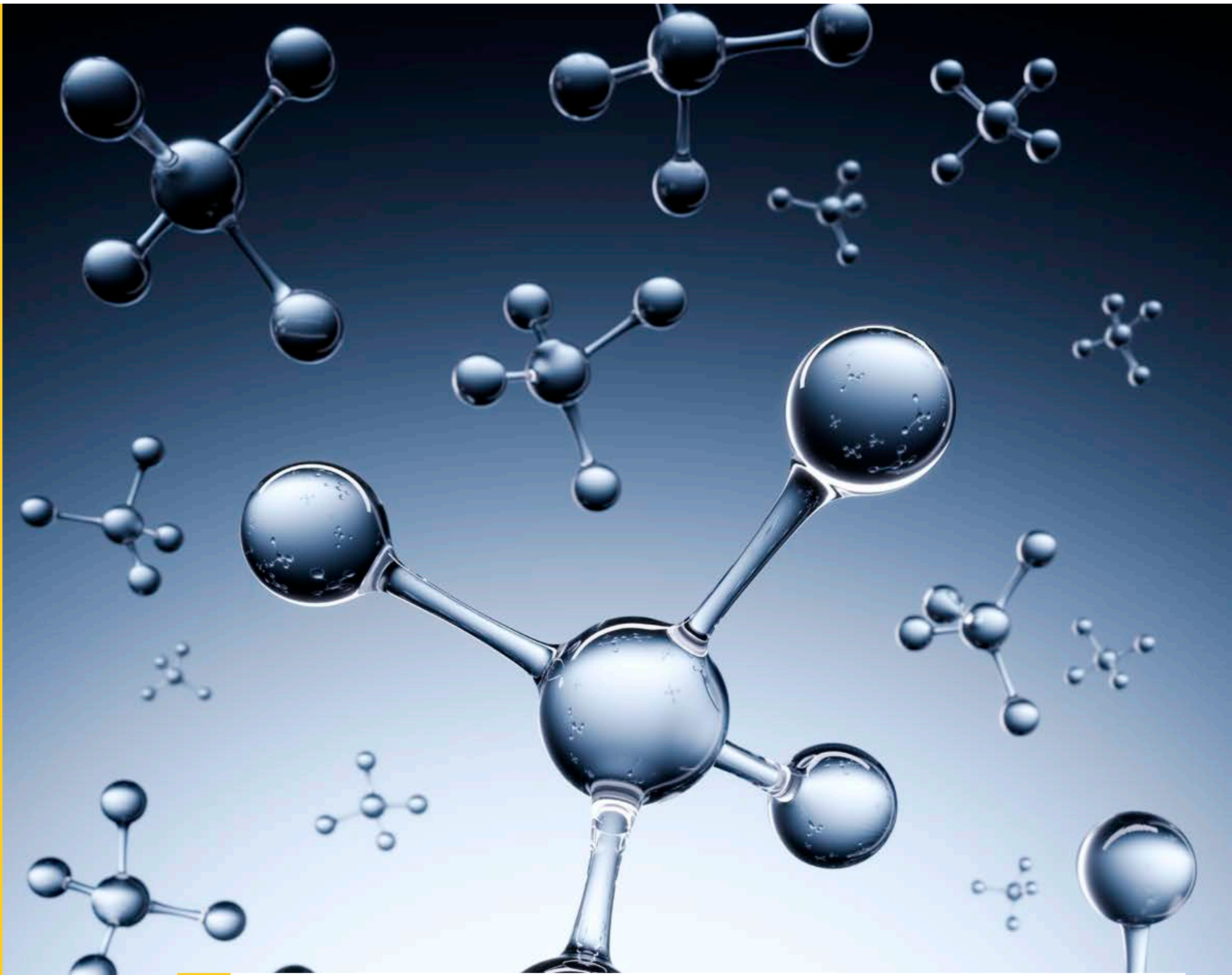

Report on methane emissions by gas transmission and distribution system operators in the Energy Community Contracting Parties

Gas

Energy Community Secretariat

May 2021

Report on methane emissions

by gas transmission and distribution system operators

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1. BACKGROUND AND CONTEXT

The Energy Community Treaty[1] defines the obligations of the Contracting Parties in the energy sectors and foresees the integration of their energy markets with the EU energy market. Their natural gas sectors are regulated by Directive 2009/73/EC, Regulation (EU) 715/2009 and accompanying Network Codes[2]. At present, gas system operators in the Energy Community (EnC) do not have legal obligations to monitor, report or decrease their methane emissions. However, this sector has significant methane emissions reduction potential. Decreasing allowed network losses, setting minimum regular maintenance levels and fostering energy efficiency measures are some of the measures that could be explored.

Methane reporting is also not mandatory in the European Union. However, this will likely change in the near future with the adoption of a new regulation as follow-up to the EU Strategy on methane emissions[3] issued in October 2020. Considering the EU Green Deal[4], the decarbonisation agenda by 2050 and the energy transition underway, it is very likely that the new regulation will entail binding methane emissions reporting as well as possible reduction measures on the gas industry.

Given the similarities between Contracting Party and EU natural gas industries, which share the same transit routes, are regulated by the same rules and are integrating their markets at an accelerated pace, albeit with a certain time lag for adoption of new legislation in the EnC, it can only be beneficial for gas industry participants in the Contracting Parties to take part in the relevant actions already now without waiting for legal obligations to kick in.

Moreover, starting the reporting process now will send an important signal by the gas industry. Firstly, it will prove the industry's dedication to lower greenhouse gas (GHG) emissions and contribute to addressing climate change. Secondly, it will build up and promote the reliability of natural gas infrastructure, which needs to prepare for transporting low carbon gasses in the future.

It is against this background that the Energy Community Secretariat launched an internal project to collect data on methane emissions stemming from gas system operation activities in the Contracting Parties, as a precondition for any concrete action to reduce emissions. The present report is the culmination of this project so far. The scope of the project also included joining the Methane Guiding Principles[5], demonstrating publically the EnC's future direction in relation to methane emission policies.

The Secretariat would like to thank EU gas industry associations, GIE[6] and Marcogaz[7], for their knowledge sharing and support in this process. It is important to underline that the data collection underpinning this report is based on the same questionnaires and methodology that GIE and Marcogaz used to collect data from EU gas industry in 2019 as input for their report on how the EU gas industry can contribute to reducing methane emissions[8].

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[1] https://www.energy-community.org/aboutus/whoweare.html
[2] https://www.energy-community.org/legal/acquis.html
[3] https://ec.europa.eu/energy/sites/ener/files/eu_methane_strategy.pdf
[4] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en
[5] https://methaneguidingprinciples.org
[6] Gas Infrastructure Europe, https://www.gie.eu
[7] Marcogaz, technical association of the European gas industry, https://www.marcogaz.org
[8] https://www.gie.eu/index.php/gie-publications/methane-emissions/methane-emission-report-2019

2. INTRODUCTION

2.1. Methane emissions, what is it all about?

Fossil fuels (coal, oil, natural gas) are the biggest source of GHG emissions – either being emitted as methane (during production, processing, transport, use or abandonment) or as carbon dioxide (a result of combustion when electricity, heat or energy for transport are produced).

When talking about the impact that GHGs have on the climate, carbon dioxide (CO_2) is always the first to be mentioned. In the EU, CO_2 accounts for 81% of GHG emissions, whereas methane (CH_4) contributes with 11%[9]. In the Contracting Parties, the ratio between two most powerful GHGs is slightly different, with a lower share of CO_2 (in range from 68 to 78%) and a higher share of CH_4 (from 13 to 20%[10]).

While methane also has a shorter atmospheric lifetime than CO_2 (8 - 12 years, compared with centuries for CO_2), CH_4 is much more powerful than CO_2 when it comes to ability to absorb energy while being present in the atmosphere. These two characteristics – length of time in the atmosphere and ability to absorb energy – determine the GHG impact on the climate.

The most common way to combine the two factors and estimate their effect on the climate is the global warming potential (GWP). It is used to provide a single measure of total GHG emissions, expressed as a tonne of a GHG emitted in CO_2 equivalent terms (in CO_2-eq). The Intergovernmental Panel on Climate Change (IPCC) has indicated a GWP for methane between 84 and 87 when considering its impact over a 20-year timeframe (GWP20) and between 28 and 36 when considering its impact over a 100-year timeframe (GWP100). In plain words, it means that one tonne of methane in 20 years has an impact equivalent to 84-87 tonnes of CO_2 and 28 to 36 tonnes of CO_2 in the timeframe of 100 years. In spite of contributing in much smaller total amounts to GHG emissions than CO_2, methane is a significant climate villain.

