ROYAL HASKONING

consultants architecten ingenieurs

Dramatic reduction in emissions of methane from landfills in the Netherlands

June 2009

Reduction of methane from Dutch landfills

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- Introduction
- Methane emissions from Dutch landfills
- Basic assumptions
- Additional measures
- Feasibility of potential measures
- Conclusions

Introduction

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SenterNovem NCGG5

Assignment:

Senter Novem

Reduction Programme non-CO_2 greenhouse gases

(Reductieplan niet-CO_2 broeikasgassen or ROB)

Introduction

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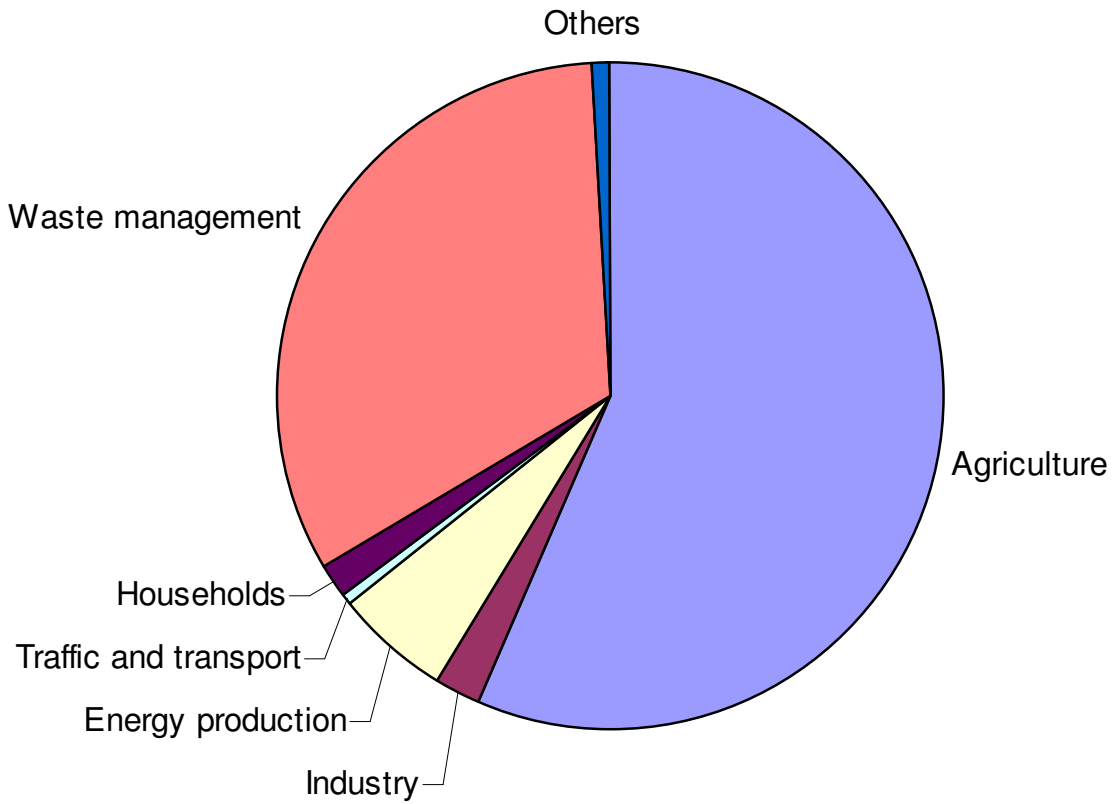
- Methane emissions from landfills in the Netherlands
  - 1990: 6% of total greenhouse gas emissions
  - 2007: 3% of total greenhouse gas emissions

Introduction

- Methane sources in the Netherlands (2007)



