marcogaz
TECHNICAL ASSOCIATION
OF THE EUROPEAN NATURAL GAS INDUSTRY

WG-ME-17-09

SURVEY METHANE EMISSIONS FOR GAS TRANSMISSION IN EUROPE

Update 2017

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1. SUMMARY

The impact of Greenhouse Gases on climate change has been recognized for some time which has led to measures aimed to reduce global warming. Methane (CH_4) which is the major component of Natural Gas is identified as a Greenhouse Gas.

As Natural Gas is a major source of energy for the society, it is the role of the gas network operators to deliver continuous and safe service whilst managing responsibly impact on the environment.

MARCOGAZ, the Technical Association of the European Gas Industry, considers that it is important for the Gas Industry to understand and quantify its emissions of Natural Gas. It is also important to be transparent about the methodology used to calculate emissions and to demonstrate that best practices are used across the European Gas Industry.

This study is an update of the 2014 study (based on a 2009-2013 dataset). A new set of data from 2015, more relevant and more accurate, has been used for that update. Together with the MARCOGAZ reports for distribution-grids, underground storage and LNG terminals, this report aims at estimating the total methane emission along the so called mid-stream sector of natural gas.

The total amount of methane emitted in Europe[1] from the Natural Gas transmission was estimated by MARCOGAZ reusing and enhancing the statistical methods used in 2014 report.

The representative dataset of 2015 is representing 47% of the European network pipeline length and its quality has been highly improved compared to the 2009-2013 dataset. It is reasonably assessed as globally representative of the European Transmission Network, being statistically and obviously consistent.

Nevertheless, MARCOGAZ continues through its Working Group Methane Emissions to investigate better methods to measure and estimate methane emissions from the gas supply chain.

Based on that study the average emission per year on the European transmission pipeline network is of: **568 kg CH_4/km** [2]

In the 2014 report, the European transmission network emission had to be maximized at 229.135 T CH_4 with the 2009-2013 dataset, thanks to the enhancement of the data completeness and quality, it is now possible to consider an estimation based on the average emissions declared in the 2015 dataset, representative of the network.

- ✓ The total calculated amount of methane emissions from European (EU28) transmission grid is in the range of **133 kT CH_4**

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[1] That calculation was based on MARCOGAZ members only, please consider that 93% of the EU28 pipeline is owned by MARCOGAZ members.

[2] at a country level, not all the gas transported in the network at a moment in time will be sold in that particular country, and the amount of methane emissions are not only depending on the gas flow

- ✓ On that base, the methane emissions from transmission grids (EU28), expressed in CO_2 equivalent, are estimated per year at **3.724 kT CO_2eq** [3]
- ✓ Considering these figures, based on global European gas sales[4] the transmission network losses are calculated to be in the range of **0,05%**.
- ✓ The total amount of GHG emissions caused by the methane emissions from Natural Gas transmission grids is estimated to be **0,08%** of the total of anthropogenic[5] GHG emission in Europe (EU28)[6].

[3] GWP: Global Warming Potential; GWP100 of CH4 (= 28) is used according to the Fifth Assessment Report (AR5) - IPCC.

[4] Source: EU28 inland gas sales: EUROGAS Statistical report 2015

[5] Anthropogenic emissions: emissions originating in human activity

[6] Approximated European Union greenhouse gas inventory: Proxy GHG emission estimates for 2015, EEA report No 23/2016, page 76

2. INTRODUCTION

In the past ten years an increasing number of reports from reputable institutions have highlighted the environmental impact of global warming and the accelerating effect that the continued release of Greenhouse Gases to atmosphere is having on this phenomenon.
This changing attitude of governments, regulatory bodies and the general public has resulted in increasing attention being paid to the methane releases from the gas networks across Europe.

Significant literature has been published which proposes various methods of estimation. This is further complicated by the differences in the different Countries.

MARCOGAZ developed and published (2005) a methodology using all existing knowledge available within the group of European gas infrastructure operators.

As Countries have differences in their operating regimes, the common methodology would allow a common approach to the estimation of methane emissions available.

In 2007, a first assessment was made to derive a range for emission factors for gas transmission and distribution. In 2014, this assessment was repeated to look at developments of the emission factor, but also to give an estimate of the total methane emissions from Natural Gas Industry.

The 2014 Survey of methane emission for gas transmission and distribution (WG-ME-14-26_D096), has explored several statistical scenarios, and defined the best option to give an estimate of the total methane emissions from natural gas industry, based on 2009 to 2013 data.

The following study updates the 2014 survey, using a significant set of updated data from 2015

Only Methane emissions from gas transmission network are considered here.

3. LIST OF DEFINITIONS

In order to obtain comparable objective emission calculations or estimations, the use of identical definitions is necessary. For this reason, a number of definitions are given below.

3.1. Emissions: sources of methane

- *Fugitive emissions*: All residual leaks from flanges, pipe equipment's, valves, joints, seals and seal gas systems etc. that are more or less continuous sources.

- *Pneumatic emissions*: All emissions caused by gas operating valves, continuous as well as intermittent emissions.

- *Vented emissions*:
  - *Maintenance vents:* Methane emissions from planned operating conditions where significant volumes of Natural Gas can be released to atmosphere from the gas network for maintenance purposes
  - *Incident vents:* Methane emissions from unplanned events. This will normally be from failures of the system due to third party activity and external factors normally outside of the control of the gas company.
  - *Operation vents:* i.e. starting and stopping of the compressors.

- *Incomplete combustion emissions:* Unburned methane in the exhaust gases from gas turbines, gas engines and combustion facilities and flares.

3.2. Gas system

- *Transmission system*: High-pressure gas transport over long distance including pipelines, compressor stations, metering and regulating stations and a variety of above-ground facilities to support the overall system. Underground gas storage and LNG are excluded. Operating pressure is normally equal or greater than 16 bar.

