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Bert Wikkerink, 8 June 2006

kiwa
Partner for progress

Improvement in the determination of methane emissions from gas distribution in the Netherlands

Determination of methane emissions

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Determination of methane emissions

Introduction

- **Methane is the second most serious greenhouse gas:**
  - global warming
  - climate change
- **The Nederlands report to the EU and the UN Climate Secretariat**
- **Kyoto Protocol: EU-15 countries have a collective target to reduce the emissions of greenhouse gases in the period between 1990 to 2008/2012 by 8 % on average**
- **Government strived to improve the method of quantification of methane emissions**

Determination of methane emissions

- **Conventional approach: Tier 1**
  - **Quantification of total emission conforming to a Tier 1 method:**

    E = Q * Ef (m³ methane/year)

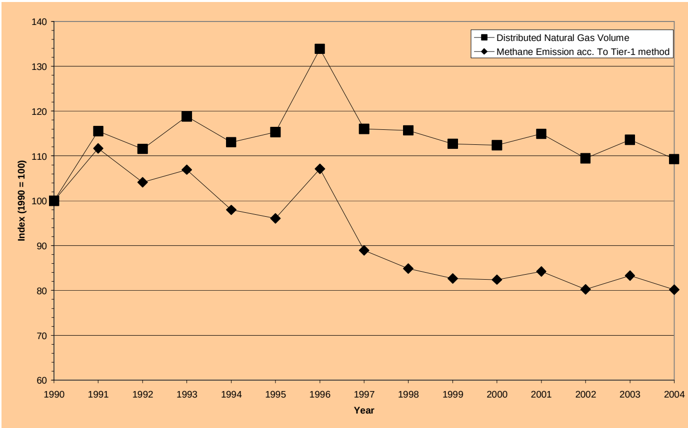
    E= total quantity of methane emissions

    Q= distributed quantity of natural gas in the Nederlands

    Ef= emissionfactor, based on an emission rate of 0,44–0,60 % of the distributed volume of natural gas
  - **Result for the year 2004: 100 * 10^6 m^3 methane**
  - **Consequence: Gas distribution is a key source category in the yearly national greenhouse gas emission inventory in the Netherlands**

Determination of methane emissions

- **Conventional approach: Tier 1**



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Determination of methane emissions

- **Reasons for change of method**
  - **For key source categories it is recommended to use a Tier 3 method**
  - **Tier 1 methods:**
    - are far less accurate
    - are more insecure
    - may include biases
  - **It is in principle incorrect to relate the amount of methane emissions to the distributed volume**
  - **The Tier 1 method is not source-specific (emission due to leakages)**

Determination of methane emissions

- **Ideal approach: Tier 3**
  - **Rigorous source specific approach for the total gas distribution system**
  - **A gas distribution system consists of:**
    - mains supply
    - service lines
    - stations
  - **Assumptions:**
    - service lines: taken into account in mains supply
    - city gate stations: part of the gas transport system
    - distribution stations: not taken into account due to lack of reliable data

Determination of methane emissions

- **Ideal approach: Tier 3**
  - **Total amount of methane emitted per unit of pipe length per year per type of pipeline (material and pressure)**
  - **Activity data is the length of the gas grid**
  - **Use self acquired data**
  - **The emission factor for the Tier 3 method is dependent on the grid length, the leakage amount and leakage frequency**

Determination of methane emissions

- **Ideal approach: Tier 3**
  - **emission factor:**
    EF = 8.76 * R * N * F * (J + j)/2 **[m³ CH4/km/year]**
  - **total emission of methane:**
    E = EF * K **[m3 CH4/year]**
  - **with:**
    - ***8.76*** = factor (hours to year/1000) [hour/year]
    - ***R*** = leakage per leak [litre/hour]
    - ***N*** = number of leaks per kilometre per year [#/km year]
    - ***F*** = percentage methane in natural gas (80%) [vol.%]
    - ***J*** = leakage survey interval (standard every 5 year) [year]
    - ***j*** = time between identifying leakage indication and repair of leak (assumption 0.5 year) [year]
    - ***K*** = amount of kilometres mains supply [km]

