Global CO2 Consideration, Trade with CO2 - Certificates

Overview of Methane Oxidation at (old) Landfills

Sardinia 2003, 6th – 10th of October

Ninth International Waste Management and Landfill Symposium

Emission trade – it's not a closed book

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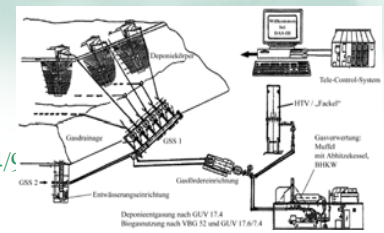

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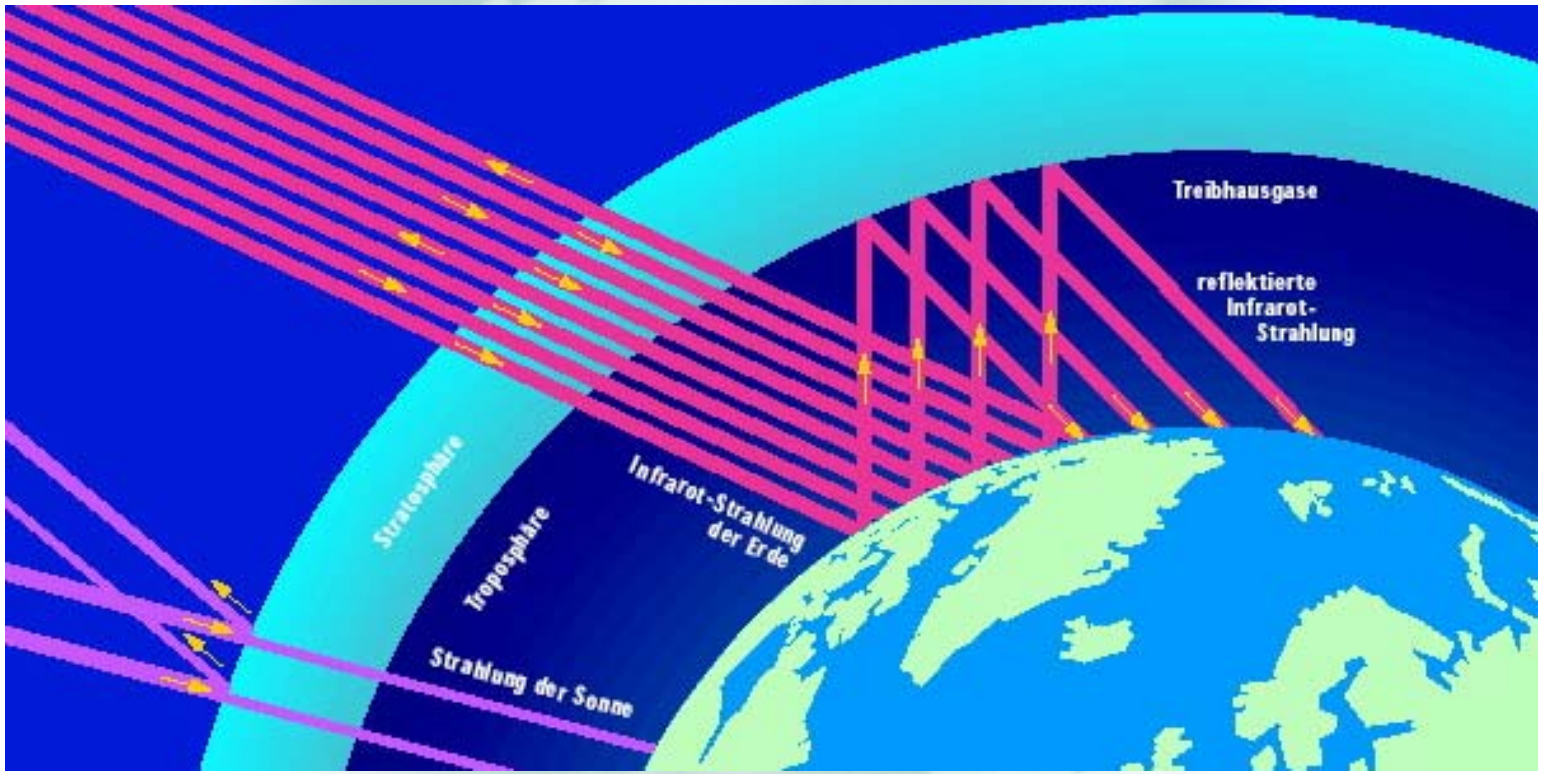