40% of global methane emissions come from biogenic sources (such us wetlands and wildfires), while 60% are caused by human activities[11]. The biggest source is agriculture, accounting for approximately half of the anthropogenic methane emissions, followed by fossil fuel production and use (19-30%) and waste (20-26%).

According to the IEA Methane Tracker[12], total methane emissions by the world's oil and gas industry were estimated at 72 Mt in 2020. Onshore conventional oil and gas account for half of this amount, followed by downstream gas.

The International Energy Agency (IEA) estimates[13] that it is technically possible to reduce 75% of global oil and gas related methane emissions, and by up to 50% only by implementing approaches with no net costs, taking into the account the value of saved gas.

Methane emissions and measures to reduce them are not new topics, especially not for the oil and gas industry. For decades, oil and gas companies have considered methane emissions and

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[9] https://www.gie.eu/download/brochure/Brochure_Methane_Emissions_singlepages_SHORT.pdf
[10] Based on UNFCC National Inventory Reports
[11] International Energy Agency (IEA), World Energy Outlook, (2018)
[12] https://www.iea.org/articles/methane-tracker-database
[13] https://www.iea.org/reports/world-energy-outlook-2017

their control from safety and commercial perspectives as well as due to environment protection requirements. The urge to react globally to climate change, expressed by the Paris Agreement[14], and the Green Deal in the EU, put methane emissions in the focus of policy-makers.

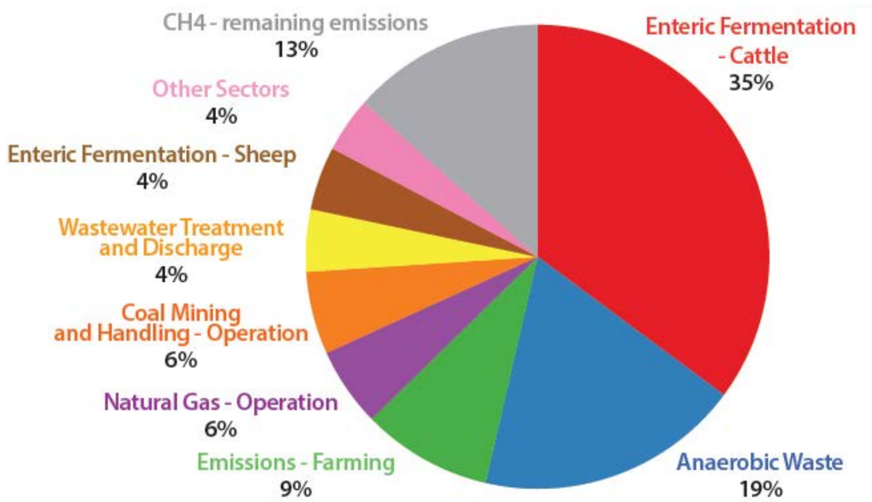
2.2. Methane emissions in the EU

As is the case worldwide, agriculture, waste and energy sectors are the main sources of anthropogenic methane emissions in the EU and in the Contracting Parties.

The EU's energy sector contributes with a relatively low share to the block's total methane emissions, mainly due to the non-significant production of fossil fuels (in comparison to the world's biggest producers of coal, oil and natural gas, where energy sectors contribute a higher share to the methane emissions)[15].

Significant differences between sub-sectors are shown by the diagram below:

Diagram 1: Anthropogenic methane emissions per source in the EU

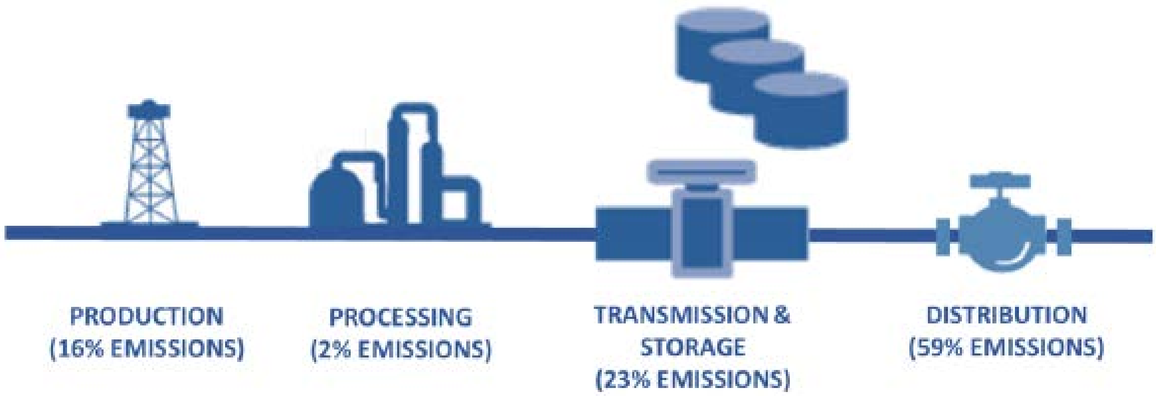


Source: European Environment Agency GHG report[16]

As the gas industry is the subject of this report, it is worth having a closer look at the structure of the 6% of anthropogenic methane emissions caused by gas operation in the EU.

[14] https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement
[15] European Environment Agency (EEA), (2018). EEA greenhouse gas - data viewer
[16] https://www.eea.europa.eu

Diagram 2 – Structure of methane emissions by EU gas industry



Source: GIE&Marcogaz report[17]

Again, it is important to underline that the EU does not have significant gas production, therefore the production and processing of gas make up 18% of the total methane emissions stemming from gas industry activities. It is the distribution of gas, which causes the majority, i.e. 59%, of methane emissions, while transmission and storage account for 23%. A similar structure could be expected in the Contracting Parties due to relatively limited production in comparison with transmission and distribution operations as dominant components in the gas chains.

The EU Governance Regulation 2018/1999[18] stipulates a strategic plan for methane, and the 2020 EU Strategy on methane emissions recognised agriculture, waste and energy as the main areas where methane emissions should be tackled.

The establishment of an international methane emissions observatory, covering emissions from all three sectors - agriculture, energy and waste - is one of the goals of the EU 2020 Strategy.

Specific to the energy sector, the Strategy's objective is to ensure more accurate and harmonised measurement and reporting methodologies for methane emissions than is currently the case. It is foreseen that legislative acts will be developed in the course of 2021 to regulate monitoring, reporting and verification of methane emissions by coal, oil and gas sectors, while the companies along the gas chain will have mandatory standards for leakage detection and repair.

[17] https://www.gie.eu/index.php/gie-publications/methane-emission-report-2019
[18] https://eur-lex.europa.eu/eli/reg/2018/1999

3. ADEQUATE REPORTING AS A POINT OF DEPARTURE

A sound framework for monitoring and reporting is the basis for all subsequent measures to mitigate methane emissions. While a mandatory framework is yet to be developed at the EU level, reporting frameworks are in place, driven by both governments and industry.

3.1. UNFCCC reporting framework

The signatories to the Paris Agreement, in line with their commitment to limit global warming, report on their GHG emissions via biannual and national inventory reports within the United Nations Framework Convention on Climate Change (UNFCCC)[19]. The reporting framework - methodology and guidelines - has been set by the Intergovernmental Panel on Climate Change (IPCC). This is a three-tier reporting framework applicable for all GHG emissions, including methane, across all relevant emitting sectors.

Tier 1 is an elementary approach, which results in simple estimations based on standard values for emission factors and where activity is determined by treating the whole system as one group or divided into only a few groups.

Tier 2 is an intermediate approach, combining elements of Tier 1 and Tier 3. It is based on a group approach to the activities using related emission factors originating in measured values on the specific system or area.

Tier 3 is the most demanding approach, resulting in the most precise estimations. It is based on complex modelling and multiple data sources or specific, individual measurement. The group approach to the activities is used and a substantial amount of emission factors stem from measured values on the specific system or area.

