Practitioners Workshop on CDM Standards (8.-10. June 2011, Bonn)

New project types in CDM waste sector:

Landfill aeration
- Current and future applications -

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Background

- Global warming is the result of a change in the atmospheric balance caused by **anthropogenic emissions of Greenhouse Gases** (GHG)
- **Methane** (CH_4) emissions account for > 14 % of the total GHG emissions

Ruminant livestock

Paddy fields

Landfills

85 M tons CH_4/year

60 M tons CH_4/year

~ 40 M tons CH_4/year

Source: IPCC Climate change 2007 – Synthesis report

How to reduce CH_4-emissions from LF ?

- **Treatment of organic wastes / waste organic fraction**
  - **Composting / anaerobic digestion**
- **Recycling and substitution of raw materials**
  (indirect avoidance of CO_2 emissions)
- **Incineration / thermal recovery (WTE)**
- **Gasification (syngas production)**

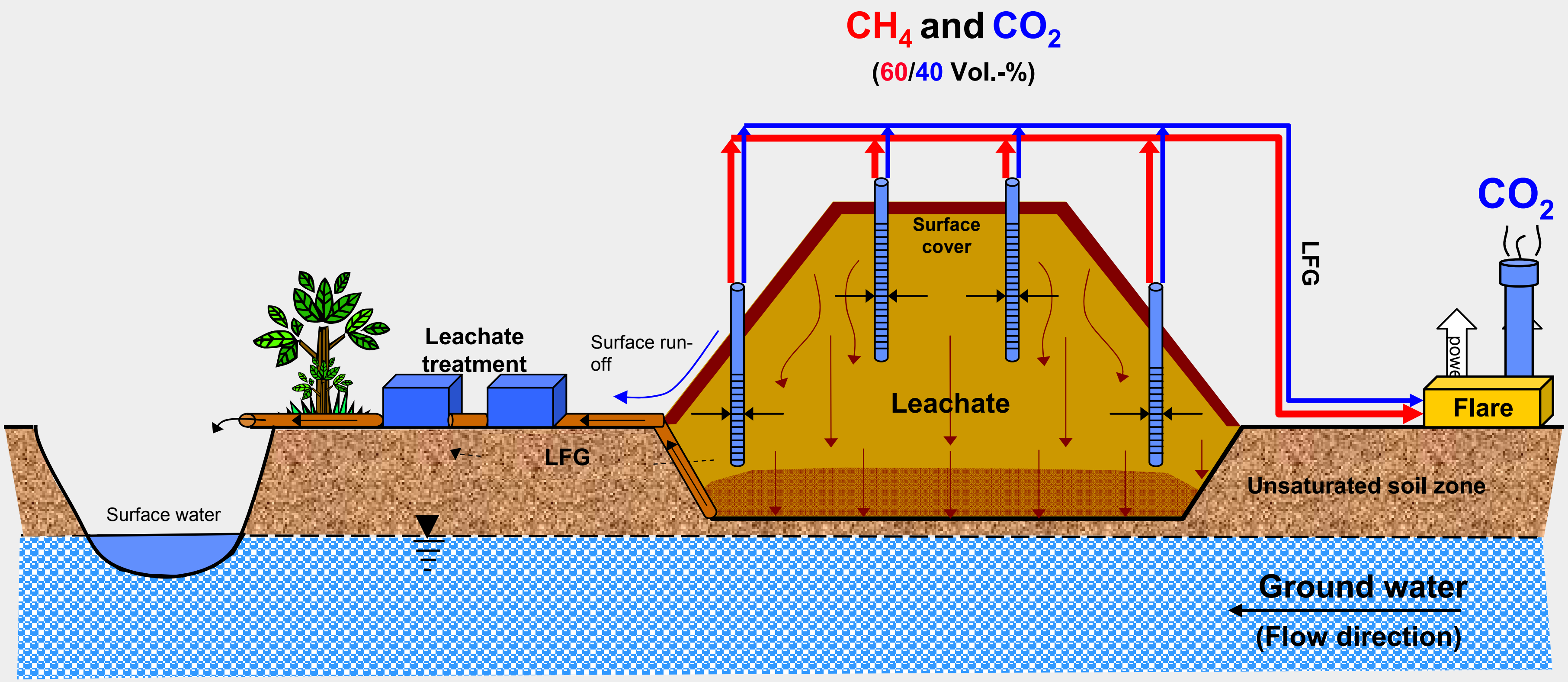
off site

- **Landfill gas capture + flaring**
- **Landfill gas capture + energy generation**
- **Landfill gas capture + heat and energy generation**
- **Avoidance of landfill gas generation on site**
  → Landfill aeration

on site

Anaerobic landfill:

LFG extraction and disposal or utilization



Approaches by IPCC
- Evaluation -

- Climate projects (JI/CDM) for direct avoidance of LFG emissions are ecologically sound, potentially create economical benefits but might prevent other (further) emission reduction measures.

