New Developments in Biogas Upgrading (in Austria)

DI Dr. Michael HARASEK, DI Aleksander MAKARUK

Technische Universität Wien
Institut für Verfahrenstechnik, Umwelttechnik und Technische Biowissenschaften

michael.harasek@tuwien.ac.at
aleksander.makaruk@tuwien.ac.at
http://www.thvt.at

NEW:
http://www.virtuellesbiogas.at
http://bio.methan.at

Agenda

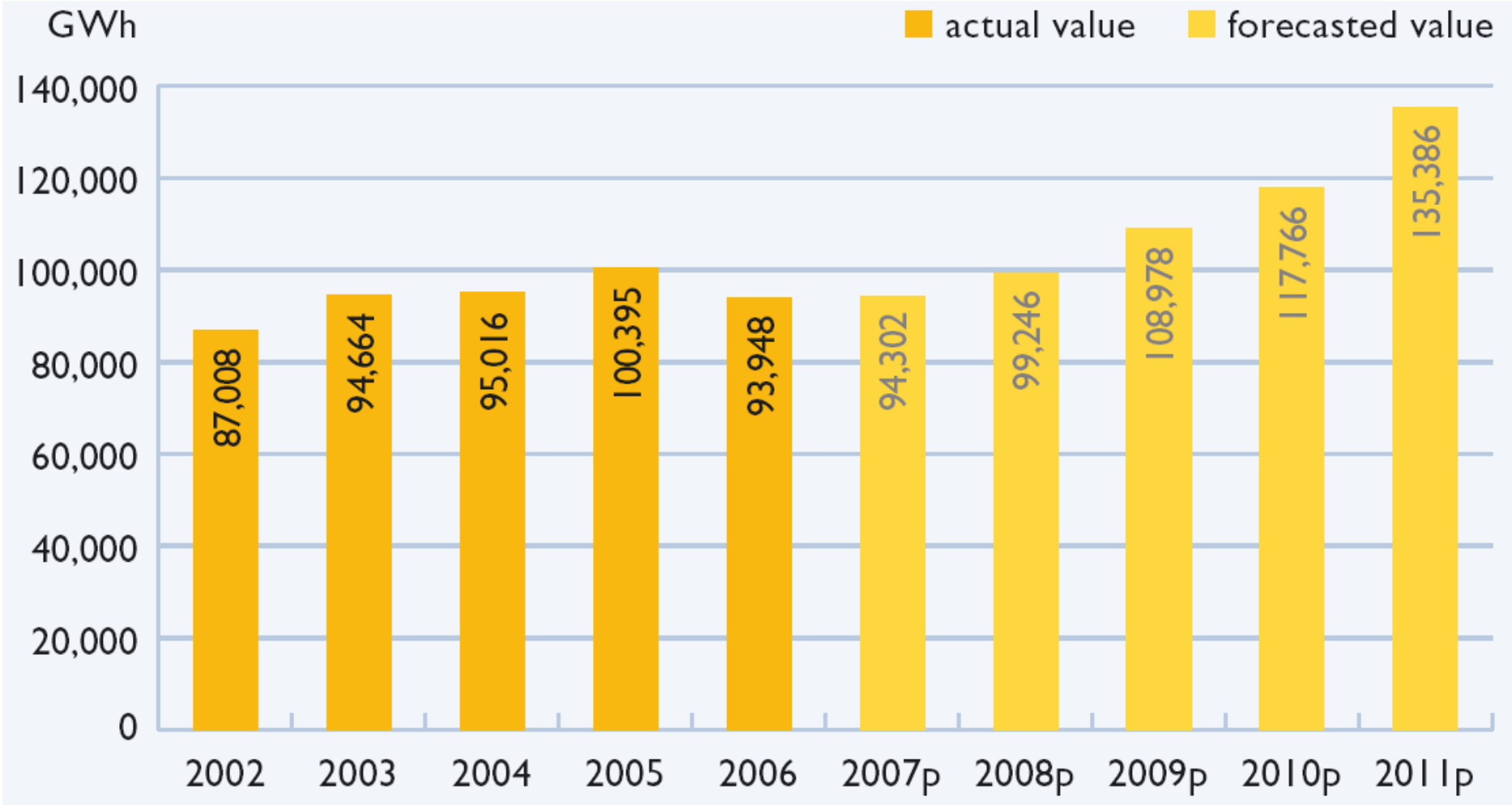
- Quality requirements of gas substitutes (biomethane) in Austria
- Biogas upgrading and grid injection
  - Projects in Austria
  - Projekt „Virtuelles Biogas“ Bruck/Leitha
- Bio-CNG fuel stations in Austria
  - Methapur fuel station Margarethen/Moos
- Economics
- Summary & Outlook

Typical Biogas Composition compared to Austrian Natural Gas Grid Standards

Parameter	Biogas	Quality according to Austrian Standard OEVGW G31 / G33	Unit
Methane (CH_4)	45 - 70	unspecified (> 97.0)	mol%
Carbon dioxide (CO_2)	30 - 45	≤ 2.0	mol%
Ammonia (NH_3)	< 1,000	Technically free	mg/m³(STP)
Hydrogen sulphide (H_2S)	< 2,000	≤ 5	mg/m³(STP)
Oxygen (O_2)	< 2	≤ 0.5	mol%
Nitrogen (N_2)	< 8	≤ 5	mol%
Water (H_2O) - Dewpoint	< 37 @ 1bar	≤ - 8 @ 40bar	°C
Upper Heating Value	6.7 – 8.4	10.7 – 12.8	kWh/m³(STP)
Wobbe-Index	6.9 – 9.5	13.3 – 15.7	kWh/m³(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

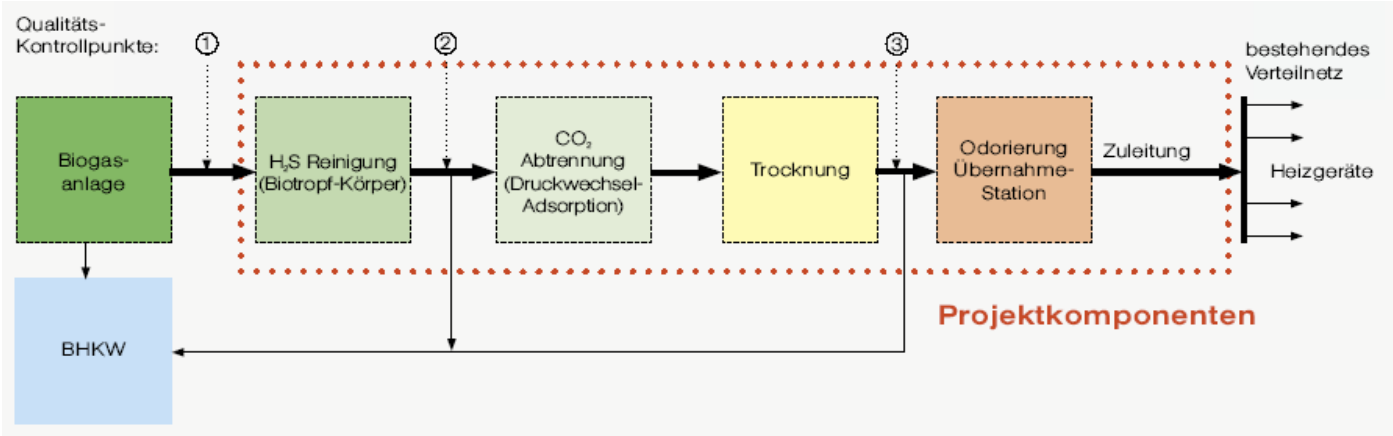
- **In Operation**
  - Pucking (Upper Austria), PSA, 6 m³/h (since 2005)
  - Bruck/Leitha (Lower Austria), Membranw, 100 m³/h (since2007)
  - Eugendorf (Salzburg), PSA, 40 m³/h (since 2008)
- **Planned or Start-up Phase**
  - Waste water treatment plant Asten/St.Florian (Upper Austria), water scrubber(?)
  - Leoben (Styria), amine scrubber
  - Zell am See (Salzburg) PSA, water scrubber or membrane (?)
- **In discussion**
  - Wiener Neustadt (Lower Austria)
  - …