- *Distribution system*: Medium to low pressure transport including distribution pipelines, service lines and a variety of above-ground facilities to support the overall system. Local transport from transmission system to customer meters. Pressure normally ranges less than 5 bar. But new polyethylene systems up to 10 bar are now developed in some EU countries. Medium pressure: 0,2 – 5 bar. Low pressure: less than 0,2 bar.

Note: The part of the system under 16 bar and above 5 bar can be considered in transmission or distribution, depending on the system boundaries adopted by each company and/or on the techniques used (steel, polyethylene…).

3.3. Emissions measurement methodology

The transmission operators in Europe underline the importance of measuring and reducing methane emissions. They have accumulated extensive knowledge and experience in recent decades around methane emissions quantification and mitigating. They monitor their own emissions and maintain intensive programs to reduce methane emissions.

Monitoring of the emissions are typically done by measurement in case of fugitive emissions. In some cases, the whole population of a specific kind of asset is measured, in other cases the fugitive emissions are calculate from a population sample, depending of course of the size of the asset population. For the measurement of fugitive emissions, the EN15446 measurement method offers an approach to determine emissions from equipment leaks by providing an equation to predict mass emission rate (in kg/hr) as a function of screening value (ppm-mol) for a particular equipment type.
The correlation factors are empirical equations based on field data and were developed for the Synthetic Organic Chemical Manufacturing Industry (SOCMI) and for the petroleum industry. The Air Flow Method (Hi Flow Sampler device – HFS) offers an approach to measure emissions from equipment leaks in specific situation.

Calculation is often performed in case of vented emissions. In this situation the total mass of methane is calculated from the length of the pipeline, the pressure, diameter and the composition of the gas.

For pneumatic emissions, both measurement and estimation are used.

3.4. Geographical boundaries

The estimations for methane for transmissions companies in Europe are based on the list of MARCOGAZ members Countries given in §7.2 (APPENDIX II: List of countries used for extrapolation.).

4. RESULTS

4.1. Data collection

MARCOGAZ started a survey among its Members in September 2016 with the question to fill in the form of the MARCOGAZ method (see 7.1). The form was returned by 12 MARCOGAZ transmission pipeline operators.

Operators were asked to fill in the emissions of the different parts of their installations and to give activity data where available.

The corresponding operators represents about 52% of the length of the European transmission network and to a representative range of networks, in length, complexity and locations.

4.2. Description of the method

The evaluation of total emissions is based on the following equation:

$$\boldsymbol{Methane\ emission} = \sum(\boldsymbol{AF} \times \boldsymbol{EF})$$

Where:

AF = activity factor
EF = emission factor

The **activity factors** are the population of emitting equipment's such as length of pipelines, number and type of valves, number and type of pneumatic devices, or the frequency of emitting events such as number of operating vents

The **emission factors** are defined as the quantity of methane emitted from each emitting source or for each emitting event. Some emissions are known, such as the gas released for operating reasons or for maintenance, some others can be evaluated on the basis of the characteristics of components and their emission factors, the emission from the operation of a pneumatic device. Other emission factors are difficult to measure such as those deriving from fugitive emissions. For fugitive emissions several measurements methods exist.

4.3. Evaluation of the quality of the data set

4.3.1. Datasets 2009, 2013 and 2015

In 2004-2005, 8 companies provided data, most of the companies did not deliver all the data according to the MARCOGAZ format. For the 2009-2013 submission, the situation became better. Although some companies are still not reporting all the data according to the MARCOGAZ methodology, the 2015 data completeness is significantly higher. This is illustrated in the following tables:

Legend:

- Data not provided
- Data provided
- Not applicable

	Company										
Methane emission source	**A**	**B**	**C**	**D**	**E**	**G**	**H**	**I**	**K**	**L**	**M**
pipe maintenance											
pipe pneumatic valves											
pipe fugitive											
pipe incidents											
CS vents starts											
CS vents stops											
CS incidents											
CS combustion											
CS fugitive gas turbines											
CS pneumatic components											
CS maintenance											
RR fugitive											
RR pneumatic											
RR maintenance											
RR combustion											

Table 1: 2009-2013 dataset

	Company											
Methane emission source	**A**	**B**	**C**	**D**	**E**	**G**	**H**	**I**	**N**	**O**	**P**	**Q**
pipe maintenance												
pipe pneumatic valves												
pipe fugitive												
pipe incidents												
CS vents starts												

CS vents stops												
CS incidents												
CS combustion gas turbines												
CS fugitive												
CS pneumatic components												
CS maintenance												
RR fugitive												
RR pneumatic												
RR maintenance												
RR combustion												

Table 2: 2015 dataset

2009-2013: 11 companies, 53% of the emission data fields were declared.

2015: 12 companies, 83% of the emission data fields were declared, this is showing a significative qualitative enhancement of the completeness of the data provided: 30 % more fields have been provided.

We note that 92% of the companies have declared fugitive leaks against 64% in the 2009-2013, which is particularly important when established that fugitive leaks are representing 39% of the declared quantities in 2015.

The plots below are qualitatively showing the consistency of 2015 data compared with 2009-2013 data.

