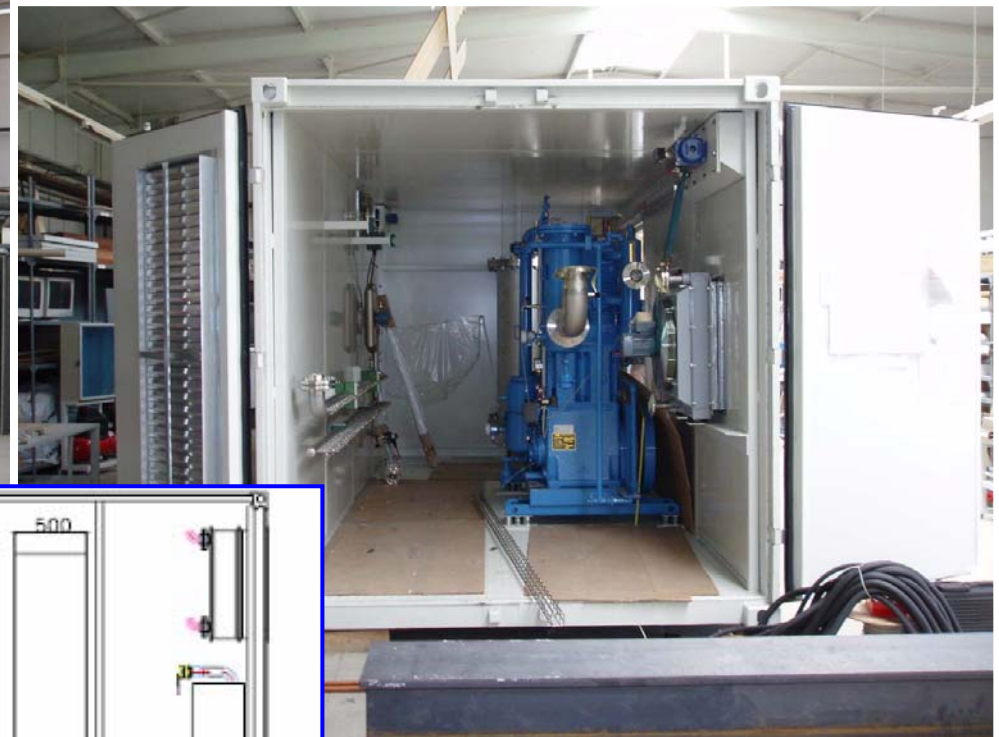
# Process Integration



- Biogas upgrading with prior biological desulphurisation
- Permeate goes back to CHP



# Container – Assembling at Axiom Angewandte Prozesstechnik GmbH





# Construction Work in Bruck/Leitha

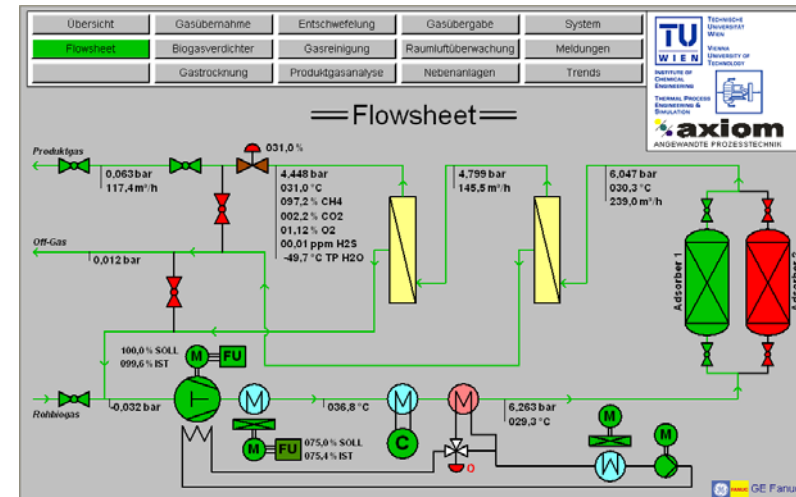
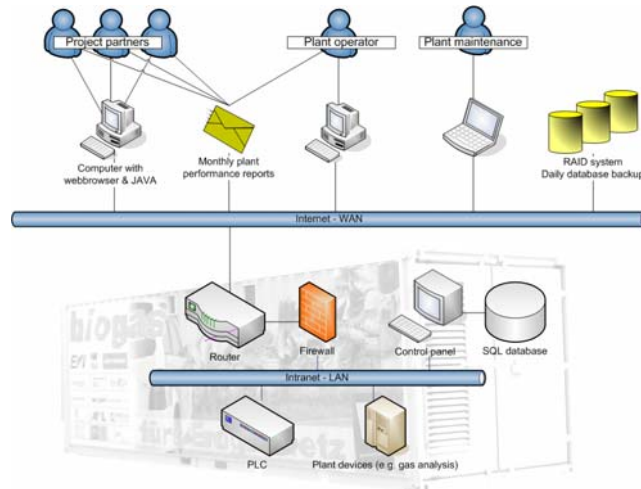


