

**The real engineering challenge when implementing biogas plants with
biogas upgrading and mobility**
**Planerische Herausforderungen bei der Umsetzung von Biogasanlagen
mit Biogasaufbereitung und Mobilität**

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Krieg & Fischer Ingenieure GmbH

Engineering Office, specialized in design and engineering of Biogas Plants, from concept to commissioning, customized, competent, innovative and independent.

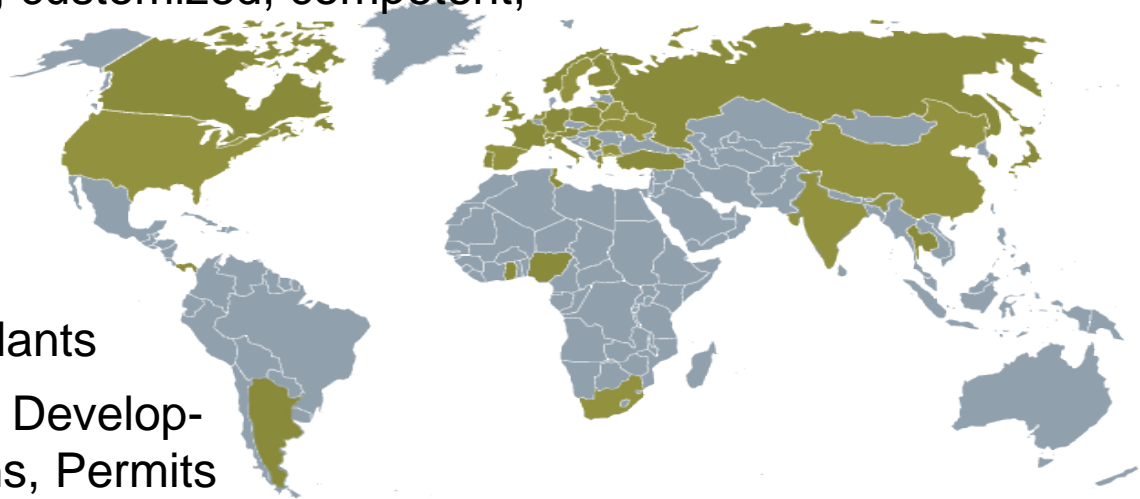
Foundation: 1999

Team: 25

Experience: > 35 Years

References: ca. 150 Biogas Plants

Services: Studies, Concept Development, Calculations, Permits & Approvals, Engineering, Tendering and Commissioning, Supervision of Construction, Start-up, Optimization/Retrofits, Supervision and Consulting



The real engineering challenge when implementing biogas plants with biogas upgrading and mobility

Content

- biogas upgrading system
 - projects
 - planning and permission
- CNG fuelling station
 - planning and permission
 - special case

Anklam, Germany

PSA



- Built: 2012
- Substrate: sugar beet waste, vinasse
184,200 t/a
- Digester: 4 x 4,500 m³ steel tanks
- Upgrading of 2,500 m³ biogas to 1,400 m³/h RNG (PSA)

Semd, Germany

Water scrubbing



- Built: 2009
- Substrate:
corn silage 13,800 t/a
- Digester: 2,300 m³
concrete tank
- Upgrading of
700 m³/h to 350 m³/h
RNG (water scrubbing)

Planning of biogas upgrading system

Choosing the upgrading system



The biogas upgrading system needs to be adapted to the biogas plant and the local conditions:

- amount of biogas
- availability of heat on site
- cost of electric energy
- natural gas grid (pressure)
- demanded RNG quality

