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Landfill gas utilization for energy to avoid greenhouse gas emissions

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Landfill gas (LFG) in brief

- LFG generates in landfills when biodegradable waste degrades anaerobically
- LFG contains mainly carbon dioxide (CO₂) and methane (CH₄). Typical CH₄ concentration is 45 -55 %
- The CO₂ from LFG is generally considered as GHG-neutral due to its biogenic origin
- Globally, landfills cause approx. 750 Mt_{CO₂-eq} of GHG emissions in 2005 (EPA 2006)
- The GWP impact of CH₄ is 25 times higher than the GWP impact of CO₂
- The LFG has to be collected and treated, or if possible, it has to be utilized (EU Directive 1999/31/EC)

Scenario-based study on LFG utilization

- This scenario-based study has two objectives:
 - To find out which utilization option can achieve the highest GHG emissions reduction.
 - To find out how the assumed values can affect the result of the estimation of the avoided GHG emissions.
- LFG utilization can substitute for electricity or district heat production by fossil fuels or fossil fuel mix
-> avoided GHG emission
- In this study, the functional unit was 1 000 000 m³/yr of LFG

Result 1: LFG utilization in electricity production

- If LFG is utilized in microturbine, utilization can produce 5.7 MJ of electricity
- If utilization substitutes marginal electricity production, the estimated amount of avoided GHG emission is 1440 t_{CO2-eq}/yr
- If utilization substitutes average electricity production, the estimated amount of avoided GHG emission is 320 t_{CO2-eq}/yr
- The electricity can be distributed to via the Nordic power grid and can be sold to some Nordic countries. The electricity markets are on-line markets and the power generation distribution can vary widely. Thus, the power generation structure is usually difficult to define.

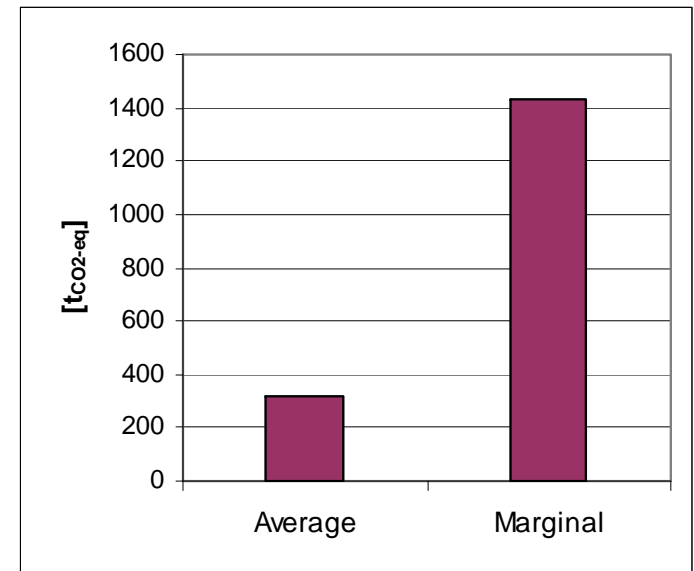


Figure 1. Estimated GHG emissions which can be avoided due to LFG utilization in power production

Result 2: LFG utilization in district heat production

- If LFG is utilized for district heating, it can produce 17.8 MJ of district heat
- The estimated amount of avoided GHG emissions are:
 - 1160 t_{CO₂-eq}/yr, if utilization substitutes for district heat production by average heat generation
 - 1820 t_{CO₂-eq}/yr, if utilization substitutes for district heat production by coal
 - 1500 t_{CO₂-eq}/yr, if utilization substitutes for district heat production by oil
 - 1050 t_{CO₂-eq}/yr, if utilization substitutes for district heat production by natural gas
- The district heat is typically distributed via local network, thus, the district heat generation structure is usually known.

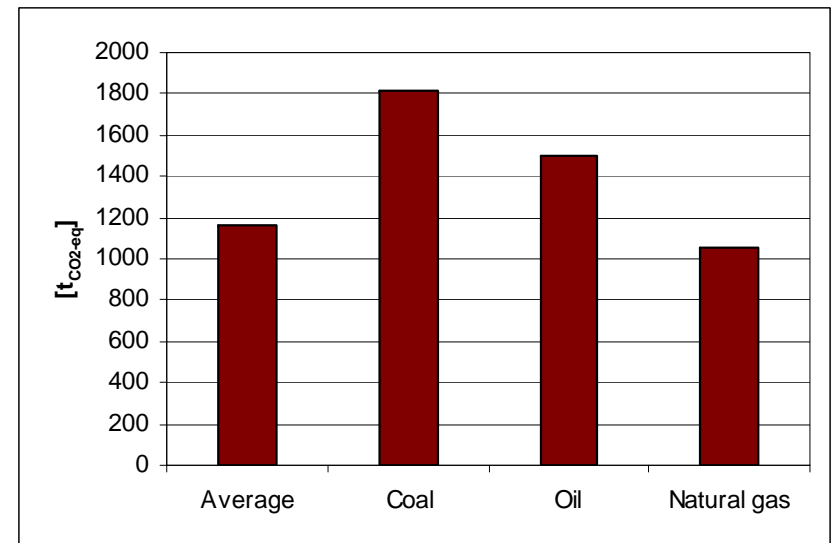


Figure 2. Estimated GHG emissions which can be avoided due to LFG utilization in district heat production

Summary

- The results shows that the highest amount of avoided GHG emissions of $1820 \text{ t}_{\text{CO}_2\text{-eq}}/\text{yr}$ can be reached if LFG is utilized as substitute to coal for district heat generation.
- Collection and selection of the data for estimation is very important because it has strong effect on the result
 - It is recommended that assumptions and definitions be done carefully and case data be used specifically.