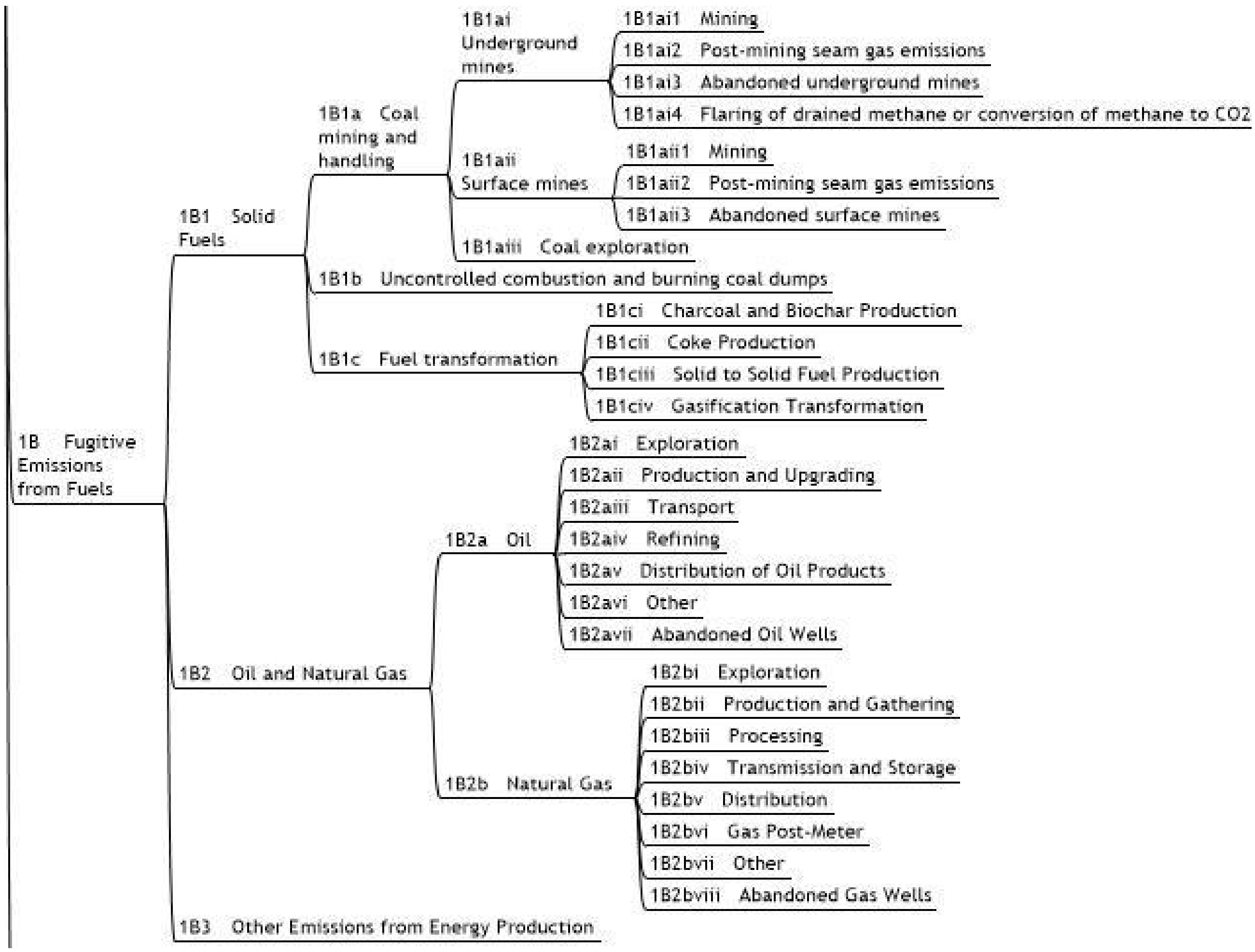
The levels of monitoring and reporting varies considerably between the UNFCCC signatories, between sectors and even between greenhouse gases.

The IPCC reporting framework divides GHG emissions per source: energy industries (1A1), manufacturing industries and construction (1A2), transport (1A3), other sectors (1A4 and 1A5) and fugitive emissions from fuels (1B), while CO2 capture and storage (1C) is considered as a taker of emissions.

The main GHG in the 1A category is carbon dioxide, while methane appears in that category at the level of a few percentages. Majority of methane emissions falls within the category 1B, as fugitive emissions of fossil fuels. In the EU in 2018, two thirds of 1B emissions were methane, and one third was carbon dioxide.

[19] https://unfccc.int

Diagram 3 – IPCC Categorisation of methane emissions (1B)



Source: IPCC (2019), Chapter 1

All but one[20] Contracting Party to the Energy Community Treaty are UNFCCC and Paris Agreement signatories. Annex 1 countries have more detailed reporting obligations than non-Annex 1 countries. Only Ukraine falls within the Annex I category, while all others are non-Annex 1 countries. All Contracting Parties report on methane emissions using a very different level of detail. Serbia, North Macedonia and Moldova report only the total amount of oil and natural gas sector (1B2) emissions, thus specific data for natural gas transmission and distribution are not available. Bosnia and Herzegovina reported only on fugitive emissions from solid fuels (1B1), while data for oil refining and natural gas transmission and distribution, despite having such infrastructure in the country, were not shown. In contrast, Georgia, being a non-Annex 1 country, provided more detailed separation within 1B emissions, showing separately fugitive emissions from solid fuel mining, oil extraction, natural gas production and natural gas transmission and

[20] Kosovo* is not a signatory

distribution. Ukraine, as an Annex 1 country, reported on fugitive emissions in detail, including data on methane emissions from natural gas transmission and distribution separately.

3.2. OGMP reporting framework

Besides the GHG emissions mandatory reporting framework at the level of states, the UNFCCC signatories, there is a voluntary reporting framework at the level of energy companies, also developed within the UN framework.

The Oil and Gas Methane Partnership (OGMP)[21] was launched at the UN Secretary General's Climate Summit in September 2014 by the Climate and Clean Air Coalition. The European Commission is one of the partners of the OGMP, along with the UN Environment Programme (UNEP) and the Environmental Defense Fund (EDF).

The OGMP aims to help companies to reduce methane emissions in the oil and gas sectors based on a sound monitoring and reporting framework. A year ago, OGMP members agreed to update this framework by extending reporting obligations to all material sources of methane emissions, including non-operational assets. The so-called OGMP 2.0, signed by 62 companies in November 2020, has established five reporting levels, whereas the highest level requires source-level and site-level emissions measurement. The companies committed to achieve compliance within three years for operational assets and five years for non-operational assets and to announce their own individual reduction targets and report periodically on progress.

The European Commission, in its Strategy on methane emissions, has considered that the Tier 3 approach is achievable for the energy industry and therefore this will be the EU target reporting standard. The Strategy foresees that the widely-used reporting framework developed under the OGMP will foster the transition to the Tier 3 approach, i.e. OGMP 2.0 will be reflected in the upcoming reporting regulation at the EU level. It has to be noted that three companies from the EnC Contracting parties, Naftogaz, Moldovagaz and GAMA, joined the OGMP 2.0 framework following awareness raising efforts by the Secretariat.

[21] https://ccacoalition.org/en/activity/ccac-oil-gas-methane-partnership

4. MARCOGAZ' ESTIMATION METHODOLOGY

The Marcogaz methodology, used in the EU report submitted to the Madrid Forum in 2019, and in this report for the Energy Community, has been developed[22] on the ground of scientific methodologies available in the literature and practices by different European gas companies. It was proposed as a common denominator methodology for estimating methane emissions in gas transmission, storage, LNG terminals and distribution[23].

Emissions of methane arise along the entire gas chain, depending on the process type, materials used, equipment and operations. They can be divided into fugitive, vented and incomplete combustion emissions.

Fugitive emissions are continuous emissions, they consist of all small leaks from pipe equipment, flanges, valves, joints, etc.

Vented emissions come from the natural gas released into the atmosphere from the gas network. Such emissions occur during normal planned maintenance and control, but also during unplanned events, caused by the failure of the system and third party activities. Flaring, when natural gas is burned during normal operations (more often in oil sector), also contributes to vented emissions by unburned methane, which is released into the atmosphere (from 0% to 5% used in flares, depending on the combustion efficiency).

Incomplete combustion emissions are caused by all unburned methane in the exhaust gases from normal operation of gas turbines, gas engines and combustion facilities.

The Marcogaz assessment methodology includes all three types of methane emissions along the gas chain, and can be considered as a Tier 2 approach, with elements of Tier 3.

Methane emissions occur due to normal operations, regular maintenance, system faults and as a result of external factors. An overview of emission types and their relationship with operational activities is shown in the table below:

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[22] Document D267, WG-MET-05-07, "Methodology for the estimation of methane emissions in the gas industry "prepared by the WG Methane Emissions and adopted by the Eurogas-Marcogaz Joint Group Environment, Health and Safety in 2003

[23] It has to be noted that Marcogaz updated its reporting template in 2020, but the data collection within the Energy Community was already ongoing at the time based on the previous template. The new template will be considered for the next data collection round, as follow-up to this report.

Table 1 – Methane emissions types – source examples

Methane emissions			
Types of emissions			**Examples**
Fugitives	**Leaks due to connexions**		Tightness failure
	Permeation		
Vented	**Operational emissions**	**Purging/venting for works, commissioning and decommissioning**	Works, maintenance
		Regular emissions of technical devices	Pneumatic emissions actuators, flow control valves, …
		Starts & stops	Emissions from start and stops of compressors, …
	Incidents		Third party, corrosion, construction defect/material failure, ground movement, failure of installation
Incomplete combustion			Unburned methane in exhaust gases from combustion installations.