Planning of biogas upgrading system

Choosing the best system

		Pressure water scrubbing	Org. physiosorption	Amine scrubbing	PSA	Membrane technology
	Parameter	Druckwasserwäsche	Organische Physiosorption	Aminwäsche	PSA	Membrantechnologie
Typical plant capacity [m ³ /h RNG]	typische Anlagenkapazität [m ³ /h Biomethan]	200-1.200	300-1.500	400-2.000	300-800	50-500
Typical methane content [Vol%]	typischer Methangehalt im Biomethan [vol%]	95,0-99,0	95,0-99,0	>99,0	95,0-99,0	95,0-99,0
Methane yield [%]	Methanausbeute [%]	98,0	96,0	99,96	98	80-99,5
Methane loss [%]	Methanschlupf [%]	2,0	4,0	0,04	2,0	20-0,5
Typical delivery pressure [bar(g)]	typischer Lieferdruck [bar(g)]	4-8	4-8	0	4-7	4-7
Electrical energy demand [kWhel/m ³]	elektrischer Energiebedarf [kWhel/m ³ Biomethan]	0,46	0,49-0,67	0,27	0,46	0,25-0,43
Process heat demand and temperature level	Prozesswärmebedarf und Temperaturniveau	-	mittelhoch 70-80°C	hoch 120-160°C	-	-
Desulphurisation needed	Entschwefelungsbedarf	prozessabhängig	ja	ja	ja	ja
Resource requirements	Betriebsmittelbedarf	Anti-fouling,	organisches Lösungs-	Aminlösung (gesundheits-	Aktivkohle (un-	

Source: TU Wien: http://bio.methan.at/sites/default/files/BiogasUpgradingTechnologyReview_GERMAN.pdf