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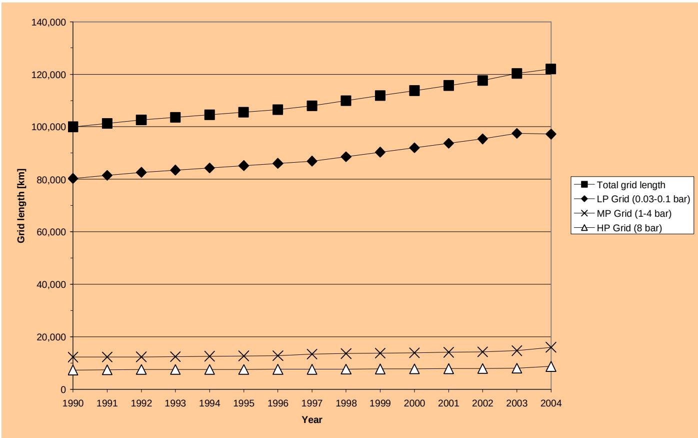
Determination of methane emissions

Data collection: Grid length (2004)

Material	Pressure Range [bar]	Length in 2004 [km]	Percentage of total [%]
Polyethylene	0.03 – 0.1	9,560	7.8
PVC - Unmodified	0.03 – 0.1	22,636	18.6
PVC - High Impact	0.03 – 0.1	48,648	39.9
Steel	0.03 – 0.1	5,592	4.6
Grey Cast Iron	0.03 – 0.1	7,184	5.9
Ductile Cast Iron	0.03 – 0.1	1,502	1.2
Asbestos Cement	0.03 – 0.1	1,828	1.5
Unknown	0.03 – 0.1	280	0.2
Polyethylene	1.0 – 4.0	7,219	5.9
Steel	1.0 – 4.0	975	0.8
Grey Cast Iron	1.0 – 4.0	184	0.2
Ductile Cast Iron	1.0 – 4.0	331	0.3
Unknown	1.0 – 4.0	16	0.0
Polyethylene	8.0	2,049	1.7
Steel	8.0	13,037	10.7
Ductile Cast Iron	8.0	630	0.5
Unknown	8.0	17	0.0
Unknown	Unknown	283	0.2
Total		**121,971**	**100.0**

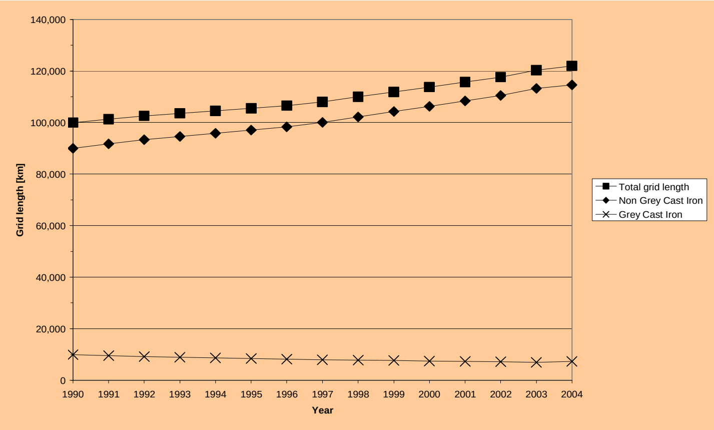
Determination of methane emissions

Data collection: Grid length (2004)



Determination of methane emissions

Data collection: Grid length (2004)



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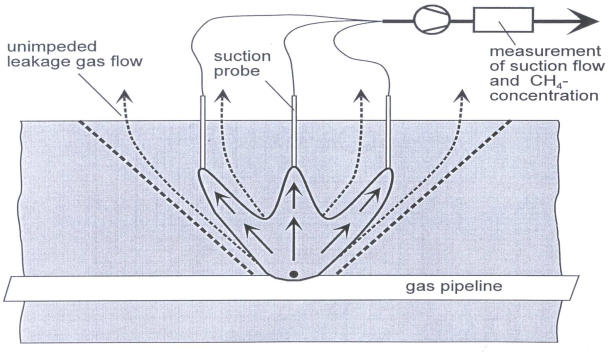
Determination of methane emissions

Data collection: number of leaks per grid length (2004)

Material	Pressure Range [bar]	Number of leakages per length of mains supply per year [#/km year]
Polyethylene	0.03 – 0.1	0.06
PVC - Unmodified	0.03 – 0.1	0.04
PVC - High Impact	0.03 – 0.1	0.02
Steel	0.03 – 0.1	0.13
Grey Cast Iron	0.03 – 0.1	0.29
Ductile Cast Iron	0.03 – 0.1	0.11
Asbestos Cement	0.03 – 0.1	0.09
Unknown	0.03 – 0.1	0.13*
Polyethylene	1.0 – 4.0	0.02
Steel	1.0 – 4.0	0.02
Grey Cast Iron	1.0 – 4.0	0.16
Ductile Cast Iron	1.0 – 4.0	0.13
Unknown	1.0 – 4.0	0.63*
Polyethylene	8.0	0.17
Steel	8.0	0.02
Ductile Cast Iron	8.0	0
Unknown	8.0	1.80*
Unknown	Unknown	0*