Example:

- Many CDM projects are based on LFG capture and flaring ('simple technique, cost effective')
  - *Registered CDM projects (06/2011):* *3131*
  - *Waste handling & disposal sector:* *544*
  - *LFG projects:* *137*
  - *LFG capture and flaring:* *76 (approx. 56%)*
- Potential for energy generation: approx. 0.63 m tons CH_4 /a (→ approx. 8,500 GWh/a; i.e. ≈ 1 nuclear power plant)

Source: UNFCCC – CDM Statistics (http://cdm.unfccc.int/Statistics/index.html) 06/2011

Approaches by IPCC
- Evaluation -

- The emission behaviour is mainly temporarily improved (avoidance of uncontrolled CH_4 emissions); after the project landfills might still exhibit a significant emission potential:
  - Continuous methane generation
  - Leachate pollution on a high level
  - Settlements not completed

Alternative or additional approach:

- Aerobic in situ stabilisation (Landfill Aeration)
  - Short <u>and</u> long term avoidance of methane generation
  - Reduced leachate pollution
  - Settlements (widely) completed

Concepts for landfill aeration

- Semi-aerobic landfill concept (NM0333)

  Aeration driven by the temperature difference between the waste and the ambience („passive“ aeration concept)

- Air venting (AM0083)

  Aeration as a result of induced negative pressure inside the landfill („overdrawing concept“)

- Low pressure aeration (AM0083)

  Aeration by compressed air; parallel extraction (and treatment) of the off-gases („active“ aeration concept)

- High pressure aeration (no methodology so far)

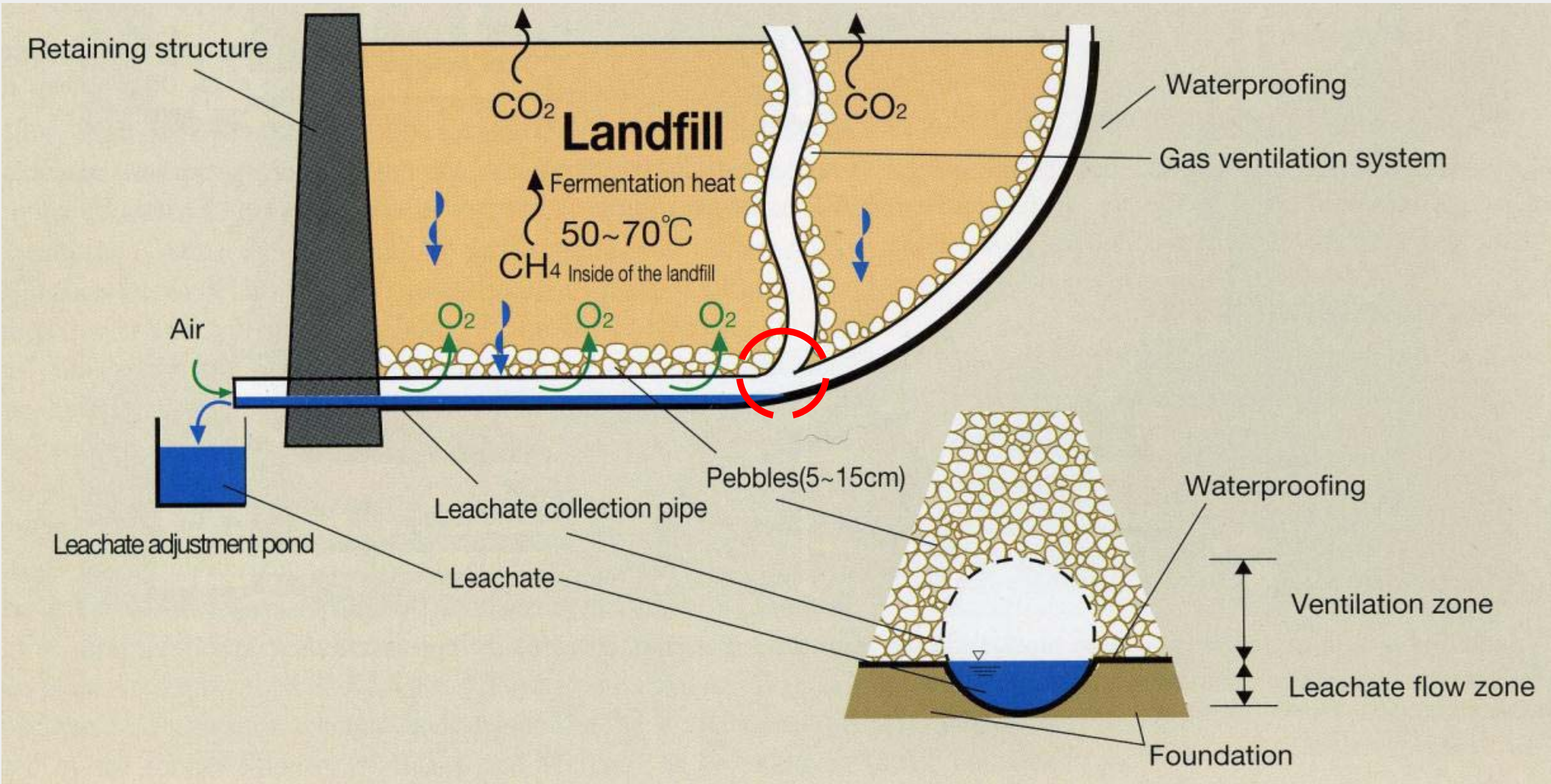
  Pulsed aeration by high pressures; air enriched with oxygen; parallel extraction (and treatment) of the off-gases