Planning of biogas upgrading system

Interfaces biogas upgrading

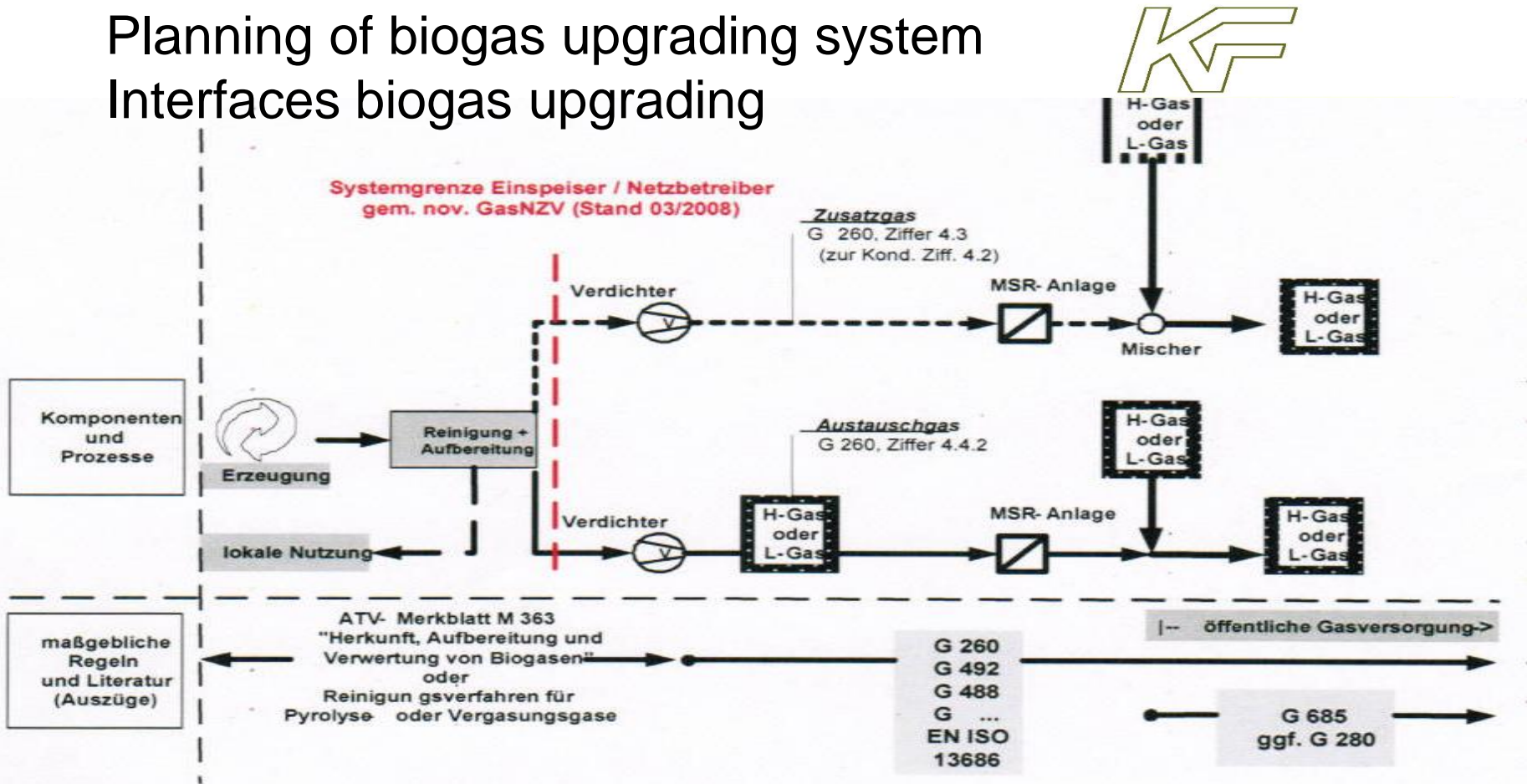


Abbildung 1-4: Einspeiseschnittstellen und relevantes Regelwerk [6]

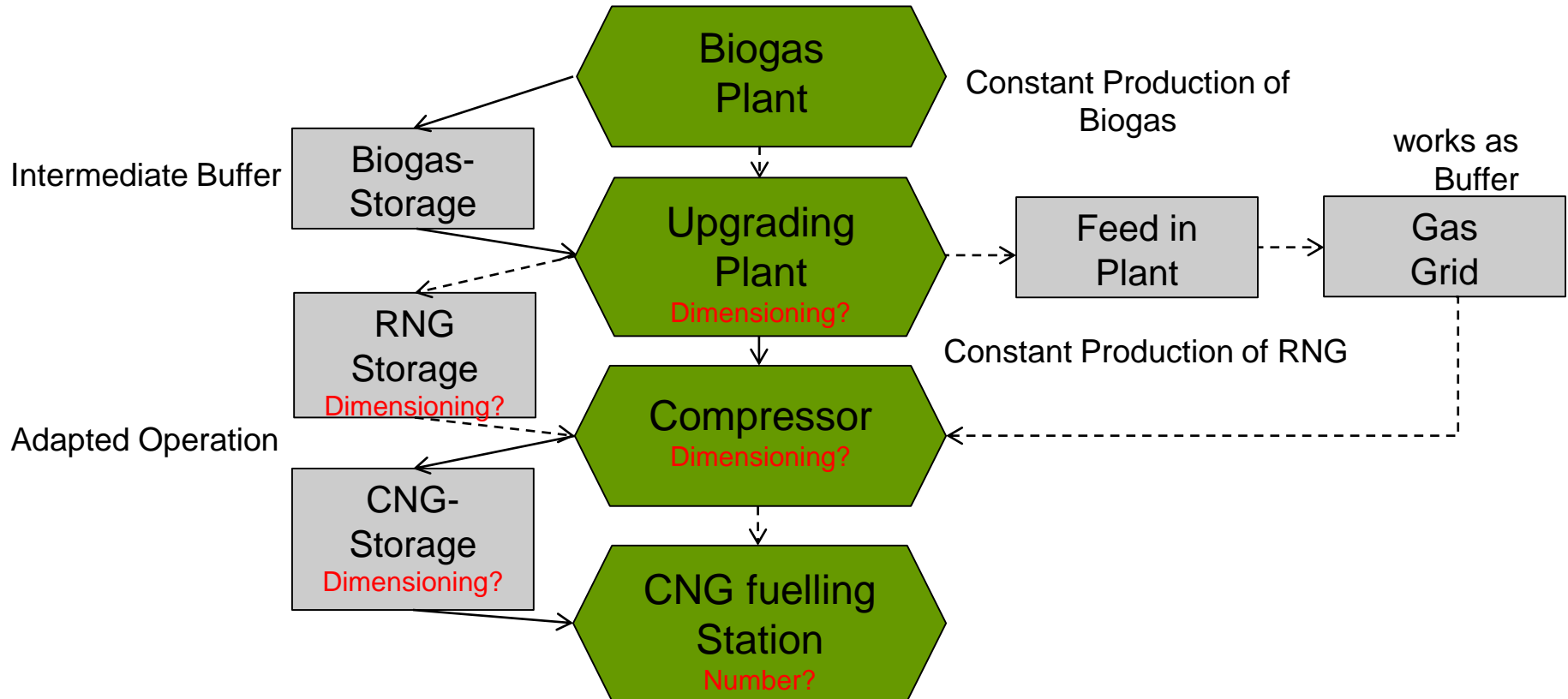
Quelle: FNR Studie: https://www.infothek-biomasse.ch/images/2006_FNR_Einspeisung_biogas.pdf