Source: Marcogaz, WG-MET-485[24]

The estimation of methane emissions by gas systems used in Marcogaz' methodology, follows a bottom-up approach whereas methane emissions from each identified source along the gas system are quantified. The total methane emissions of a particular system are calculated by summing up all emissions of the individual sources.

The emission sources in the gas systems (assets and operations) are described by the ***activity factors (AF)***, provided usually from asset management databases and incident registrations of the operators. The activity factors are expressed in kilometres (km), number of particular devices, number and duration of operation and incidents, i.e. they are shown as: length of the pipelines, number and type of valves, number and type of pneumatic devices, number of compressors, gas turbines and gas engines, as well as frequency of pneumatic interventions, operating and incidental vents and gas used as fuel gas.

For each system, being transmission, distribution, storage or LNG terminal, system boundaries, subsystems and related components have to be clearly identified. For transmission, considered sub-systems are pipelines, gas compressor stations, metering and regulating stations and city gates and customer supply stations. Sub-systems of distribution networks include distribution and service lines and city gates and customer supply stations. At gas storage sites, compressor stations and gas treatment are considered as sub-systems, while an LNG terminal is divided between different elements along receiving, storing and gasifying LNG. The activity factors for the same type of system can vary between individual system operators.

[24] Document WG-ME-485, published in 2019, https://www.marcogaz.org/publications-1/documents

The ***emission factors (EF)*** describe a quantity of methane emitted from each emitting source (e.g. main lines, service lines, pressure regulating stations, delivery stations, compressor stations, etc.) and for each emitting event (e.g. leakages of pipelines, maintenance operations on pipelines or on facilities, incidents etc.). Further distinction can be made among materials, pressure levels, locations (above ground or underground), diameters, etc.

Emission factors are determined by direct measurement, estimated or calculated.

Measured data can be used for quantification of some particular event and as such taken into the reporting or as an estimation of the emission factor for a relevant group of assets.

The emission factor can be determined by using a typical methane emission from a piece of equipment or an emission event, as established from literature, gas industry practice and research, or from equipment supplier data, in a way that the chosen EF is as close as possible to the equipment used by the particular company.

The emission factor can be calculated from field data or/and design data. For example, in the case of vents, the amount of methane emitted can be accurately derived from the pipe section volume (length and diameter) and the pressure condition in that particular pipe section.

Total emissions are calculated as:

$$E = \sum_{i}^{n} E_i = \sum_{i}^{n} (EF_i \, . \, AF_i) \qquad \textit{formula 1}$$

Where:

"E" are total methane emissions, in [kg]

"E"$_i$ is the methane emission of "i" source, in [kg]

"n" is the number of all considered emission sources

"EF$_i$" is the emission factor, usually expressed as a mass flow rate (Qm) in [kg] per time unit and per "i" event or device or group of assets (if expressed in volumetric flow rate and for natural gas, as is the case with tables 3 and 4, relevant recalculation for methane and mass rate have to be done, to calculate methane emissions in [kg] as provided by formula 2)

"AF$_i$" is the activity factor = N_i x t_i

"N$_i$" is the number of "i" events or devices or group of assets, it can be length of pipelines, number of devices, number of vents, number of starts & stops, number of leaks, number of incidents

"t$_i$" is the duration of methane leakage due to "i" event or device or group of assets, it is expressed in years or in hours, depending on the category of emission and units of the Qm

Methane emissions, as all GHG emissions, are expressed in kilograms (i.e. usually in tonnes, kilotonnes or even megatonnes), thus emission factors are expressed in a mass rate. However, flows in the gas systems are usually expressed in volumetric rates (Q_v in cubic metres, m^3, per time unit), that is why conversion from volumetric to mass rate has to be done. For the entire estimation, the density of methane (CH_4) as well as the share of methane in natural gas has to be taken into account. The calculation is shown in formula 2:

$$Q_m = Q_v \cdot x_{CH4} \cdot \rho_{CH4}$$ *formula 2*

Where:

Q_m is the mass rate, expressed in [kg] per time unit
Q_v is the volumetric rate, expressed in [m^3] per time unit
X_{CH4} is the methane share in the natural gas composition (in %), typical for a particular gas system, subject to reporting
ρ_{CH4} is the density of methane (i.e. 0,715 kg/m^3 in normal conditions; i.e. at 0°C and 1 bar)

Examples of expressions of different activities and emission factors, related to different operations and types of emissions, are as follows:

Table 2 – Examples of EF and AF for different methane emissions

<table>
<tr><th colspan="3">Types of emissions</th><th>EF</th><th>AF</th></tr>
<tr><td rowspan="2">Fugitive emissions</td><td colspan="2">Pipeline permeation</td><td>Q_m in [kg/km*yr]</td><td>N = length of pipelines, in [km]
t = duration of the leak expressed in [year] (for new pipeline, t can be < 1)</td></tr>
<tr><td colspan="2">Leaks due to connexions (flanges, pipe equipment, valves, joints, seals)</td><td>Q_m in [kg/leak*yr]</td><td>N = number of assets of each group
t = duration of the leakage expressed in [year]</td></tr>
<tr><td rowspan="5">Vented</td><td rowspan="3">Operational emissions</td><td>Purging/venting for works, maintenance, commissioning and decommissioning</td><td>Q_m in [kg/event]</td><td>N = number of vents or purges
t is not relevant (t=1)</td></tr>
<tr><td>Regular emissions of technical devices (e.g. pneumatic)</td><td>Q_m in [kg/h*device]</td><td>N = number of devices of each type
t = duration in [hour]</td></tr>
<tr><td>Start & Stop</td><td>Q_m in [kg/(start/stop)]</td><td>N = number of starts & stops
t is not relevant (t=1)</td></tr>
<tr><td rowspan="2">Incident emissions</td><td>Distribution grid</td><td>Q_m in [kg/incident] or [kg/km]</td><td>N = number of incidents or km of pipeline
t is not relevant(t=1)</td></tr>
<tr><td>Transmission grid</td><td>Q_m in [kg/incident]</td><td>N = number of incidents
t is not relevant(t=1)</td></tr>
<tr><td colspan="3">Incomplete combustion</td><td>Q_m in [kg/h]</td><td>N = number of combustion installations in service
t = duration in running [hour]</td></tr>
</table>

Source: Marcogaz, WG-MET-485

In the estimation templates (Annexes 1 and 2), calculation formulas and correction factors from natural gas composition to the methane emissions are provided, as well as wide ranges of the emission factors for each activity factor.

Marcogaz issued Guidelines for choosing methane emission factors (D135, WG-MET-06-02) to help companies determine the appropriate EF from the wide range when filling the template tables and estimate own methane emissions.

Different parameters influence the emission factors, increasing or decreasing their values.

An overview of the emission factors for transmission is shown in Table 3, and the main parameters influencing them are shown in Table 4.

Table 3 – Natural gas emission factors for transmission[25]

NATURAL GAS EMISSION FACTORS FOR TRANSMISSION					
No.	**System Category**	**Emission factors**			**Unit**
		MIN	**MAX**	**Average**	
1.	**Pipeline System**				
1.1.	Fugitive Emissions				
	Length of pipelines including valves, flanges ..	**0,8**	**107**	**42**	m^3/km/a
1.2.	Pneumatic Emissions				
	Valves with pneumatic operation	**129**	**129**	**129**	m^3/No./a
2.	**Compressor Stations**				
2.1.	Fugitive Emissions				
	Mechanical power of gas turbines	**454**	**10500**	**3914**	m3/MW/a
	Mechanical power of gas engines	**7800**	**7800**	**7800**	m3/MW/a
	Blow Down Valves	**1846**	**36039**	**13781**	m3/No/a
2.2.	Pneumatic Emissions				
	Valves with pneumatic operation	**10**	**3194**	**1261**	m3/No/a
3	**M&R Stations**				
3.1.	Fugitive Emissions				
	Stations	**4972**	**10132**	**7470**	m3/No/a
3.2	Pneumatic Emissions				
	Stations	**3791**	**27126**	**15566**	m3/No/a
4	**City Gate and Customer Supply Stations for M & R**				
	Stations	**43**	**407**	**171**	m3/No/a

Source: Marcogaz, WG-MET-06-02, D135

As demonstrated in the table above, older equipment, longer time to repair and longer time between inspections directly increase emission factors for all activity factors (sign "**↗**"). Increasing a pipe's diameter, pressure in the equipment or the number of valves also leads to an emission factor increase. On the other hand, higher frequency of maintenance decreases the emission factors (sign "**↘**"). The better the pipe protection and sealing quality in place, the lower the fugitive emissions of pipelines and related equipment.