Reduction of methane from landfills

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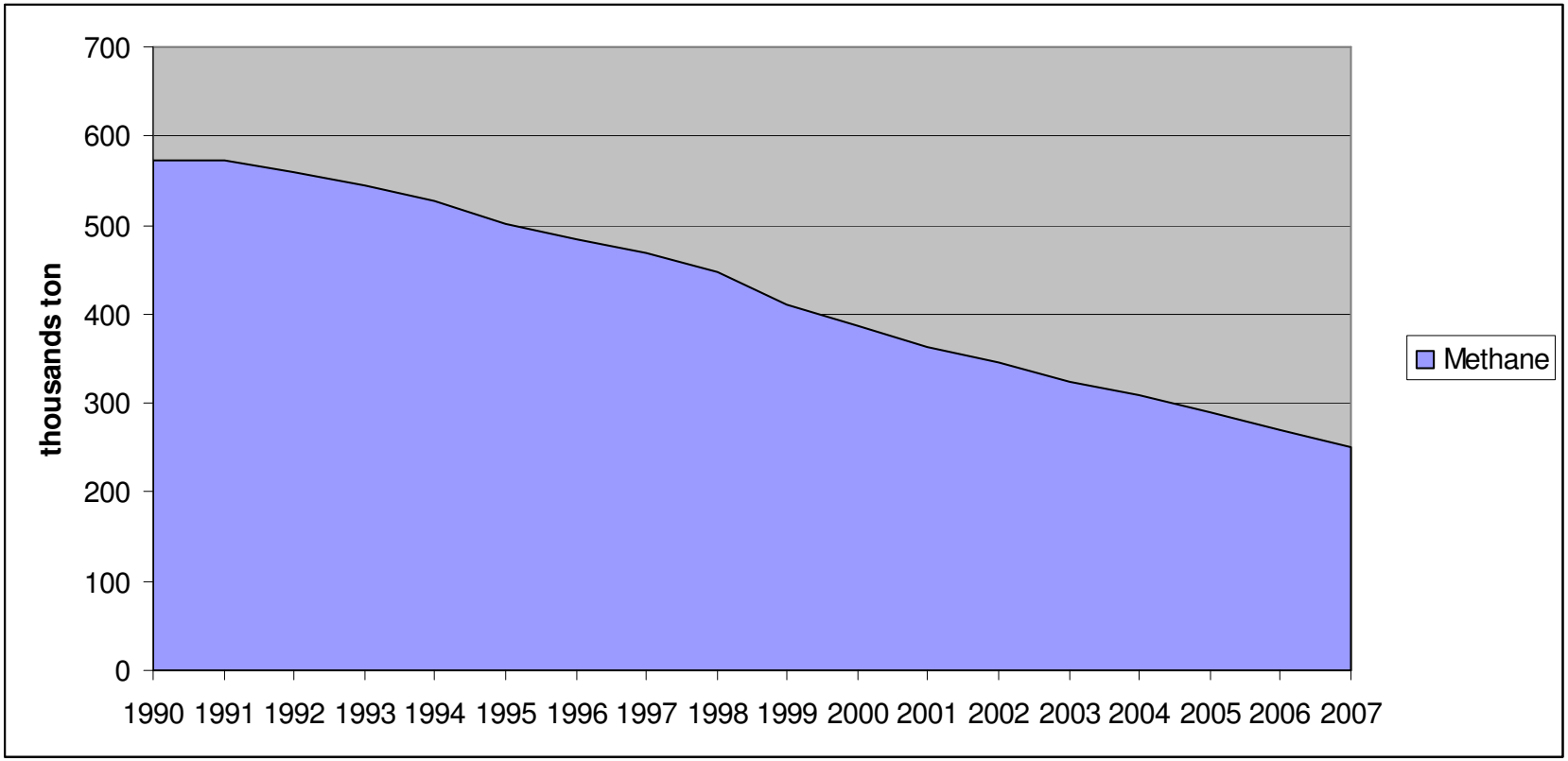
- 572 kton methane in 1990
- 243 kton methane in 2007



