Carbon Trading with Landfill Gas (LFG) and carbon credits; JI - and CDM - projects

Trade with greenhouse gas emissions respectively greenhouse gas allowances

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1. GREENHOUSE EFFECT

1.1 Basics

Natural greenhouse effect (the glass panes of a greenhouse): tropospheric solar energy is captured by letting the sunlight through (short-wave radiation high in energy) and then retaining infrared radiation (long-wave heat radiation) res. delaying radiation. This "natural greenhouse effect" prevents infrared radiation from the sun which warms the earth from being re-reflected into space. This results in a heating up of the earth's surface. In the absence of this natural effect, the average temperature of the earth would not lie at approx. +15°C, but instead at approx. -18°C (WWF report) and most life on earth not be capable of existence.

Furthermore, the greenhouse effect is increased by climate-relevant gases such as carbon dioxide (CO_2), methane (CH_4) or chlorofluorocarbons, resulting in an undesired enhancement of the average temperature on earth (anthropogenic greenhouse effect). It is likely that early man's use of fire was the first anthropogenic source. From that moment onwards, WE were the ones to consume fossil energies and biomass for conversion ("generation of") into heat, electricity, motion (traffic), food, waste…

Table 1 - Total greenhouse effect

Water vapor	Remaining greenhouse gases	Anthropogenic (undesired) greenhouse effect
60 – 95 %	5 – 40 %	0. 5 – 1.5 %

Table 2 - Anthropogenic (undesired) greenhouse effect

Tropospheric ozone	Nitrous oxide	Stratospheric H_2O	CFC	Methane (CH_4)	Carbon dioxide (CO_2)
– 10 %	2 – 10 %	0 – 10 %	5 – 25 %	10 – 25 %	35 – 65 %

Table 3 - Anthropogenic (undesired) CH4 emissions (in Germany: 380 Mt / a)

Cultivation of rice	Ruminants	Landfills	Combustion of biomass	Coal-mining industry and utilization	Natural gas, oil generation and utilization	Traffic	Waters
35 %	24 %	13 %	9 %	9 %	9 %	0.5 %	0.5 %

Source: Abridged VDI report entitled "Emissionen und Luftqualität", 1998

1.2 History

Until the mid-eighties, there was no concrete proof of global ecological crises, such as the anthropogenic greenhouse effect and the reduction of the stratospheric ozone carrying layers. It was only during the seventies that such climatic concerns were examined more closely and systematically. The first World Climate Summit in Geneva in 1979 is considered the landmark of climate impact research.
Climatic reconstruction until 1000 AD carried out by the American Geophysical Union shows a long-term cooling-down trend until the era of industrialization. The latter started the acceleration of the changes witnessed up to the present. Within the next fifty years, an irreversible change in the climate must be assumed, the results of which are already noticeable.

1.3 Present assessments and prognoses

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).

Forecasting on the basis of the present knowledge assumes a rise in temperature of 1.5 to 4.5 K (°C) within the next 50 years, and by 5 to 6 K (°C) in the next 100 years on the surface of the earth.

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

1.4 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.
* Extinction of 15 – 37% of the terrestrial animals and plants until 2050 (Nature and taz 08.01.04)
* Insured losses of approx. 1.62 trillion Euros worldwide until 2050, according to the DIW (German Institute for Economic Research) (Nov. 04)

1.5 Relative greenhouse effect caused by various gases

The effect of the anthropogenic gases relevant to the climate varies considerably and depends on the emission mass flow and the specific greenhouse potential (Global Warming Potential). Furthermore, the examination period is of importance as the individual substances show different degradation rates in the atmosphere. Quite often, a period of 100 years is used.

According to:
"Wuebbles D. & Edmonds J. – 1991, Primer on Greenhouse Gases, Lewis Publishers Inc. Chelsea, Michigan. First Edition IBN 087371 222 6" and "Intergovernmental Panel on Climate Change Third Assessment Report, 2001" UK
the following GWP must be considered (extract):

Table 4

Greenhouse gas	Estimated life-time (years)	20 years GWP	100 years GWP	500 years GWP
CO_2	Variable	1	1	1
CH_4	12	62	**23**	7
N_20	114	275	296	156
Various CFCs (Chlorofluorocarbons)	Depending on the gas type	Depending on the gas type	Depending on the gas type	Depending on the gas type

GWP: Global Warming Potential

When fixing the GWP factor, the absorption of heat radiation of the respective molecule and the average retention time of the latter in the atmosphere is taken into consideration.