Source:AGGM
Date
31.08.2009

Biogas Upgrading using Pressure Swing Adsorption

Betreiber: erdgas oö. sorgenfrei versorgt; OÖ.FERNGAS
Projektpartner: Landwirtschaftskammer für Oberösterreich; LAND OBERÖSTERREICH
Partnerunternehmen: Awite Bioenergie GbR; Johann Hochreiter GmbH; PROFACTOR Produktionsforschungs GmbH; RÜTGERS CarboTech Engineering GmbH; Schmack Biogas AG

Pucking



(Source: erdgas OÖ)

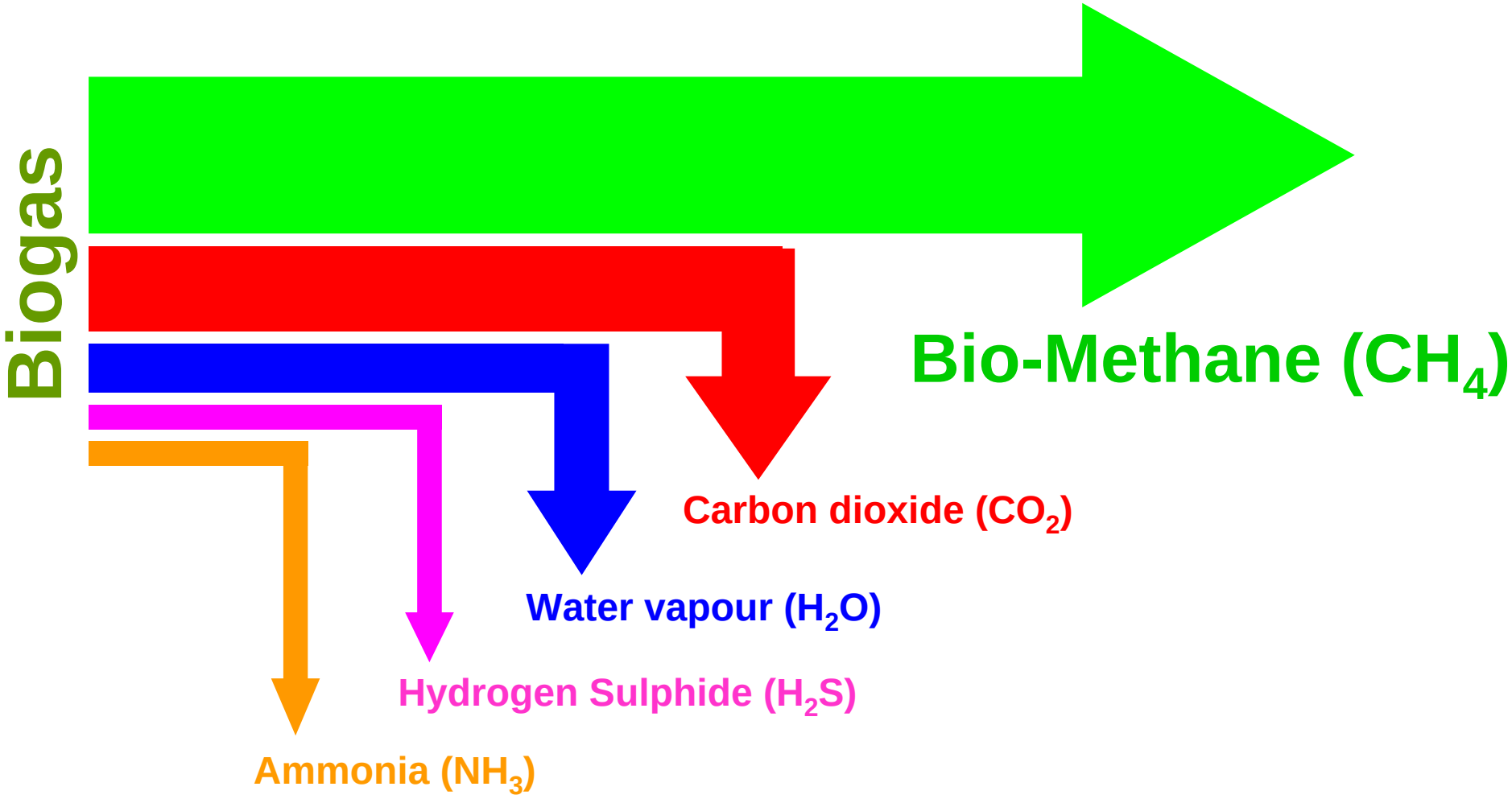
Project Pucking
Pressure Swing Adsorption (PSA)

(Photos: M.Harasek)

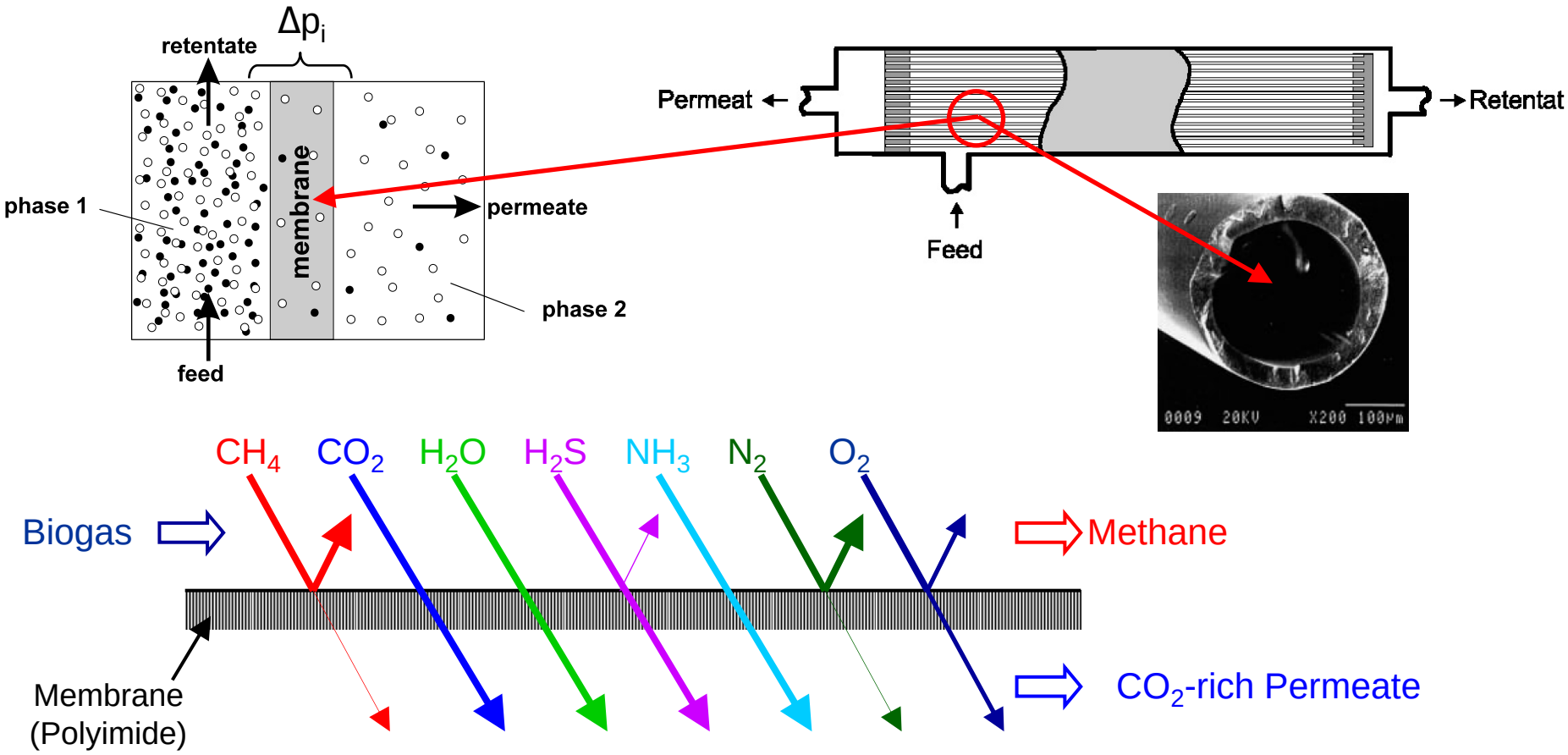
Biogas upgrading plant Bruck/Leitha

- **2-stage gas permeation** plant producing 100m³(STP)/h corresponding to about 180m³(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 50m³/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