# Construction Work in Bruck/Leitha



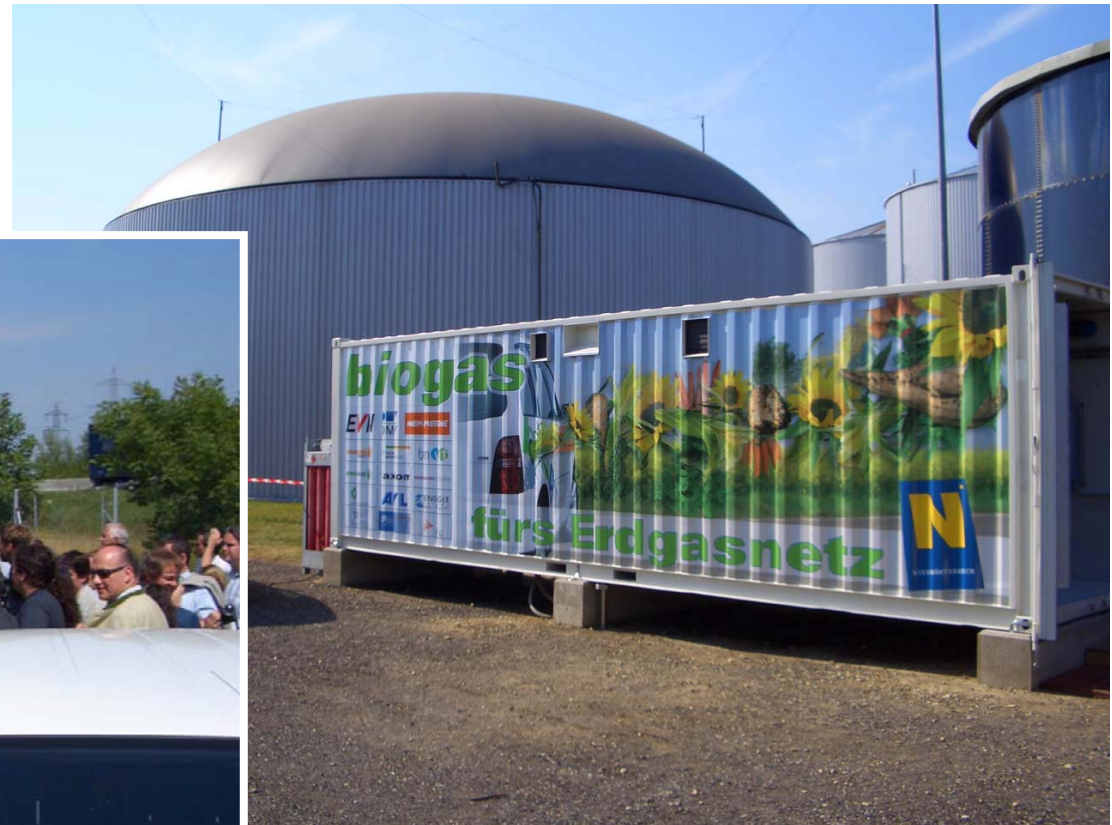
## High Pressure Compressor

## Process Control

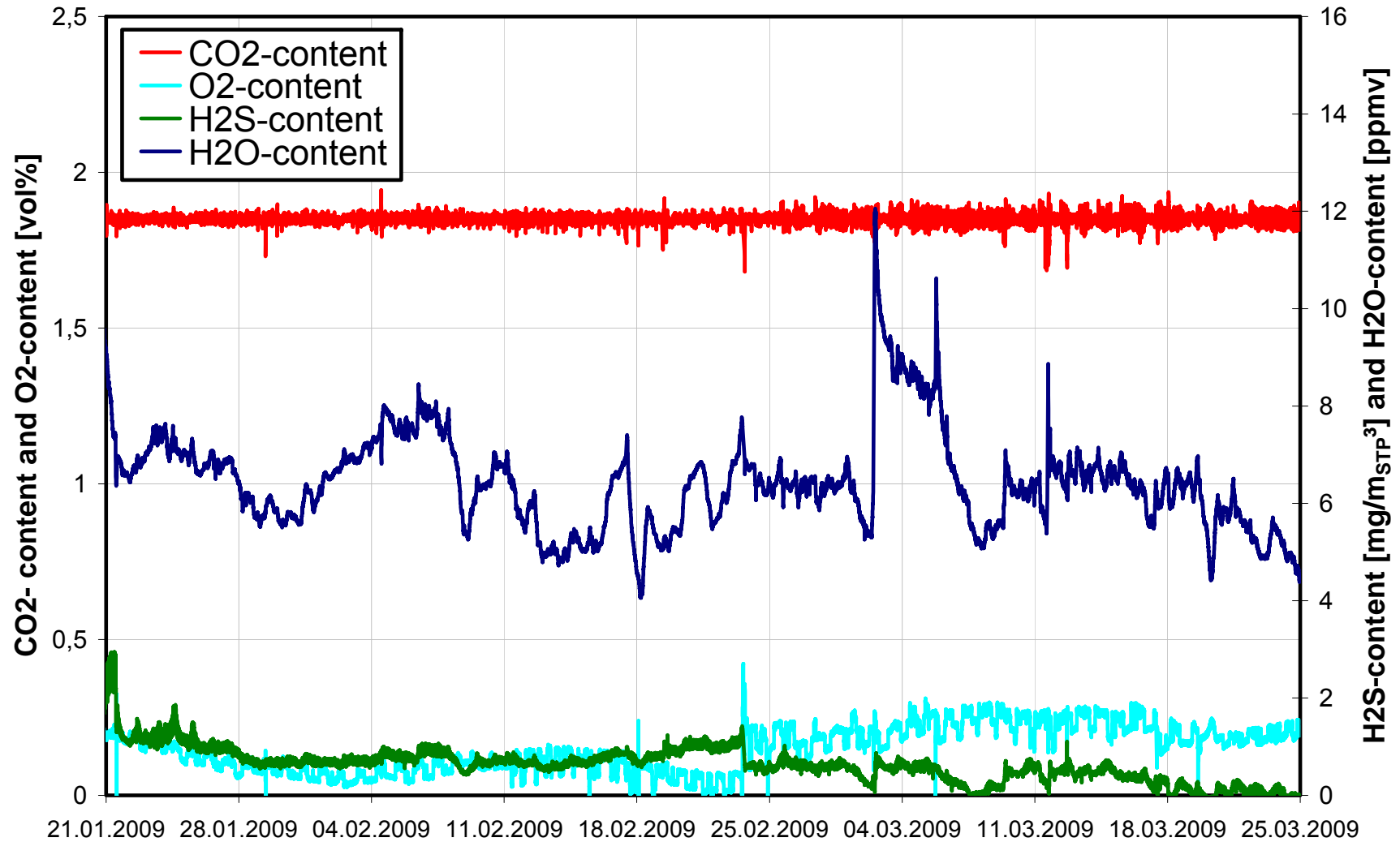




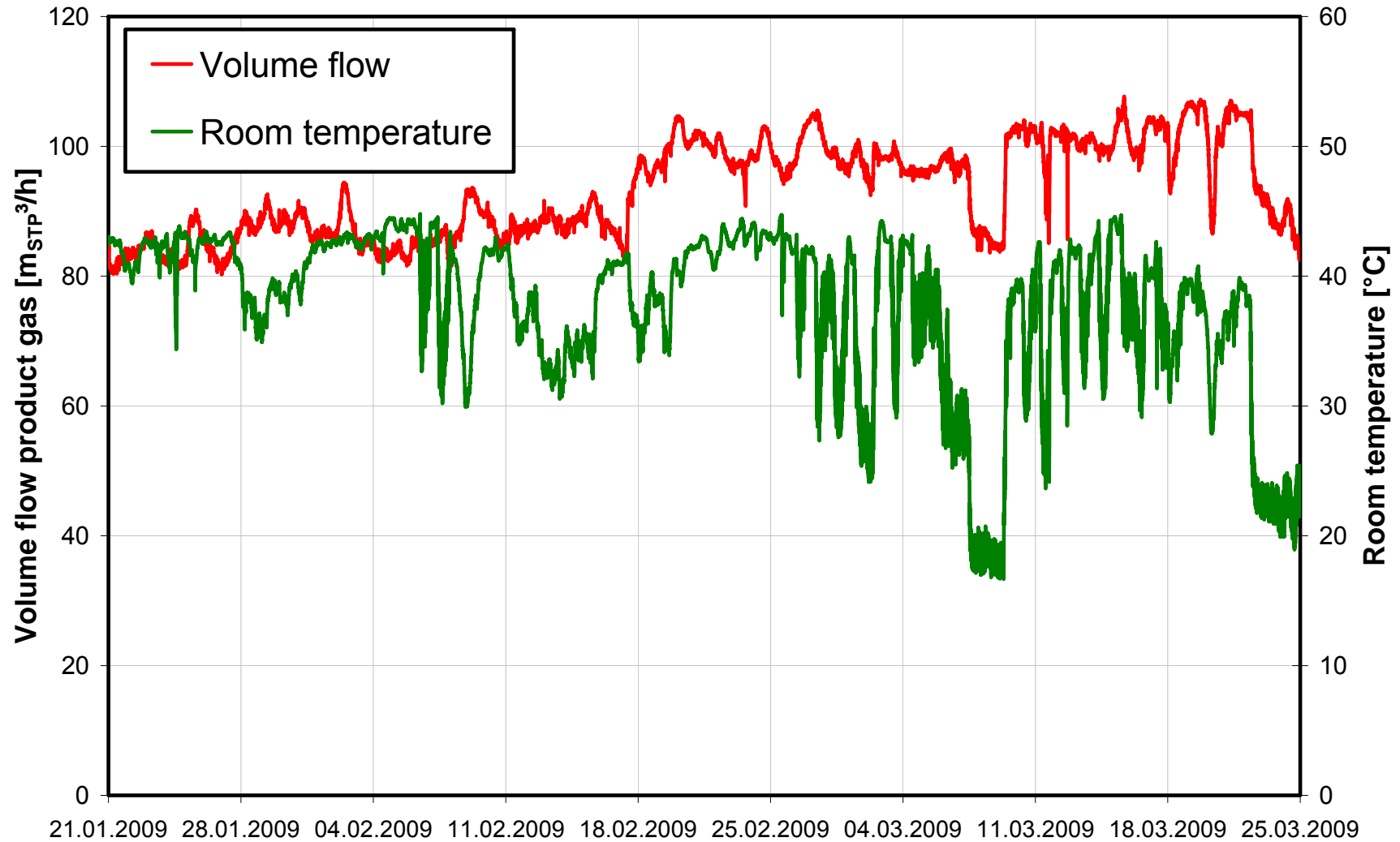
# Opening Celebration on June 25, 2007



# Long term feed-in performance of GP unit (I)

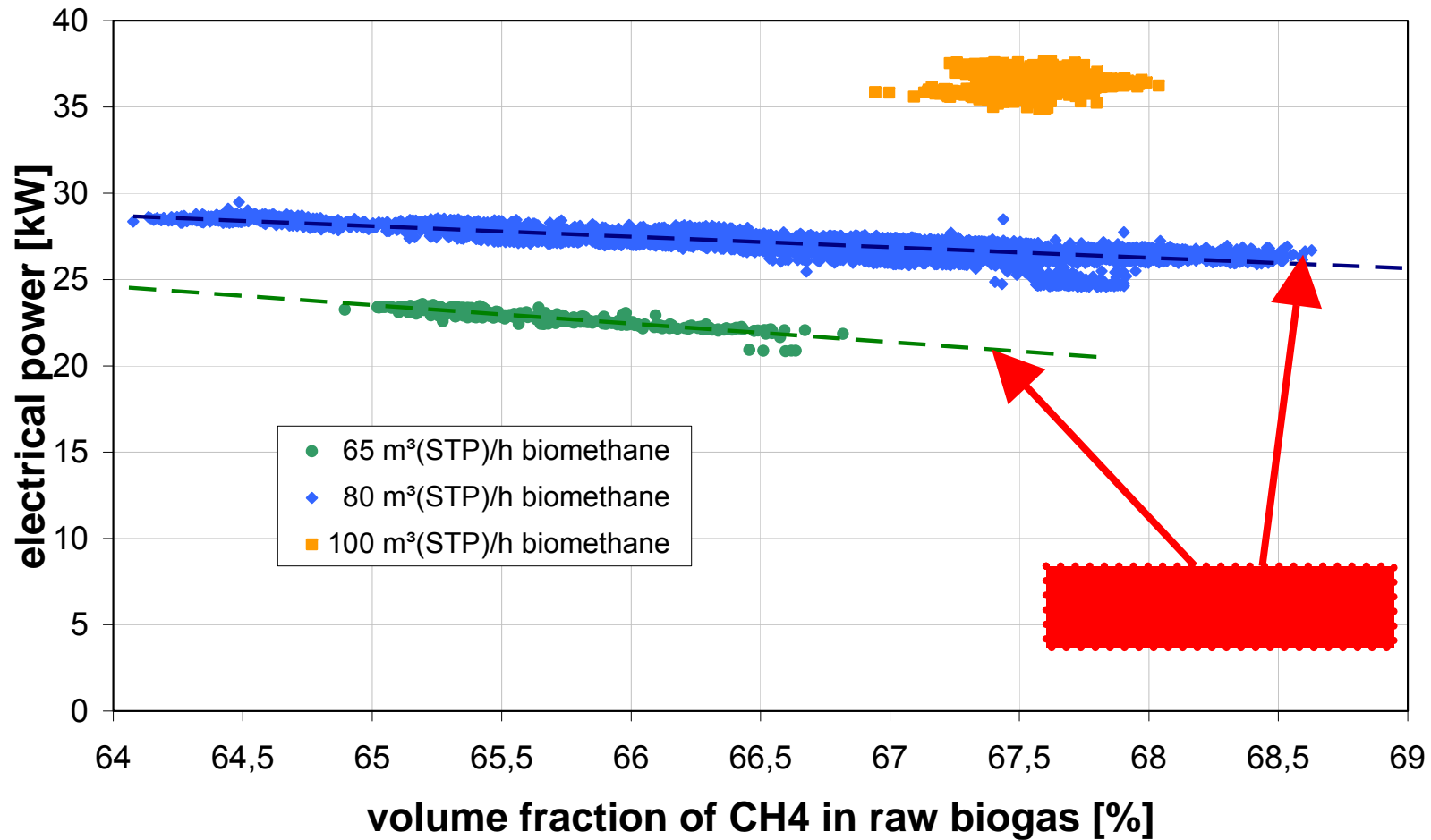