Reduction of methane from landfills

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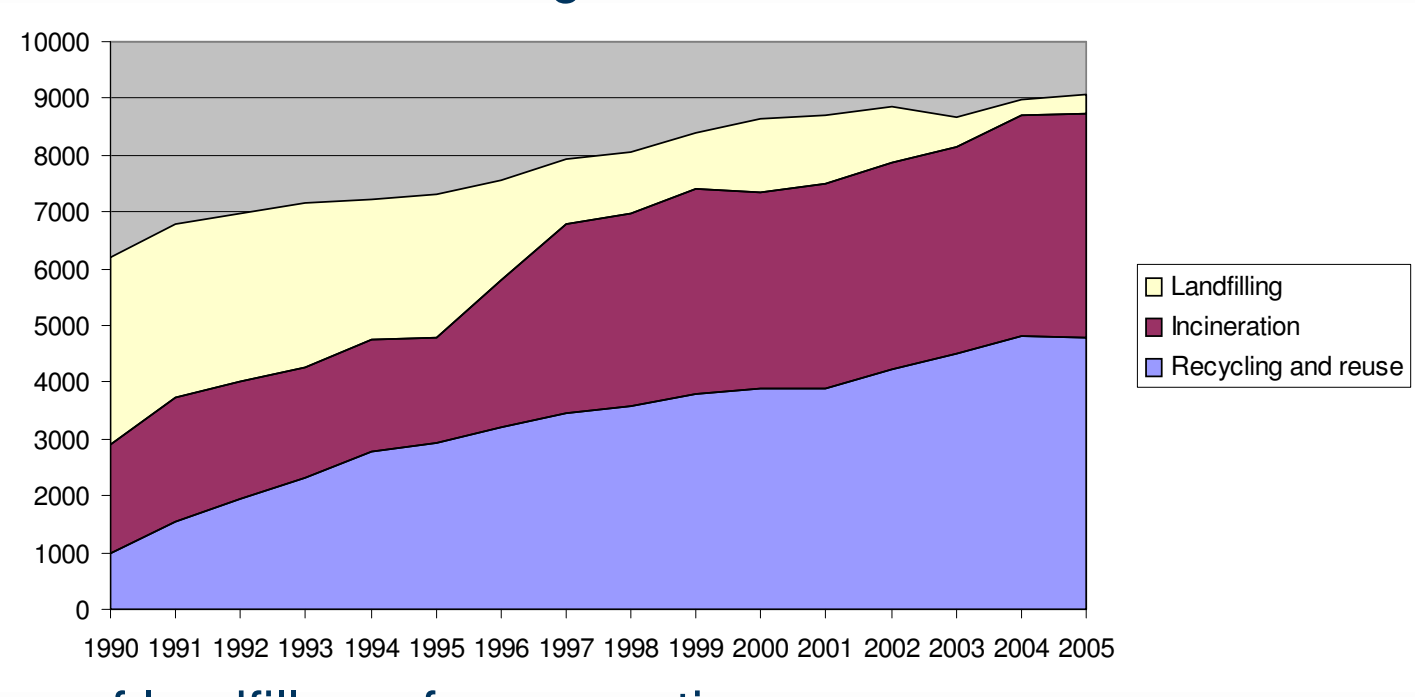
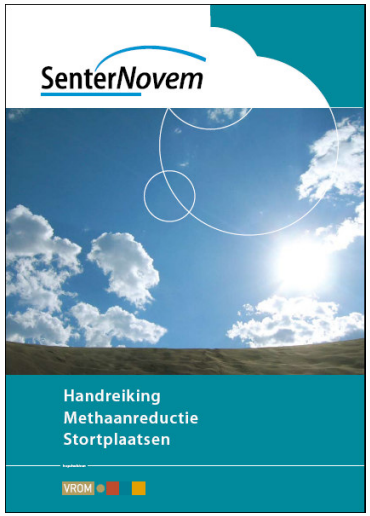
- Less waste disposal
- Separate collection of biodegradable waste



