

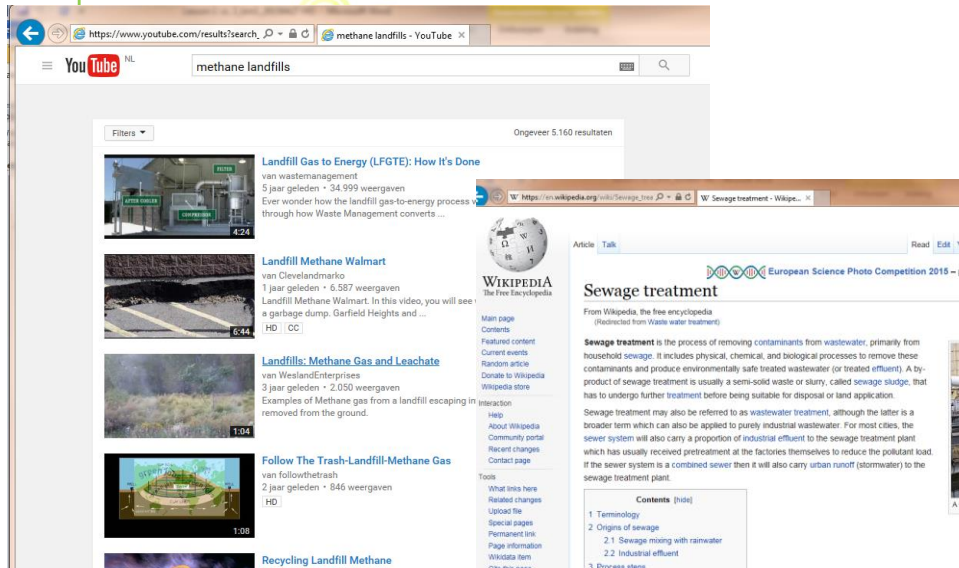
GHG-emissions from waste

Why emissions ...
and how to quantify them

What causes GHG-emissions

	<i>Waste Sector Category</i>			
Processes producing emissions	Solid waste disposal	Biological treatment	Waste incineration	Wastewater handling
Methanogenesis	CH ₄	CH ₄	-	CH ₄
Nitrification and Denitrification	-	N ₂ O	-	N ₂ O
Combustion	-	-	CH ₄ , N ₂ O, CO ₂	-
Aerobic decomposition	CO ₂	CO ₂	-	CO ₂

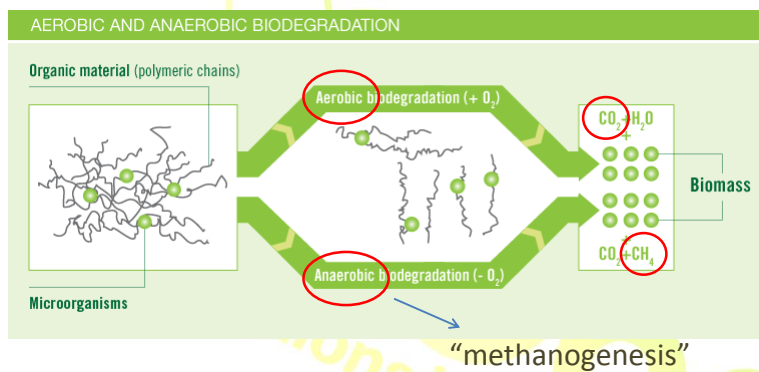
Check the web!!!



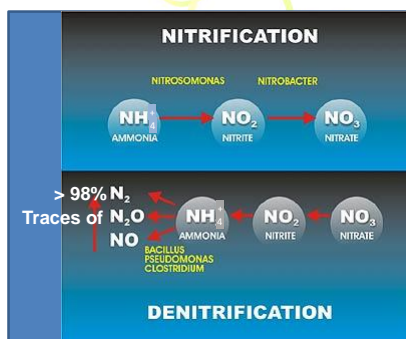
Carbon-Cycle and CO₂

- Youtube
www.youtube.com/watch?v=2Jp1D1dzxj8
- So it is about disturbing the carbon cycle
- Biogenic CO₂ is part of the carbon cycle
 - Biological CO₂ does *not* count
 - It's about **FOSSIL** CO₂

Methane generation



Nitrification - denitrification



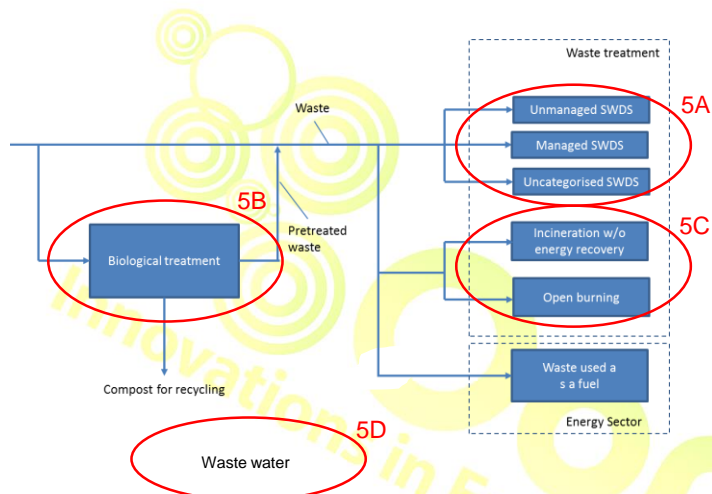
First ...