# Long term feed-in performance of GP unit (II)





# Upgrading plant Bruck/Leitha – compressor power consumption

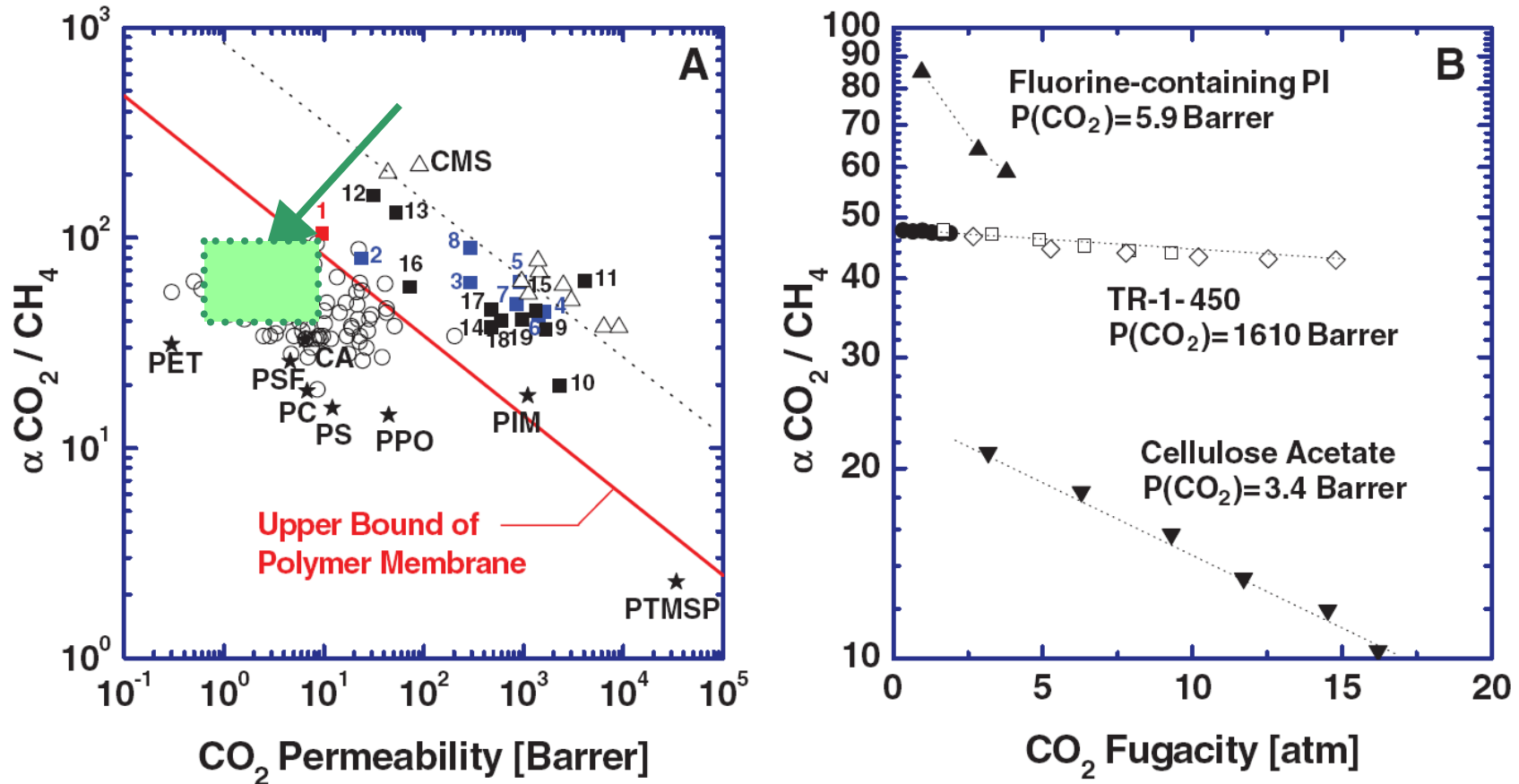


# Energy consumption analysis

- **Main energy consumer of upgrading is the raw biogas compressor.**
- Energy demand for constant product gas quality and quantity depends also on raw biogas methane content.
- **Effect of plant layout** (number of stages) on energy consumption:
  - **Two stage gas grid injection plant:** 0,378 kWh/m<sup>3</sup>STP of product gas
  - **Single stage Bio-CNG-plant:** 0,280 kWh/m<sup>3</sup>STP of product gas
- Related to the methane content of the produced biomethane gas stream:
  - Two stage gas grid injection plant: 3,2% (98,1vol% CH<sub>4</sub>)
  - Single stage Bio-CNG-plant: 2,8% (96,1vol% CH<sub>4</sub>)
- All values are valid for a product gas delivery pressure of about 3 bar(g).