The type of soil does not influence the emission factor of most activity factors (sign "**-**"), while the exact trend in relation to fugitive emissions of a pipeline cannot be defined (sign "**x**"). This is the

[25] Emission factors are expressed in volumetric flow rate and for natural gas, thus recalculation for methane and mass rate has to be done to calculate methane emissions in [kg] as provided by formula 2. This conversion is provided by the estimation template for distribution in Annex 1.

case also for the type of equipment – there is no determined correlation between a type of equipment and an increase or a decrease in the emission factor for that particular activity factor.

Table 4 – Overview of the parameters influencing the emission factors for transmission

Parameter	EF 1.1	EF 1.2	EF 2.1.1	EF 2.1.2	EF 2.1.3	EF 2.2	EF 2.4.1.1	EF 2.4.1.2	EF 3.1	EF 3.2	EF 3.4	EF 4
Age of the equipment	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗
Frequency of maintenance	↘	↘	↘	↘	↘	↘	↘	↘	↘	↘	↘	↘
Time to repair	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗
Time between 2 inspections	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗
Pressure in the equipment	↗	-	↗	↗	↗	-	-	-	↗	-	-	↗
Diameter of pipe	↗	↗	-	-	-	↗	-	-	-	↗	-	↗
Number of valves	↗	-	-	-	-	-	-	-	↗	-	-	↗
Type of soil	x	-	-	-	-	-	-	-	-	-	-	-
Protection of the pipe	↘	-	-	-	-	-	-	-	-	-	-	-
Type of equipment	x	x	x	x	x	x	X	x	x	x	x	x
Sealing quality	↘	-	↘	↘	-	-	-	-	↘	-	-	↘
Operat. philosophy (1)	x	x	x	x	x	x	X	x	x	x	x	x

(1) Operating philosophy is the way the network is operated: for example the emission factor will be different if the compressors stay in gas during maintenance or not, if the pressure is adapted during the day to optimise the network.

Source: Marcogaz, WG-MET-06-02, D135

An overview of emission factors for distribution is shown in Table 5, while Table 6 shows the parameters influencing the emission factors for distribution.

Table 5 – Natural gas emission factors for distribution[26]

NATURAL GAS EMISSION FACTORS FOR DISTRIBUTION						
No.	**System Category**	**Pressure**	**Emission factors**			**Unit**
			MIN	**MAX**	**Average**	
1.	**Distribution Lines**					
1.1.	Grey cast iron with lead joint	Low	**2528**	**11160**	**7388**	m^3/km
1.2.	Ductile cast iron	Low	**671**	**8000**	**3190**	m^3/km
1.3.	Steel	Low	**300**	**869**	**585**	m^3/km
		Medium	**869**	**1300**	**1085**	m^3/km
1.4.	Steel with cathodic protection	Low	**70**	**900**	**485**	m^3/km
		Medium	**300**	**300**	**300**	m^3/km
1.5.	Steel without cathodic protection	Low	**900**	**3813**	**2357**	m^3/km
		Medium	**300**	**3822**	**2061**	m^3/km
1.6.	Plastic Polyethylene PE	Low	**72**	**900**	**292**	m^3/km
		Medium	**64**	**300**	**153**	m^3/km
1.8.	Material in general not specified	Low	**869**	**1284**	**1018**	m^3/km
2.	**Service Lines**					
2.1.	Customers		**3**	**3**	**3**	m^3/No./a
2.2.	Percentage of Total emissions of Distribution Grid		**20%**	**90%**	**55%**	%

Source: Marcogaz, WG-MET-06-02, D135

[26] Emission factors are expressed in volumetric flow rate and for natural gas, recalculation for methane and mass rate has to be done, to calculate methane emissions in [kg] as provided by formula 2. This conversion is provided by the estimation template for distribution in Annex 2.

Table 6 - Overview of parameters influencing the emission factors for distribution

Parameters	Effect of parameters on Emission Factor	Reference with distribution sheet [No.]
Pressure	E.F. increases in proportion to increasing pressure	From 1.1 to 1.8 & 2.1 – 2.2 -3
Maintenance Monitoring – leak detection	E.F. decreases (not linear) to the increase in monitoring frequency	From 1.1 to 1.8 & 2.1 – 2.2 -3
Time to fix escapes	E.F. decreases (linear from locating of escape) proportionally to the decreasing time to fix	From 1.1 to 1.8 & 2.1 – 2.2 -3
Joint treatment	E.F. decreases (not linear) to increasing use of treatment	1.1
Access	When pipes are located in inaccessible locations monitoring for leakage may not be possible. I such cases, total emissions can be expected to increase with the increasing time taken to detect the failure. When pipes are located in accessible positions and open to public access then they may be damaged by third party activity causing a release of methane. In this case it is likey that an early report of escaping gas would be received limiting the time from damage to repair. In both cases, the emission factor may need to be adjusted to reflect high proportions of inaccessible pipes and/or high levels of third party damage.	From 1.1 to 1.8 & 2.1 – 2.2 -3
Age of pipes	E.F. increases in proportion to age of system	From 1.1 to 1.8 & 2.1 – 2.2 -3
Time of change to natural gas	E.F. decreases to increase of time of change from city gas to natural gas	1.1
Soil condition	E.F. can be expected to increase under the following conditions: when soil contains large rocks or other sharp objects: when the structure of the soil is less permeable; when the water content of the soil is reduced; when the corrosive nature of the soil is increased when the ground is subjected to increased movement due to changing conditions: The EF will also be seen to decrease when the opposite circumstances exist.	From 1.1 to 1.8
Location (urban or rural)	E.F. increases with increased frequency or weight of traffic.	From 1.1 to 1.8
Method of installation	E.F. increases where the quality of the installation technique is reduced. This could include the laying of pipes on hard materials with fixed contact points.	From 1.1 to 1.8 & 2.1 – 2.2 -3
Service Lines	E.F. increases with increased density of service lines, expressed as nr service lines / km of distribution grid. E. F. is also influenced by the type of service lines (above/under ground, protected or not protected ...)	
Cathodic protection system	E.F. decreases to the increase with efficiency of cathodic protection system	1.4
Fault on other utilities	E.F. increases with increasing frequency of third party work near the pipes.	From 1.1 to 1.8

Source: Marcogaz, WG-MET-06-02, D135

The Marcogaz methodology provides also the emission factors and relevant parameters for storage and LNG terminals, but they are not relevant for this report.

5. **METHANE EMISSIONS OF GAS COMPANIES IN THE CONTRACTING PARTIES**

This chapter starts by proving an overview of the structure of the gas industry in the Contracting Parties, identifying existing gas infrastructure and operating companies which could (and should) monitor and report on methane emissions. It then outlines the data collection process before presenting the data collection results and drawing conclusions.

5.1 Gas industry overview

The market structure, level of market development, operational infrastructure and role in energy consummation of the gas sector vary across the Contracting Parties.

Two of the nine Contracting Parties (Montenegro, Kosovo*[27]) do not have gas infrastructure in place at all. Albania has a small distribution network developed decades ago to bring natural gas from oil fields to a small city in their vicinity. The Trans Adriatic Pipeline currently only transits gas through the territory of Albania.

Bosnia and Herzegovina and North Macedonia have gas transmission infrastructure that is limited to pipelines, a couple of hundred kilometres in length, from the border entry point to the capital. Neither country produces gas or has underground gas storages (UGS). There are several developed distribution networks in Bosnia and Herzegovina, while North Macedonia's distribution infrastructure is limited with only a few hundred connected customers. At present, North Macedonia is in the process of expanding its transmission network and plans to develop also its distribution infrastructure on a mayor scale.

Serbia has a relatively developed transmission network, serving also for transit to Bosnia and Herzegovina. However, distribution networks are limited to the northern part of the country. Serbia has gas production and UGS facilities.