1.6 Emission trade – in accordance with the Kyoto protocol (act on greenhouse gas emission trade)), the EU directive 003/87/EU and the "grey market"- "environmental indulgence"

At the beginning of a trading period, the total quantity of allowable CO_2 emissions is determined for each of the plants concerned (approx. 2631 in Germany, as of November 2004, respectively 1849 German industrial plants, as of January 2005); for trading with emission rights each receives tradeable "allowances". The first period started on January 1st 2005, and ends on December 31st 2007. The amount of allowances received will then be reduced at the beginning of the subsequent periods, that is, from 2008 onwards. The second period of trading starts on January 1st 2008 official with methane and regarding to the determination of the EU governments and EU departments on March 23rd 2005 starts a 3rd period until 2020. The concerned companies have the choice either to take saving measures themselves or to purchase additional emission allowances from the market. They thus have the possibility to select the "prevention option" which they deem cost-effective. The trade is legally binding throughout Europe. In addition, Switzerland and Norway are now participating in the trade. Since Mr. Putin has ratified the Kyoto protocol on behalf of Russia at the beginning of November 2004 (both Russia and the USA signed), worldwide CO_2 trade has come into effect (16th February 2005). In Germany, the EU certificates (EU allowances / EUA) were first issued on February 28th 2005 on the basis of the "Nationaler Allokationsplan (NAP)" (national allocation plan). First accounting for the companies involved will take place on April 30th 2006. A company which is able to implement a cost-effective reduction of its emissions (which, according to the author, is unlikely) may sell to others the amount of emission allowances which are not required. On the other hand, and for economic reasons, it may be much more interesting not to reduce own emissions but to buy additional emission allowances (e.g. from biogas or landfill gas projects). This decision will depend on the market prices (€ / t Co_2 e) / marginal abatement costs.
Furthermore, two project-related mechanisms exist abroad (from the emitter's point of view) called "Joint Implementation" (JI) and the "Clean Development Mechanism" (CDM) – see slides during the lecture. The emission allowances (“certificates”) of these projects are named ERUs (Emission Reduction Units) for JI projects and CERs (Certified Emission Reductions) for CDM projects. The current market price from January - April 2005 for

* EU allowances (EUA) lies at approx. 8.50 € - 15 € / t CO_2 CO_2 1st period

* ERU lies at approx. 5.00 € - 7.00 €/ t CO_2 in the so-called “Forward Contract“. JI projects (> 10,000 t p/a)

* CER lies at approx. 3 – 5 $ / t CO_2 CDM projects (> 100,000 t p/a)

On account of the convertibility of CER, (ERU 2nd period) into EUA, an equalising of the prices is to be anticipated within the first trading period of 2005 – 2007. Note: In contrast to EUA, CER may be transferred from the first into the second trading period (2008 – 2012), which might enhance the value of the latter.

In addition, a so-called “grey market” or “environmental indulgence” exists. On this market, aircraft users, for example (www.atmosfair.de), may “buy a clear conscience“ by paying compensation for the CO_2 contamination that they cause. The climatic protection projects which are financed through these payments are implemented outside the ambit of the relevant EU directive as well as the Kyoto protocol. However, more than state-of-the-art technology is required in this respect.

Potential buyers – potential sellers
source: BMfUNR, Mr F. Schafhausen

DAS – IB GmbH, LFG & Biogas- Technology,
www.das-ib.de , phone & fax #49 / 431 / 683814

EU-member state	CO2-Emission 1990	CO2-Emission 2000	aim	difference in Mio. t CO_2-Äquivalenten
Belgium B	143,1	151,9	132,4	- 19,5
Danmark DK	69,4	68,5	54,8	- 13,7
Germany D	1222,8	991,4	966,0	- 25,4 / - 17 Industry
Finnland FIN	77,1	74,0	77,1	+ 3,1
France F	551,8	542,3	551,8	+ 9,5
Greece GR	104,8	129,7	131,0	+ 1,3
Ireland IR	53,4	66,3	60,4	- 5,9
Italy I	522,1	543,5	488,2	- 55,3
Luxemburg L	10,8	5,9	7,8	+ 1,9
Austria A	77,4	79,8	67,3	- 12,5
Portugal P	65,1	84,7	82,7	- 2,0
Sweden SWE	70,6	69,4	73,4	+ 4,0
Espania ESP	286,4	386,0	329,4	- 56,6
United Kingdom UK	742,5	649,1	649,7	+ 0,6
Netherlands NL	210,3	216,9	197,7	-19,2