Engineering challenge when planning a CNG fuelling station, basics

- Location
 - at a biogas plant or not?
 - connection gas grid?
- Requirements, fuelling conditions
 - public use or only own vehicles (availability, redundancy,...)
 - vehicle fleet: Type and number of vehicles?
 - tank volume?
 - available time for fuelling? Fast fuelling or slow fuelling over night
 - availability of CNG per hour?



Engineering challenge when planning a CNG fuelling station, logistics and design



Engineering challenge when planning a CNG fuelling station, logistics and design



Basis: Biogas plant produces biogas continuously

Case 1. Biogas upgrading plant produces RNG continuously

→ compressor to fuelling station is constantly in operation

→ large CNG high pressure storage is necessary

→ fuelling within a short time possible

Engineering challenge when planning a CNG fuelling station, logistics and design



Case 2. Biogas upgrading plant is operated as needed

- design of larger biogas upgrading is necessary
- compressor operates as needed - bigger compressor necessary
- small CNG high pressure storage
- fuelling time depending on the size of the compressor

Case 2a. Slow fill

- small upgrading plant and small compressor operate as needed
- direct fuelling „Slow fill“

Engineering challenge when planning a CNG fuelling station, permission

The construction and operation of a gas fuelling station requires the approval of the relevant licensing authority (in general occupational health and safety) in “§18 Erlaubnispflicht Absatz 1 **BetrSichV**“

The application includes:

- Inspection report of an certified inspection body (e.g. TÜV)
- Various permission documents

In case a threshold value according 4. **BImSchV** is exceeded a permit according to BImSchG is required (for example storage >3 t Gas 9.1.1.2 4 Anhang 1, 4. BImSchV)

Relevant Technical Regulations for Hazardous Substances

- [TRGS 201](#) Einstufung und Kennzeichnung bei Tätigkeiten mit Gefahrstoffen
- [TRGS 400](#) Gefährdungsbeurteilung für Tätigkeiten mit Gefahrstoffen
- [TRGS 407](#) Tätigkeiten mit Gasen - Gefährdungsbeurteilung
- [TRGS 510](#) Lagerung von Gefahrstoffen in ortsbeweglichen Behältern
- [TRGS 529](#) Tätigkeiten bei der Herstellung von Biogas
siehe auch: [KAS 12](#), [KAS 28](#)

- [TRGS 720](#) Gefährliche explosionsfähige Atmosphäre - Allgemeines - (entspricht [TRBS 2152](#))
- [TRGS 721](#) Gefährliche explosionsfähige Atmosphäre - Beurteilung der Explosionsgefährdung - (entspricht [TRBS 2152 Teil 1](#))
- [TRGS 722](#) Vermeidung oder Einschränkung gefährlicher explosionsfähiger Atmosphäre (entspricht [TRBS 2152 Teil 2](#))
- [TRGS 725](#) Gefährliche explosionsfähige Atmosphäre - Mess-, Steuer- und Regeleinrichtungen im Rahmen von Explosionsschutzmaßnahmen
- [TRGS 745](#) Ortsbewegliche Druckgasbehälter - Füllen, Bereithalten, innerbetriebliche Beförderung, Entleeren (entspricht [TRBS 3145](#))
- [TRGS 746](#) Ortsfeste Druckanlagen für Gase (entspricht [TRBS 3146](#)) Nachfolgeregelung zur TRGS 726
- [TRGS 751](#) Vermeidung von Brand-, Explosions- und Druckgefährdungen an Tankstellen und Gasfüllanlagen zur Befüllung von Landfahrzeugen (entspricht [TRBS 3151](#))