Landfill aeration in the framework of CDM projects

- CDM-Methodology NM0333

  „Avoidance of landfill gas emissions by passive aeration of landfills“
- Not yet approved by the CDM Executive Board; Meth Panel 49 (May 2011): “external expertise on appropriate N_2O emission factor is needed”
- Aims and characteristic:
  - Avoidance of anaerobic conditions inside the landfill
  - Conversion of anaerobic landfill to semi-aerobic conditions
  - Reduction of methane emissions; faster bio-stabilisation
  - Does not require mechanically induced air injection, thus very limited in operation costs and indirect $CO_{2,e}$ emissions

Semi-aerobic landfill concept (type 1)



Two options (types):

1)Gas wells connected to the leachate collection pipes (for new LF constructions)
2)Gas wells without direct connection to the leachate pipes (for LF remediation)

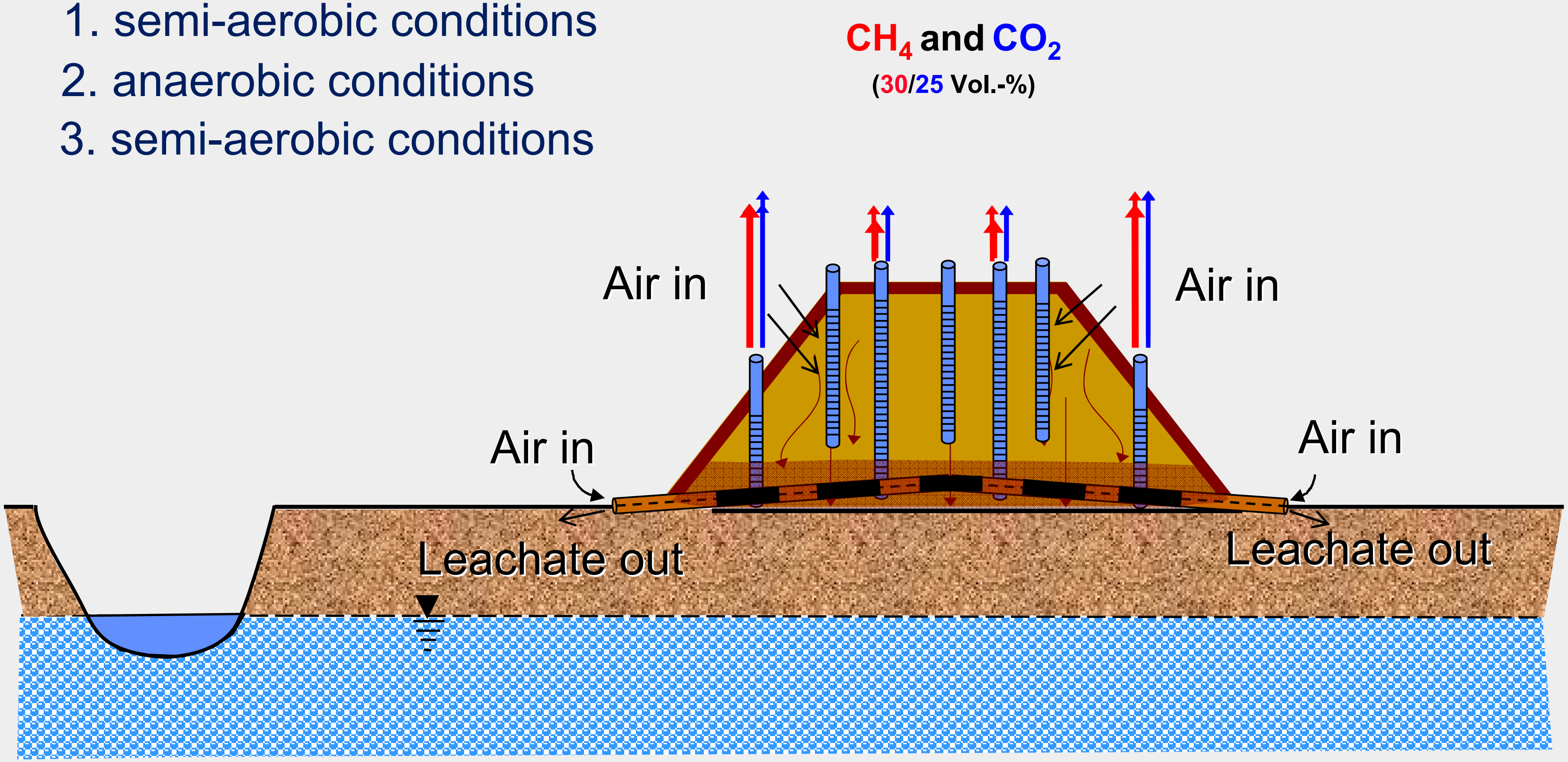
Semi-aerobic landfill (Example type 1)