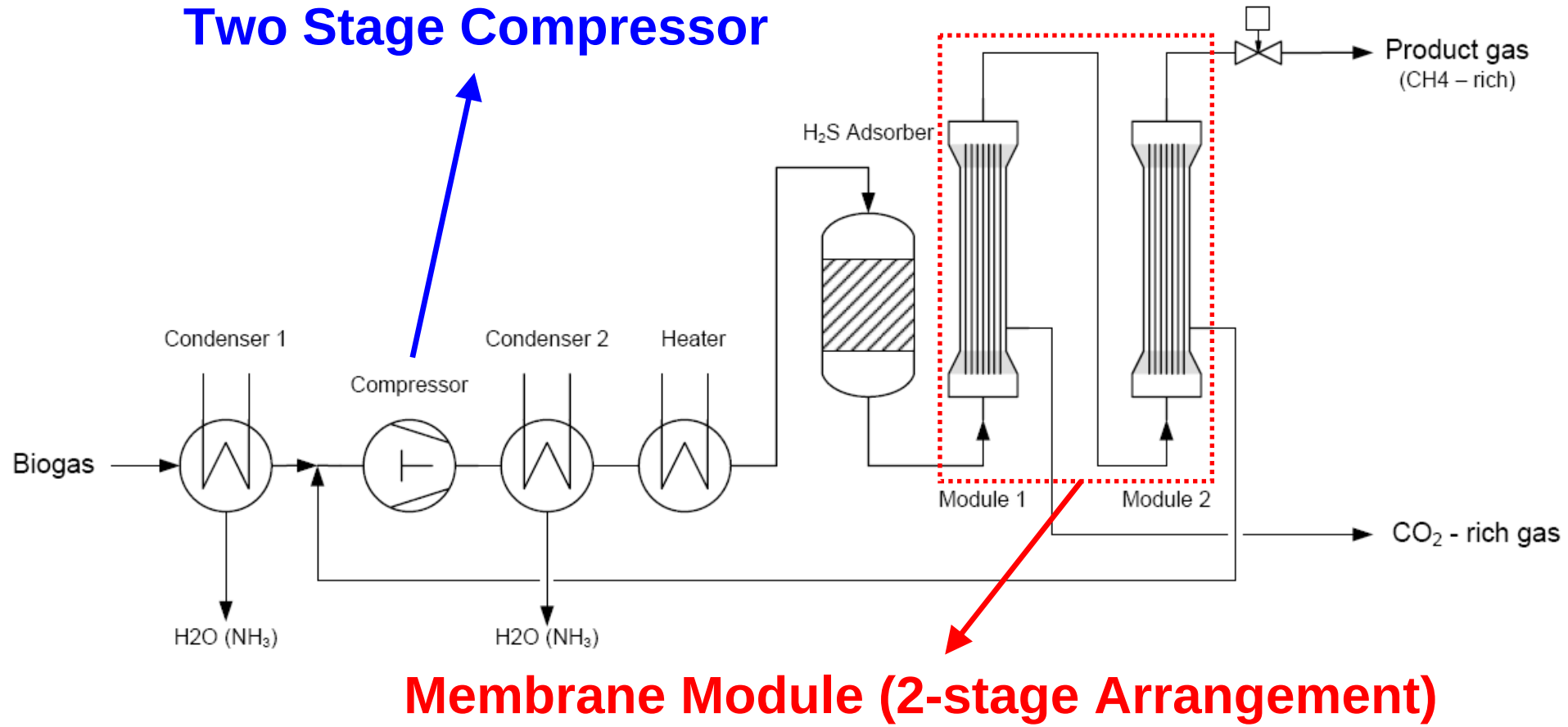
Biogas Upgrading – A Separation Problem



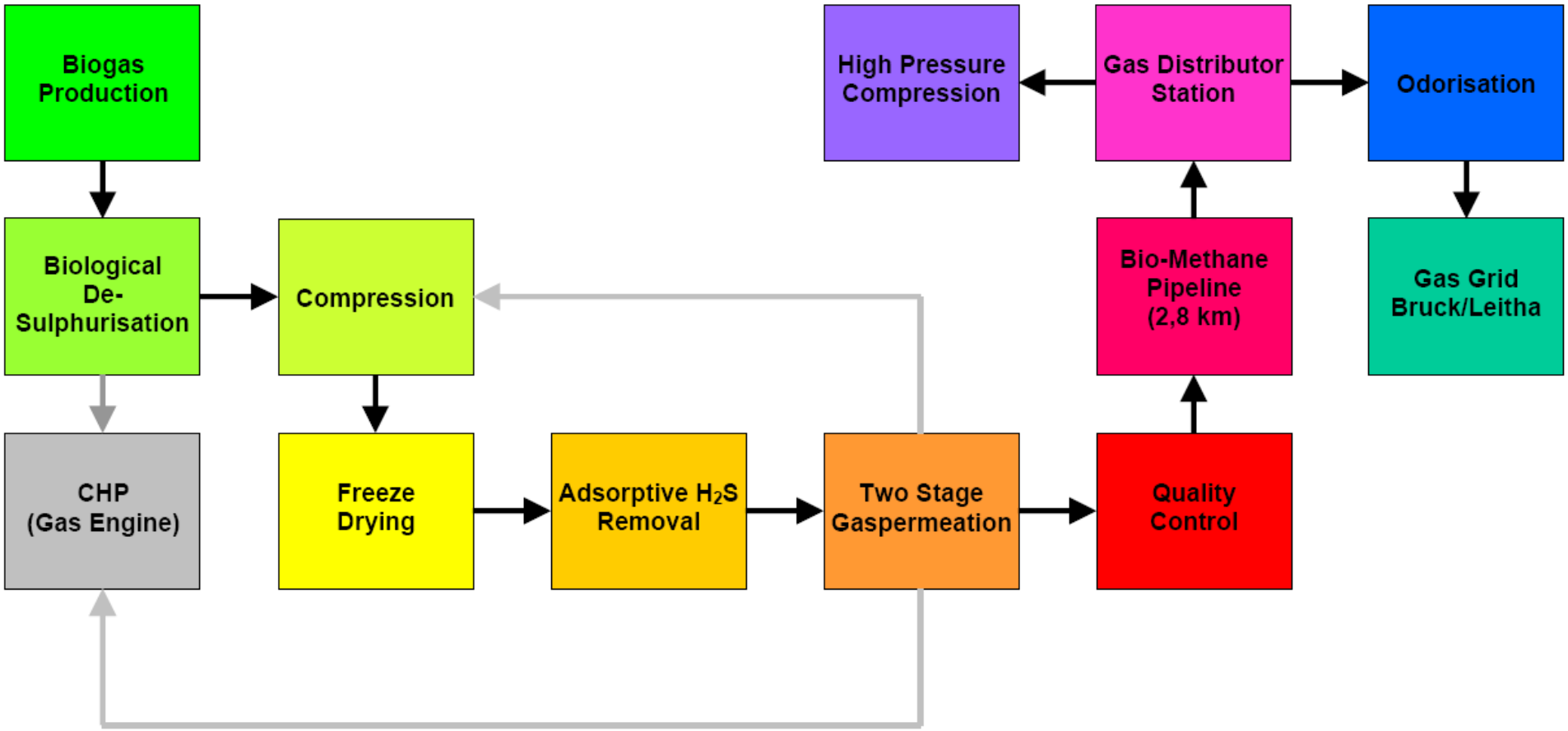
Separation principle of gas permeation (GP)