# Possibilities of CO<sub>2</sub> selective membranes for the separation of CH<sub>4</sub>/CO<sub>2</sub>

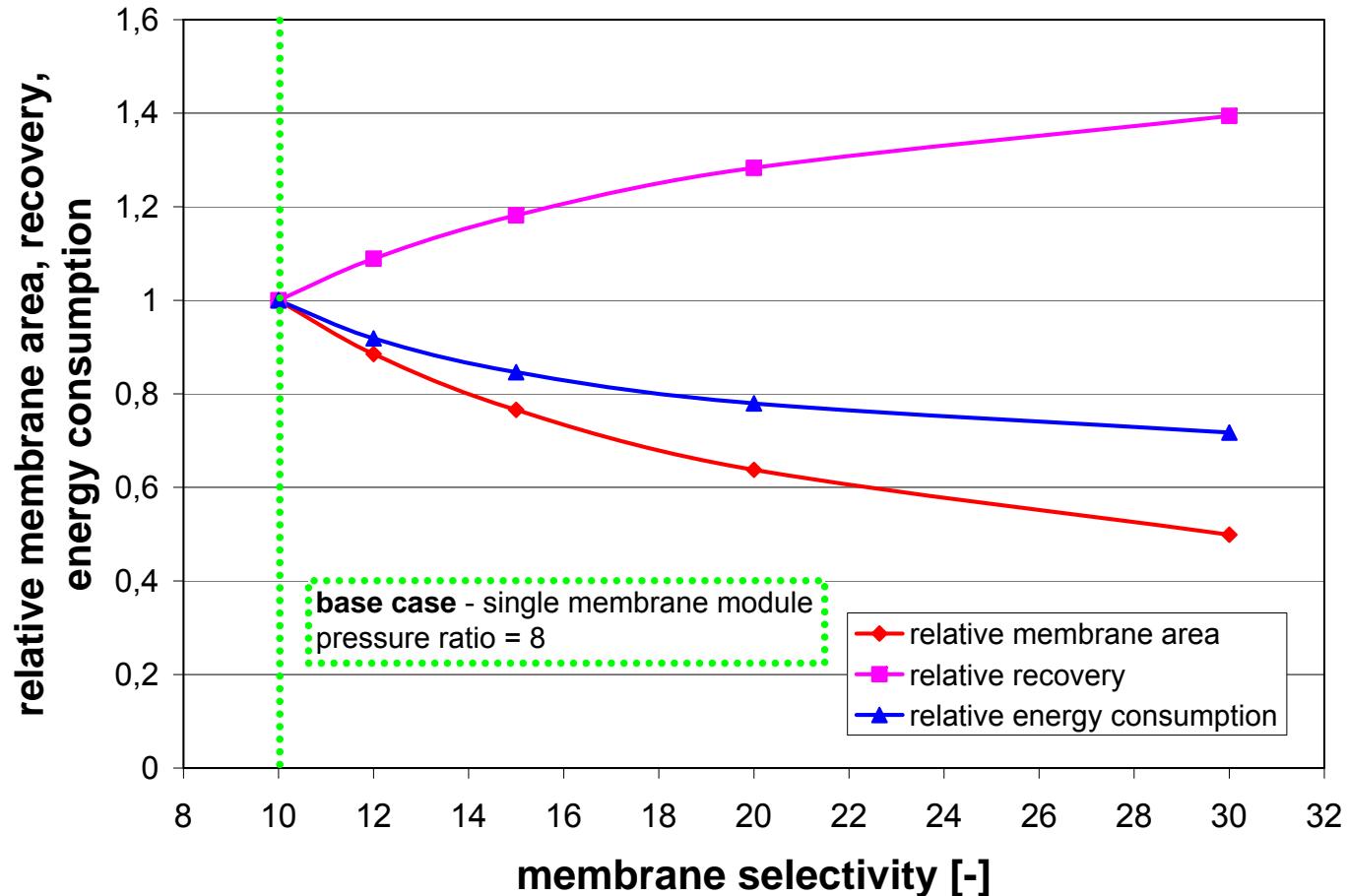


Relation between CO<sub>2</sub> permeability and CO<sub>2</sub>/CH<sub>4</sub> selectivity of TR polymers (PI derived polymers with intrinsic cavities)

From [H. B. Park et al., Science 318, 254 -258 (2007)] Reprinted with permission of AAAS



# Improvements using more selective membranes



- Single stage countercurrent-flow membrane model
- 60% CH<sub>4</sub> in feed; 97% CH<sub>4</sub> in product (retentate)