Vertical gravel layers

Vertical gas venting wells

Semi-aerobic landfill (Example type 2)

1. semi-aerobic conditions
2. anaerobic conditions
3. semi-aerobic conditions



Semi-aerobic landfill (Example type 2)

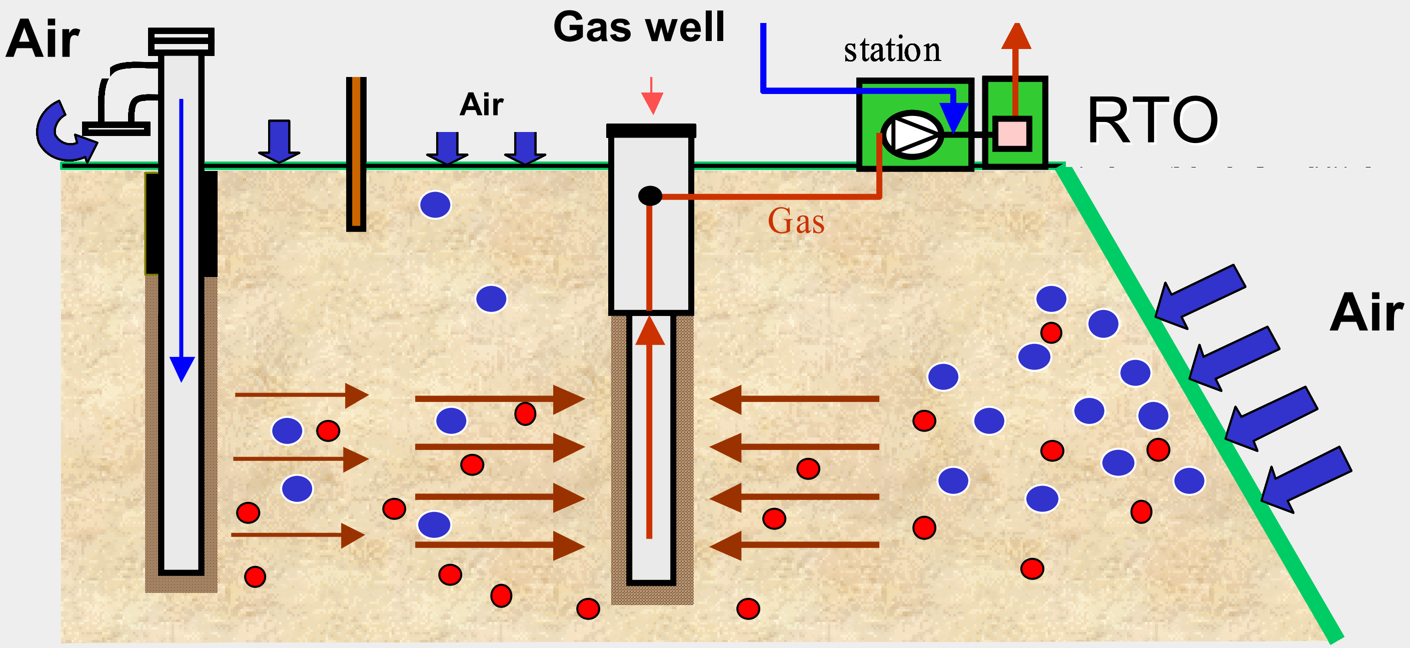
Landfill aeration in the framework of CDM projects