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Figure 0. Buyers and sellers in Europe (EUA, CER, ERU)

2. LANDFILL GAS

2.1 Technical fields of application, explosion protection

2.1.1 Firing ranges, state-of-the-art

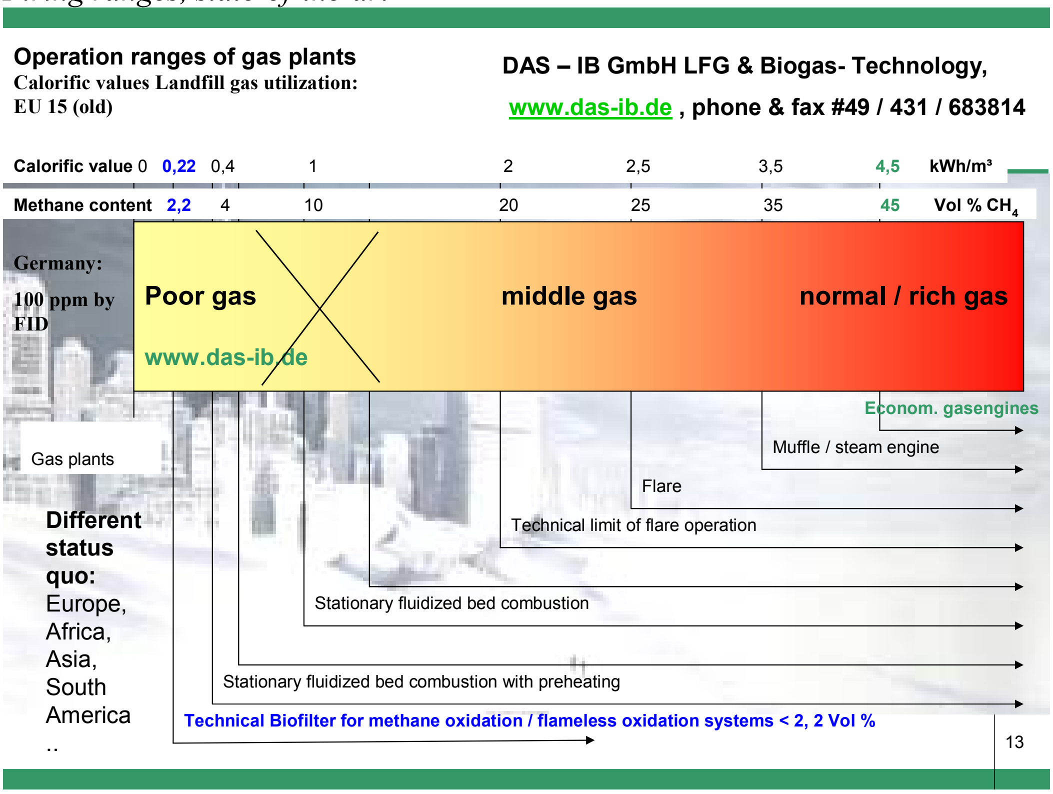

Figure 1. Operating ranges of gas utilization plants

2.2 Carbon / CO_2 trading certificates for landfill gas? YES

According to the Council of the EU (October 2003), the directive 2003/87/EC describes the so-called "CO_2 trading certificates" as "authorizations to trade with greenhouse gas emissions". According to addendum II, the greenhouse gases CO_2 (1st phase), CH_4, N_2O, SF_6 and fluorocarbons as well as perfluorinated hydrocarbons fall within the scope of this directive. The emission trade directive was promulgated on October 25th 2003. It thus constitutes part of European legislation and must be implemented in the member countries. The translation into national law e.g. Germany is called "Treibhausgas-Emissionshandelsgesetz" – the TEHG (act on greenhouse gas emission trade). You will find the latest update at: **www.das-ib.de/links.htm** or on BMU (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety) website. Official trade started on January 1st 2005. The law refers to "greenhouse gas allowances" instead of "certificates". In March 2004, DAS-IB GmbH has submitted a brief check of the emission reduction project / residue emissions from (old) landfills through poor gas utilization / disposal to the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) in Germany, for the first concrete projects. At the end of April 2004, the BMU granted us the permit for the first two JI projects in Germany for landfill poor gas. The lecture will inform you about the latest developments in this field, particularly with regard to the NON-equal treatment of mine gas and landfill gas in Europe: is it the case that mine gas flares, but not landfill gas flares, fall within the scope of the directive? Furthermore, we participate in projects in Eastern Europe and in the Near East. Under the direction of the Federal Environmental Agency, we participated in working groups of the "Workshop Nationales System Emissionsinventare" (Workshop on National System Emissions Inventories") on the 8th and 9th November 2004 and continue consultation there to this day. Further meetings with the BMU (Mr. Forth), the BMW (Mr. Frisch) and the German KfW bank group will take place in spring 2005.

2.2.1 Introduction and basis