Process Concept

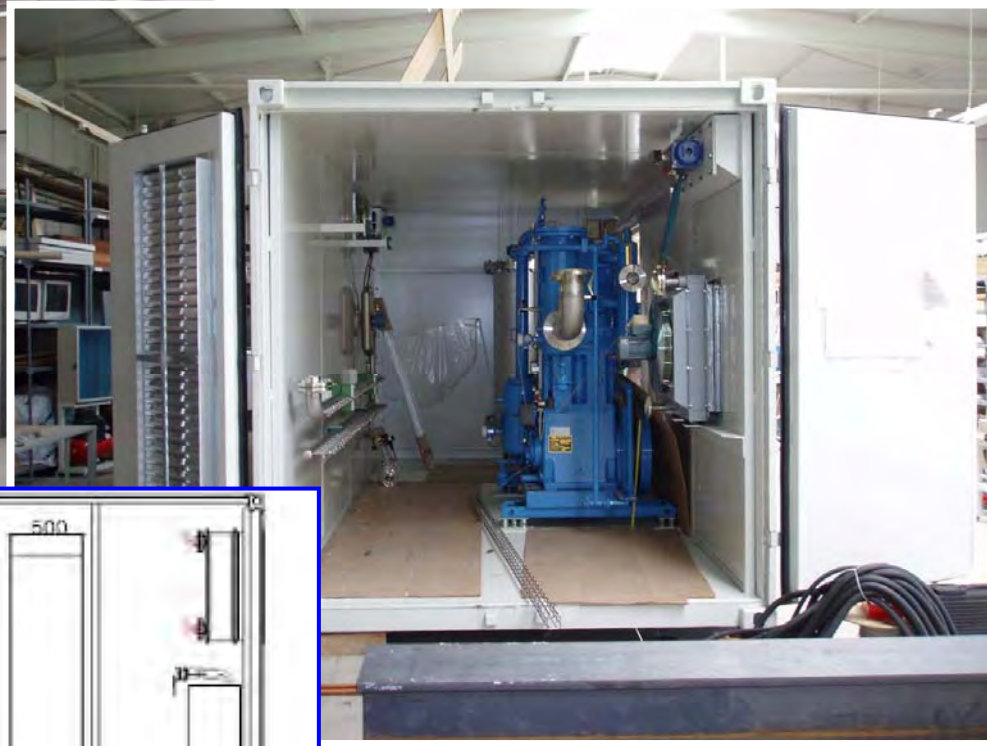


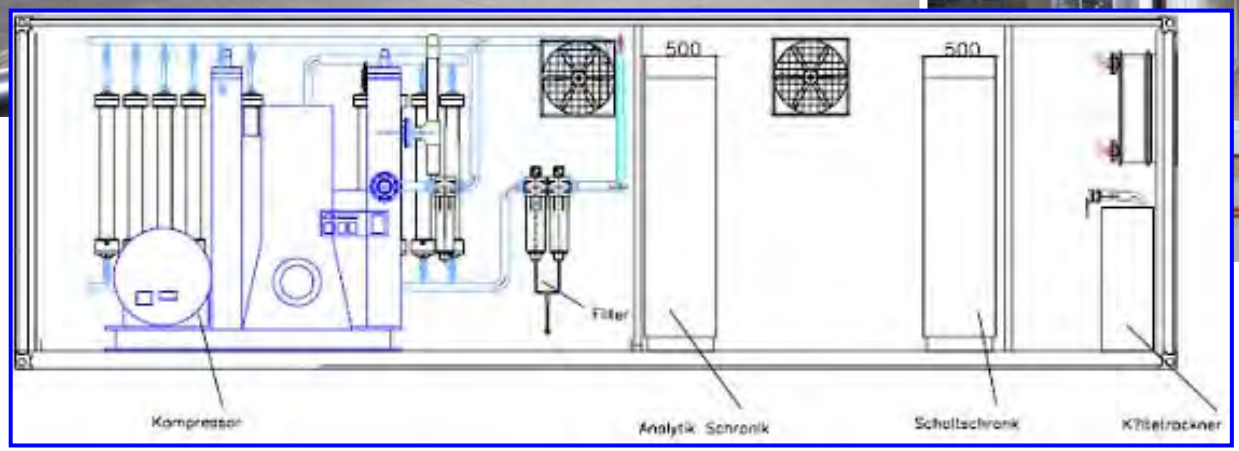
Process Integration



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

Container – Assembling at Axiom Angewandte Prozesstechnik GmbH