- CDM-Methodology AM0083

  „Avoidance of landfill gas emissions by in-situ aeration of landfills"
- Approval by the CDM Executive Board in July 2009
- Aims:
  - Reduction of methane emissions
  - Creation of environmentally compliant landfills
  - Shortening of landfill aftercare
- Concepts:

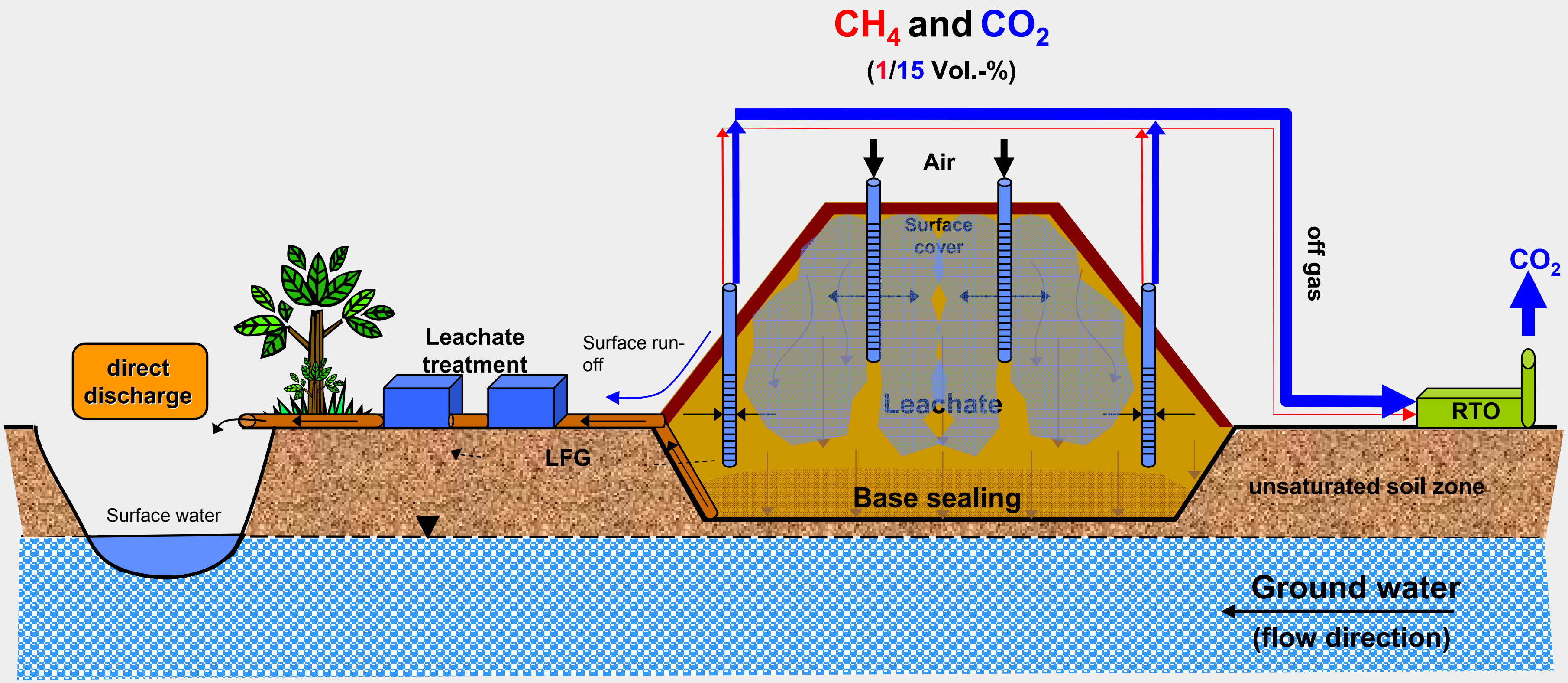
  Air venting and low pressure aeration

Air venting



Source: J. Heerenklage, TUHH

Low pressure aeration



Aerated landfills (examples, D)