Natural greenhouse effect (Troposphere solar energy) approx. 1,35 kW / m2

In the absence of this effect we have approx. 15°C instead of approx. - 18°C

And most life on earth is capable of existence

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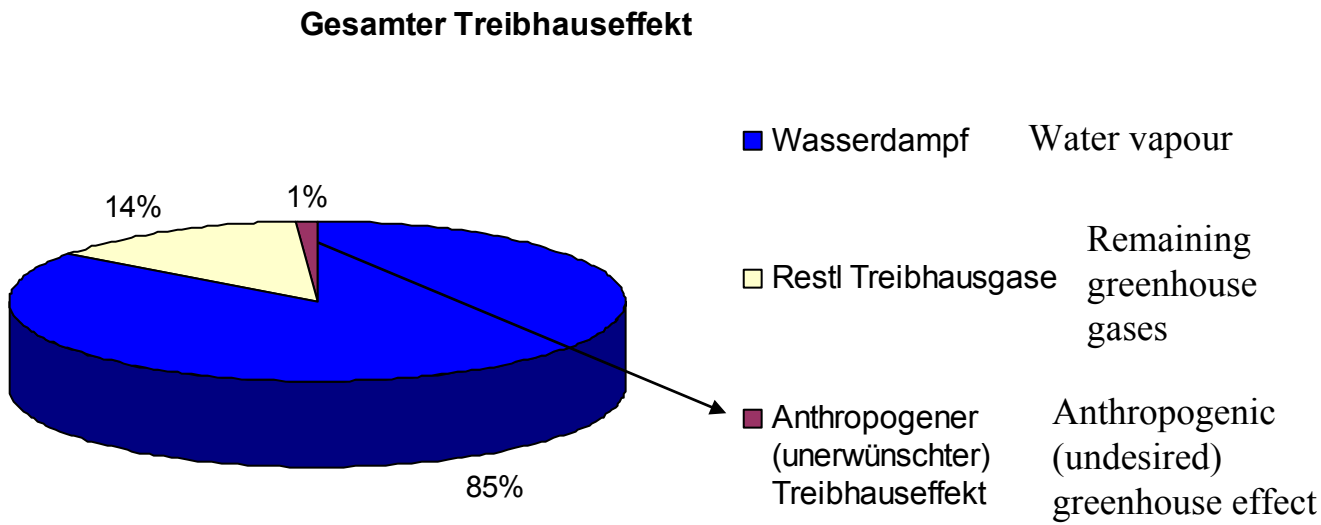
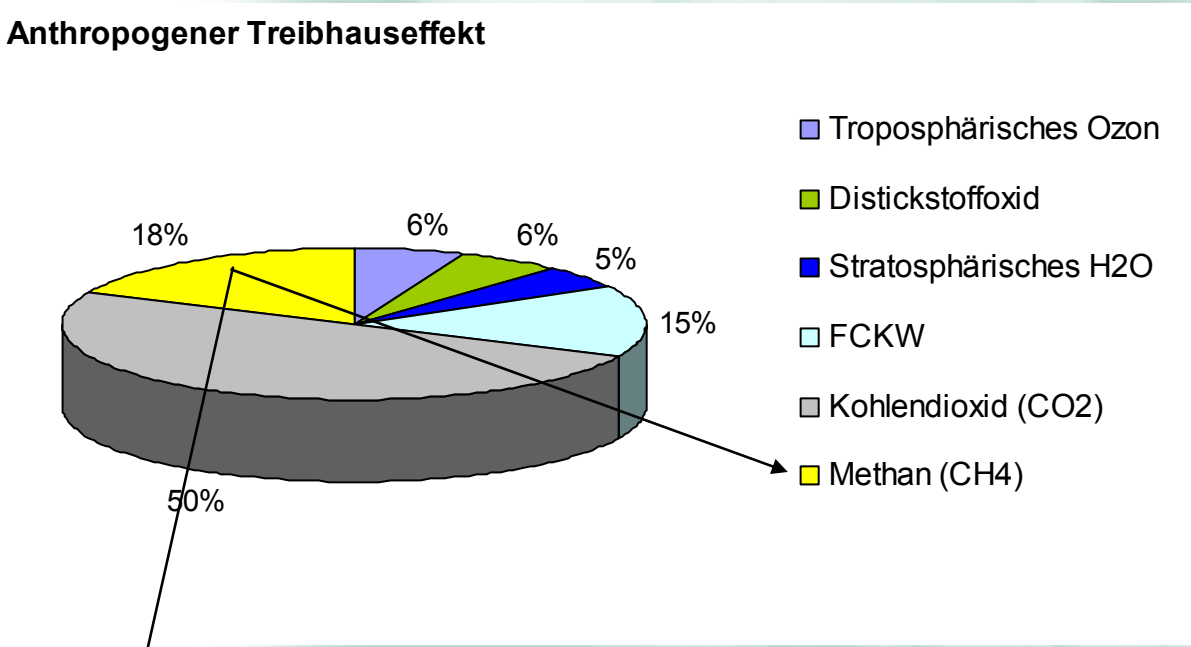