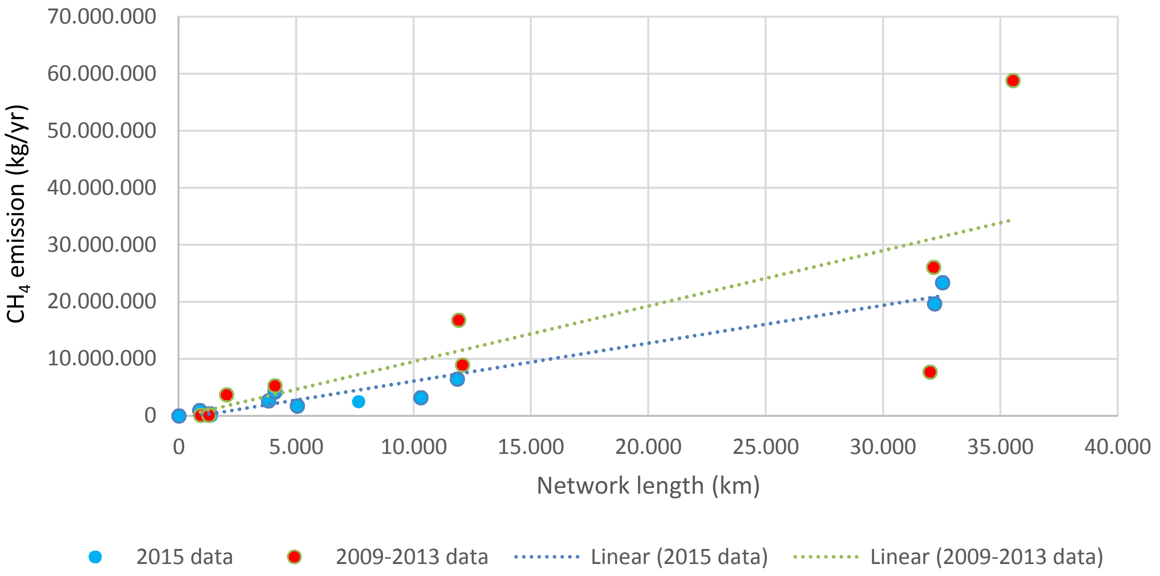

Figure 1: Total CH_4 emissions in kg per TSO for 2009-2013 and 2015 datasets

4.3.2. Scenarios

The analysis has confirmed, with a more complete dataset, the assumption made in 2014 and the total emissions were derived as a first approach from a first order polynomial in which the total methane emission was calculated directly from the total pipeline length. A Second approach has been developed considering 3 different sets of activity and emission factors, related to:

- The pipelines
- The compressor stations
- The regulating and reduction stations.

In the 2014 report 4 scenarios were distinguished, i.e.:

1. **Average emission factor** in which the emission factor is derived as the average factor from polynomial fitting including uncertainty of the coefficients.
2. **Median emission factor** in which the emission factors is calculated as the median emission factor of the sample population.
3. **Worst case emission factor** where the largest emission factors from the sample population is used for the estimation of the methane emission.
4. **Most representative emission factor**, in which the most representative values are used. These are from the companies who delivered complete datasets.

The 4th scenario is finally the more efficient to define representative emission factors and has been re-used as a first approach for that study.

4.3.3. Further Analysis, definition of the most representative dataset

The methodology chosen in 2014 (scenario 4 (see paragraph 4.3.2)) was applied as a first approach.

To comply with that strategy, a representative dataset was selected. To do so, following a preliminary analysis, 2 criteria were defined:

1) a minimal completeness of the data provided (at least 7 fields filed on 15 possible)
2) and a minimal amount of declared fugitive leak of 10% of the declared total. Considering the importance of fugitive leaks in the dataset (39% of the total declared in 2015 and a maximum of 69%)

Applying these criteria, the representative data set is made of companies: **B, C, D, E, G, H, N, O, P, Q**. When considering the length of the networks, these companies are representing 92% of the 2015 declared basis and 47% of the European transmission network.

Considering that the MARCOGAZ data questionnaire is covering 3 main fields of emissions:

- the pipeline,
- the compressor stations,
- and the pressure Reduction and Regulating stations.

A correlation check has been made between the declared amount of CH_4 emitted and, for each company of the representative dataset:

- the pipeline length,
- the compressor stations installed power,
- the number of pressure Reduction and Regulating stations.

Correlations of emitted kg/year of methane		
Pipe length Corr	**MW Comp. Corr**	**N° of RR station Corr**
98%	86%	86%

Table 3: Correlation of representative companies' total methane emissions with diverse factors

The results are considered as excellent.

For information, the same check for the complete 2015 dataset was made and the results are shown in the table here below:

Correlations of emitted kg/year of methane		
Pipe length Corr	**MW Comp. Corr**	**N° of RR station Corr**
98 %	54 %	86 %

Table 4: Correlation of the complete 2015 dataset total methane emissions, with diverse factors

The correlations are globally degraded and down by 30% for compressor stations related data, which confirm the validity of the representative company choice, knowing that in the 2015, data the emissions from the compressor stations represent 30% of the total.

4.4. Emission factors and derived EU28 transmission emissions

4.4.1. First approach

As a first approach, in accordance with the last report and as the correlation showed a very good fit between the pipe length and the declared methane emitted quantities for the representative dataset, a single emission factor related to the pipeline length was used.