Examples world wide

- Aerated Landfills in Germany
  - Kuhstedt, Amberg-Neumühle, Milmersdorf, Dörentrup, Schwalbach-Griesborn, Süpplingen (all by means of low pressure aeration)
  - Kiel Drachensee, Schenefeld (air venting)
- Aerated Landfills in Austria
  - Mannersdorf, Pill, Heferlbach (LPA)
- Aerated Landfills in Italy
  - Sassari, Legnago (LPA)
- Aerated Landfills in the USA
  - NY, NJ, TN, MI, FL, KY, CA, AZ
- Aerated landfills in Switzerland and The Netherlands
  - Sass Grand (SUI); Almere, Landgraaf (NL) (AV (SUI); LPA (NL))
- Semi-Aerobic Landfills in Japan and Malysia

CDM methodology AM0083
- Calculation of emission reductions -

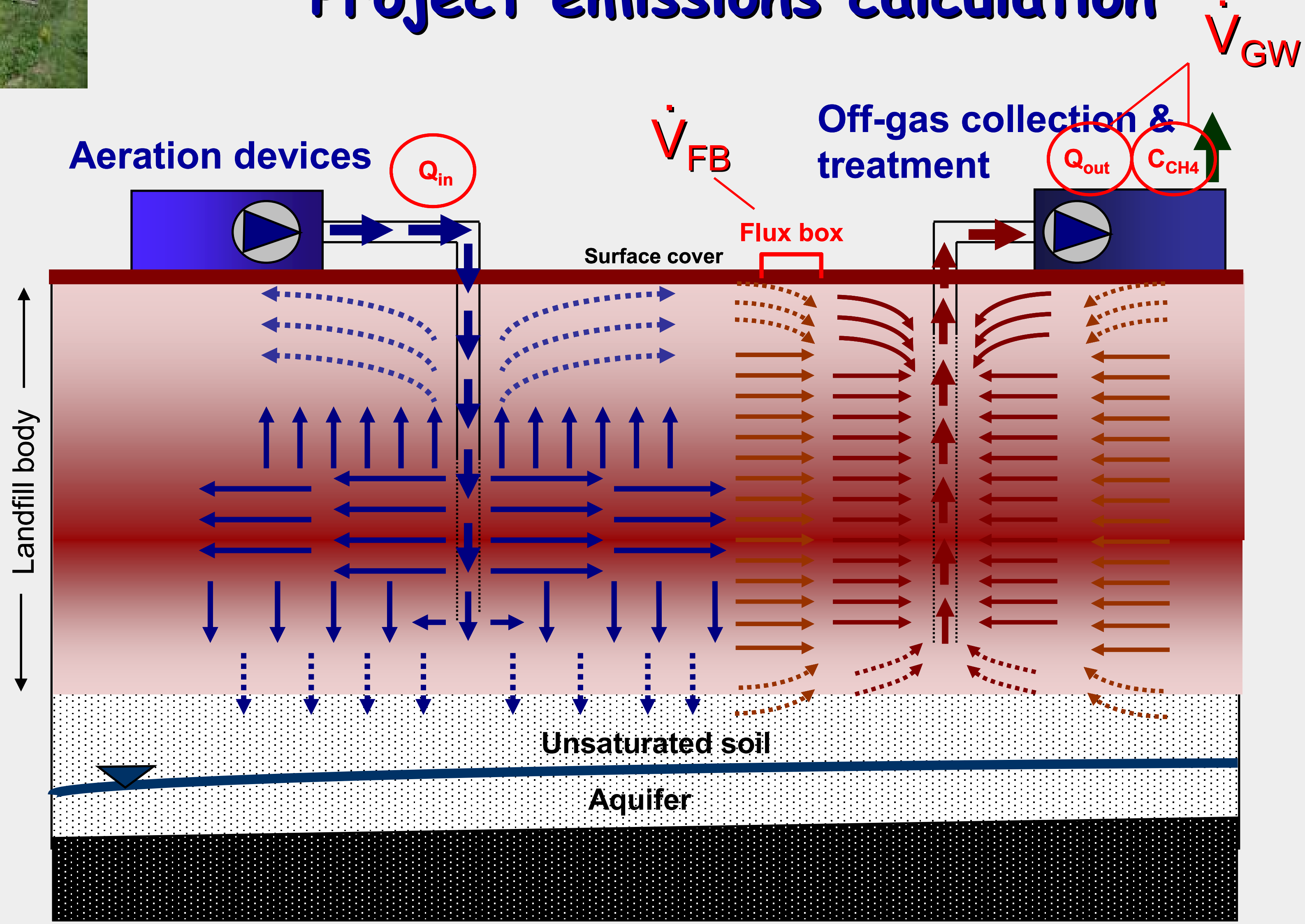
- Comparison between the status without CDM project activity („Baseline“) and the actual project emissions (incl. secondary emissions from energy production and fossil fuel consumption)
- Baseline emissions:

  Only CH_4-emissions; N_2O-emissions are supposed to be irrelevant under anaerobic conditions