Water vapour: 60 – 95 %, Remaining greenhouse gases: 5 – 40 %

Anthropogenic (undesired) greenhouse effect: 0.5 – 1.5 %

Anthropogenic (undesired) greenhouse effect



Tropospheric ozone

N2O: Nitrous oxide

Stratospheric H2O

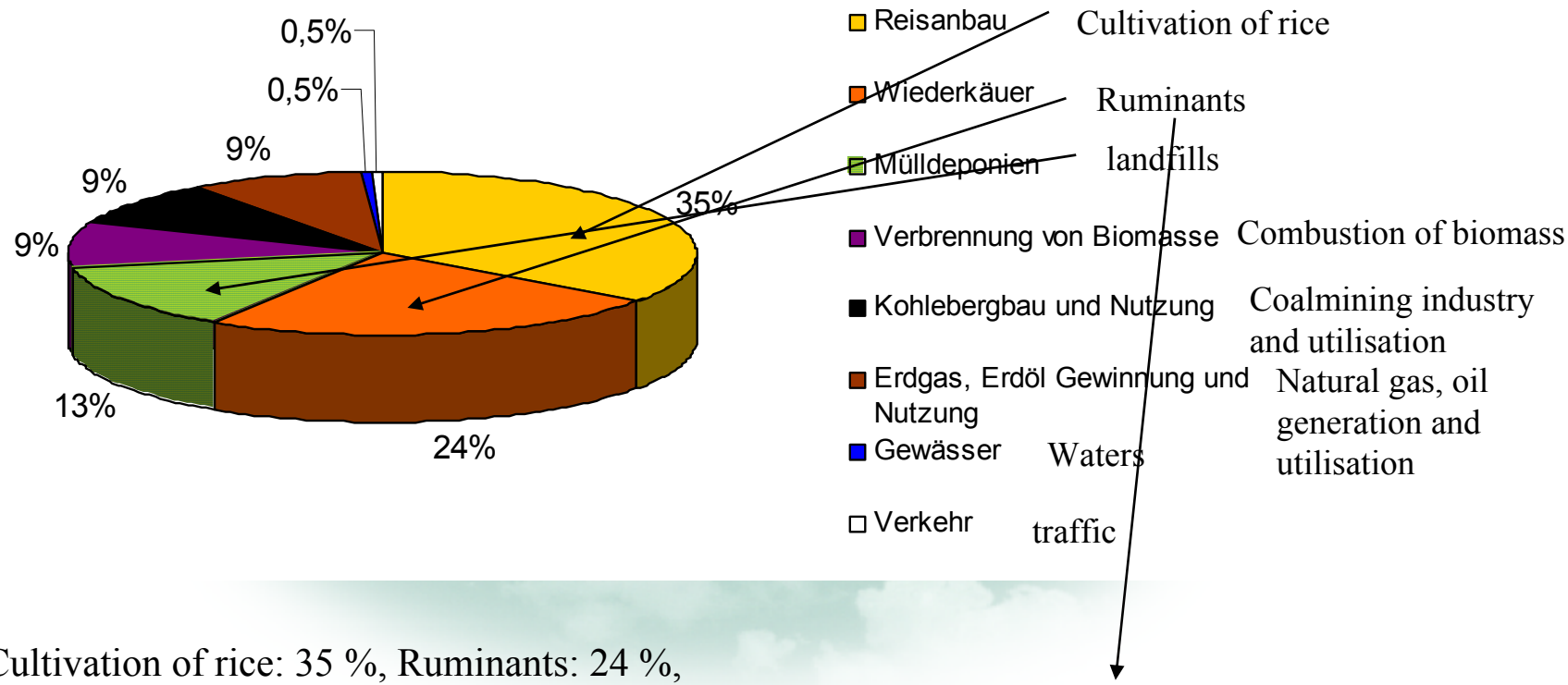
CFC

Tropospheric ozone: 2 - 10 %, N2O: Nitrous oxide: 2 – 10 %,

Stratospheric H2O: 0 – 10 %, CFC: 5 – 25 %, CO2: 35 – 65 %

Methane: 10 – 25 %

Zusammensetzung der anthropogenen Methanemissionen (D : 380 Mt/a)



Cultivation of rice: 35 %, Ruminants: 24 %,

landfills: 13 %

New Zealand is planning a „flatulence tax“, dpa dated of July 16th 2003

Matters of facts by the Anthropogenic (undesired) greenhouse effect

Rise in temperature of the ground-level atmosphere by 0.3 to 0.6 °C since the late 19th century, according to: Assessment Report IPCC dated 1994.

The "US Global Change Research Information Office (GCRIO)" ascertains a rise in temperature of 1 °C since 1860

According to the "US Global Change Research Information office – GCRIO", it is due to this temperature rise, that the ocean level has risen by 10 to 25 cm (reduced by the expansion of the water, meaning in addition to the latter).

The "United Nations Framework Convention on Climate Change" expects a temperature rise of 1 to 3.5 K by the year 2100.

The consequences of an increasing greenhouse effect

According to "Enquete – Kommission des Deutschen Bundestages", the following effects on humans and the environment are to be expected, should current trends concerning emissions continue:

* **A further rise in sea level by 30 to 90 cm**
* **A shifting of the climatic zones by 200 to 400 km towards the pole**
* **Extensive forest extinction in mid- to high latitudes**
* **Impairment of water resources**
* **A worsening of the global nutrition situation**

Examples:

* **In the Sahara, a rise in temperature of 0.1 to 0.2 K at constant rainfall will result in an expansion of the desert by approx. 100 km.**
* **In England, a temperature rise of 0.5 K will prolong the vegetation period by approx. 14 days.**

Global Warming Potential (GWP)

Greenhouse gas	Estimated lifetime (years)	20 a GWP	100 a GWP	500 a GWP
CO2 (reference)	variable	1	1	1
CH4	12	62	23	7
N2O	114	275	296	156

Extract of: Intergovernmental Panel on Climate Change Third Assessment Report, 2001 UK and others

In 1997, after a long period of negotiation, the foundations for worldwide climate protection were laid with the passing of the Kyoto protocol. The target of this agreement is the global reduction of greenhouse gas emissions.