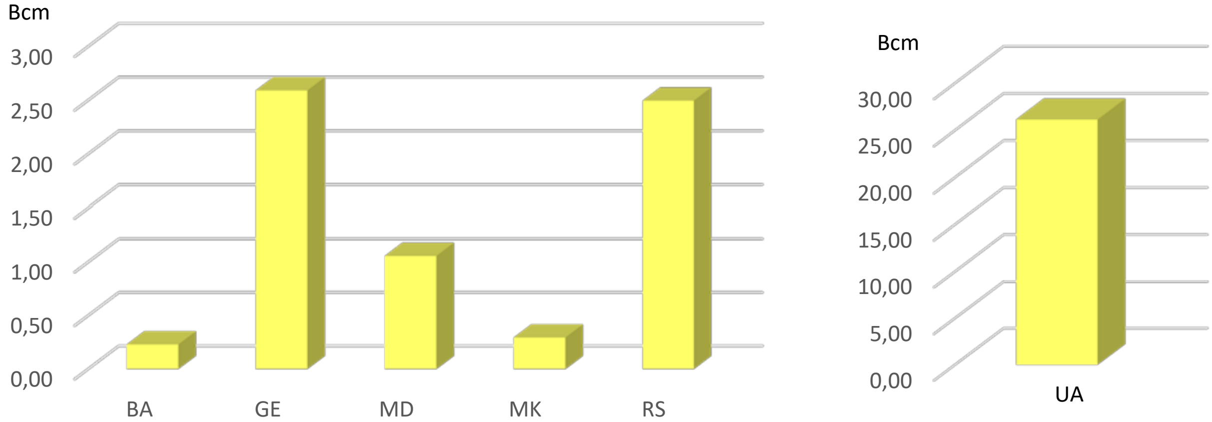
Moldova and Georgia are examples of countries with huge transmission capacities and well-developed transmission and distribution networks covering the majority of their territory but no domestic gas production and UGS facilities.

Ukraine is a Contracting Party with the most developed gas sector, consisting of huge transit and transmission capacities, significant gas production, immense UGS capacity and huge distribution networks covering the entire country.

Gas consumption and length of the networks are shown in Diagrams 4 and 5, based on data from the 2020 Annual Implementation Report of the Energy Community Secretariat[28]. A ratio of 10:1 between Ukraine and all other Contracting Parties is used.

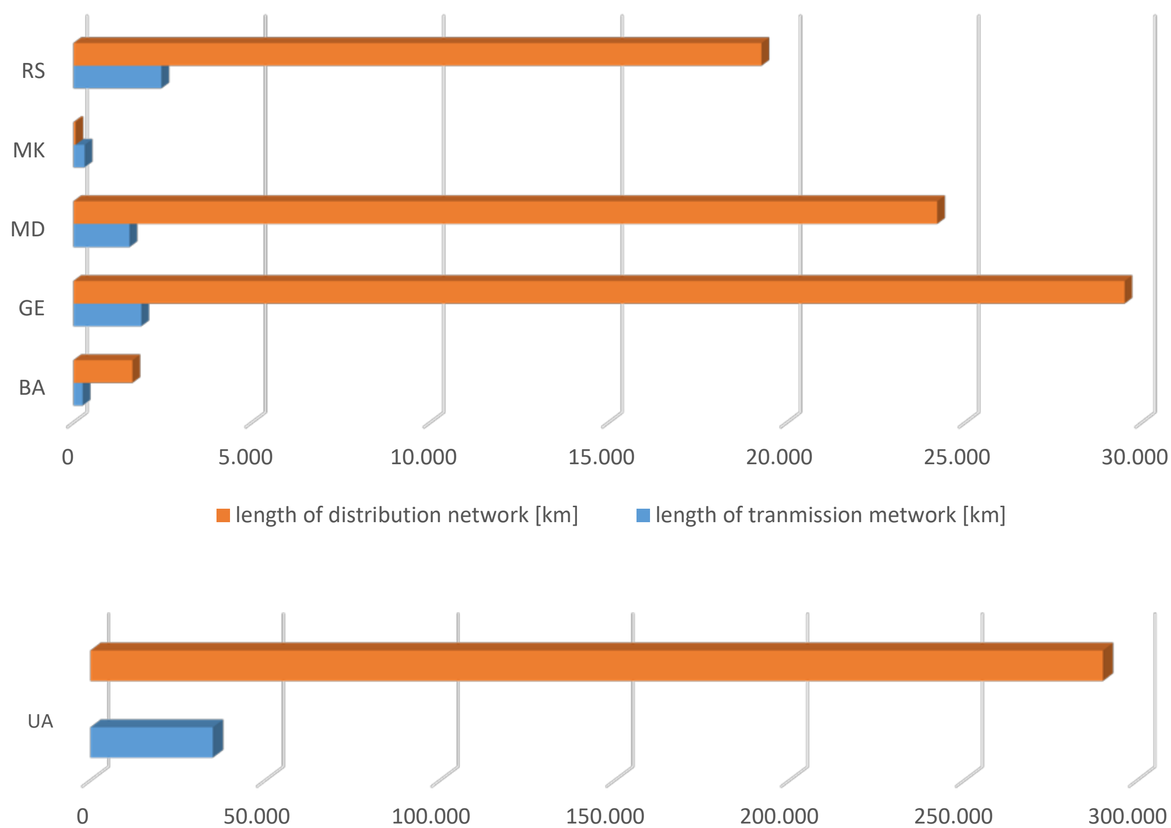
[27] This designation is without prejudice to positions on status, and is in line with UNSC 1244 and the ICJ Opinion on the Kosovo Declaration of Independence
[28] https://www.energy-community.org/implementation/IR2020.html, consumption of Moldova includes only the right bank of Dniester river

Diagram 4 – Gas consumption in 2019



Source: compiled by the Energy Community Secretariat

Diagram 5 – Length of gas transmission and distribution networks in the Contracting Parties



Source: compiled by the Energy Community Secretariat

The structure of companies operating the transmission and distribution networks reflects historical development of the Contracting Parties' gas sectors during the previous decades, as well as more recent cross-border infrastructure expansion in particular countries, and it is not proportional to the level of consumption or network length. Table 7 shows the total number of companies with a license for transmission and distribution as well as the number of respondents to the questionnaire.

Table 7 – Overview of gas system operators in the Contracting Parties

	No. of TSOs	No. of DSOs	No. of SSOs
Albania	2 (0)	1 (0)	0
Bosnia and Herzegovina	3 (2)	4 (0)	0
Georgia	1 (1)	30 (1)	0
Moldova	3 (1)	24 (12)	0
North Macedonia	1 (1)	3 (0)	0
Serbia	3 (0)	32 (0)	1 (0)
Ukraine	1 (1)	42 (20)	1 (1)
Total	**14 (6)**	**136 (33)**	**2 (1)**

Source: compiled by the Energy Community Secretariat

Numbers in brackets represent the number of companies which responded to the questionnaire

It has to be noted that not all transmission system operators (TSOs) are unbundled and certified in line with the Third Energy Package. Many distribution system operators (DSOs) are not unbundled due to the possibility of Contracting Parties to exempt DSOs with less than 100.000 connected customers from unbundling requirements. This is the case for all DSOs in Bosnia and Herzegovina, North Macedonia, Serbia and for the most part Georgia. The majority of DSOs in Moldova are very small, but half of them are part of a vertically integrated company which is the biggest supplier in the country.

Albania, practically without domestic gas consumption, has two certified TSOs: TAP with its pipeline in operation since the end of 2020, and a combined TSO and DSO, which operates a very small distribution network on local gas from domestic oil production and has been tasked to develop further the transmission network.

Ukraine and Serbia are the only Contracting Parties with domestic gas production and UGS facilities. Serbia has one UGS facility of 0,45 Bcm and one gas production company with annual production of 0,4 Bcm in 2019.

Ukraine's huge storage working capacity, consisting of 31 Bcm in 11 UGSs, is managed by one operator. National production is 20 Bcm, 77% of which comes from the Naftogaz group, and 23% from different national and international producers.

There are no LNG terminals in any of the Contracting Parties.

5.2. Data collection process

With the curtesy of Marcogaz and GIE, the Secretariat disseminated the methane emissions estimation templates in early 2020. The purpose, methodology and tables were explained and discussed in numerous e-mails and bilateral calls.

The entire data collection process fell in the period of the covid-19 lockdowns across Europe, which made access to data and internal communication within companies more complicated and slowed down the filling out of the tables. The language also was an obstacle in some Contracting Parties, i.e. not only the tables but the entire methodology and guidelines for emission factors had to be translated from English into local language. Nevertheless, the companies' responses with 2019 methane emissions data were collected by the end of 2020.

In total, the Secretariat received filled out tables from six TSOs and 33[29] DSOs; i.e. 39 system operators replied (see Table 7). While the number of respondents may seem moderate, the **six TSOs that replied operate 93% of the total transmission network in the Energy Community (38.000 km of pipelines); while the 33 DSOs that responded operate 71% of the total distribution network (almost 262.000 km of pipelines).**

The two existing SSOs did not submit the filled out template, but one of them submitted (Tier 3) data based on its own project of methane emissions measurement. While the data could not be included in this report due to the different methodology used, it provides a basis for future harmonization with the template and inclusion in follow-up activities.

Due to confidentiality reasons, the findings of this report are expressed without company names and references to individual emission amounts. However, real data will serve to inform future actions by the companies and within the Energy Community.