  → *3 stage calculation (!)*
- Project emissions:

  CH_4 and N_2O emissions, CO_2 from energy production and fossil fuel consumption

Project emissions calculation



Source: K.-U. Heyer, IFAS Hamburg

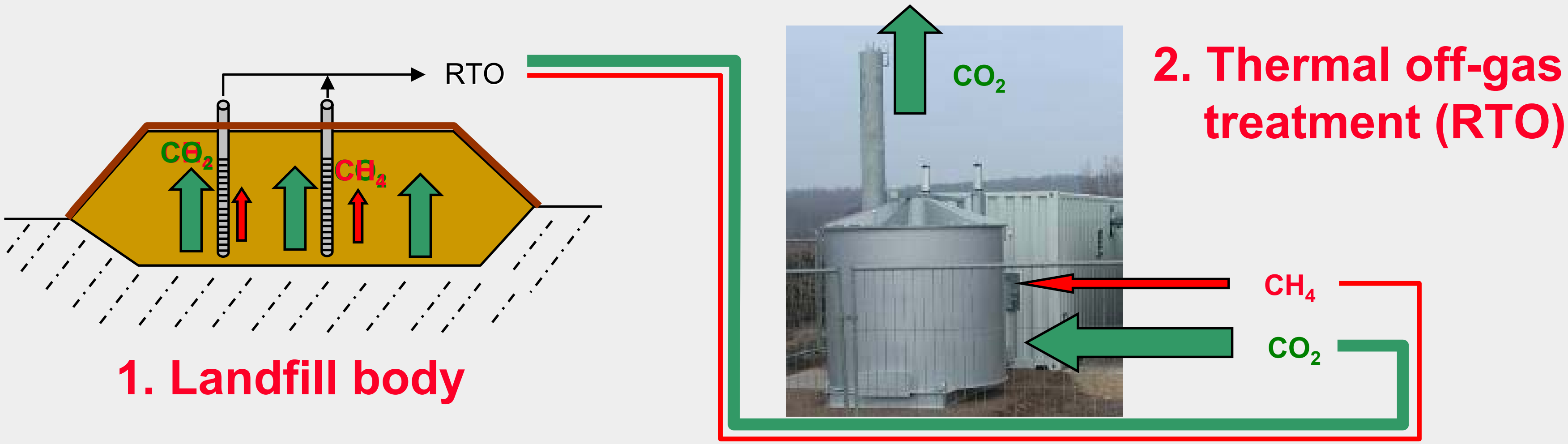
Landfill aeration – Calculation approaches

MSW landfills in „non annex I countries“ (CDM-projects)

- No or limited legal or contractual obligations for LFG recovery
- Amount of biodegradable organic carbon: 40 – 60 kg per ton waste; up to 70% (90% with RTO) of the resulting CH_4 emissions avoided by LF aeration (secondary emissions: 10%; N_2O according to IPCC default value (0.027 kg/Mg TS))
- Approach:
  - Landfill aeration after LFG projects or as an alternative to LFG capture and flaring
  - Thermal off-gas treatment not mandatory (NM0333, AM0083); but it would significantly increase the project performance

Assessment and balance of GHG emissions from aerated LF

- Methane (major contributor of GHG emissions from landfills) generation and release can be minimized
- GHG emission reductions can be achieved in two areas:

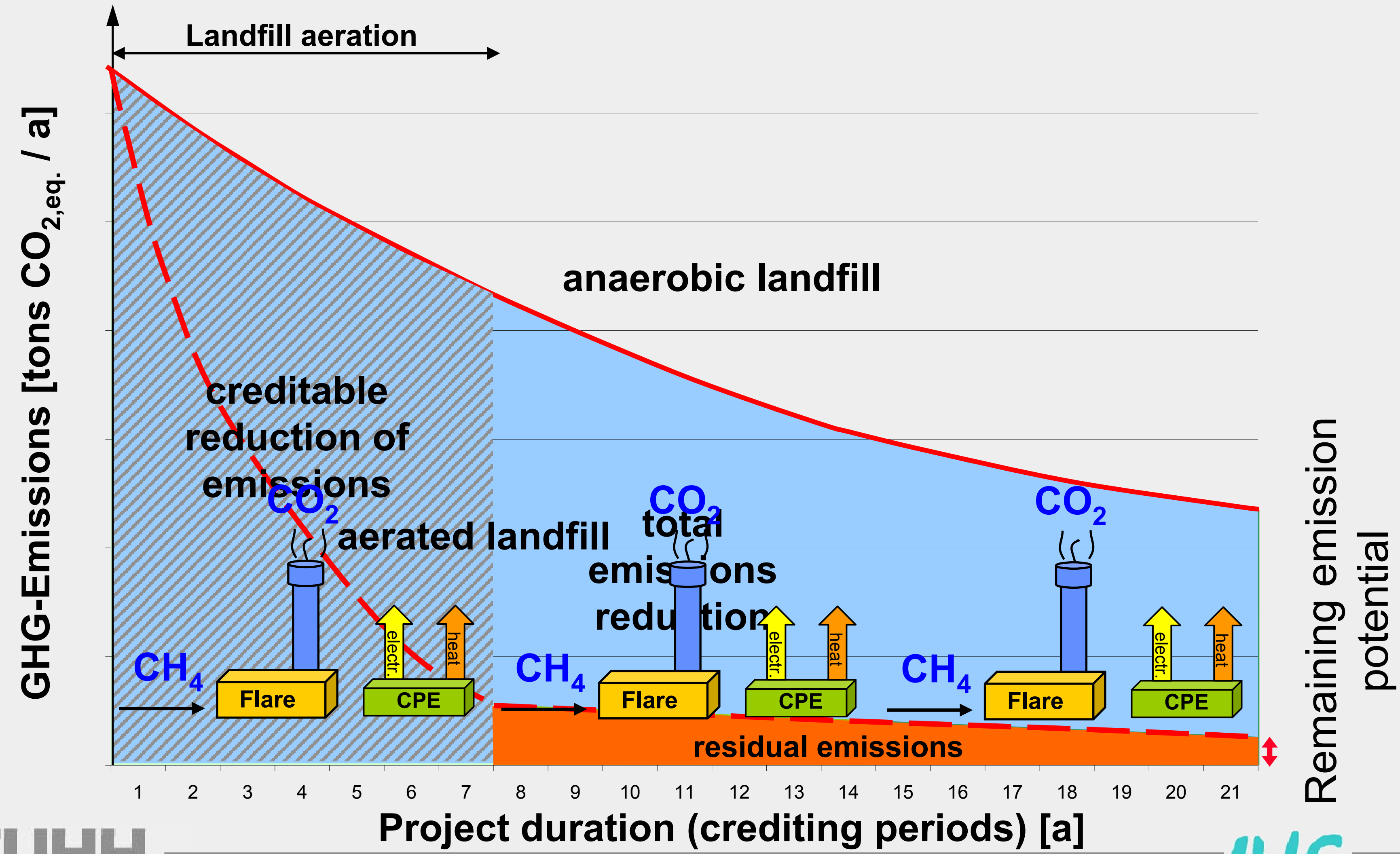


Emission reductions (anaerobic and aerobic landfills)

Landfill / example	Annual ER (per ton TS) [kg $CO_{2,e}$ / Mg TS*a]	Annual ER (per project) [Mg $CO_{2,e}$ / a]	Crediting period [a]
Anaerobic landfills (CDM LFG-projects*, according to PDD's)	10 – 100	180.000	7 (21) or 10
Aerobic landfill (planned CDM project in Israel, according to PDD)	30	20,000	7
Aerobic landfill (example from Germany)	30	4,750	6
Aerobic landfills 1 million tons MSW (non Annex I countries)	40 – 70	42,000 – 68,000	7
Semi aerobic landfill (planned CDM project in Malaysia, according to PDD)	~ 15	43,000	8

*** as per 09/2010; projects based on ACM0001 and AMS-III.G; UNFCCC/CDM**

LF Aeration and Climate Protection
- Reduction of GHG emissions -



Landfill aeration
- Critical remarks -

General:

- Uncertainty regarding the actual amount of N_2O emissions
- Risks related to increased temperatures during aeration
- Emission reductions potentially limited without RTO integration
- Creditable reduction of emissions is limited

Air venting:

- Aeration is secondary effect; at first increase in the amount of captured biogas (i.e. increase in CH_4 emissions)

Semi-aerobic concept:

- Emission reductions probably limited (CH_4 flux, not concentration !)
- Discontinuous measurement of PE might be critical

Costs vs. Benefits

Costs:

- **Very rarely in literature**
- **For low pressure aeration:**

  D:

  approx. 1 to 3€ per m³ of landfilled waste*

  A:

  approx. 2 to 5€ per m³ of landfilled waste*

Benefits:

- **Reducing CH_4 emissions from landfills**
- **Reducing the duration of LF-aftercare – reducing the costs for LF-aftercare**
- **Improving the quality of leachate – reducing the costs for leachate treatment**
- **Enhanced environmental conditions**

* depending on various factors such as existing infrastructure and landfill volume

Thank you very much for your atention!