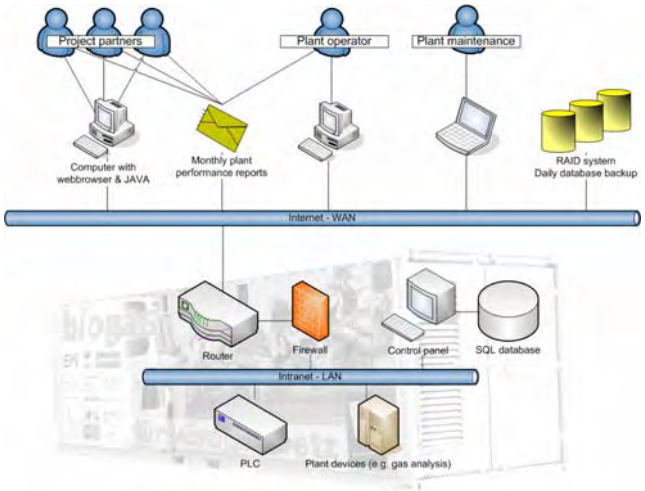


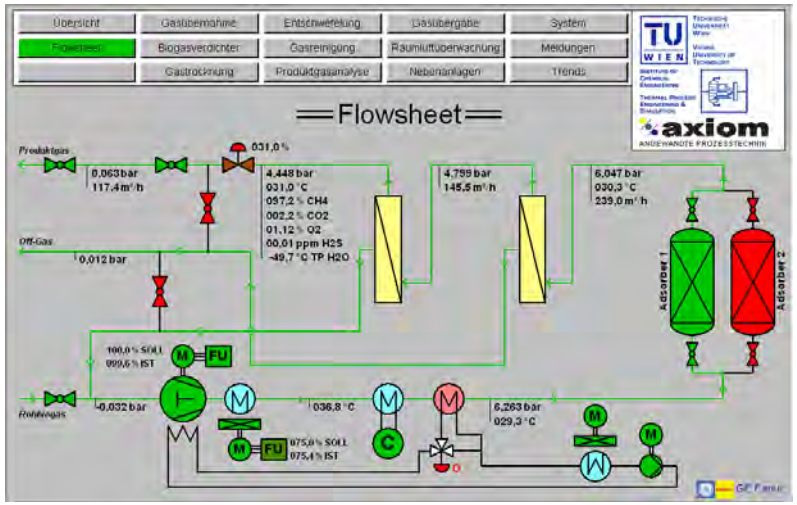
Construction Work in Bruck/Leitha

Construction Work in Bruck/Leitha

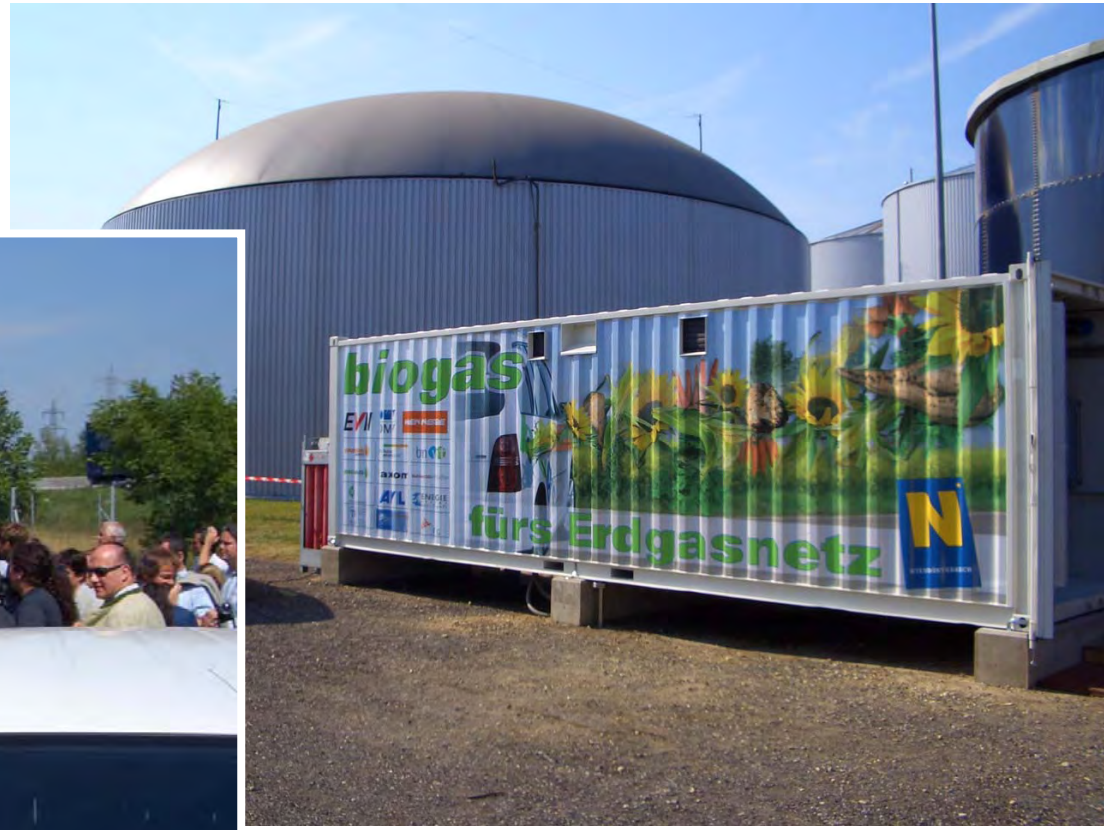
High Pressure Compressor