In order to achieve a reduction in the discharge of greenhouse gases by 8% by 2012 (related to base year 1990) (this being an EU liability of Kyoto), and to implement the resolution of the Federal Cabinet dated November 1990: reduction of the most important greenhouse gas CO_2 by 25% by 2005 (base year also 1990), the aforementioned trade in emissions (emission rights) will be set up as a tool for effective climatic protection. The Europe-wide trade in greenhouse gas emission certificates has come about! It started on January 1st 2005 with 15 EU countries, acceding countries + other participants (e.g. Switzerland, Norway etc.). "Early actions", 1990 being the earliest base year can be taken into consideration.

Germany: According to the DIW (German Institute for Economic Research) (weekly report 6/01), the Federal Republic of Germany achieved a CO_2 emission reduction of approx. 15% (reduced by the temperature effect) by the year 2000 (which was a warm year). In order to reach the target that was set for 2005, the CO_2 emissions have to be reduced by an additional approx. 100 million t within the following 5 years – meaning a reduction of approx. 12%.
In contrast to 2001, CO_2 emissions were only reduced by 0.2% (reduced by "temperature") in 2002 (which was also a warm year). According to the DIW, CO_2 emissions must be reduced by approx. 11% (reduced by "temperature") during the current year and in the 2 years to come in order to be able to achieve the national aim. In a dpa press communication dated 20th February 2003, the DIW warns that even the German target contribution to the Kyoto climate protection protocol (see above) currently risks not being met.
According to the NAP (National Allocation Plan) in Germany, approx. 17 mio t CO_2 emissions must be reduced annually in German industry from 2005 onwards.

2.2.2 Landfill gas (CH_4) and technologies for the reduction of CO_{2e} emissions

Taking into consideration the reflections under 2.1, state-of-the-art technology, the Waste Management Act and the promotion on the basis of the Renewable Energy Act (EEG) it may be anticipated that there will be no CO_2 trading certificates in Germany for technologies above 25 vol. % CH_4 (pure combustion / oxidation) and above approx. 35 – 38 vol. % (use in gas engines), as a double benefit is excluded. Compared with mine gas in Germany, there is a discrepancy though (cold venting to atmosphere or combined heat and power plant - no "flare technology"). However, legal feeding compensations res. regulations regarding the flaring of biogas / landfill gas do not exist in all countries involved. There is a big chance and opportunity for development countries – a new income through CDM - projects. But don't be late and have a look at: **http://cdm.unfccc.int/** many LFG - projects are presently being launched.

On the other hand there is "old" Europe with JI – LFG – projects:
The use of 95 kW_{el} micro gas turbines (Pro2 Anlagentechnik GmbH, Germany, RPS Ltd., UK) within this capacity range, (roughly 25 – 30 vol. % CH_4) must be separately reflected. Keyword: no double benefits – see lecture.