Natural gas fuelling stations - CNG stations for fuelling vehicles

- scope: Design, construction, operation, inspection, maintenance of refueling stations for vehicles with compressed natural gas
- when using CNG fuelling stations, there are obligations of the employer with regard to occupational safety organization, operation, maintenance and testing

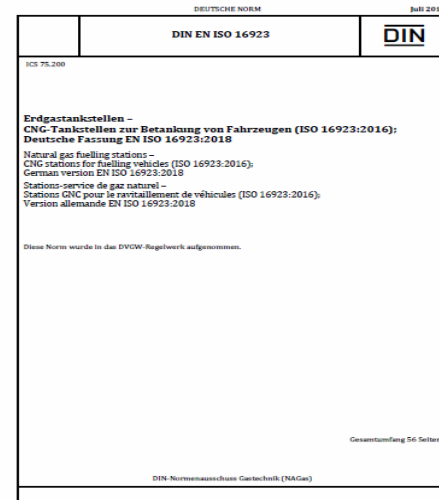
(ISO 16923:2016)
(DIN EN ISO 16923)

Content:

Risk management
Design requirements
(site design, safety distances)
Fuel supply

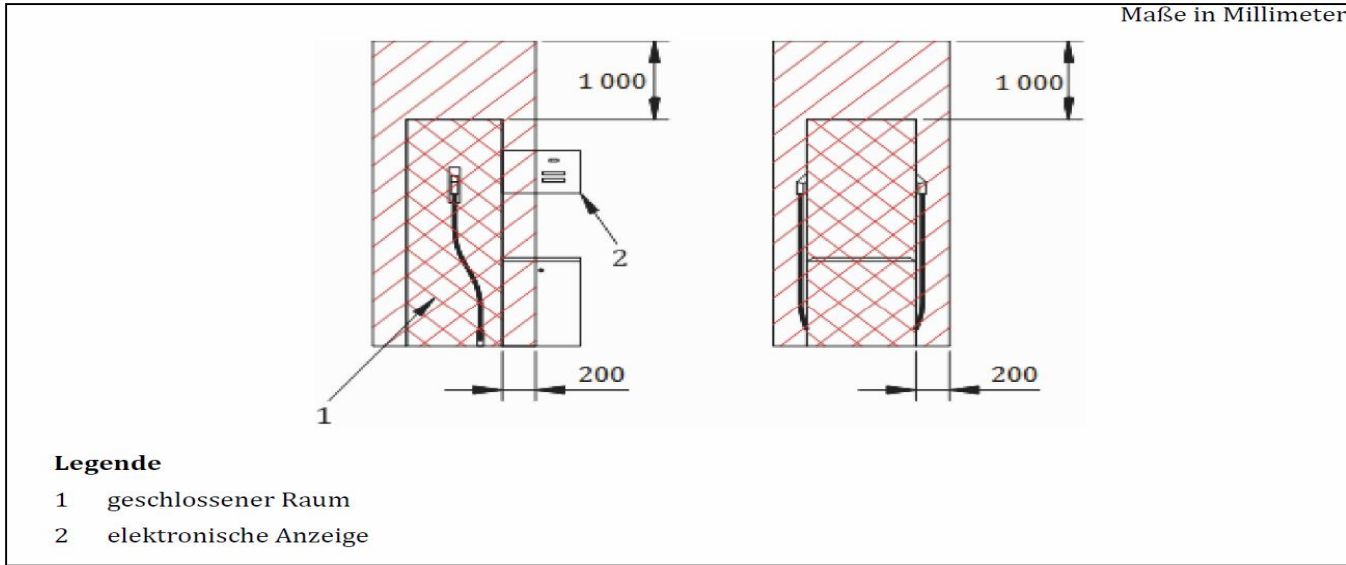
Dryer
Compressor
Intermediate storage
Dispensers
Odorization
Piping