Operation ranges of gas plants

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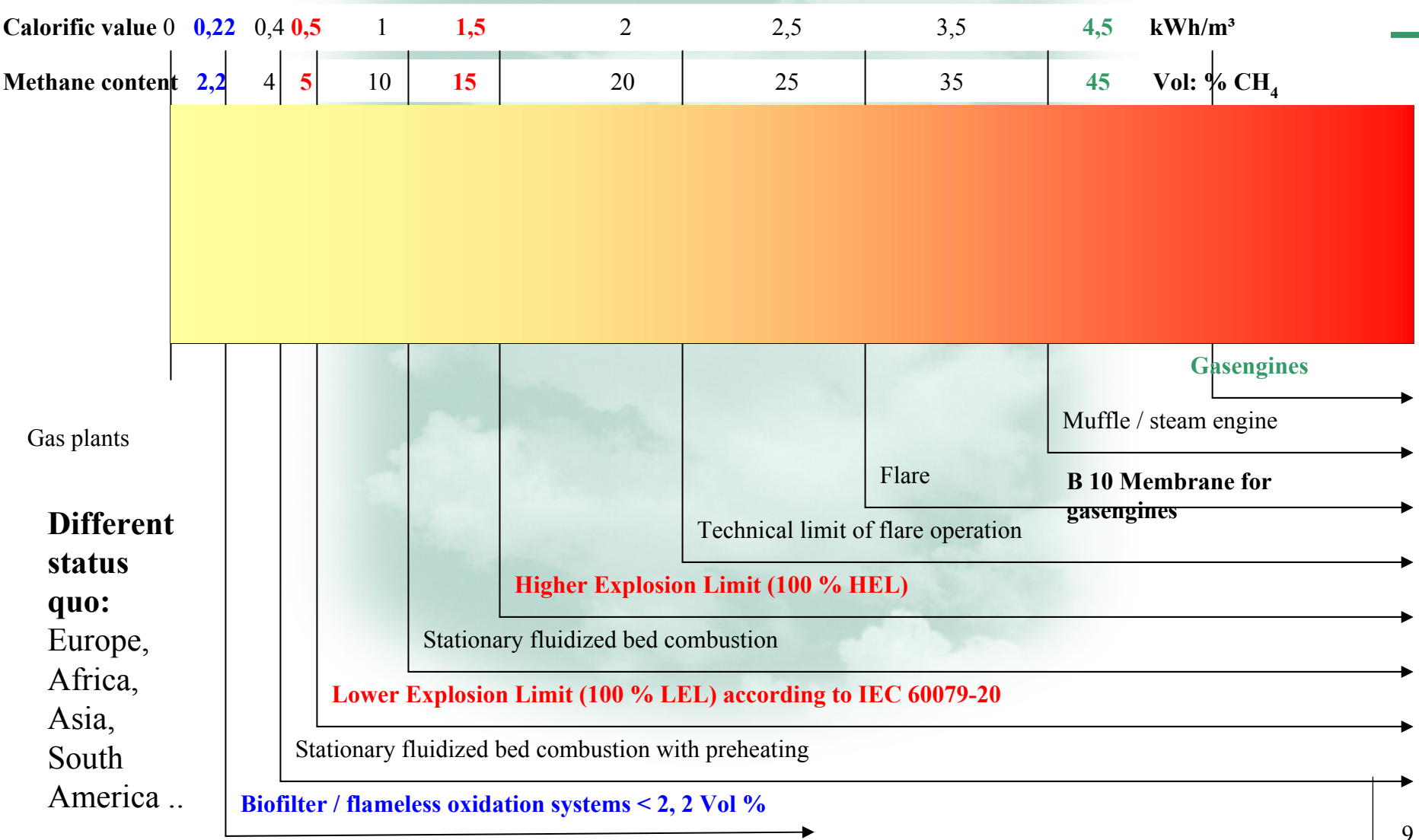

Gas plants

Different status quo:
Europe,
Africa,
Asia,
South America ..

Ternary diagram (explosive triangle), atmospheric

for the explosive range methane / air / CO2- N2 – mixtures

According to Tabasaran / Rettenberger (UBA – research report 12/1982, no. 10302207 part 1)

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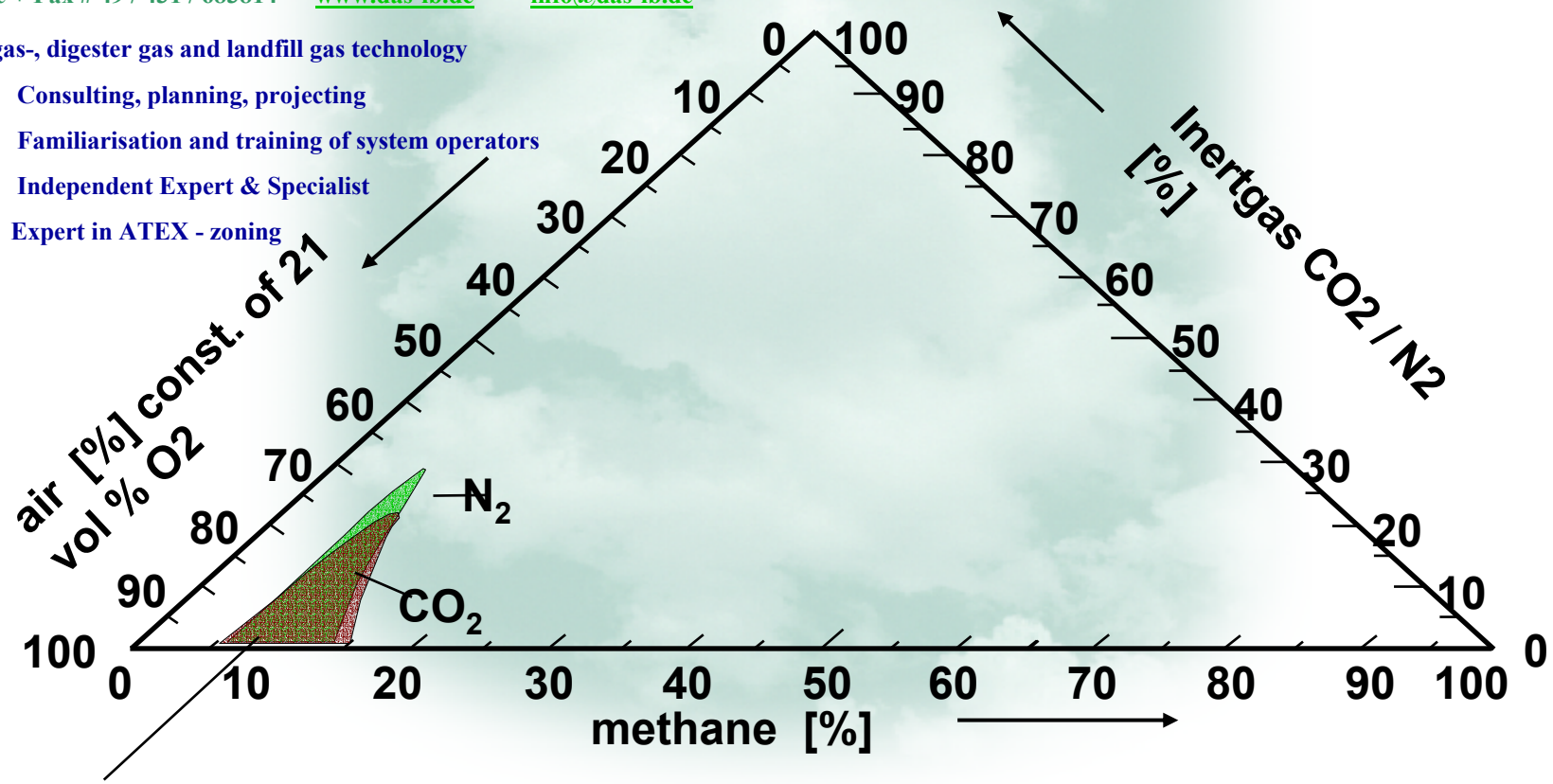