Process Control

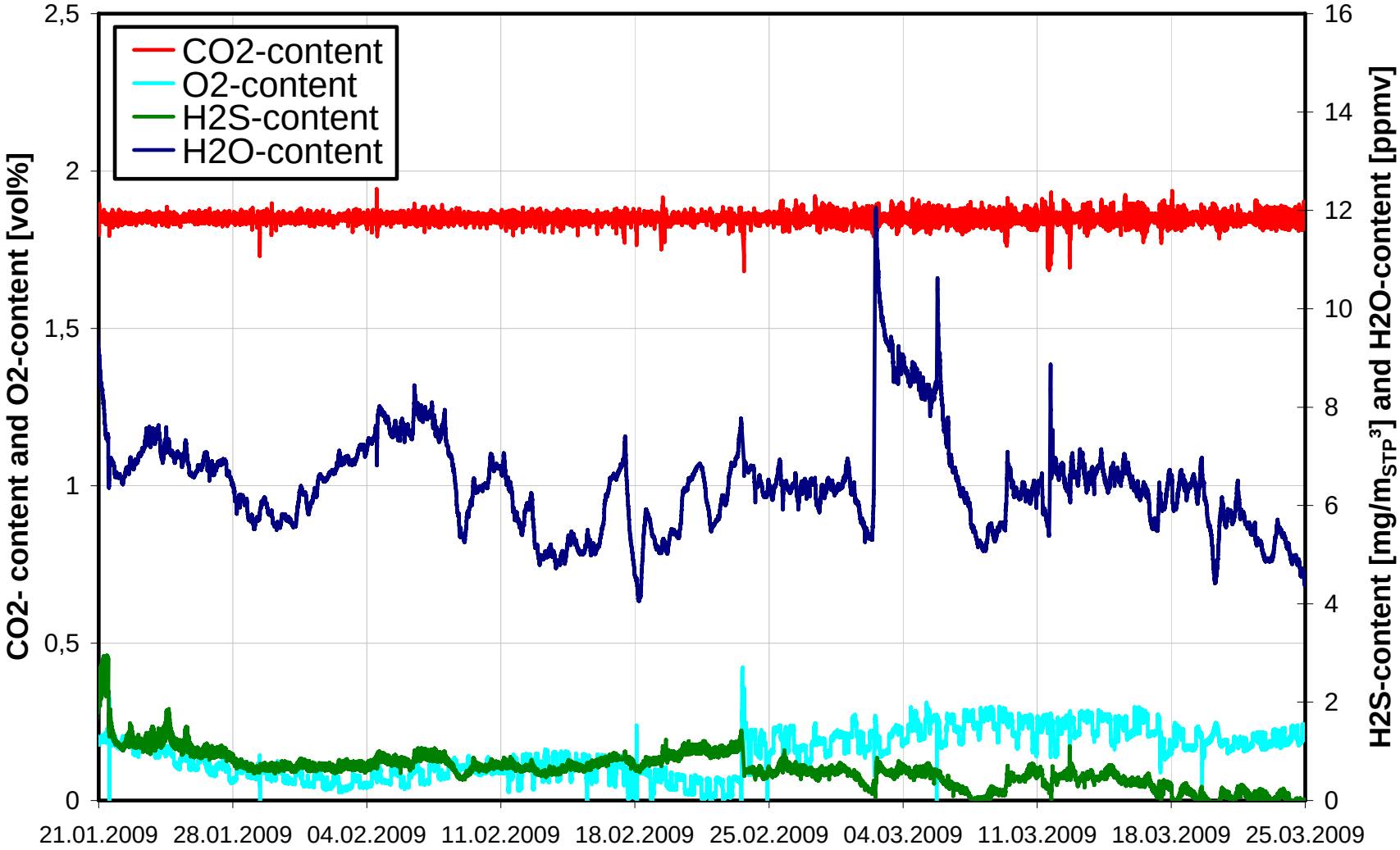




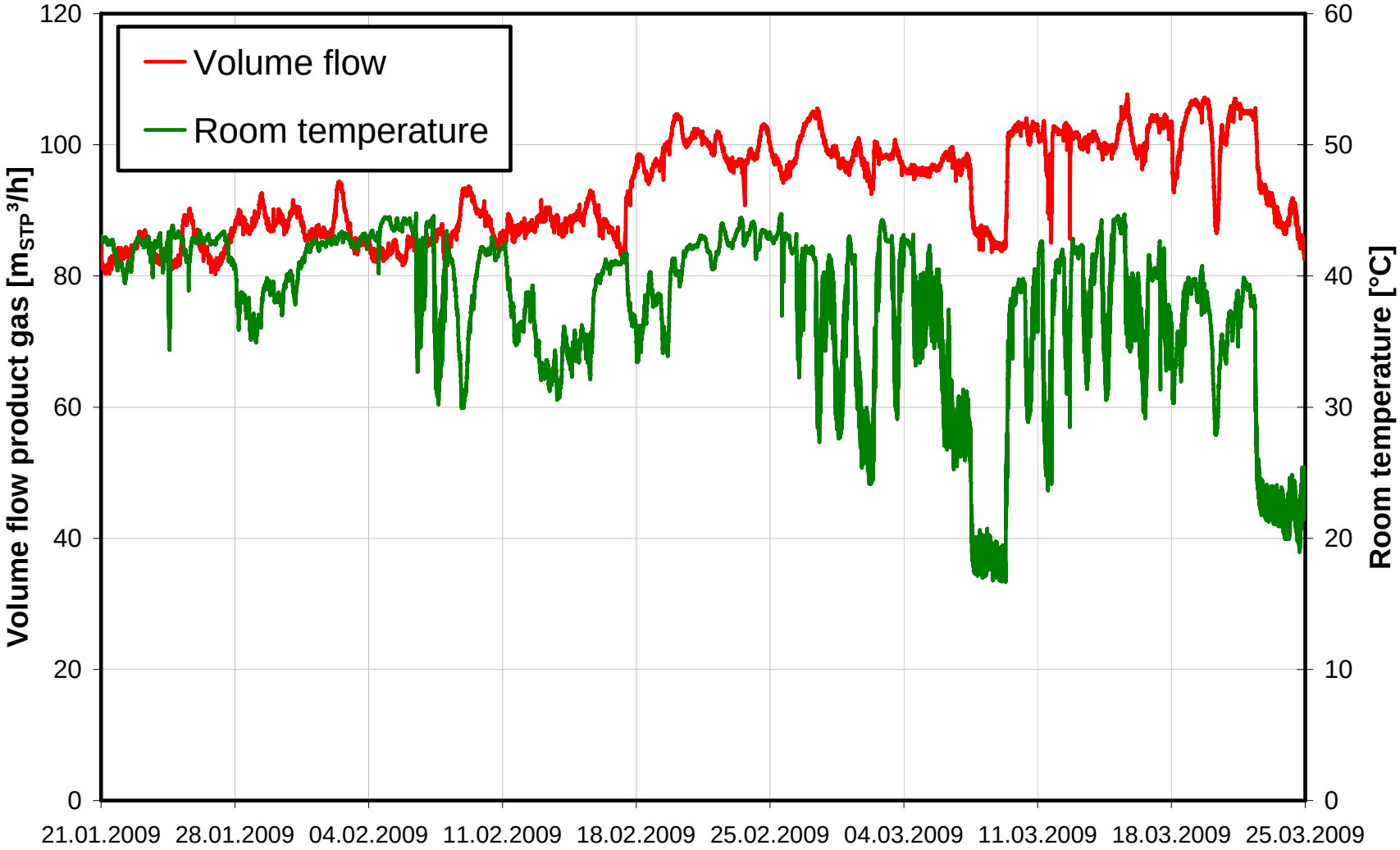
Opening Celebration an June 25, 2007



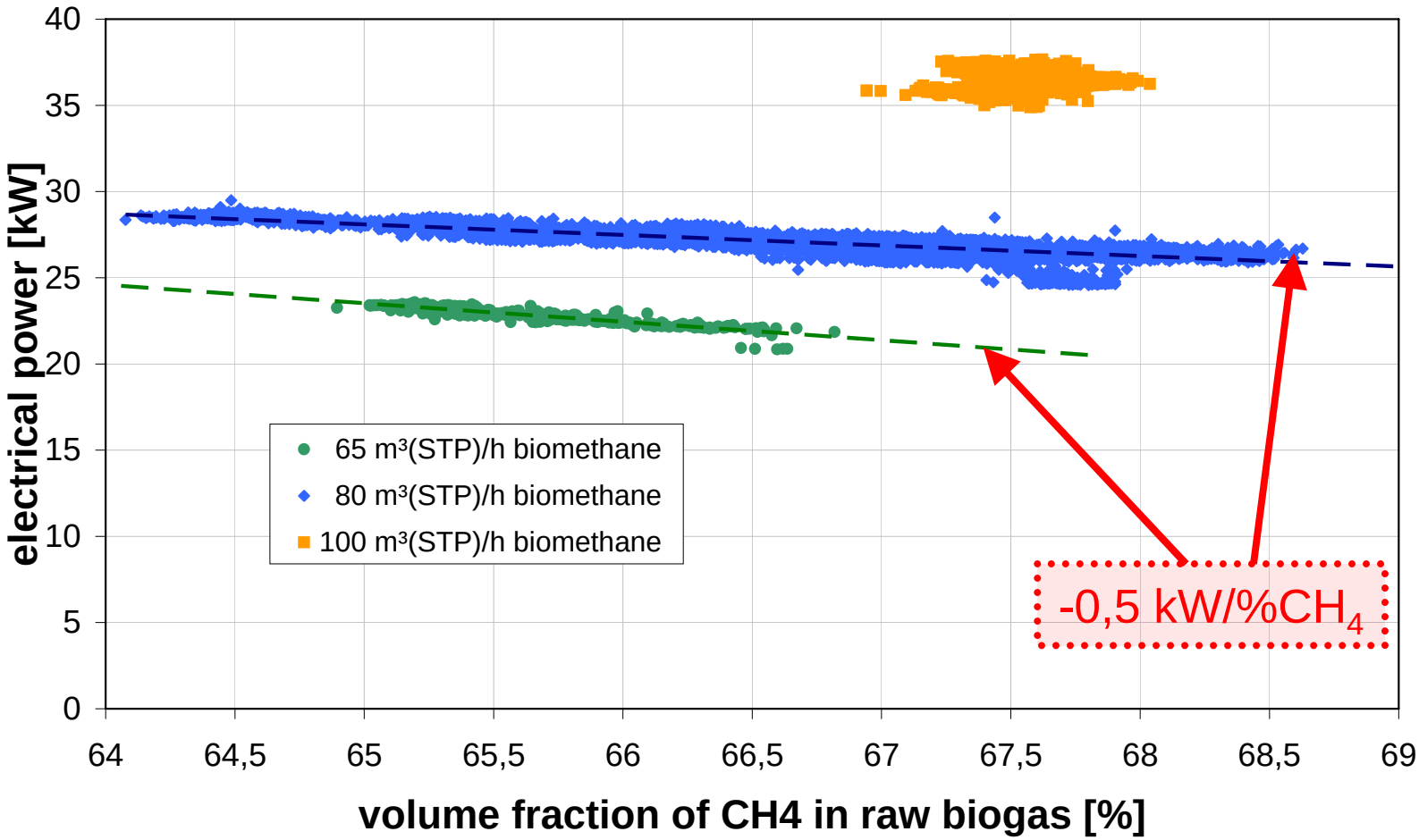
Long term feed-in performance of GP unit (I)