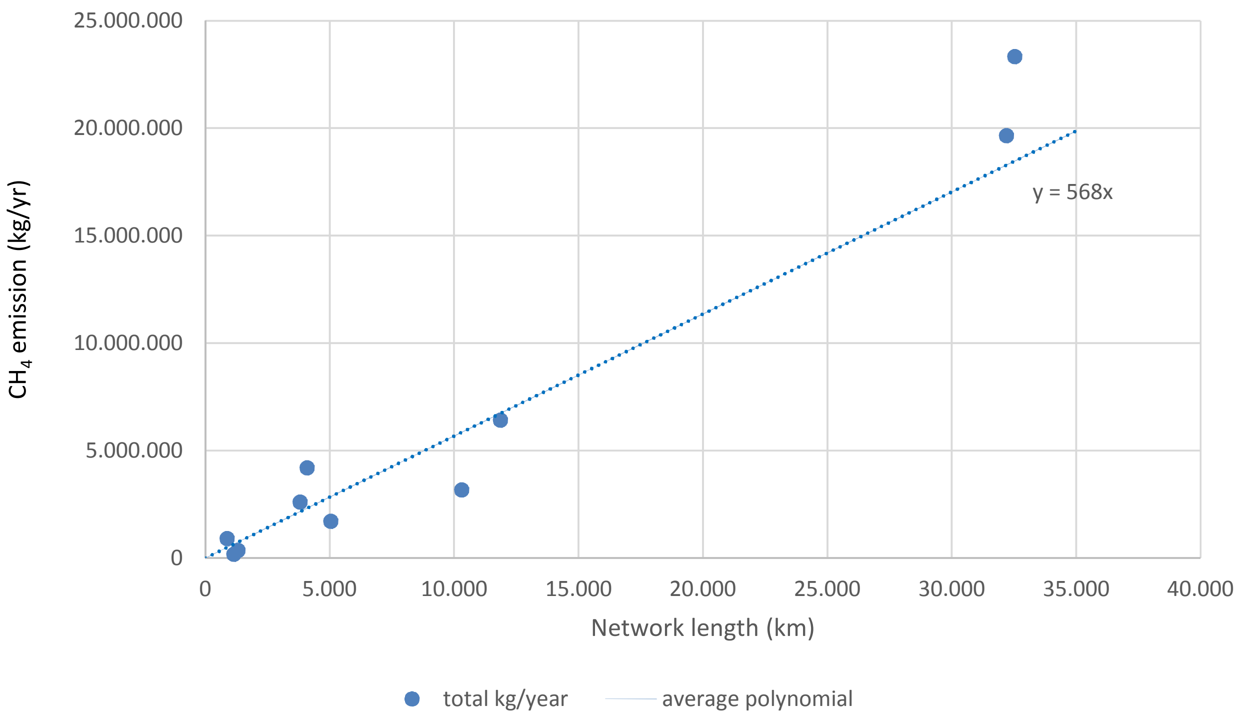

Figure 2: Total CH_4 emissions in kg per TSO of the 2015 representative dataset relative to pipeline length in km and corresponding average polynomial

The average coefficient is defining the emission factor (*EF)*:

EF = 568 kg/km

The corresponding activity factor is AF, the total length of the gas transmission pipeline network in Europe[1] :

AF = 218.355 **km**

Based on that single emission factor, the yearly global CH_4 emissions of the European[2] gas transmission Network according to approach1 ($TOTCH_4\_1$) can be estimated as:

$$\mathbf{TOTCH_4\_1} = 568 \times 218.355 = \mathbf{124{,}3\ kT\ CH_4}$$

or **3.472 $kTCO_2eq$**

4.4.2. Second approach

As very good correlation was seen in the representative dataset choice, not only with pipeline length but also with compressor station installed power and the number of pressure Regulating and Reduction station (RRst). It was decided to estimate the global European network emissions using 3 activity factors:

- the pipeline length *(AF1),*
- the compression installed power *(AF2),*
- the N° of RRst *(AF3).*

Pipeline length

That emission factor was derived from the emission declared to be emitted solely by pipelines in the representative dataset.

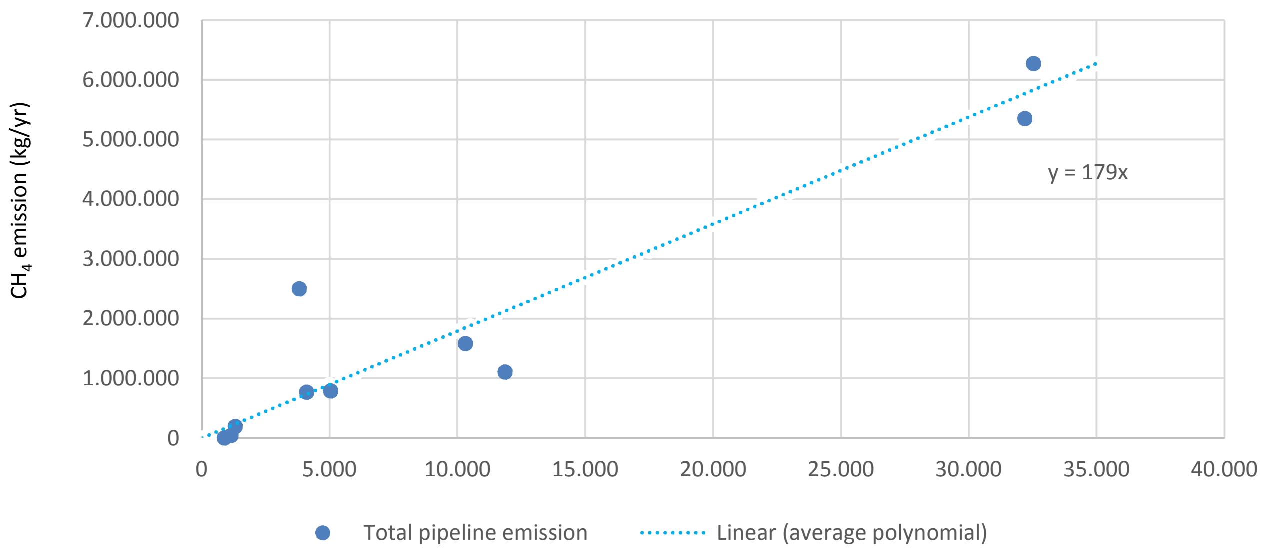

Figure 3: Emissions related solely to pipelines in kg per TSO of the representative dataset relative to pipeline length in km and corresponding average polynomial

The average coefficient is defining the pipeline emission factor (EF1):

EF1 = 179 kg/km

The corresponding activity factor is AF1, the total European[1] transmission pipeline length:

AF1 = 218.355 **km**

The global European CH_4 emission purely related to the pipelines EM1 can be evaluated as:

EM1 = AF1 x EF1 = 218.355 x 0,179 = **39 kT CH_4**

Or **1.094 kT CO_2eq**

Compression

That emission factor was derived from the emission declared to be emitted solely by the Compressor Stations (CS) in the representative dataset.