Aerobic

And then ..

Anaerobic

How to quantify



Biological treatment

- Composting
 - Aerobic conversion of biological waste



Biological treatment

- Composting
 - Aerobic conversion
 - CO₂ is main product
 - Not counted since it is of biogenic origin
 - Nitrification biological N to NO₃⁻
 - Not well aerated pockets
 - CH₄ -generation
 - N₂O due to denitrification
- Emission = Activity * EF



Biological treatment

- Anaerobic digestion:
 - www.youtube.com/watch?v=TXXfLwvjO5k
 - Methane is primary product, but captured and utilised
 - Emissions due to leakages
- Emission = Activity * EF
 - Activity is amount of waste biologically treated

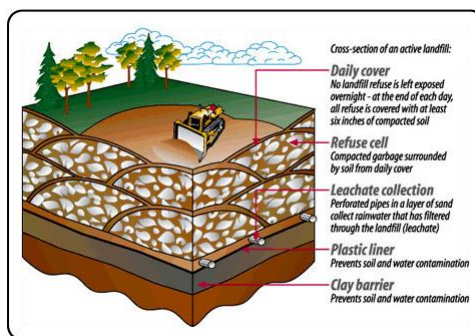


Waste combustion & open burning

- Straightforward:
- Emission = Activity * EF
 - Activity: amount of waste burnt
 - EF CO₂: contains fossil carbon

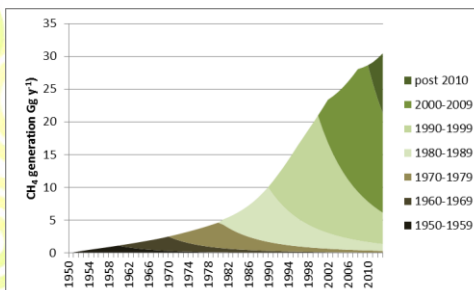
Solid waste disposal

- Anaerobic
 - methane
 - [Youtube](#)
- Management →
 - Prevents oxygen
 - More anaerobic
 - High MCF
 - Methane collection



Solid waste disposal

- Slow methane generation
- Waste history is important

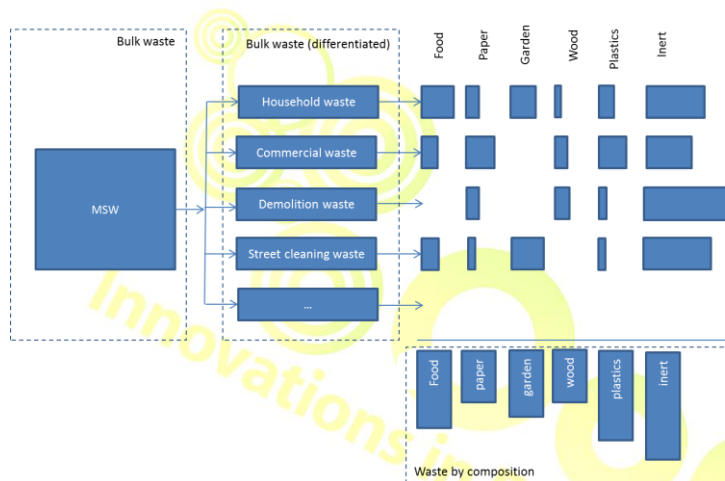


- Emission = Generation – Recovery - Oxidation

IPCC waste model

- Generation is result of
 - Methane potential: W, MCF, DOC (DOC_F, F)
 - Release in time: FOD, k
- Facilitated by IPCC model
 - Bulk waste: MSW, IW
 - Waste by composition: Food, garden, paper, wood

IPCC Waste model



Waste water treatment and discharge

- Different treatment/discharge pathways

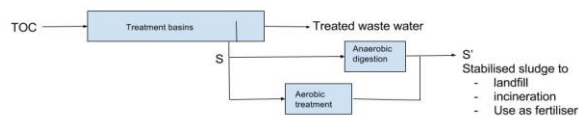


WWT&D

- Uncontrolled anaerobic
 - Partially CH_4
- Controlled aerobic
 - Limited methane (only in anaerobic pockets)
 - Nitrification/denitrification $\rightarrow \text{N}_2\text{O}$
- Controlled anaerobic
 - CH_4 but collected

Waste water treatment

- www.youtube.com/watch?v=Ldz29NqwK78



- All CH_4 and N_2O on-site WWTP
 - Water
 - Sludge pretreatment on-site

WWT&D

- Emission per pathway: activity * EF
 - Activity = TOW = f (P, BOD, I)
 - EF = BO * MCF
- WWTP
 - Default: Water and sludge combined
 - Emission = (TOW) * EF₁
 - Better: Water and sludge separately
 - Emission = (TOW-S) * EF₁
 - Emission = S * EF_{2-R}

WWT&D

- Industrial WW; CH₄ = activity * EF (-R)
 - Activity: TOW (per ton product)
- N₂O = activity * EF
 - Activity (P, Protein, F_{pr}, ad-ons)