In our opinion, a possible trade with CO_2 certificates in "old" Europe (as our projects inGermany) will only apply to operating ranges below the lower explosive limit (LEL). This would apply to techniques involving the use of technical biofilters (several retailers), VocsiBox® (HAASE Energietechnik AG), Depotherm® (UMAT – Deponietechnik GmbH) for so-called "non-catalytic oxidation", micro gas turbines in the range below 20 vol. % CH_4, fluidized-bed combustion and catalytic poor gas disposal (Pro2 Anlagentechnik GmbH) or the green energy (NFFO in the UK, EEG in Germany etc.) feeding compensation is set aside.

Back to the CDM – projects:
In countries where no corresponding provisions exist (in this respect, Brazil; Philippines and South Africa are the trailblazers within the scope of CDM projects), this looks "different" (see lecture and slides there). These are the first landfill gas CDM projects: eThekwini Municipality (formerly Durban Metropolitian City Council), Durban, South Africa und Salvador Da Bahia Landfill Gas Project (Aterro Metropolitano do Centro – AMC) near Salvador, Brazil, a Philippine landfill gas project (Payatas, Manila) well as Chinese projects has been published now as PDD at: http://cdm.unfccc.int/.

2.2.3 The "currency" of CO_2 trade- carbon trading

Exchange obligation of: CER and ERU (from CDM or JI projects) into allowances ->
CER (Carbon Emission Reduction) = ERU (Emission Reduction Unit) = EUA (European Allowance). Attention: The market prices in April 2005 do not correspond to a 1:1 ratio, see point 1.6.

2.3 Values of the trade with CO_2 certificates

Table 5

Price per CO_2 equi-valent	**"Stock exchange"**	**Source**
€ 8,50	EEX, Leipzig, Germany	Market price of the European Energy Exchange (EEX) in Leipzig for EUA "allowances"
€ 25	e.on Energie AG	For new combined gas and steam turbine power plants in exchange for coal-fired power plants
€ 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
€ 12	Franzjosef Schafhausen	Federal Ministry of the Environment, Nature Conservation and Nuclear Safety, on November 17th 2003 in Potsdam
€ 5 – 6.5	Own investigation	Market price in April 2005, for ERU from JI projects
$ 3 - 5	Own investigation	World market price (World Bank) for CER from CDM projects
€ 8,3 – 15	Point Carbon	Market price **www.point.carbon.com** for EUA in March / April 2005

2.4 Technology comparisons for the possible trade with CO_2 certificates

2.4.1 Biofilters in JI - projects

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 optimum humidity etc. In the event 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 CH_4. 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 CH_4 resulted from excessive moisture and a shortage in O_2 due to the formation of anaerobic zones within the biofilter.
According to laboratory tests carried out by J. Streese, R. Stegmann "Microbial oxidation of methane from old deposits in biofilters", a biofilter volume of 900 m^3 (meaning > 30 m * 30 m * 1 m) may be achieved when meeting the aforementioned requirements (pH, T, f) for: 50 m^3/h landfill gas, CH_4 = 20vol.-%, raw gas with 400 m^3/h at 2.5 vol.-% CH_4 and a desired cleaning

rate of 90%. With regard to practical operation, even larger biofilters are expected due to drying and varying temperatures in the biofilter. Earlier publications still indicate a biofilter volume of 276 m^3, based on laboratory tests.
In the opinion of the author, only technical biofilters may therefore be considered for CO_2 trading certificates (due to a more reliable methane oxidation). Example: the Horb – Rexingen landfill in the Freudenstadt district (Ministry for the Environment and Transport, Baden-Württemberg, Abfall Heft (waste brochure) 77, 2004). That brochure contained a report in which the Contec GmbH registered approx. € 5 / t CO_2 (approx. 100 € / t CH_4 over a duration of 5 years).

2.4.2 Technical systems, so-called "non-catalytic oxidation" and "catalytic oxidation" in JI - projects

A short description of the "noncatalytic oxidation": In these systems, methane is converted into CO_2 and H_2O due to thermal oxidation. Thermal oxidation is an exothermic process and takes place at approx. 850°C to 1000°C (depending on the manufacturer of the system) in the insulated reactors. The released thermal energy is emitted into the purified waste gas and used for the heating of the reactor. An autothermic operation is possible from approx. 0.3 to 0.5 vol.% CH_4 on (depending on the manufacturer of the system). An "undiluted" operation is possible up to approx. 1 – 1.5 vol. % CH_4. At higher methane contents, the reactor overheats. This may be avoided by the addition of air. The starting-up / heating of the system is implemented electrically or by means of a small pilot gas burner. It is a discontinuous process as, using a reverse shutter, the flow direction in the "reactor" must be changed due to the temperature profile that develops.
The process of "catalytic oxidation" which is presently being developed aims to reach ranges of operation of 5 to 25 vol.% methane. Hence, there are two good reasons to use this method: the landfill gas does not need to be diluted, and it would be a continuous process which does not require a switching-over. The use of micro gas turbines aims to reach similar ranges. We are overseeing such a project abroad, although it is still in its experimental stage.