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



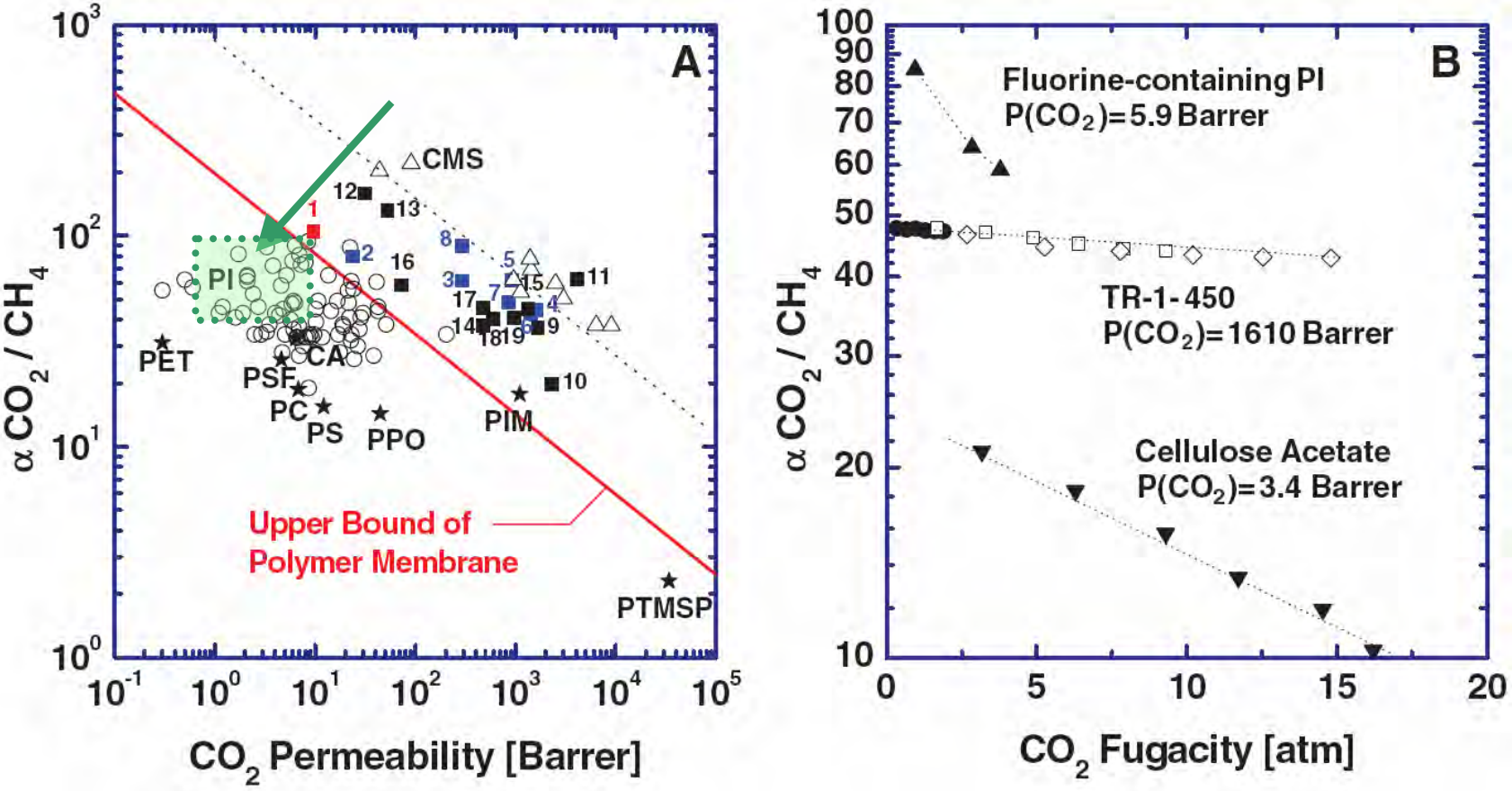
Upgrading plant Bruck/Leitha – compressor power consumption



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/m³STP of product gas
  - **Single stage Bio-CNG-plant:** 0,280 kWh/m³STP of product gas
- Related to the methane content of the produced biomethane gas stream:
  - Two stage gas grid injection plant: 3,2% (98,1vol% CH4)
  - Single stage Bio-CNG-plant: 2,8% (96,1vol% CH4)
- All values are valid for a product gas delivery pressure of about 3 bar(g).

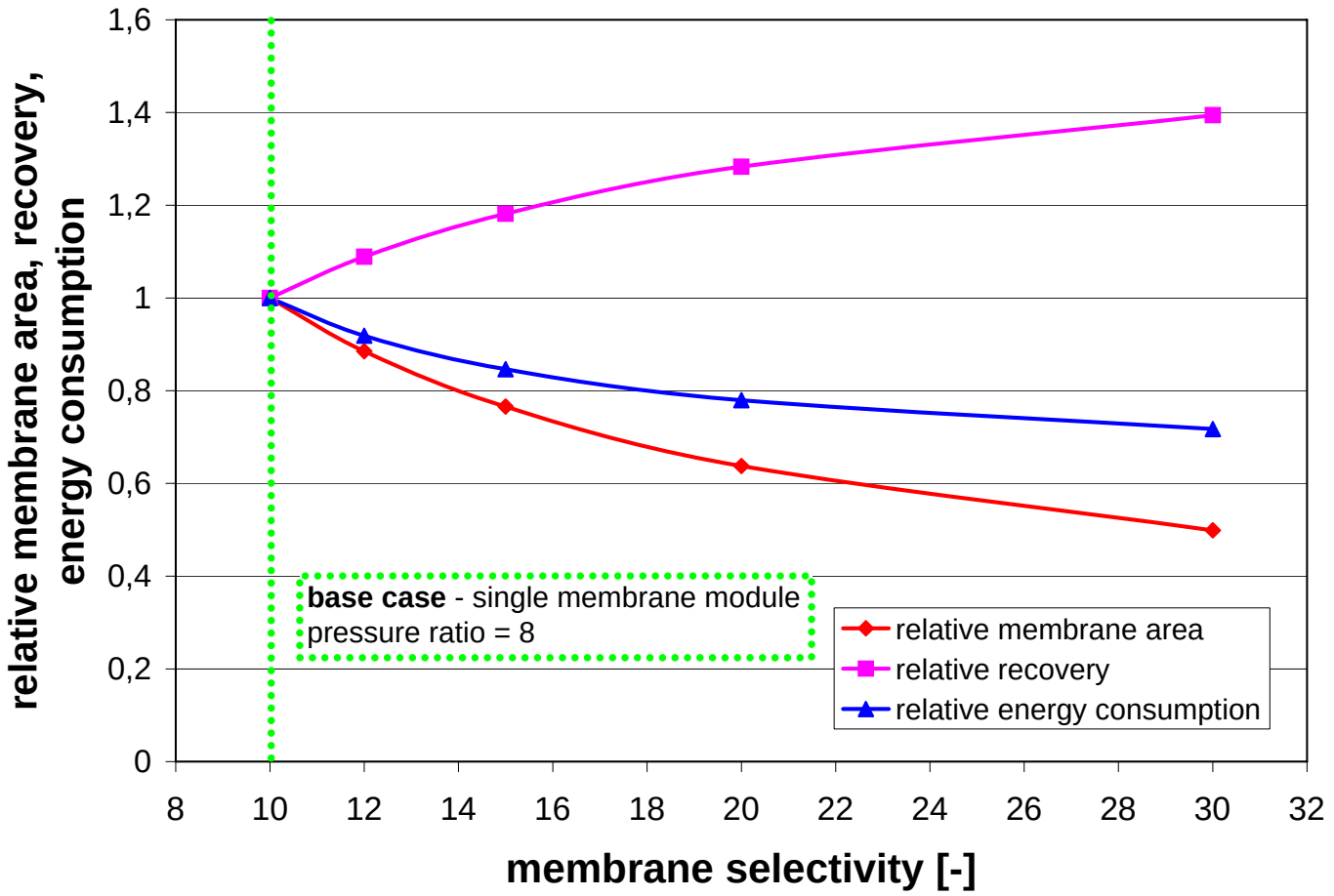
Possibilities of CO_2 selective membranes for the separation of CH_4/CO_2



Relation between CO2 permeability and CO2/CH4 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