# First Austrian biomethane fueling station in Operation...



35 m<sup>3</sup>/h biomethane

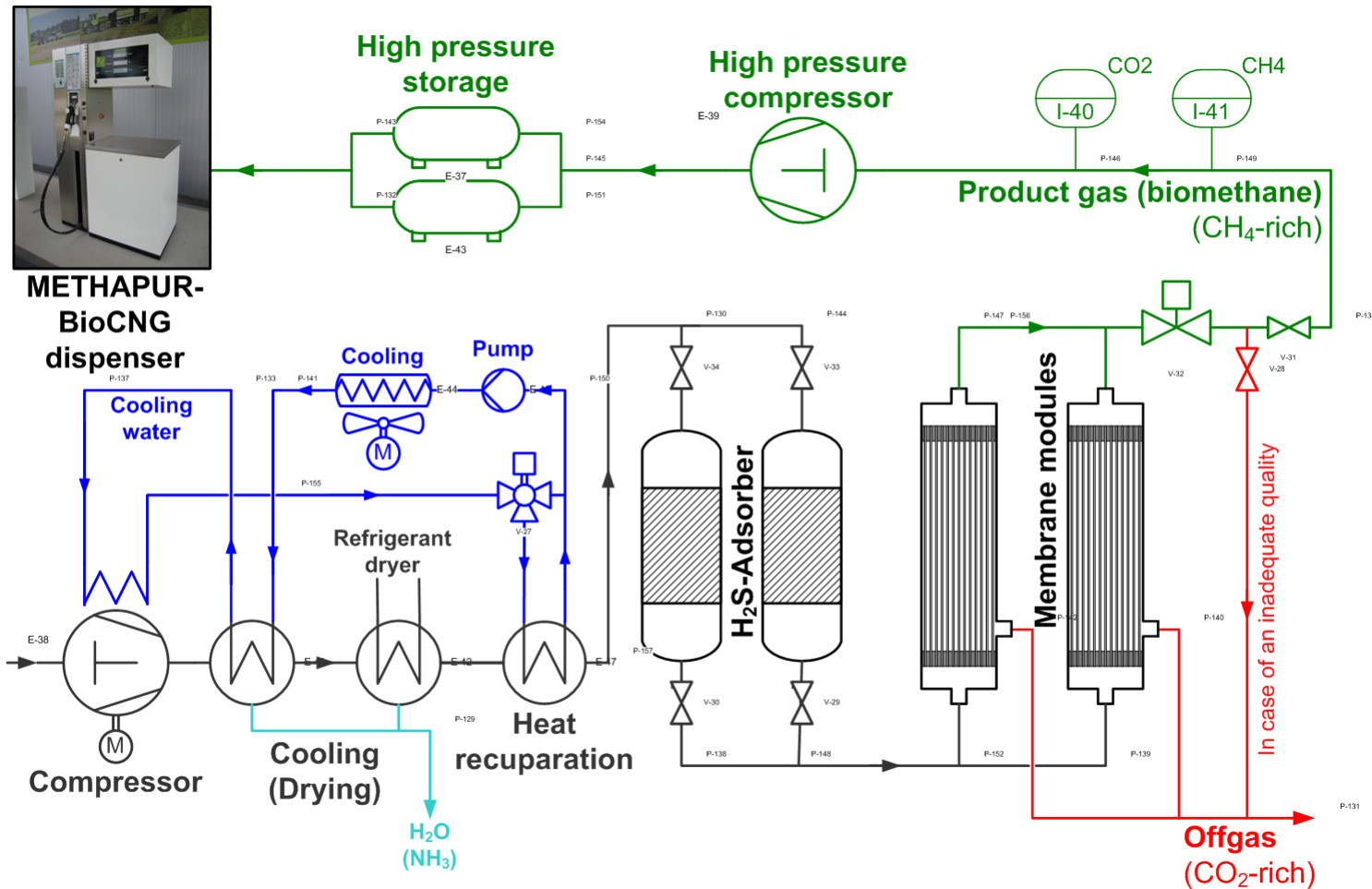


- Further Information: <http://www.methapur.com>  
„Biomethantankstelle Margarethen/Moos“





# Process Design – Margarethen am Moos



- Concept includes in-situ desulphurization / single stage gas permeation
- Permeate fed back to CHP plant – Zero methane emission of biogas upgrading system