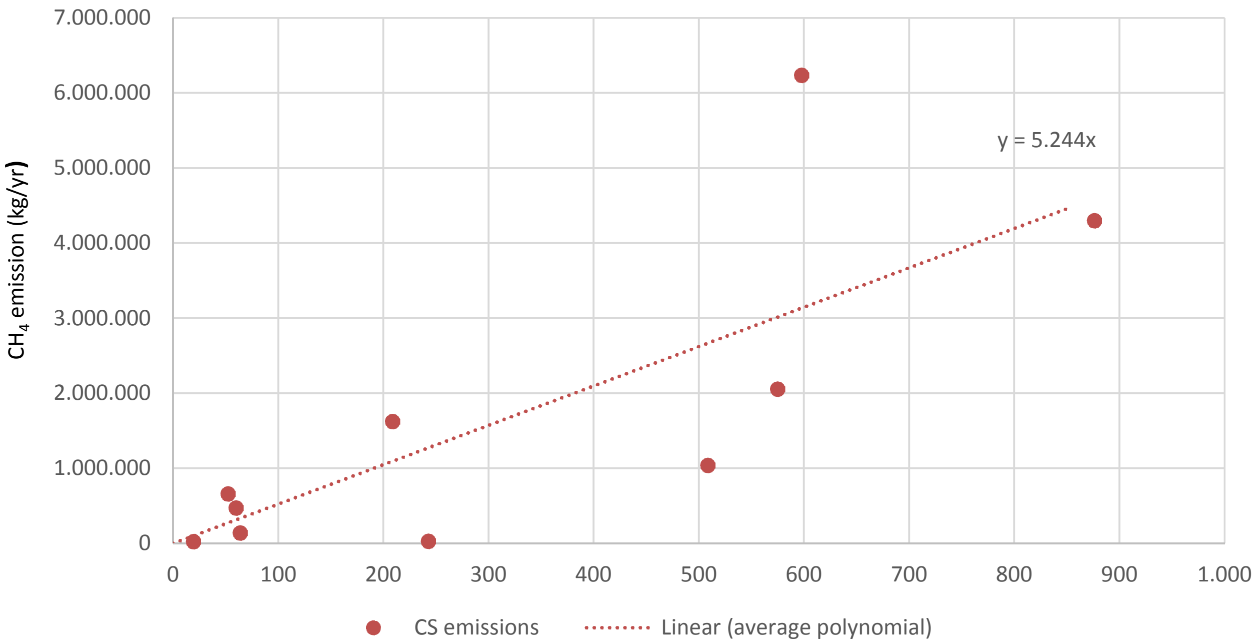

Figure 4: Emissions related solely to compression activities in kg per TSO of the representative dataset relative to compressor stations installed mechanical power in MW and the corresponding average polynomial

The average coefficient is defining the compression emission factor (*EF2)*:

EF2 = **5.244 kg/MW**

The corresponding activity factor is AF2, the total European compression installed power for transmission, has been derived from a well-known pool of 110 compressor stations representing 5.490 installed MW (2013, data from a European compression benchmarking group, internal data). On that basis, the average of compression power installed on a European compressor station is estimated to be 5.490 / 110 = 49,9 MW. As the total number of compressor station on the transmission European[1] network is 173:

AF2 = 49,9 x 173 = **8.633 MW**

The global European[1] CH_4 emission purely related to compression EM2 can be evaluated as:

EM2 = AF2 x EF2 = 8633 x 5.244 = **45 kT$_{CH4}$**

Or **1.268 kT CO_2eq**

Pressure Regulating and Reduction stations

That emission factor was derived from the emission declared to be emitted solely by Regulating and Reduction stations (RRst) in the representative dataset.

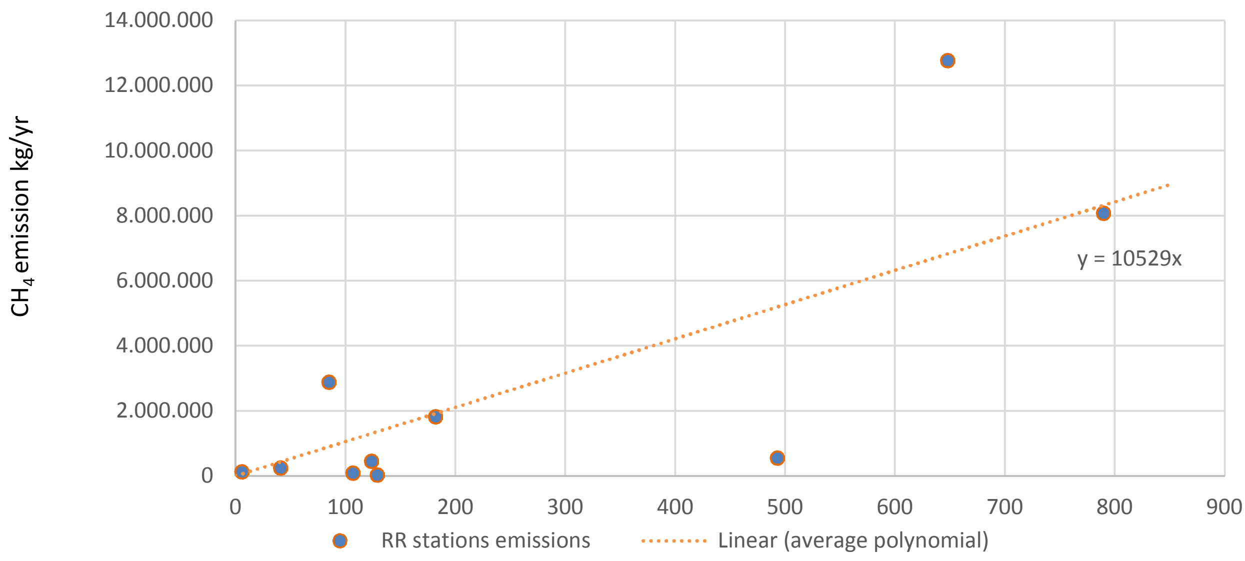

Figure 5: Emissions related solely to RRst in kg per TSO of the representative dataset relative to the number of RRst and the corresponding average polynomial