Explosive range: Exceeding of 11.6 vol. % oxygen and

between 4.4 (5) vol. % methane (100 % LEL) and 16.5 (15) vol. % methane (100 % HEL)

Stachowitz, October 03

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With respect to the following objectives, the trade in emissions (emission rights) will be set up as tool for effective climatic protection:
*** EU – liability of Kyoto: Reduction of the greenhouse gas discharge by 8% by the year 2012, taking the year 1990 as a starting point and**
*** The resolution of the federal cabinet of Germany dated November 1990: To achieve the reduction of the most important greenhouse gas CO2 by 25 % until 2005 (basis also 1990)**
*** UK: minus 60 % C02 until 2050 (Energy White Paper; www.dti.gov.uk).**

According to the Council of Ministers of the EU (agreement dated March 18th 2003, dossier 2001/0245 COD, the directive 15792/02 describes the so-called "CO2 trading certificates" as "authorizations to trade with greenhouse gas emissions".

According to addendum II, the greenhouse gases: CO2 (1. Phase), **CH4 (2008 ?)**, N2O, SF6 and fluorocarbons as well as perfluorinated hydrocarbons **fall within the scope of this directive.**

The Kyoto protocol only governs the emission trade between states.

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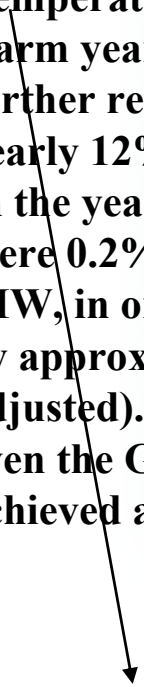
According to the DIW (Deutsches Institut für Wirtschaftsforschung / German Institute of Economic Research) weekly report 6/01, the Federal Republic of Germany achieved a reduction in CO2 emissions of approx. 15% by the year 2000 (temperature effect already taken into consideration (the year 2000 having been a warm year)). In order to achieve the target set for 2005, the CO2 emissions must be further reduced by approx. 100 million t in the following 5 years, the equivalent of nearly 12%.

In the year 2002 (which was also a warm year), the CO2 emission decreased by a mere 0.2% (temperature already adjusted), compared with 2001. According to the DIW, in order to be able to fulfill the national aim, CO2 emissions must be reduced by approx. 11% during this year and in the following 2 years (temperature adjusted). In a press communication dated February 2003, the DIW warns that even the German contribution to the Kyoto protocol (see above) may not be achieved at present.



Aim: CO2 by 25 % until 2005

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2.2.2 Landfill gas and possible technologies for the reduction of CO2 emissions

Taking into consideration the reflections under folder 11, state-of-the-art technology, the Waste Management Act and the promotion on the basis of the Renewable Energy Act (EEG in Germany or NFFO in the UK), it may be expected that there will be no CO2 trading certificates for technologies above 25 vol. % CH4 (pure incineration / oxidation) or approx. 35 – 38 vol. % (used by gas motors), as a double benefit is excluded.

However, a Government support grant (buyback price) does not exist for all countries.

And this is the reason for existing landfill gas CO2 - trading - project under JI or CDM of the EU – document in foreign countries.

You have also to consider (No active extraction system if …) in Germany:

Recommendation after Rettenberger for surface area gas emissions: 4 l / (m2 *h) by FID – measurement > 100 ppm (Height over ground?)
e.g.: 10 ha landfill site: - > 4l (m2*h) * 100.000 m2 = 400 m3 / h landfill gas

Real technical solutions for poor gas quality

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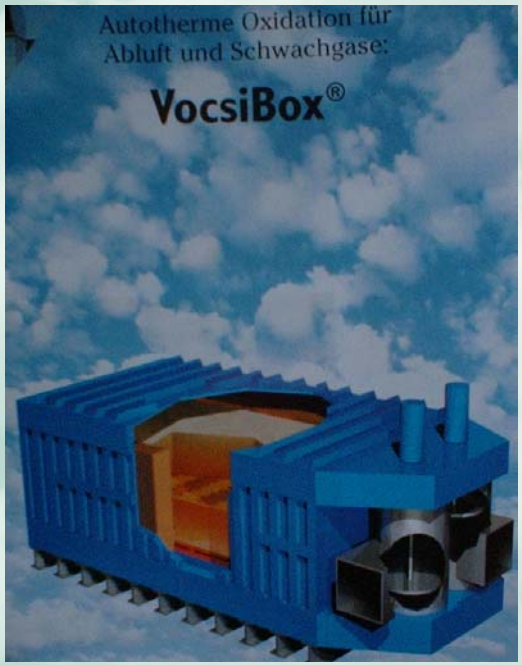