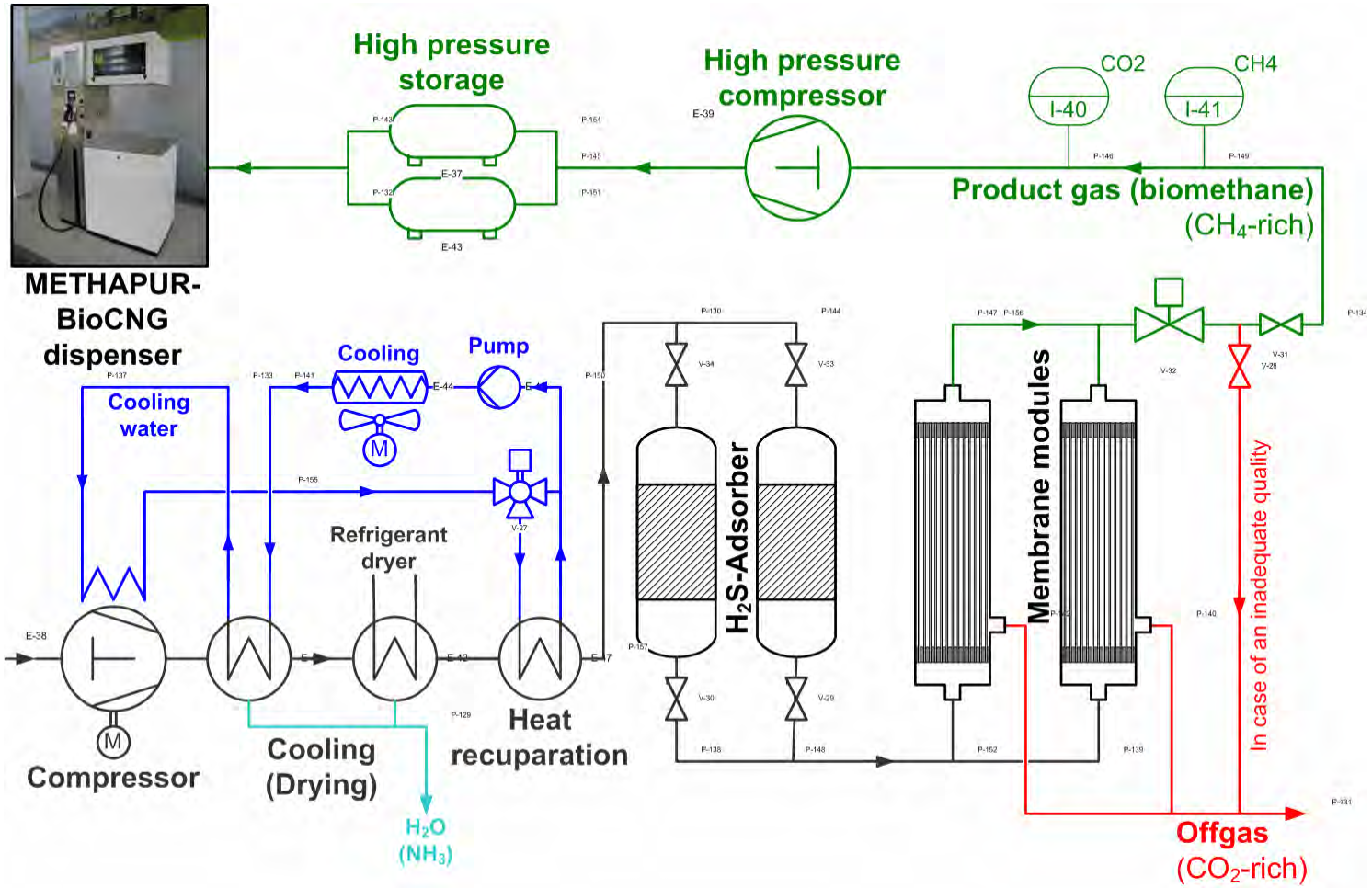
- Single stage countercurrent-flow membrane model
- 60% CH_4 in feed; 97% CH_4 in product (retentate)

First Austrian biomethane fueling station in Operation…

35 m³/h biomethane

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

Process Design – Margarethen am Moos



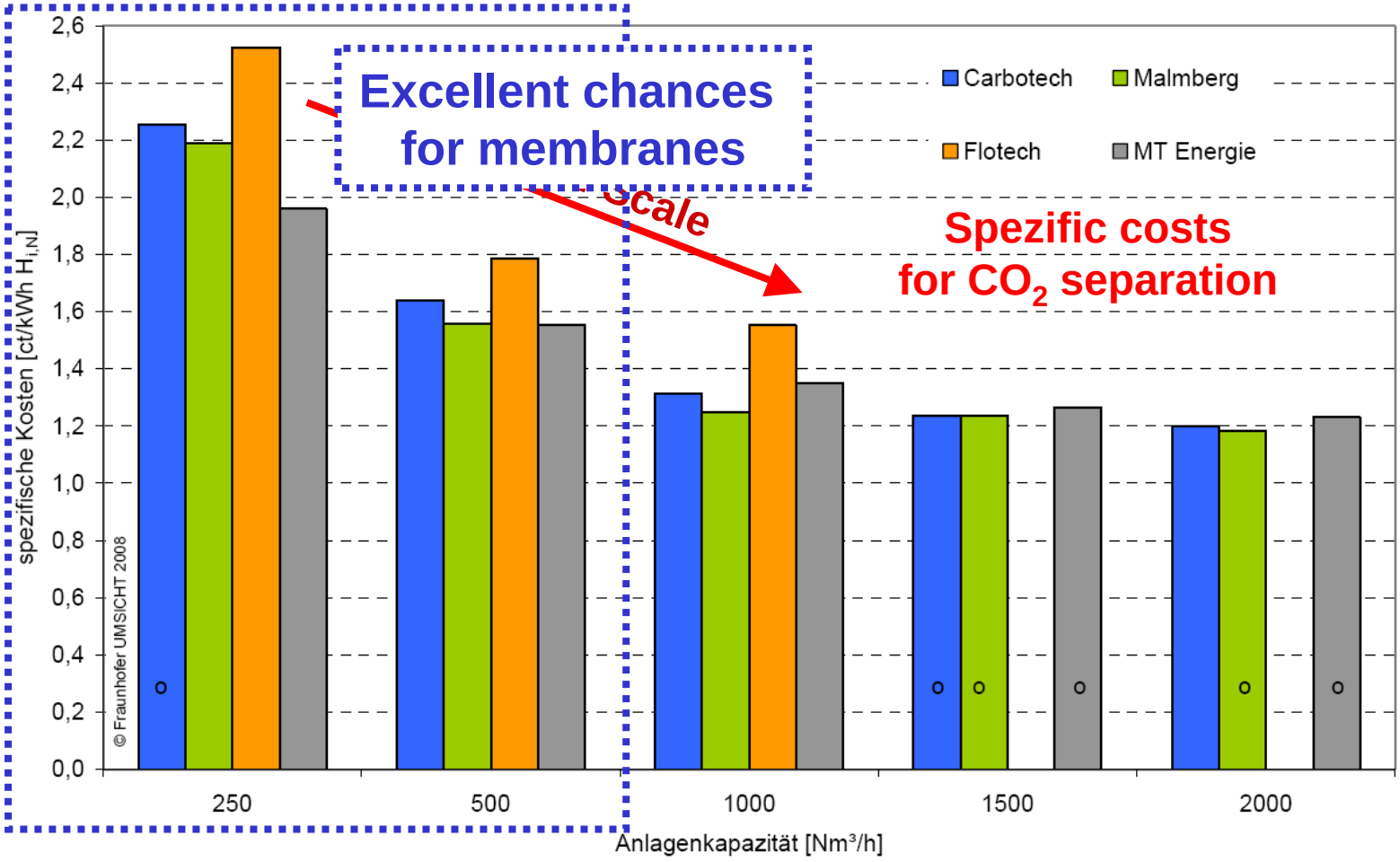
- **Concept includes in-situ desulphurization / single stage gas permeation**
- **Permeate fed back to CHP plant – Zero methane emission of biogas upgrading system**

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_2 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^3/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 €/m³)
- **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 m³ 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

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