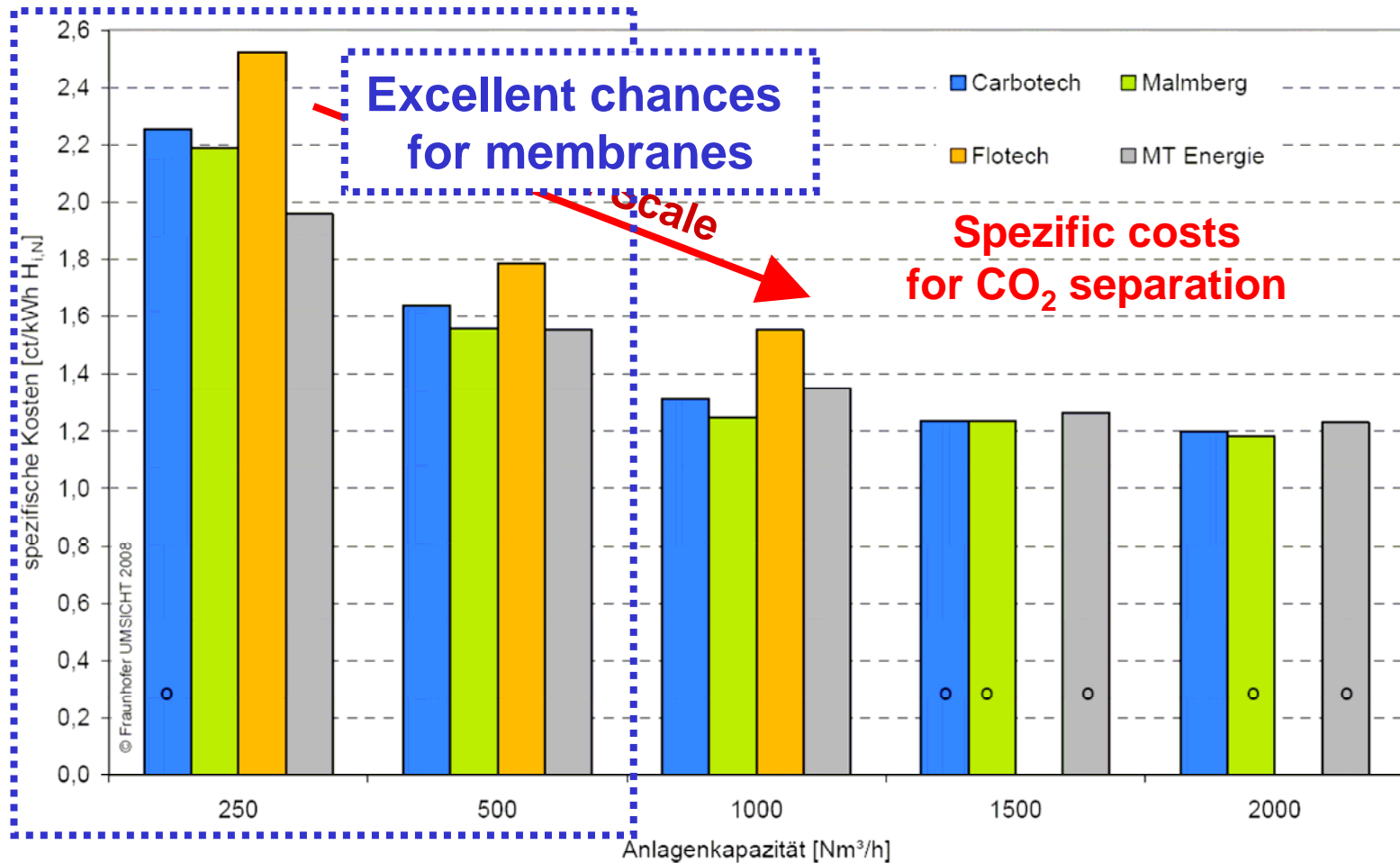
# Methapur concept: supply of max. 100 vehicles with biomethane

- Capacity up to 500 kg/d biomethane
- Operation of the first biogas driven tractor in Austria



# Costs for CO<sub>2</sub> Separation

- New calculations by Fraunhofer Institut UMSICHT (2008)





# Biogas-upgrading in Leoben

- Project of Energie Steiermark Gas & Wärme
- Low pressure amine scrubbing system (delivery pressure 100 mbar)
- Full capacity of approx. 130-160 m<sup>3</sup>/h biomethane
- Start-up in 2009 (?)

[Machan (2009)]



# Economics of biomethane production in Austria

- To date **no innovation bonus**
- To date **no central combined heat and power production** with renewables feed-in tariffs
- Full competition with gas market (0,30 – 0,35 €/m<sup>3</sup>)
- **New law (Ökostromgesetz Novelle 2008)** could lead to **better legal and economic situation** – yet no new feed-in tariffs
- **Sale as Bio-CNG** still better revenues
- **Methapur concept** for the self supply of car fleets



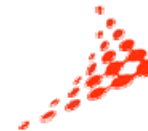
# Summary & Conclusions

- **Technology demonstration** successful
  - Bruck/Leitha
  - Margarethen/Moos
  - Eugendorf
  - Pucking
- **> 180.000 m<sup>3</sup> fed into grid** within first few operation months in Bruck/Leitha
- **Quality requirements** easily met
- **Zero methane emission** of upgrading system
- Technology multiplication planned





# Acknowledgements



**biogas**



Visit us @: <http://bio.methan.at>