The Secretariat would like to express its gratefulness to the companies which submitted the completed templates on a completely voluntary basis and individual experts who made that possible.

[29] Eleven DSOs in the Moldovagaz group were included in one questionnaire table, Chisinaugaz shown separately

5.3. Results

Total estimated methane emissions by transmission and distribution system operators, which responded to the Secretariat's questionnaire, amounted to approximately 200 kt[30] in 2019, which represents 0,3% of world methane emissions by the oil and gas industry. The split of contributions - 85% by distribution networks and 15% by transmission networks – corresponds in a very general manner with the shares shown in the report for gas industry in the EU. However, a full comparison is not possible due to the complete lack of data for storage operators and producers as well as missing data for 30% of the distribution networks in the Contracting Parties.

Estimations based on Marcogaz' methodology received from Ukrainian operators for 2019 correspond to the 2018 report submitted within the UNFCCC reporting framework. For transmission, estimated methane emissions are at the same level as in the National Inventory Report (NIR) by absolute amount and a leak factor. For distribution, only data by range of a leak factor corresponds.

For Georgia, methane emissions estimated by the Marcogaz' methodology and those reported within the UN framework vary significantly. This can partially be explained by the time lapse (last reporting year in the NIR is 2015) and considerable investments done in the last 5 years by the biggest DSO, aimed in particular to decrease leakage.

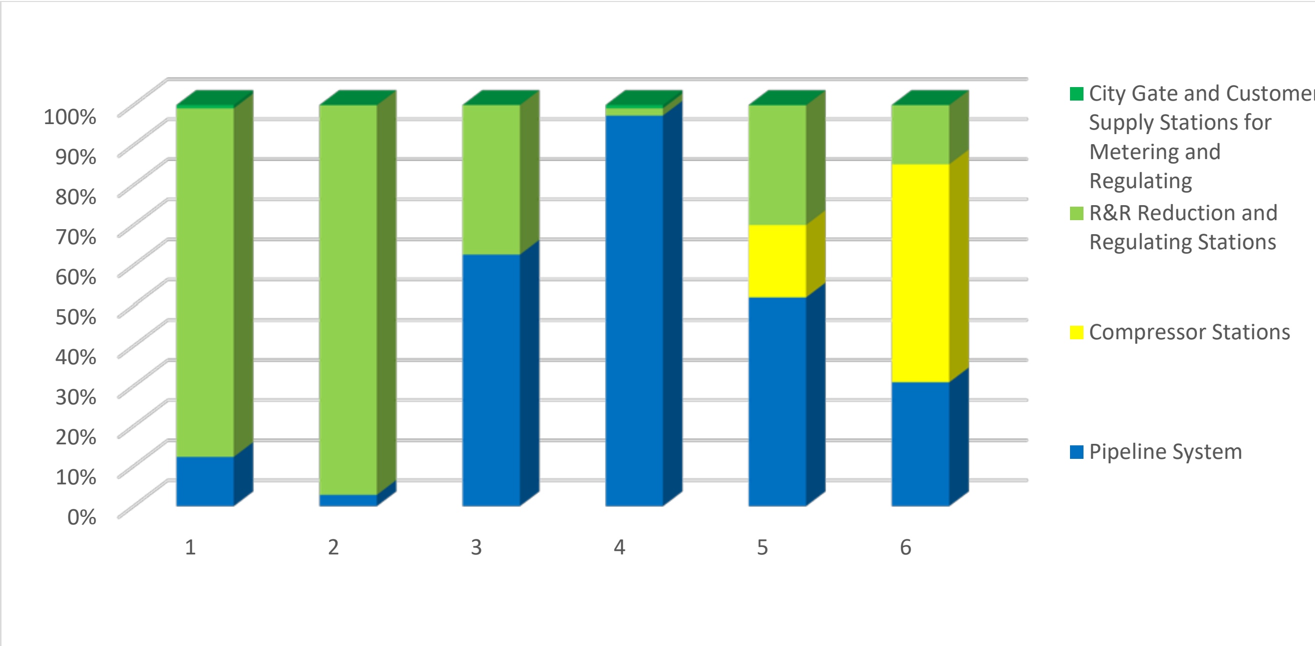
As explained in Chapter 3, all other Contracting Parties, as non-Annex 1 countries, do not report to the UNFCCC at a sufficient level of detail to provide a basis for comparing the methane emissions of gas transmission and distribution networks estimated by the different methodologies.

The results are displayed by type of emission and system asset, as structured by the estimation templates (Annexes 1 and 2).

There is no common pattern with respect to the percentage of emissions contributed by the different transmission system components of the six examined TSOs. Diagram 6 illustrates the importance of system composition when it comes to methane emissions. In a small system, regulation stations could be a more significant source of emissions than pipelines. In a lengthy but simple system, pipelines will be the main source of methane emissions. Further, the situation will differ based on whether or not the system includes compressor stations. A common point for all system configurations is that delivery stations represent the smallest, almost neglectable, share of methane emissions.

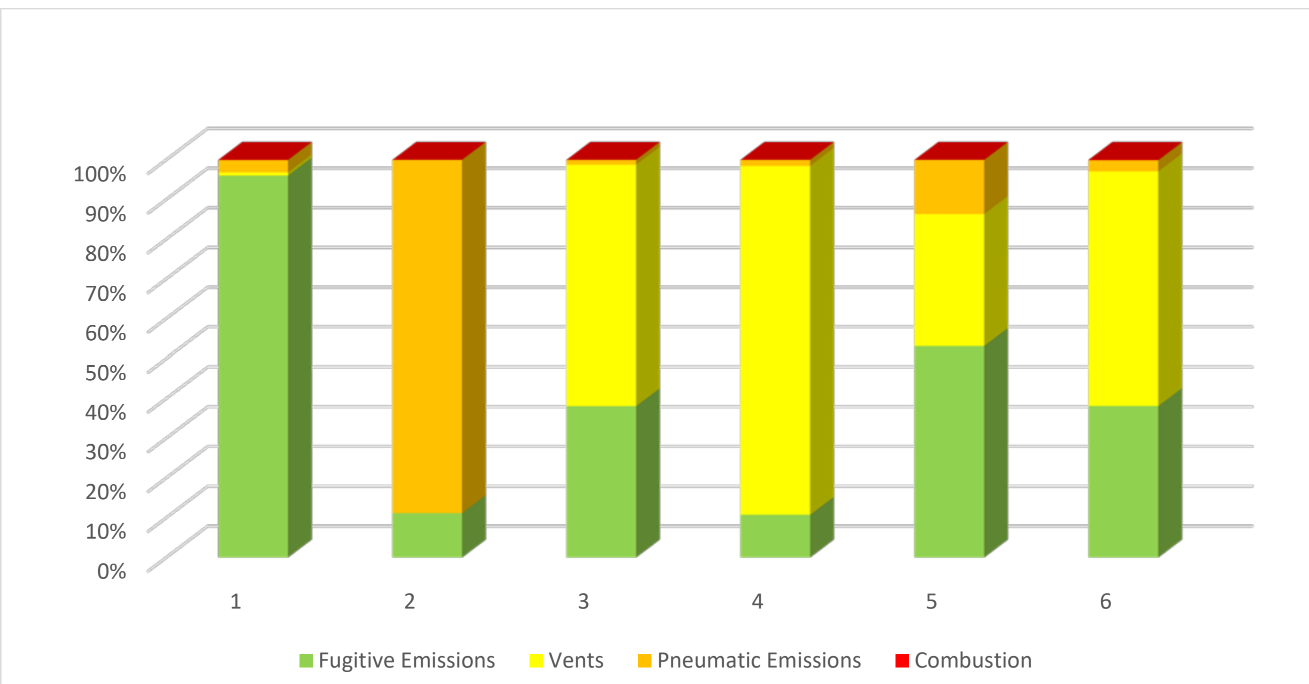
[30] Based on data submitted by 39 system operators, operating 3/4 of total gas network in the Contracting Parties; i.e. 93% of total transmission and 71% of total distribution networks