The average coefficient is defining the RRst emission factor (*EF3)*:

EF3 = 10.529 kg/RRst

The corresponding activity factor is AF3, the total number of RRST on the European transmission network:

AF3 = 3.015

The global European[1] CH_4 emission purely related to the RRst, EM3, can be evaluated as:

EM3 = AF3 x EF3 = 3015 x 10,529 = **31,7 kT CH_4**

Or **889 kT CO_2eq**

Global emissions according to approach 2

The global CH_4 emissions of the European[1] gas transmission Network according to approach2 ($TOTCH_4\_2$) can be estimated as:

$$\mathbf{TOTCH_4\_2} = EM1 + EM2 + EM3 = 39.085 + 45.271 + 31.745 = \mathbf{116{,}1\ kT\ CH_4}$$

Or **3.250 kT CO_2eq**

4.4.3. Discussion

Approach 1 and 2 give very close results ($TOTCH_4\_1$ is only 7% up $TOTCH_4\_2$), both giving a credible estimation of CH_4 emission in European[1] transmission networks.

Nevertheless, Figure 4 and Figure 5 (and to some extent Figure 3) are showing results less consistent, then what was shown in the approach 1 and Figure 2. This is obvious when considering the related correlations:

Correlations of emitted kg/year of methane		
Pipe length Corr. with pipeline related emissions	**MW Comp. Corr. with compression related emissions**	**N° of RRst Corr. with RRst related emissions**
94 %	78 %	79 %

Table 5: Correlation of representative companies' methane emissions per field, with the corresponding activity factors.

This can be explained by the fact that sometimes data are not reported in the corresponding category (see §7.1) i.e.: RR fugitive leakages included in pipeline fugitive leakages or discrepancies in meaning of R&R from a company to another. Having said so and as a consequence, it is important to note that the data and Emission Factors shown in approach 2, have to be considered carefully and not used for specific comparisons. We have here a field of improvement in the data collection to be taken into account for the next report.

Therefore, and to remain on a maximizing approach, TOTCH4_1 will be considered as the reference number.

4.5. Further analysis

4.5.1. A representative and enhanced dataset of the European emissions collected in 2015

Compare to the 2009-2013 dataset, the 2015 dataset is significantly more complete (by 20%) compared with the previous report dataset.

The companies selected as representative in the 2015 dataset, are representing more the 90% of the dataset and about 50% of the European pipeline length.

The emission figures given by these companies are showing a high level of correlation with the activity factors of the 3 main emission fields (pipeline, compression, pressure Reduction and Regulating stations).

That dataset gives a credible picture of the methane emissions in European Transmission networks.

4.5.2. Fugitive emissions are more taken into account

In the past years, the methane fugitive leaks quantification became a key item in the understanding and mitigation process of CH_4 emissions (see the following figure).

Compared to 2009-20013, the 2015 dataset shows how seriously that matter has been addressed by Transmission companies in the last years. In 2015, 92% of the declaring companies are declaring fugitive leaks against 64% in the previous report.

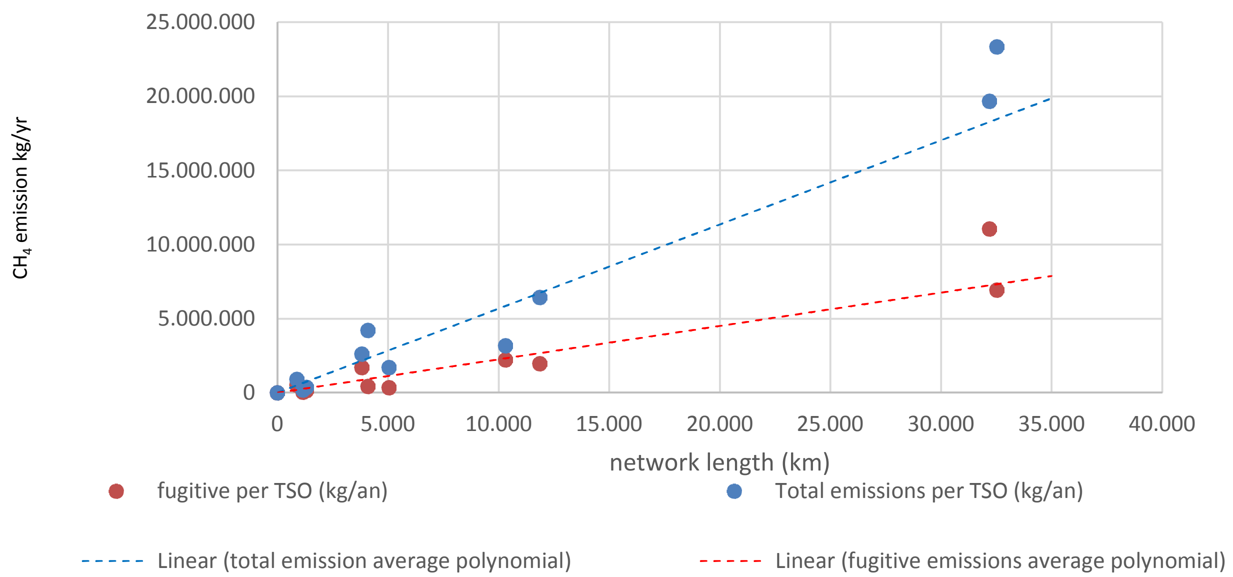

Figure 6: Total emissions and fugitive emissions per TSO of the 2015 representative dataset, in kg/yr relative to the network length and respective average polynomial.