2.4.3 Landfill gas electricity generation including / excluding heat extraction – instead of a promoted feeding compensation (Normally in JI – projects)

On the one hand, conventional current from coal, natural gas, oil, or nuclear power plants is superseded and on the other, fossil fuels, such as oil, gas, coal, etc. are possibly being replaced.
For both possibilities, CO_2 equivalence certificates are thus directly regenerated when the EEG feeding compensation is set aside or not paid within the scope of JI or CDM projects abroad.
CDM and JI projects may already be initiated. Emissions credits from CDM projects before 2008 may be "saved" whilst emissions credits from JI projects may not be saved – "banking" – (allocation period).

Furthermore, projects with existing gas motors are interesting from an economic point of view when additional thermal energy is "extracted" which also supersedes fuel oil and natural gas as primary energies. We are currently developing corresponding projects from approx. 1.5 MW_{th} onwards.

2.5 Eventual proceeds and costs involved as a result of the trade in CO_2 certificates relating to the application of the technologies presented under 2.4.2 (JI - projects), and general information about all types of projects

As the following paragraphs deal with landfill gas (with CH_4 as central gas), we are talking about

CO_2 certificates. However, in the narrower sense these are "carbon dioxide equivalents" with an equivalent global warming potential.

2.5.1 Requirements in general for all kinds of projects

„Project document“ and „Base line“
In these documents, CO_2 reductions and technology are determined, as well as substitutions and the reference situation.

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

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

Certification
Subsequent to the examination of the monitoring report according to validation, a CO_2 reduction quantity is certified for the observation period (usually a calendar year).

Phases b and d must be accompanied and approved by independent institutions (for Germany: TEHG expert offices in accordance with para. 10, clause 1, phrase 3 / you can find the updated list on our web-site: www.das-ib.de/mitteilungen/TEHG_Sachverstaendigenliste.pdf) ; phases a and c may be supplied by the project-executing organization itself.

2.5.2 Process stages (see also the slide of the lecture) in general for all kinds of projects

a) Pre-check

b) PDD (Project Design Document)

c) Approval

d) Monitoring and evaluation

2.5.3 Example plants for poor gas oxidation / JI - project

a) High quantity, low loading
1500m^3/h mixed gas, loading 1 vol. % CH_4, energy demand approx. 15 kW el, operating hours p.a. 8400h

Costs: approx. 10 – 15 € / t CO_2 equivalent

For plant types using "German technology"

b) As a result of synergies, costs of approx. 8 – 10 € / t CO_2 equivalent are possible

c) Technical biofilter: In this respect, the Horb-Rexingen landfill in the Freudenstadt district (Ministry for the Environment and Transport, Baden-Württemberg, Abfall Heft (waste brochure)

77, 2004) may serve by way of example. Contec GmbH registered an amount of approx. 5 € / t CO_2 equivalent (approx. 100 € / t CH_4 over a duration of 5 years) in its corresponding report.

2.5.4 Consideration of the marginal costs / Break Even Point: EEG - feeding compensation (Germany) or trade with CO_2 certificates? The "old" Europe's projects

The following approach may be established for a relatively simple comparison: when the reduction (combustion in the gas motor in accordance with Ta air) of the landfill gas (CH_4 oxidation) - as state of the art - and the exhaust gas emissions of the gas motors resulting from it are neglected.

The revenues of the feeding compensation p.a:

x kW el * 0.0767 €/ kWh * operating hours p.a. = annual proceeds

The latter is compared with the possible proceeds of the CO_2 reduction (CO_2 savings of the power plants as the national average):

x kW el * 0.6 – 0.9 kg CO_2 / kWh * equivalent of the CO_2 certificate = annual proceeds

Therefore, the marginal costs are:

Equivalent of the CO_2 certificate = (0.0767 €/kWh) / (0.6 – 0.9 kg CO_2/kWh) =85 – 130 € / t CO_2 equivalent.