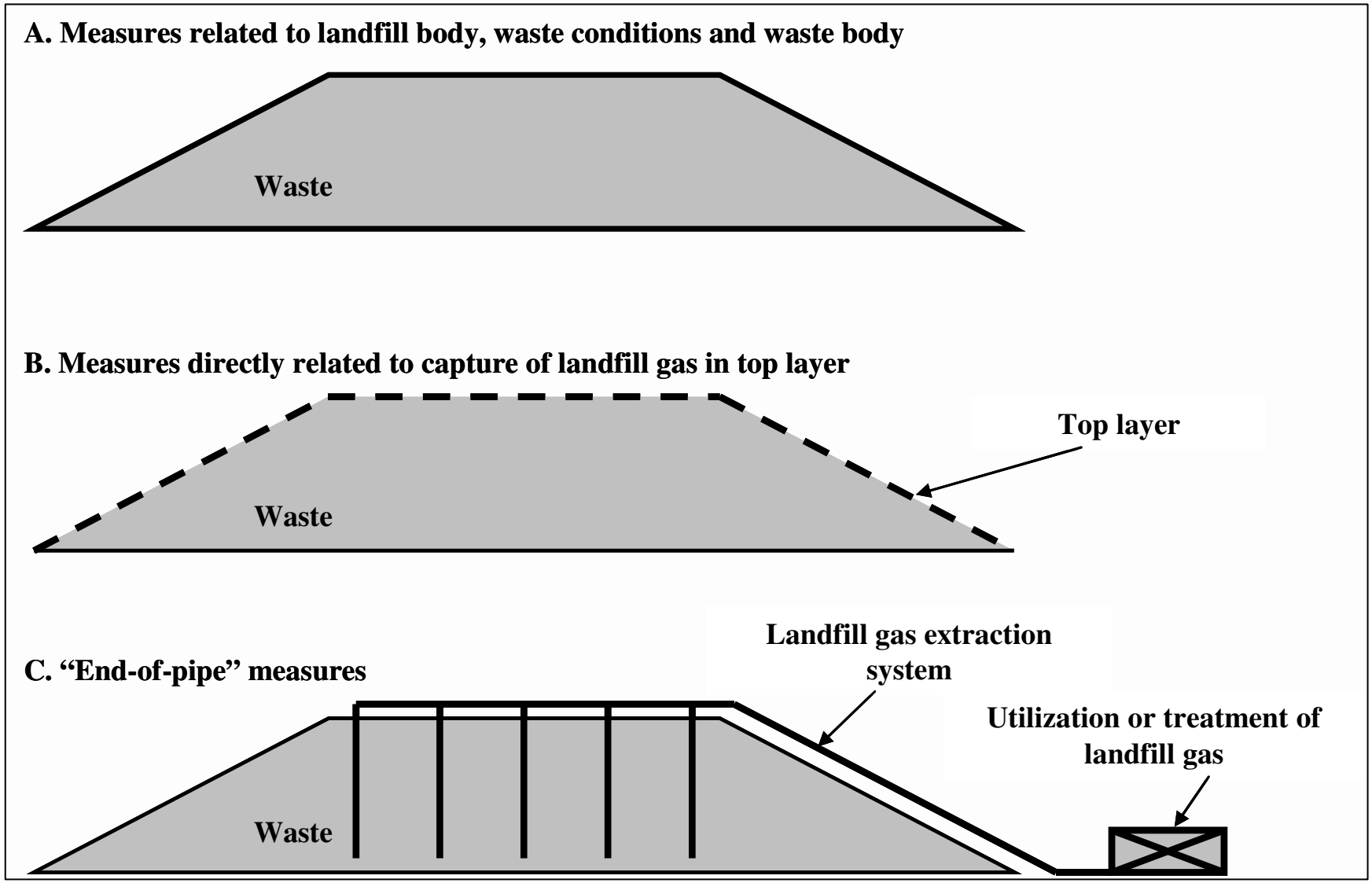
- The use of landfill gas for generating power
- Flaring of landfill gas

Basic assumptions

- Landfills in the Netherlands
  - Former landfills
    - approximately 4000
  - Medium size landfills
    - closed before 1-9-1996
    - organic household waste
    - approximately 30
  - Landfills in use
    - approximately 50
    - guidelines (BAT)
      - landfill gas collection
      - landfill gas utilization



Additional measures (types)



Additional measures

A Landfill body and waste

A1 shift waste to a sanitary landfill
A2 Waste mining
A3 Anaerobic bioreactor landfill.
A4 Aerobic bioreactor
A5 Adjusting waste body shape
A6 Waste pretreatment
A7 Waste management