Electricity
Monitoring
Emergency shutdown
Operation
Inspection and maintenance



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Natural gas fuelling stations - CNG stations for fuelling vehicles



(ISO 16923:2016)
(DIN EN ISO 16923)

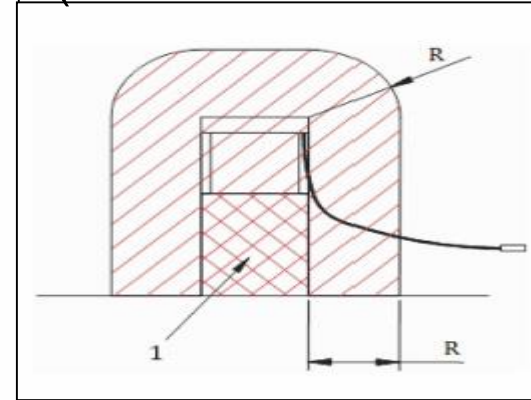
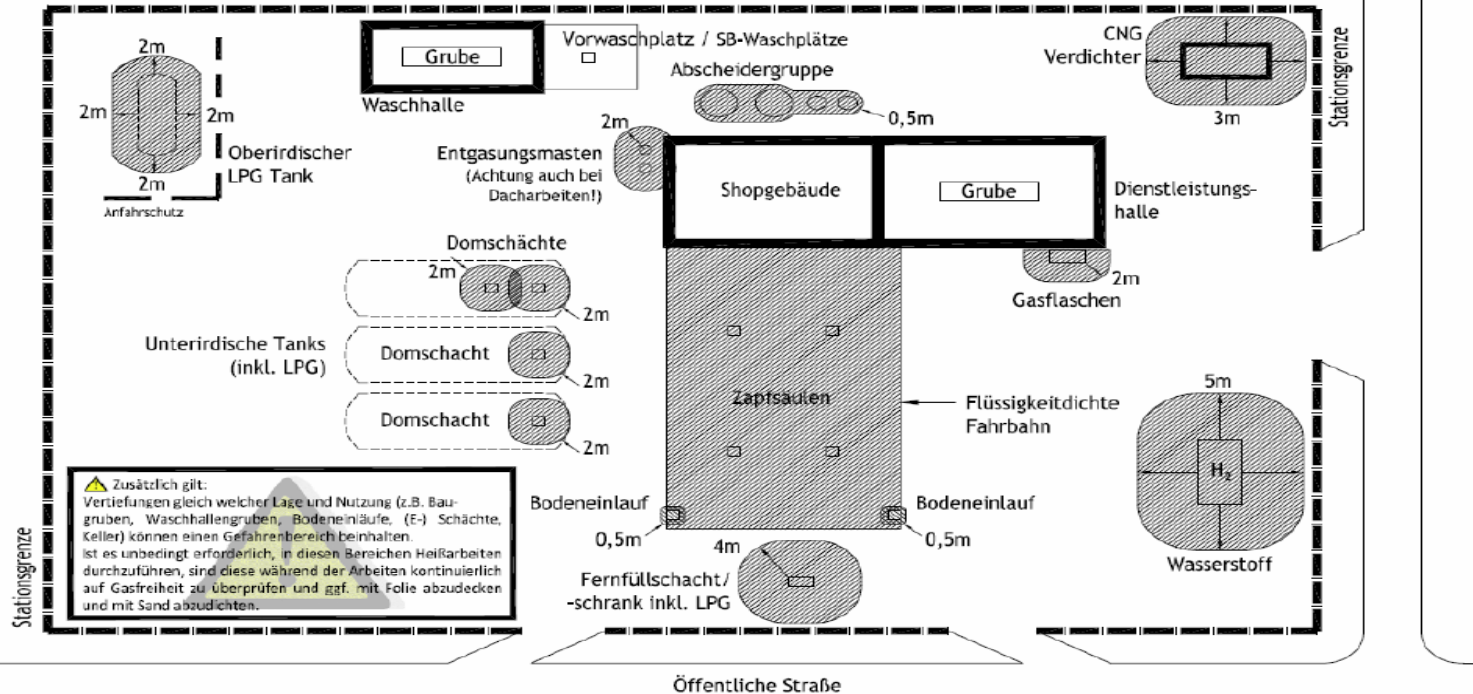