This represents the "value" excluding the CH_4 / CO_2 GWP of 23, meaning that mine gas / biogas may work with 3.7 – 5.5 € / t CO_{2e}.

"Market value" at 5 € / t CO_2: 0.005 – 0.003 €/kWh excluding the GWP of 23.

It must be noted that the "green" power produced (the merchandise in kWh) may also be sold and, thus, is an additional source of revenue (e.g. eco-stock markets). The same goes for the sale of thermal and exhaust energy, not including further CO_2e certificates resulting from it. This also applies to the retrofitting of already existing plants, according to the principle that landfill gas supersedes fossil oil or gas firing.

As aforementioned, mine gas (still?) takes another place in Germany (currently better due to a GWP of 23) and in any case outside the EU 15 (old), in the absence of legal provisions regarding landfill gas combustion (see lecture). Besides our JI landfill poor gas project in Germany, a JI mine gas project is presently being implemented at the BMU with the Netherlands as a potential buyer.

2.5.5 CDM - projects: revenues, durations of contract, Risk

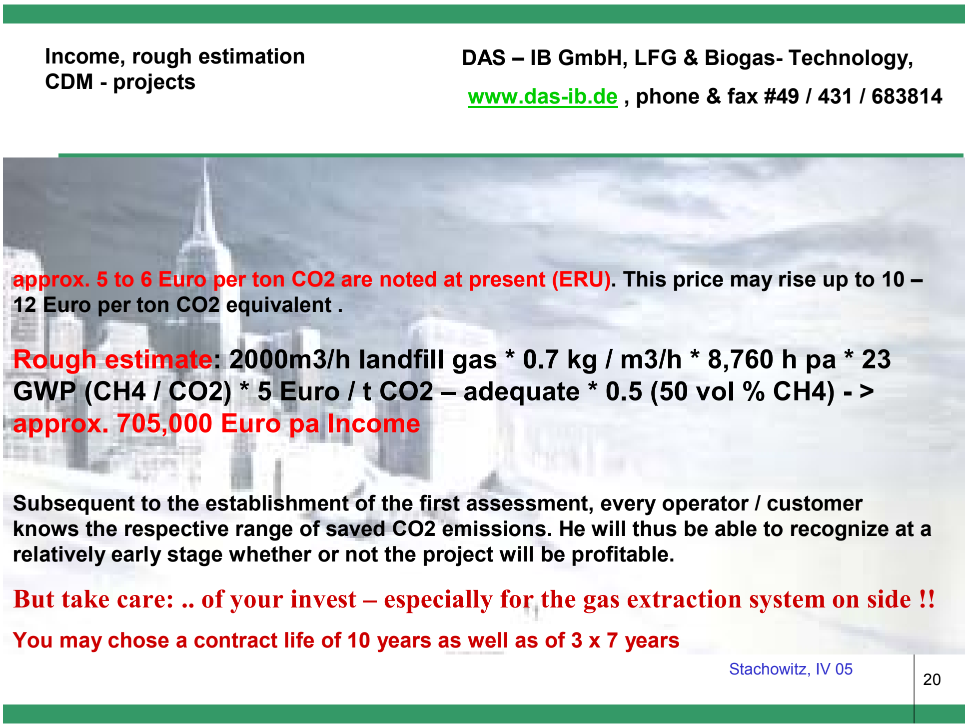

Figure 2. Rough estimation of your income / CDM - projects

The only risk is: “exact” gas prognosis, a “good” gas extraction system, operation costs and the O&M costs for a contract duration of 10 years or 3 times 7 years in a CDM – LFG- project.
See:
* Stachowitz, 15 Years of experience in the field of LFG disposal – standards, problems, solutions and procedures, Sardinia 2001, 8th International Waste Management and Landfill Symposium
* http://www.das-ib.de/mitteilungen/Payatas_Landfill_Gas_PDD_Comments.pdf
* http://www.das-ib.de/vortraege/sardinia_en.pdf