Determination of methane emissions

■ Data collection: leakage rate



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Determination of methane emissions

- **Data collection: leakage rate**

- **Measurement Amsterdam (2005) carried out by EEM**

Determination of methane emissions

Data collection: leakage rate

Material	Average	(Min-Max)	No. of locations
	[litres nat.gas/hour]		
PVC (Unmodified and High Impact) – low pressure	180	(1.6-580)	5
Grey cast iron – low pressure	110	(4.6-350)	7
Steel – low pressure	20	(11-32)	3
Ductile cast iron – low pressure	160	(96-231)	3
PE – medium pressure	270	(22-690)	3
Steel – high pressure	170	(55-461)	4

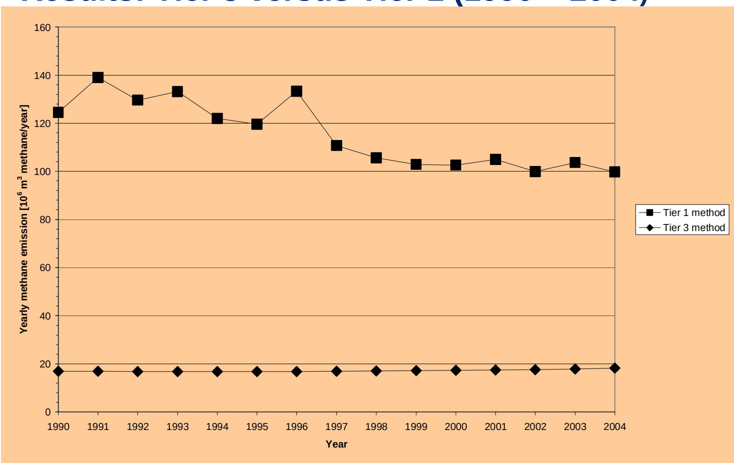
Determination of methane emissions

Results

Material	Pressure Range [bar]	Length in 2004 [km]	Number of leakages per length per year [#/km year]	Leakage rate [litre/hour]	Emission factor [m^3 CH_4/km year]	Emission [10^6 m^3 CH_4/ year]
Polyethylene (PE)	0.03 – 0.1	9,560	0.06	180	210	2.0
PVC - Unmodified	0.03 – 0.1	22,636	0.04	180	140	3.1
PVC - High Impact	0.03 – 0.1	48,648	0.02	180	70	3.6
Steel	0.03 – 0.1	5,592	0.13	20	50	0.3
Grey Cast Iron	0.03 – 0.1	7,184	0.29	110	620	4.4
Ductile Cast Iron	0.03 – 0.1	1,502	0.11	160	340	0.5
Asbestos Cement (AC)	0.03 – 0.1	1,828	0.09	180	320	0.6
Unknown	0.03 – 0.1	280	0.13	180	440	0.1
Polyethylene (PE)	1.0 – 4.0	7,219	0.02	270	90	0.6
Steel	1.0 – 4.0	975	0.02	170	80	0.1
Grey Cast Iron	1.0 – 4.0	184	0.16	170	540	0.1
Ductile Cast Iron	1.0 – 4.0	331	0.13	170	420	0.1
Unknown	1.0 – 4.0	16	0.63	170	2,050	0
Polyethylene (PE)	8.0	2,049	0.17	270	880	1.8
Steel	8.0	13,037	0.02	170	60	0.8
Ductile Cast Iron	8.0	630	0	170	10	0
Unknown	8.0	17	1.80	170	5,900	0.1
Unknown	Unknown	283	0	170	0	0
Total		**121,971**				**18.3**

Determination of methane emissions

Results: Tier 3 versus Tier 1 (1990 – 2004)



Determination of methane emissions

- **Conclusions**
  - **Decrease of the total methane emissions from gas distribution with a factor 5 to 8 by:**
    - change from a Tier 1 into a Tier 3 method
    - improvement in the quality of the data
  - **Change into a Tier 3 method resulted in a substantial improvement in the quality and the accuracy of the emissions estimate**
  - **The total amount of emission will increase slightly in the next years, due to the increases in distribution grid length, despite the continued replacement of grey cast iron**
  - **In the coming years the quality and reliability of data will improve further as more leakage rate data will become available**
  - **This changed approach is incorporated into the reporting protocol of the Dutch authorities**

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