Bild A. 6/7 Explosive areas around a CNG dispenser

Gesamtspeichervolumen unter 10 000 l		
Gefahrenquelle	Zapfsäule	Speicherzylinder und Kompressor
Gebäudeöffnungen	> 3 m	> 3 m
Gebäudewände (nichtbrennbar)	≥ 0 m	> 1 m
Umfang der Anlage	> 5 m	> 5 m (> 10 m für Speicherung > 10 000 l)

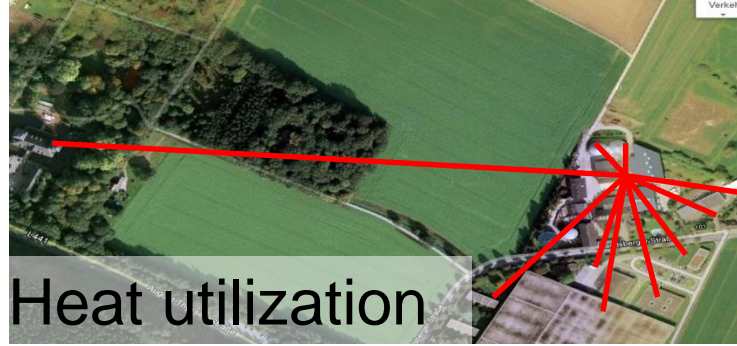
Tab. B.1 – intern safety distances

CNG stations for fuelling vehicles (TRBS 3151/TRGS 751)



Working with ignition and fire hazards: Hazardous areas when working on CNG fuelling stations

Biogas plant Special case

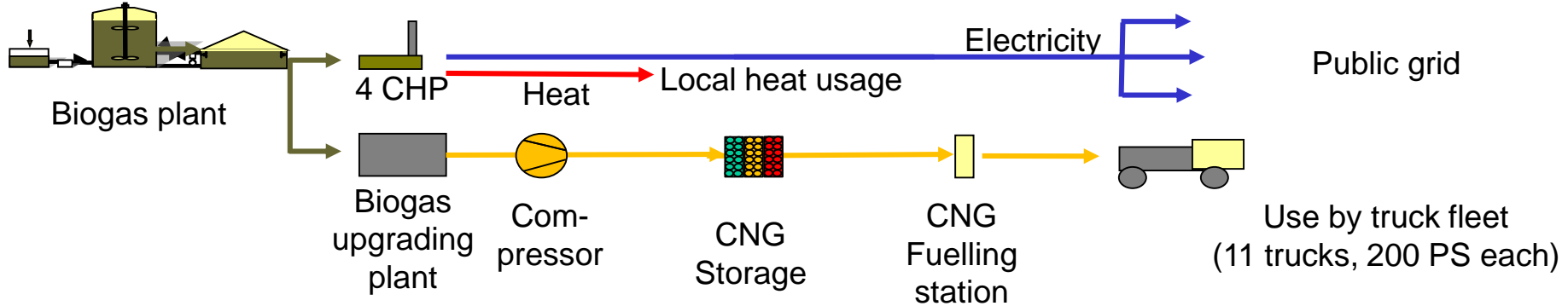


Heat utilization

- Built: 2005
- Substrate: kitchen waste, pig manure, horse dung
- Digester: 2 x 1,200 m³ concrete tanks
- CHP: 4 x 190 kW_e gas engines
- Mesophilic process, engineering with hydrolysis