4.5.3. Analysis emission per cause

Based on the 2015 representative dataset, the repartition of methane emissions per cause has been estimated for:

- Pneumatic valves actuator movements
- Vents
- Fugitives

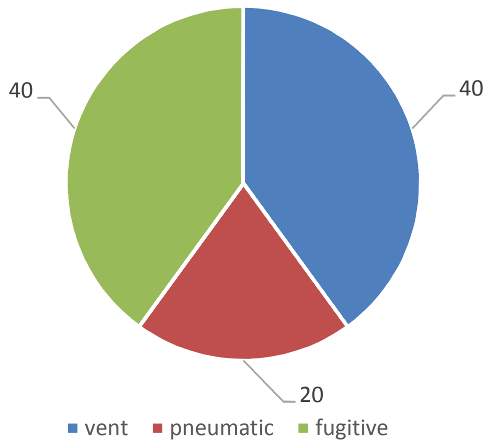

Figure 7: Total transmission CH_4 emissions repartition per main cause

4.5.4. Two calculation methods have been explored, with consistent results

First approach

Based on the previous report study, the most representative companies' method has been preferred, using as a first approach a single activity factor related to pipeline length, the correlation check has allowed to validate that methodology also for the 2015 dataset.

Second approach

Thanks to the enhancement of the data completeness and quality, it is now possible to consider an estimation based on the average emissions of 3 different activity factors related to the 3 main fields of data using the most representative company datasets.

These factors are:

- Pipeline
- Compressor stations
- Pressure Regulating and Reduction stations

Allowing to estimate the following repartition at European level:

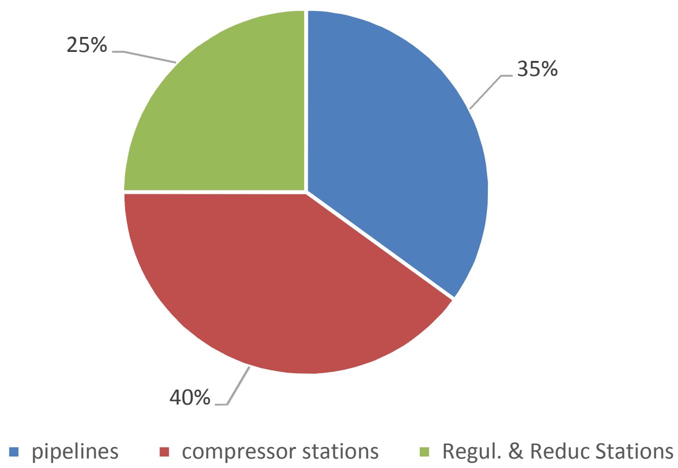

Figure 8: Total transmission CH_4 emissions repartition per main activity fields

Both methods gave very consistent final figures in terms of total emissions (less than 7% difference). Nevertheless, the correlation study showed the approach 1 was still the more consistent even if the correlations results of approach 2 were in the range of 75% to 95%.

Results at EU28 level

The MARCOGAZ Network is 218.355 km, the EU 28 transmission Network is around 234.467 km (see appendix paragraph 7.2). 218.063 km are common (93% of EU total pipeline transmission network) to both categories which are geographically highly superimposed (see appendix paragraph 7.2).

This being said, we propose to extrapolate the emission factors calculate for the MARCOGAZ network to the EU28 Network.

Taking the European length of the transmission system to be 234.467 km, using the first approach as a reference, the methane emission can be calculated as:

EF x 234.467 = **133.177 kT CH_4**.

From this the CO_2 equivalent of the methane emissions from transmission grid in EU28 is estimated at:

3.729 kT CO_2eq [3]

4.5.5. The industry best practices

Methane emissions are not only impacting the environment but also potentially safety and the amount of gas sales. As a consequence, the mitigation and control of methane emissions has been a key issue for gas industry far before the recent acceleration of studies and position papers on the subject. Best practices are already well in place in the gas transmission industry such as:

- Pumping and recompression of the gas in the pipeline before a maintenance requesting to empty them instead of venting.
- Replacement of the valves driven by gas actuators (with methane vents related to their operation) by either electric or compressed air valve.
- Replacement of oil seal, by Dry Gas Seals on gas compressors (much more efficient in gas leakage control)
- Directed inspections and maintenance of the underground pipelines, and above ground installations such as LDAR (Leak Detection And Repair) programs.

The industry maintain its efforts of continuous improvement. As example, in the field of fugitive leaks detection and quantification, several programs are launched on that matter. Together with an evolution of the equipment maintenance program, this will allow further improvements in the methane emission understanding and mitigation.

5. CONCLUSION

The MARCOGAZ Network is 218.355 km, the EU 28 transmission Network is around 234.467 km. 218.063 km are common (93% of EU total pipeline transmission network) to both categories which are geographically highly superimposed (see 7.2).

This being said, we propose to extrapolate the emission factors calculate for the MARCOGAZ network to the EU28 Network.

Based on that study, the average emission per year on the European transmission pipeline network is of **568 kg CH_4/km** [7].

In the 2014 report, the European transmission network emission had to be maximized at 229.135 T CH_4 with the 2009-2013 dataset, thanks to the enhancement of the data completeness and quality, it is now possible to consider an estimation based on the average emissions declared in the 2015 dataset, representative of the network.

- ✓ The total calculated amount of methane emissions from European (EU28) transmission grid is in the range of **133 kT CH_4**
- ✓ On that base the methane emissions from transmission grids (EU28), expressed in CO_2 equivalent, are estimated per year at **3.724 kT CO_2eq** [8]
- ✓ Considering these figures, based on global European gas sales[9] the transmission network losses are calculated to be in the range of **0,05%**.
- ✓ The total amount of GHG emissions caused by the methane emissions from Natural Gas transmission grids is estimated to be **0,08%** of the total of anthropogenic[10] GHG emission in Europe (EU28)[11].

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[7] at a country level, not all the gas transported in the network at a moment in time will be sold in that particular country, and the amount of methane emissions are not only depending on the gas flow

[8] GWP: Global Warming Potential; GWP100 of CH4 (= 28) is used according to the Fifth Assessment Report (AR5) - IPCC.