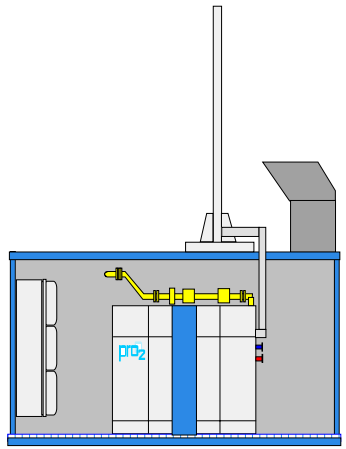

Typ			Leistungen			Wirkungsgrade			Abmessungen	
			elektr.	therm. primär		elektr.	therm.	ges.	Modul (M)	Container (C)
Modul	Container	Gasart	kW	kW	kW	%	%	%	LxBxH(m)	LxBxH(m)
NTM100	NTC100	Erdgas/Gruben-gas	100	152	333	30	46	76	2,9x0,9x1,9	6x2,5x2,6
LTM100	LTC100	Bio-/Klärgas Deponiegas	95	141	316	30	45	75	2,9x0,9x1,9	6x2,5x2,6

Micro turbine: Pro2,
Session B9

DEPOPTHERM® (UMAT GmbH) und VocsiBox® (HAASE AG), non catalytic systems

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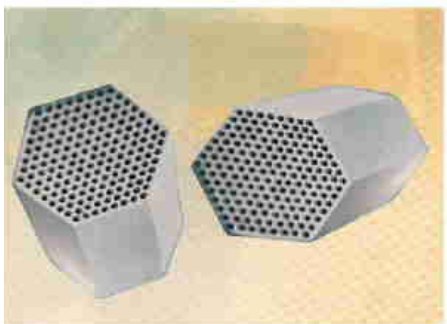
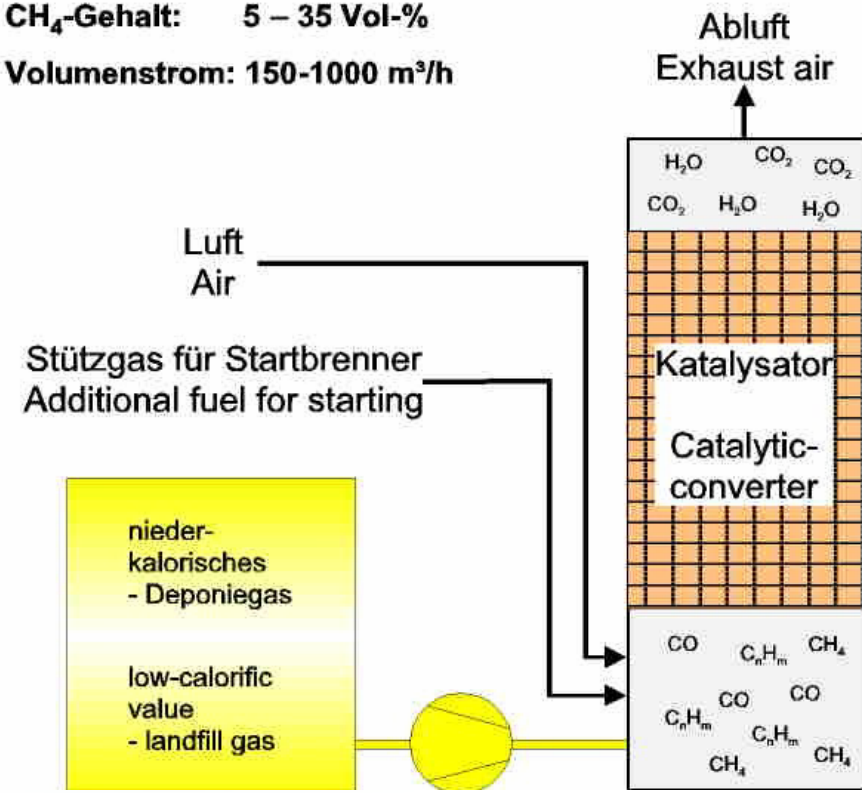
Katalytische Oxidation
Catalytic oxidation



Einsatzgebiet:

CH_4-Gehalt: 5 – 35 Vol-%

Volumenstrom: 150-1000 m³/h



Section B 8 now approx. 0,43 m3 of BF material for 1 m3/h methane gas

2.4.1 Biofilter

An indispensable requirement for **methane oxidation** is the **establishment** of ideal physical and chemical conditions: **heat** (with a temperature of approx. 30°C), **humidity** (30 to 70 % of the respective max. water holding capacity), **pH values** must be neutral to slightly acid, **nutrients** in/at the biofilter material etc., such that colonies of microorganisms inhabiting the liquid film may continue to thrive. For this purpose, relatively high personnel costs and technical expenditure is required in order to control temperature (also in winter), pH value, and establish the optimum humidity etc.. In the case that these conditions may not be optimally controlled, biodegradation is negatively influenced due to irreversible damage of the microorganisms. According to G. Kobelt, 1999 (symposium entitled "Poor gas" dated March 17th in Offenbach), a reduction of approx. 70% is considered a "good" biological purification of CH4. In field tests (according to C. Cuhls, J. Clemens, J. Stockinger, H. Doedens; "Gefahrstoffe – Reinhaltung der Luft" 62 (2002) no. 4 – April, p. 141 ff) poor degradability of CH4 resulted from excessive moisture and a shortage in O2 due to the formation of anaerobic zones within the biofilter.
According to laboratory tests carried out by J. Streese, B. Dammann and R. Stegmann "Microbial oxidation of methane in biofilters", a desired oxidation capacity of 90% was achieved using a biofilter with a volume of 400 m3 (meaning > 20 m x 20 m x 1 m). The flow rate was: 50m3/h landfill gas @ CH4 = 20 vol. %, or dirty gas with 400m3/h at 2.5 vol. % (all the aforementioned requirements (pH, T, f) must be met!!). With regard to practical operation, even larger biofilters are expected due to drying and varying temperatures in the biofilter. Earlier publications still indicated a biofilter volume of 276 m3, based on laboratory tests.
In the opinion of the author, biofilters may, therefore, not be considered for CO2 trading certificates (due to the uncertainties in the efficiency of methane oxidation).

2.5 Possible proceeds and costs involved due to the trade in CO2 certificates concerning the application of the technologies

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As the following paragraphs deal with landfill gas (with CH4 as the main gas), we are talking about CO2 certificates. However, in the narrower sense these are "carbon dioxide equivalents" with an equivalent global warming potential.

2.5.1 Requirements

a) „Project document“ / „Base line“

In these documents, CO2 reductions and technology are determined, as well as substitutions and the reference situation.

b) Validity / validation

During validation, the method applied for the determination of the emission reduction is examined and fixed one single time.

c) Monitoring report

This report documents and proves the relevant data concerning the emission reduction. An observation period is fixed.

d) Certification

Subsequent to the examination of the monitoring report according to validation, a CO2 reduction quantity is certified for the observation period (usually a calendar year).

Phases b) and d) must be accompanied and confirmed by independent departments, phases a) and c) may be supplied by the project-executing organization itself.

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In order to be able to roughly estimate the CO2 savings that may be taken into account for certificates, the process chains (current situation < -- > future situation) must be documented:

1) What is the current situation?

What happens to the landfill gas/waste at present? We need the input quantity, landfill gas quantities, composition of the gas, landfill size (waste quantities and type -> gas prognosis), applied energies (process heat and electricity; how is the latter produced at present?) and the current CO2 emissions.

2) What is the situation like subsequent to treatment (e.g. co-generation sets, gas engines, low methane oxidation systems)?

Besides the input quantity (landfill gas) that should be identical, information is required for the new process.

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In order to be able to roughly estimate the CO2 savings that may be taken into account for certificates, the process chains (current situation < -- > future situation) must be documented:

3) When gas is converted into electricity, what does the electricity replace? Electricity from the supply network or an individual plant. In the first case, the energy from the supply network or 'grid' consists of a mixture of water power, electricity generated in nuclear power plants, and coal-based electricity generation. Therefore the amount of CO2 produced per kWh for each of the different technologies is required. In the case of an individual plant, the description of the system is required (e.g. combined oil heat and power station). Where is the heat supposed to go, is it used? (-> further CO2 certificates)

4) How is the plant financed?

Are there any subsidies granted? Does any particular compensation exist for the electricity (similar, for example, to the renewable energy act (EEG) in Germany or the NFFO in the UK)? Is it a private investor; is it an "inland" investor? Is the measure undertaken cost-effective? Do acts or guidelines stipulate this measure at present or will they do so in the future?

a) First assessment

For the creation of a first assessment (assessment of the CO2 savings documented on one or two pages), a cost of approx. 1,000 Euro is estimated (exclusive of taxes and travel expenses). The customer (e.g. the operator of a landfill) will be refunded for these costs when commissioning the complete study (a to c). On this basis, the customer must decide whether or not the project shall be continued.

b) Project Idea Note (PIN)

In case the project should be continued, the next step would be the implementation of the so-called Project Idea Note (PIN). The PIN is supposed to document the project technically, economically and legally. All influences that the system may have globally must also be taken into consideration and, vice versa, the global influences on the system. This finally indicates whether or not there are any objections to the project and to what extent CO2 quantities will be credited to the customer. This document also enables the customer to make provisional contracts with potential buyers. The costs are very high: they amount to approx. 10,000 Euro plus VAT, travel expenses (Europe) res. to 15,000 Euro plus VAT and travel expenses (Asia).

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c) Project Design Document (PDD)

For certification purposes, a so-called Project Design Document (PDD) is required, consisting mainly of the PIN, monitoring and validation plan. Depending on the complexity, the costs will be between 15000 and 20,000 Euro plus taxes and travel expenses (Europe) res. between 25000 and 30000 Euro plus taxes and travel expenses (Asia). The costs for the establishment of the PIN will be charged proportionally.

These prices may only be specified in more detail after a rough copy has been initially carried out. In addition, costs for certification and fees must be taken into consideration. Estimated range: 15,000 to 60,000 Euro.

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In contrast, proceeds of approx. 2 to 6 Euro per ton CO2 are noted at present. This price may rise up to 20 Euro per ton CO2 adequate.

Rough estimate: 2000m3/h landfill gas * 0.7 kg / m3/H * 8,760 h pa * 23 GWP (CH4 / CO2) * 5 Euro / t CO2 – adequate * 0.5 (50 vol % CH4) - >
approx. 705, 000 Euro pa Income

Subsequent to the establishment of the first assessment, every operator / customer knows the respective range of saved CO2 emissions. He will thus be able to recognize at a relatively early stage whether or not the project will be profitable.