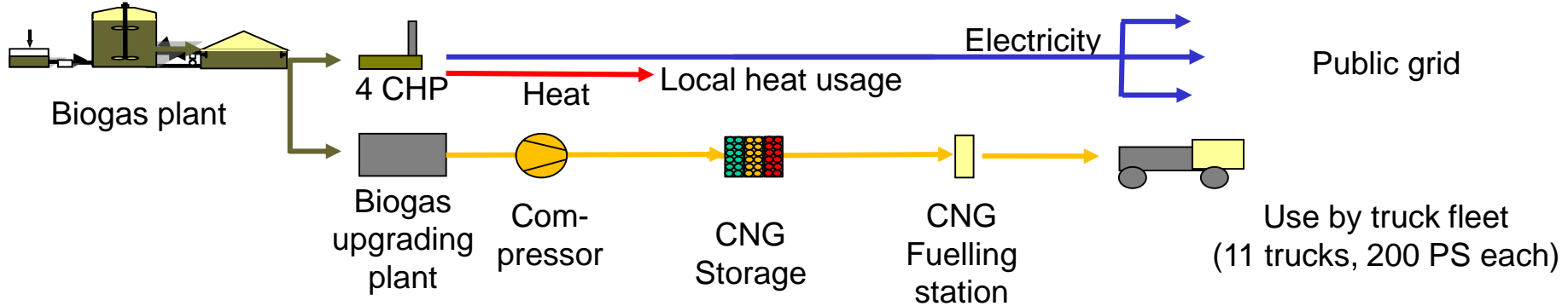
Biogas concept special case



Advantages

- CO₂ neutral transport with significantly lower emissions
- easy access to the downtown areas with environmental zones
- reduced noise emission (-50% noise)
- toll free / carbon credits
- positive image - regional / self-produced fuel

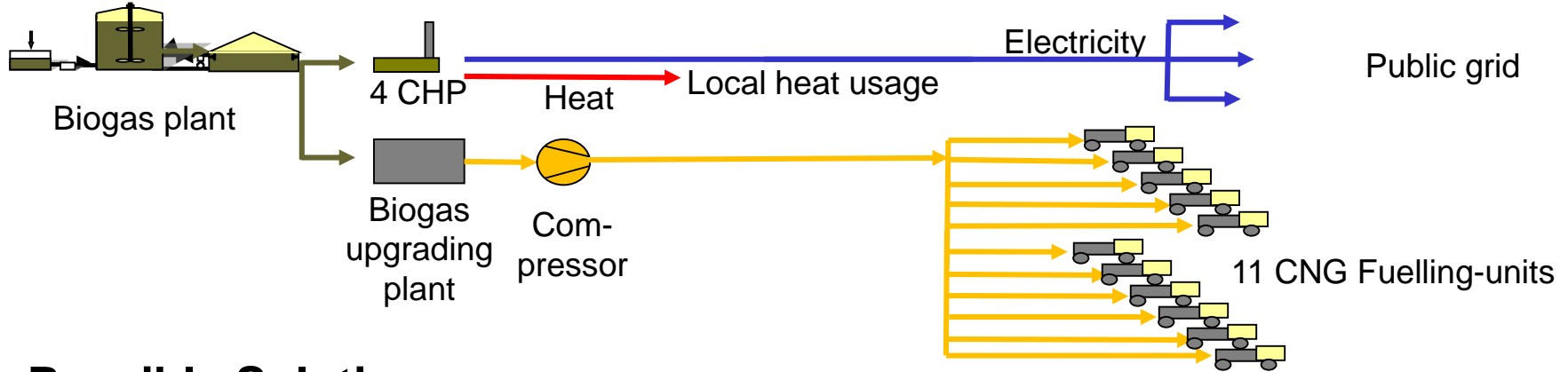
Biogas concept special case



Engineering challenges

- engineering size of upgrading plant (complete/partial)
- feed in plant and connection to gas grid
- compressor and CNG high pressure storage with high capacity for short fuelling times (4 trucks in 1 hour) or slow fill over night

Biogas concept special case



Possible Solution

- small biogas upgrading plant (about 100 m³/h)
- no feed in plant but connection to gas grid
- compressor (capacity 100 m³/h)
- no CNG high pressure storage
- 11 CNG fuelling units for 11 trucks – slow fill

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