Diagram 6 – Respondent TSOs' methane emissions per type of asset



Source: compiled by the Energy Community Secretariat

Diagram 7 – Respondent TSOs' methane emissions per type of emission

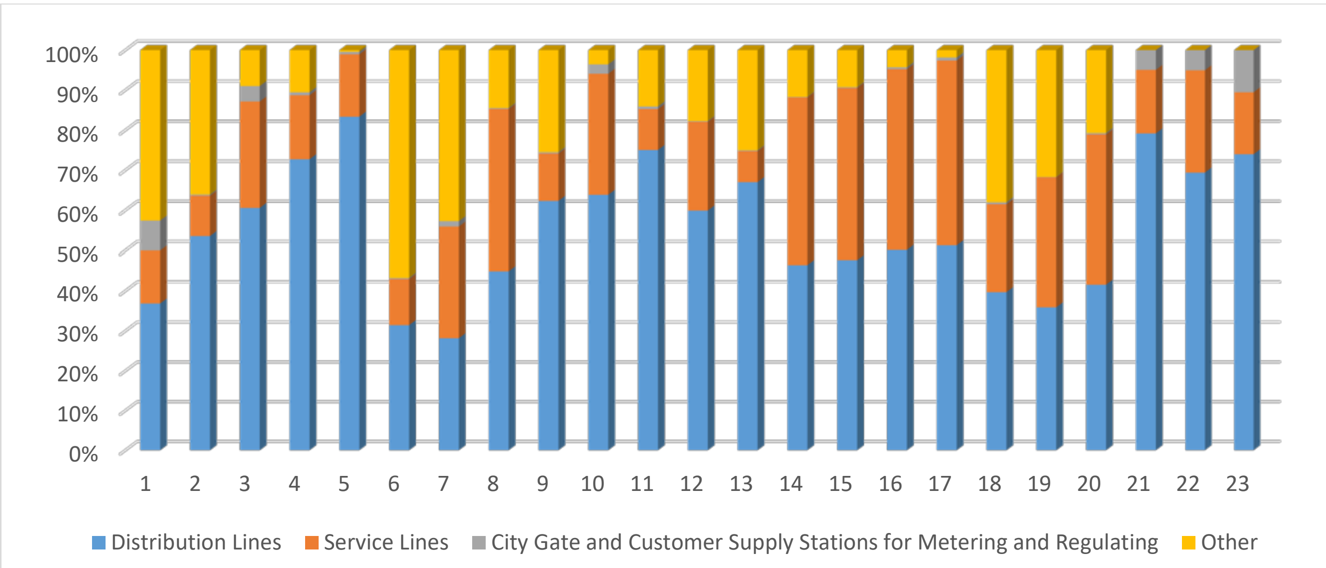


Source: compiled by the Energy Community Secretariat

The configuration of a transmission system also impacts the emission type, as shown in Diagram 7. Beside the assets composing a particular system, the structure of emissions depends on the type of activities in a particular year. For example, the more repair and reconstruction work, the higher the share of vent emissions. Emissions caused by incomplete combustion always have the smallest share.

For distribution networks, the analysis was conducted by type of asset only.

Diagram 8 – Respondent DSOs' methane emissions per type of asset



Source: compiled by the Energy Community Secretariat[31]

Diagram 8 shows that the structure of methane emissions depends on the configuration of the system, as is the case for the transmission system. The higher the number of service lines and additional equipment (mainly under category "other"), the lower the contribution of distribution lines to total methane emissions.

Issues related to gas being used for technological needs and total losses in distribution networks were raised during the collection of estimation tables and cross-checking of the submitted data. It is important to stress that estimation of methane emissions is not a replacement for methodologies determining losses for tariff purposes. However, increasing the knowledge of methane emissions, improving estimations, monitoring and reporting may contribute to refinement of the losses methodologies and, ultimately, to a decrease of the losses.

[31] 33 DSOs responded, 11 DSOs of Moldovagaz group are covered by one bar in the chart

The following conclusions can be drawn:

- ***System composition plays a crucial role in the structure of methane emissions, and simple comparisons between emission sources, companies and networks are not possible;***
- ***Companies have very different levels of measurement and recording of methane emissions, including approaches to allocation of emissions;***
- ***Choosing emission factors is crucial for the accurate estimation of emissions, and increasing knowledge in this area will be crucial for follow-up data collection; and***
- ***Reporting on methane emissions and reporting on total network losses are not fully interchangeable processes and should be decoupled.***

6. CONCLUSIONS AND PROPOSALS FOR FOLLOW-UP ACTIONS

This report successfully concludes the first project led by the Energy Community Secretariat to collect data on methane emissions stemming from gas system operation activities in the Contracting Parties. It not only resulted in invaluable data, providing a solid basis for future activities, but also raised awareness of methane emissions and established cooperation with relevant stakeholders. Overcoming initial concerns over data confidentiality could trigger new ways of cooperation in the future. At the same time, the exercise demonstrated the need for collecting additional data and improving the existing data collection methods in order to allow for better data comparability and drawing even more valuable insights.

In summer 2021, the Secretariat will launch a new collection exercise for 2020 methane emissions data, possibly based on an updated reporting template developed by Marcogaz. Special efforts will be dedicated to ensuring the participation of the missing gas operators. The launch will be accompanied by a webinar explaining the methodology to be followed, with a focus on emission factors, and individual discussions with stakeholders covered by the first report (on unclear elements or estimations). In parallel, the Secretariat will continue its various training and awareness raising activities, including on best practices in leak detection and repair.

Following the receipt of new data, the Secretariat will open discussions on setting company level targets to decrease methane emissions.

The Secretariat will also strive to extend the scope of methane emissions reporting to the entire energy sector of the Energy Community. It will promote the OGMP 2.0 reporting framework as well as other relevant initiatives to gas producers and oil companies in the Contracting Parties. The Secretariat will examine an adequate reporting framework for coal companies, which already exists within the UN ECE framework, and ensure synergies with the Coal Regions in Transition Initiative.

Annex 1 – Estimation template – methane emissions in gas transmission

METHANE EMISSION Calculation for Transmission

Organisation		**Natural Gas Composition**		
Company:		Average Methane Content of Natural Gas:		% (Vol.)
Emissions for the Year:	**2019**	Density of Methane:	0,7175	kg/m³
Responsible Person:		Conversion Factor from m³ Nat.gas to g CH4:		g CH4 / m³ Gas

Calculation

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

Annex 2 – Estimation template – methane emissions in gas distribution

METHANE EMISSION Calculation for Distribution

Organisation			Natural Gas Composition		
Company:			Average Methane Content of Natural Gas:		% (Vol.)
Emissions for the Year:	2019		Density of Methane:	0,7175	kg/m³
Responsible Person:			Conversion Factor from m³ Nat.gas to g CH4:		g CH4 / m³ Gas

Calculation

No.	System Category	Pressure	Activity Factors: Data	Activity Factors: Unit		Emission Factors: Marcogaz Range* Minimum	Emission Factors: Marcogaz Range* Maximum		Emission Factors: Company Data	Emission Factors: Unit	Total Emissions: Nat.Gas m³/a	Total Emissions: Methane g/a	Source for own factor: Measurement	Source for own factor: Literature	Source for own factor: Estimation	Remark (please specify, if possible)
1.	**Distribution Lines**															
1.1.	Grey cast iron with lead joint	Low		km	M	5.020	11.160	M		m3/km						
		Medium		km	M	1.207	1.300	L		m3/km						
		(1)		km						m3/km						
1.2.	Ductile cast iron	Low		km	L	900	8.000	L		m3/km						
		Medium		km	M	1.241	1.300	L		m3/km						
		(1)		km						m3/km						
1.3.	Steel	Low		km	L	300	300	L		m3/km						
		Medium		km	L	1.300	1.300	L		m3/km						
		(1)		km						m3/km						
1.4.	Steel with cathodic protection	Low		km	L	70	900	L		m3/km						
		Medium		km	L	300	300	L		m3/km						
		(1)		km						m3/km						
1.5.	Steel without cathodic protection	Low		km	L	900	3.436	M		m3/km						
		Medium		km	M	2.074	2.074	M		m3/km						
		(1)		km						m3/km						
1.6.	Plastic Polyethylene PE	Low		km	L	100	900	M		m3/km						
		Medium		km	M	161	300	L		m3/km						
		(1)		km						m3/km						
1.7.	Plastic PVC	Low		km						m3/km						
		Medium		km						m3/km						
		(1)		km						m3/km						
1.8.	Material in general not specified	Low		km	M	1.211	1.211	M		m3/km						
		Medium		km	M	1.207	1.300	L		m3/km						
		(1)		km						m3/km						
1.9	Total of Distribution Lines (1.1-1.8)															
2.	**Service Lines (2)**															
2.1.	No. Of Customers			No.	M	3	3	M		m³/No./a						
2.2.	Percentage of Total of Distribution Lines			m³/a	L	20%	90%	L		%						
2.3.	Total Emissions Service Lines															
3.	**City Gate and Customer Supply Stations for Metering and Regulating**															
	Number of Stations			No	M	45	45	M		m³/No/a						
4.	**Other (please specify)**															
5.	**Total Emissions**									Nat. Gas			Methane			
										Mio. m³			t/a			

Note (1): Use this when the emission factor is refered only to the material and not to pressure
Note (2): One alternative should be chosen