2.3 Equivalents of the trade with CO2 certificates

Price per "t" CO_2 equi-valent	"Stock exchange"	Source
6,58 €	Hessen Tender, spring 2003	Technical journal: wlb 1-2/2003 **Pilot project of the Hessian state government** www.Hessen-tender.de
5 bis 30 €	**UBA – Expectation special field II 6.3 "Situation of the emissions"**	**Mail dated 22.01.03 to the author**
40 €	Fine from 2005 on for companies for each ton of "unapproved" CO_2	Council **of the European Union – Political agreements dated December 11th 2002, 14935/02 "Greenhouse gas emission allowance trading", article 16**
100 €	**Fine from 2008 on for companies for each ton of "unapproved" CO_2**	Council **of the European Union – Political agreements dated December 11th 2002, 14935/02 "Greenhouse gas emission allowance trading", article 16**
5 – 10 €	Öko – Institut e.V.	**Brief report for the WWF Environmental foundation, December 9th 2002**
3 – 5 €	**Certificate sale of the Schmack Biogas AG**	**Mail to the author dated February 10th 2003**
20 – 33 €	**IG BCE – Certificate**	**Information dated April 10th 2002, minister for economic affairs Werner Müller and** www.igbce.de **dated 27.01.2003**
5.5 – 7 $	**DIE ZEIT, economy**	**Schmutz im Angebot 48 / 2000** www.zeit.de **dated 11.02.2003**
7 $	**Certificate, Wirtschaftsvereinigung Stahl**	**Verein Deutscher Eisenhüttenleute, certificate „Emissionsrechtehandel der Europäischen Kommission.." dated 22.10.2002**
20 – 40 €	Fraunhofer Institut	www.isi.fhg.de/u/planspiel/zsfg.pdf dated 26.02.2003
£ 15	UK Emissions Trading Group	**www.greenergy.com/our_company/media_centre/arc_april_2000_co2.html**
6 – 7 €	EU – Allowances (actual market price)	Future camp, Mr. Geres (phone call dated April 2003)

Actual prices:

a) High quantity, low loading (for non catalytic systems, Poor gas system)

1500m3/h mixed gas, loading 1 vol. % CH4, energy demand approx. 15 kW el, operating hours p.a. 8400h
Costs arising in this example: approx. 15 € / t CO2 equivalent

b) Consideration of the marginal costs (Break Even Point): EEG (renewable power supply grant in Germany) – support grant or trade with CO2 certificates ?

The revenues of the support grant p.a:
x kW el * 0.0767 €/ kWh * operating hours p.a. = annual proceeds

The latter is compared with the possible proceeds of the CO2 reduction (CO2 savings of the power plants as the national average):
x kW el * 0.6 – 0.9 kg CO2 / kWh * equivalent of the CO2 certificate = annual proceeds

Therefore, the marginal costs are:
Equivalent of the CO2 certificate = (0.0767 €/kWh) / (0.6 – 0.9 kg CO2/kWh)
= 85 – 127 € / t CO2 Equivalent without GWP of 23 CH4 / CO2
plus CO2 certificates out of the heat exchanger if ….
plus your price for the electric energy from your local grid

3. CONCLUSIONS

Lobbying of landfill operators is required in order to achieve consideration of the trade with CO2 certificates as long as everything is moving.

At this moment, landfill- and mine gas projects are realized abroad (means not in Germany).

In all probability, the allocation mechanism (assignment of certificates) for the emission trade will be fixed in autumn of this year.

Every (future) operator of a landfill-gas electricity installation should ask himself which situation (in respect of the proceeds) appears most economic to him at that moment (support grants or sale of the CO2 certificates plus free energy sale) as, today, there are already companies purchasing CO2 certificates to enhance their 'green image'.

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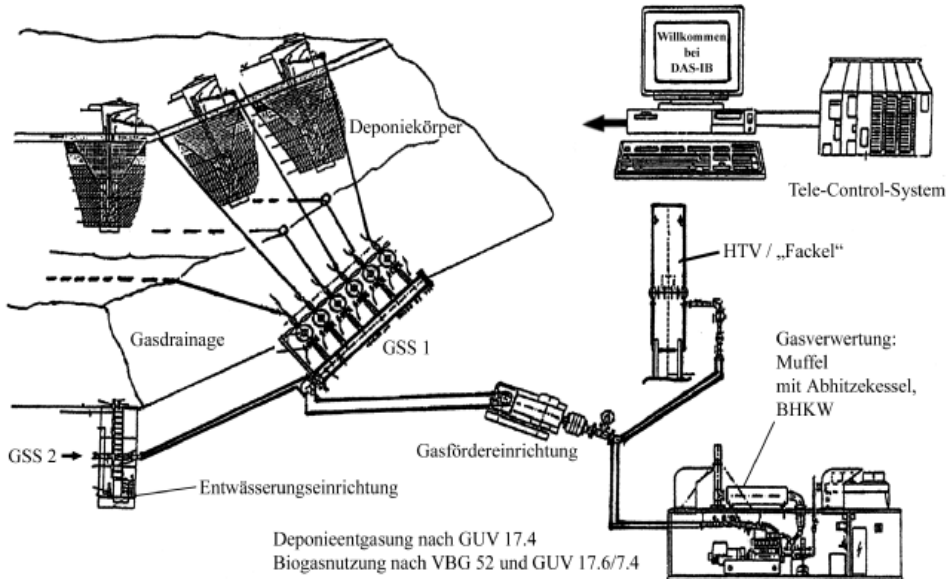
Landfill gas technology

Thanks



Thank you for your attention !

More details in the Sardinia CD and at our web: www.das-ib.de

Or ask the author here !

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