B Landfill gas capture

B1 Methane oxidation in top layer
B2 Early sealing of landfill
B3 Aeration of top layer

Additional measures

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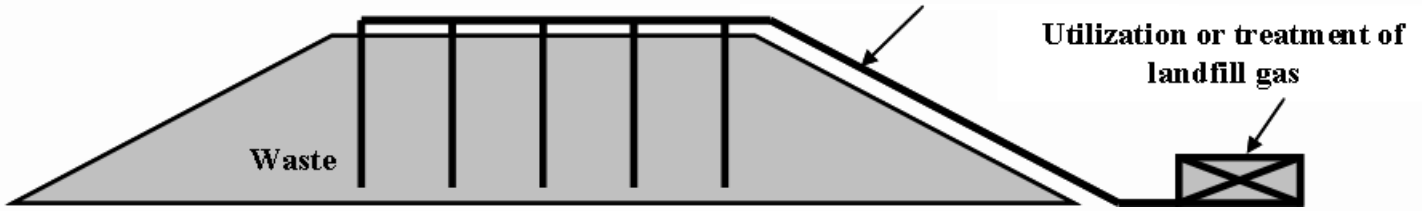
C End of pipe techniques

- C1 Installment of additional extraction wells
- C2.1 Flaring of low-calorific landfill gas (30% to 45% CH4)
- C2.2 Flaring of low-calorific landfill gas (15% to 30% CH4)
- C2.3 Flaring of low-calorific landfill gas (8% to 15% CH4)
- C.2.4. Collection and flaring of landfill gas without the use of compressor
- C3 Gas utilization by ORC (Organic Ranking Cycle)
- C4 RTO (regenerative thermal oxidation)
- C5 Separate extraction and treatment of high-calorific and low-calorific landfill gas
- C6 Discontinuous landfill gas extraction
- C7 Optimization of existing landfill gas extraction systems



Additional measures

Most promising
(after multi criteria analysis)

C2.1 Flaring of low-calorific landfill gas (30% to 45% CH4)

C1 Installment of additional extraction wells

B2 Early sealing of landfill

C7 Optimization of existing extraction systems

Feasibility of potential measures

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- Former landfill types (assumptions)

Scenario	Operation Period	Area (hectare)	Waste amount (m3 per year)
1 Very old landfill	1950 – 1960	2	4000
2 Small old landfill	1975 – 1980	2	8000
3 Large old landfill	1970 – 1985	10	54000
4 Small landfill	1990 – 1995	2	12000
5 Large landfill	1985 – 1995	15	150000

- Landfills in use

Feasibility of potential measures

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- Revenues and feasibility at former landfills

Scenario	Operation period	Revenues period 2009 – 2020 (Euro)	Conclusions (summary)
1 Very old landfill	1950 1960	2,500	• Revenues do not cover costs of measures
2 Small old landfill	1975 1980	23,000	• Revenues do not cover costs of measures
3 Large old landfill	1970 1985	500,000	• Revenues are calculated for 100% utilization of methane. • In practice a maximum of 70% is realistic. Then revenues will not cover costs of measures (over a period of 12 years).
4 Small landfill	1990 1995	156,000	• Revenues do not cover costs of measures
5 Large landfill	1985 1995	3,132,000	• Flaring of low-calorific landfill gas and increasing the amount of gas wells might be cost effective. • Early sealing of landfill specific for landfill gas capture is not viable. • A site specific business case shall give further insight in potential measures.

Feasibility of potential measures

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- Landfills in use
  - Have to fulfil guidelines
  - Best Available Technology
  - Additional measures have minor impact on methane emissions in the Netherlands
  - Quick win: Optimization of existing landfill gas extraction systems

Conclusions

- Significant reduction of methane emission from landfills since 1990
- Additional measures in general not cost effective
- Low-calorific gas flares most promising
- Several potential measures are expected to be feasible at large former landfills
- Quick wins at landfills in use, by optimization of the extraction system

Contact

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Thank you for your attention!