[9] Source: EU28 inland gas sales: EUROGAS Statistical report 2015

[10] Anthropogenic emissions: emissions originating in human activity

[11] Approximated European Union greenhouse gas inventory: Proxy GHG emission estimates for 2015, EEA report No 23/2016, page 76

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- Source: EU28 inland gas sales: EUROGAS Statistical report 2015

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7. APPENDIX

7.1. APPENDIX I: MARCOGAZ forms methane emission

METHANE EMISSION Calculation for Transmission

Organisation		**Natural Gas Composition**		
Company:		Average Methane Content of Natural Gas:	0%	% (Vol.)
Emissions for the Year:		Density of Methane:	0,7175	kg/m³
Responsible Person:		Conversion Factor from m³ Nat.gas to g CH4:	0	g CH4 / m³ Gas

Calculation

		Activity Factors		Emission Factors						Total Emissions		Source for own factor			
					Marcogaz Range*			Company		Nat.Gas	Methane				
No.	System Category	Data	Unit		Minimum	Maximum		Data	Unit	m³/a	g/a	Measurement	Literature	Estimation	Remark (please specify, if possible)
1. **1.1.**	**Pipeline System** **Fugitive Emissions**														
	Length of pipelines including valves, flanges etc.		km	M	0,80	106,87	M		m³/km/a	0,0E+00	0,0E+00				
1.2.	**Pneumatic Emissions**														
	Number of valves with pneumatic operation		No.	M	129	129	M		m³/No./a	0,0E+00	0,0E+00				
1.3. **1.3.1.**	**Vents** **Maintenance vents**														
	Total emission caused by maintenance incl. Pigs, deviations, commissioning etc.										0,0E+00				
											0,0E+00				
1.3.2.	**Incident vents**														
	Total emission caused by incidents										0,0E+00				
1.3.3.	**Flares**														
	Total emission caused by flares										0,0E+00				
2. **2.1.**	**Compressor Stations** **Fugitive Emissions**														
	Mechanical power of gas turbines		MW	E	450	6.521	M		m3/MW/a	0,0E+00	0,0E+00				
	Mechanical power of gas engines		MW	E	7.800	97.000	L		m3/MW/a	0,0E+00	0,0E+00				
	Number of Blow Down Valves		No	E	1.850	35.291	M		m3/No/a	0,0E+00	0,0E+00				
			No												
			No												
			No												
			No												
2.2.	**Pneumatic Emissions**														
	Number of valves with pneumatic operation		No.	M	1.106	3.193	M		m3/No/a	0,0E+00	0,0E+00				
2.3. **2.3.1.**	**Vents** **Maintenance vents**														
	Total emission caused by maintenance vents										0,0E+00				
											0,0E+00				
											0,0E+00				
											0,0E+00				
											0,0E+00				
											0,0E+00				
2.3.2.	**Incident vents**														
	Total emission caused by incident										0,0E+00				
2.3.3.	**Start vents**														
	Total emission caused by starts										0,0E+00				
											0,0E+00				
											0,0E+00				
											0,0E+00				
2.3.4.	**Stop vents**														
	Total emission caused by stops										0,0E+00				
	...										0,0E+00				
	...										0,0E+00				
	...										0,0E+00				
2.3.5	**Flares**														
	Total emission caused by flares										0,0E+00				
2.4. **2.4.1.**	**Combustion** **Waste gas**														
2.4.1.1.	Fuel gas consumption turbines		m³	E	0,001%	0,95%	M		%	0,0E+00	0,0E+00				
2.4.1.2.	Fuel gas consumption engines		m³	E	0,114%	3,70%	M		%	0,0E+00	0,0E+00				
3 **3.1.**	**R&R Reduction and Regulating Stations** **Fugitive Emissions**														
	Number of Stations		No	M	4.972	10.132	M		m³/No/a	0,0E+00	0,0E+00				
			No												
			No												
			No												
			No												
			No												
			No												
			No												
3.2	**Pneumatic Emissions**														
	Number of Stations		No.	M	22.311	24.459	M		m³/No./a	0,0E+00	0,0E+00				
3.3.	**Vents**														
3.3.1.	Total emission caused by maintenance										0,0E+00				
3.3.2.	Total emission caused by incident										0,0E+00				
3.4.	**Combustion**														
3.4.1.1.	Fuel gas consumption		m³	E	0,01130%	0,01130%	E		%	0,0E+00	0,0E+00				
4	**City Gate and Customer Supply Stations for Metering and Regulating**														
	Number of Stations		No	M	43	62	E		m³/No/a	0,0E+00	0,0E+00				
5.	**Other (please specify)**														
										0,0E+00	0,0E+00				
6.	**Total Emissions**								Nat. Gas	0,0E+00	0,0E+00	Methane			
									Mio. m³	0,000	0	t/a			

7.2. APPENDIX II: List of countries used for extrapolation.

MARCOGAZ Members	Transmission network length [km]	EU28
Austria	3.007	Yes
Belgium	4.057	Yes
Czech Republic	3.810	Yes
Denmark	831	Yes
France	37.246	Yes
Finland	1.318	Yes
Germany	62.500	Yes
Greece	1.819	Yes
Italy	34.415	Yes
Ireland	2.417	Yes
the Netherlands	11.896	Yes
Poland	10.077	Yes
Portugal	1.298	Yes
Romania	13.110	Yes
Slovakia	8.533	Yes
Slovenia	1.094	Yes
Spain	12.987	Yes
Switzerland	292	No
United Kingdom	7.648	Yes
	1.835	**Bulgaria**
	2.034	**Croatia**
	No data	**Cyprus**
	885	**Estonia**
	1.193	**Latvia**
	2.113	**Lithuania**
	No data	**Malta**
	1.962	**Luxembourg**
	5.782	**Hungary**
	600	**Sweden**
MARCOGAZ pipeline length [km]		**EU28 pipeline length [km]**
218.355		**234.467**

Table 6: Transmission networks