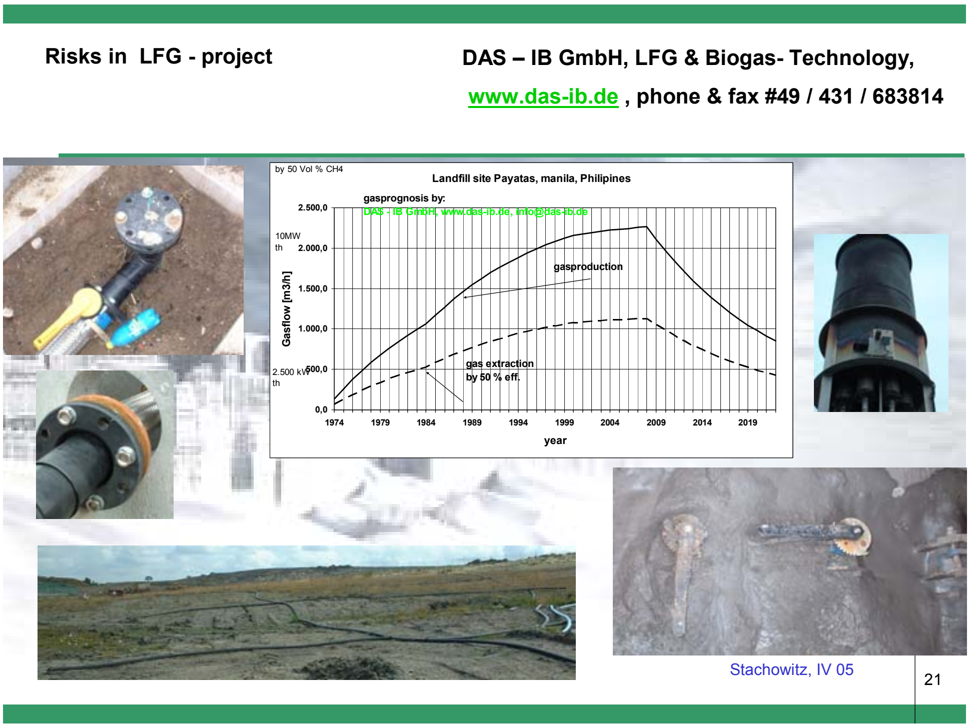

Figure 3. Risk in LFG - projects

3. CONCLUSIONS

CDM - projects:
Develop your projects before your government will enact regulations with regards to LFG oxidation or “waste to energy” in your host country.

JI - projects in “old” Europe (EU 15):
An ecological balance is more than necessary as a decision-making tool for the maintenance or discontinuance of the poor gas disposal operation for the CO_2 emissions trade, as by means of these plants, CO_2 emissions of the slightly caloric landfill methane gas may be reduced at a reasonable price.

A trade with CO_2 certificates may offer incentives to the operators of (older) landfills to install poor gas disposal systems or to install a gas extraction system for a landfill operator in a development country. However, the operator is competing with "other" performers of CO_2 reduction projects and should, for reasons of contractual reliability (delivery commitments), join a pool (minimizing the risk for delivering the certificates over the whole contract period).

JI - projects:
In any case, it is likely that projects will only be of economic interest at >15m^3/h pure methane gas over a longer duration and when there is a plant pool which is able to deliver > 10,000 t CO_2 certificates p/a over a period of 10 years.
In the summer of 2004, the "project release – landfill poor gas oxidation as a JI project" as a specific type of project was granted to us in writing by the BMU.

CDM - projects:
In any case, it is likely that LFG-flaring projects will only be of economic interest at >125 m^3/h pure methane (250 m^3/h LFG) gas over a longer duration and when there is a plant pool which is able to deliver > 100,000 t CO_2 certificates p/a over a period of 10 years.

Furthermore, we are working on projects in Asia for the (partial) financing of complete landfill construction projects and for the FEA, for the "Nationales System Emissionsinventar" (National System Emissions Inventory), workshops: Energy and Waste.

CO_2e: The issue of certificates before 2008 will be possible – but most likely no release of allowances will take place. But make sure that you will make your forward contract, paper work (PIN, PDD etc.) and start in time. Remember don’t be late.

As our powerpoint (ppt) lecture will be more up-to-date than this text version, we would like to offer to send the ppt presentation to any interested conference participants by mail, fax or letter.

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