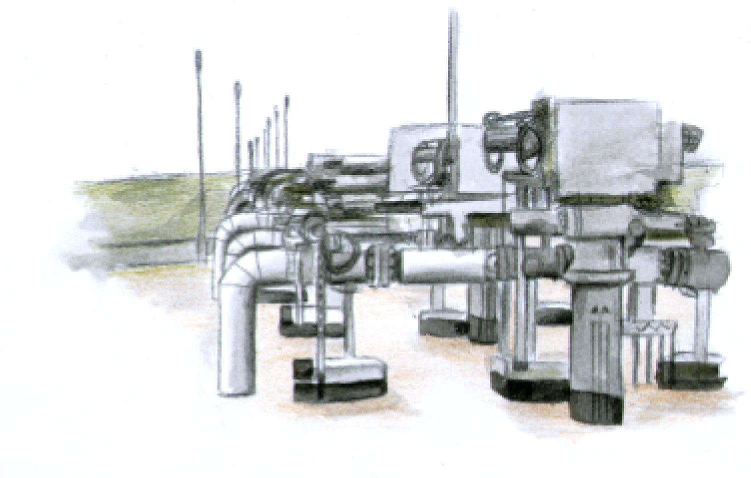
1.B.2.b - Natural Gas



Category Code	Method	AD	EF
1.B.2.b	T2, T3, M	AS	CS

Key Category	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	PB	Cd	Hg	Diox	PAH	HCB
1.B.2.b	-/-	-/-	-/-	-	-	-	-	-	-/-	-	-	-	-	-	-

.

Method(s) applied	
D	Default
T1	Tier 1 / Simple Methodology *
T2	Tier 2*
T3	Tier 3 / Detailed Methodology *
C	CORINAIR
CS	Country Specific
M	Model
* as described in the EMEP/EEA Emission Inventory Guidebook - 2019, in category chapters.	
(source for) Activity Data	
NS	National Statistics
RS	Regional Statistics
IS	International Statistics
PS	Plant Specific
As	Associations, business organisations
Q	specific Questionnaires (or surveys)
M	Model / Modelled
C	Confidential
(source for) Emission Factors	
D	Default (EMEP Guidebook)
CS	Country Specific
PS	Plant Specific
M	Model / Modelled
C	Confidential

1.B.2.b.i - Exploration

Source category 1.B.2.b.i is considered together with source category 1.B.2.a.i (Oil, exploration). Consequently, the aggregated, non-subdivided data of 1.B.2.b.i are included in source category 1.B.2.a.i.

1.B.2.b.ii - Production

The emissions of source category 1.B.2.b.ii consist of emissions related to production. Since 1998, the Federal Association of the Natural gas, Oil and Geothermal Energy Industries (BVEG) has determined the emissions from production and published the relevant data in its statistical report.

Table 1: Produced quantities of natural gas, in [Billion m^3]

1990	1995	2000	2005	2010	2015	2020	2022
15.3	19.1	20.1	18.8	12.7	8.6	5.2	4.8

Table 2: Emission factors for Natural gas production, in [g/ 1000 m^3]

Substance	Emission Factor
NMVOC	2
Mercury	0.0007

1.B.2.b.iii - Processing

The emissions of this category consist of emissions from the activities of pretreatment and processing. After being brought up from underground reserves, natural gas is first treated in drying and processing plants. As a rule, such pretreatment of the natural gas takes place in facilities located directly at the pumping stations. Such processes separate out associated water from reserves, along with liquid hydrocarbons and various solids. Glycol is then used to remove the water vapour remaining in the gas (p. 25)[1]. Natural gas dehydration systems are closed systems. For safety reasons, all of such a system's overpressure protection devices are integrated within a flare system. When such protection devices are triggered, the surplus gas is guided to a flarehead, where it can be safely burned. After drying, the natural gas is ready for sale and can be delivered to customers directly, via pipelines [2]. The relevant quantities of flared gas are reported under 1.B.2.c. The natural gas drawn from Germany's Zechstein geological formation contains hydrogen sulphide. In this original state, the gas – known as “sour gas” – has to be subjected to special treatment. Due to the hazardousness of hydrogen sulphide, this gas is transported via separate, specially protected pipelines to German processing plants that wash out its hydrogen sulphide via chemical and physical processes. About 40 % of the natural gas extracted in Germany is sour gas [3]. The natural gas that leaves processing plants is ready for use. The hydrogen sulphide is converted into elementary sulphur and is used primarily by the chemical industry, as a basic raw material.

Table 3: Sulphur production from natural gas production, in [kt]

1990	1995	2000	2005	2010	2015	2020	2022
915	1,053	1,100	1,050	832	628	353	371

For processing of sour gas, data of the BVEG (the former WEG) for the period since 2000 are used. This data is the result of the BVEG members' own measurements and calculations. For calculation of emissions from sour-gas processing, a split factor of 0.4 relative to the activity data is applied. That split factor is based on the BVEG report [4] on sour-gas processing.

Table 4: Emission factors for emissions from treatment of natural gas, in [kg/ 1000 m^3]

	Value
NMVOC	0.005
CO	0.043
NO_x	0.011
SO_2	0.140

1.B.2.b.iv - Transmission

This source category's emissions consist of emissions from activities of gas producers and suppliers. In Germany, natural gas is transported from production and processing companies/plants to gas suppliers and other processors. In addition, natural gas is imported and transmitted via long-distance pipelines. Almost all of the pipelines used to transmit natural gas are steel pipelines [5].

One important emissions pathway consists of the compressors that are used to maintain pressure in pipelines. They are spaced at intervals of about 100 km along lines [6]. At present, the compressors involved have a total power output of about 2,585 MW [7]. The pipelines are also fitted with shut-off devices (sliding sleeves), which are safety mechanisms located at intervals of about 30 km along high-pressure pipelines, and with systems for regulating and measuring gas pressure.

In pipeline inspection and cleaning, tools known as pipeline inspection gauges (“pigs”) are used. In a pipeline system, a pig moves, driven by the gas flow, from a launching station to a receiving station (pig trap). Systems for launching and catching pigs can be either fixed or portable. Small quantities of methane are emitted in both insertion and removal of pigs. In addition, pig traps can develop leaks. Normally, however, such traps are regularly monitored for leaks and repaired as necessary. Not all types of pipelines can be pigged; diameter reductions, isolation valves, bends, etc. in pipelines can block pigs. These emissions have been estimated in the framework of a study carried out by the firm of DBI Gas- und Umwelttechnik GmbH [8].

Table 5: Activity data applied for NFR 1.B.2.b.iv

	Unit	1990	1995	2000	2005	2010	2015	2020	2022
Length of transmission pipelines	km	22,696	28,671	32,214	34,086	35,503	34,270	33,809	34,035
Cavern reservoirs	Billion m³	2.8	4.8	6.1	6.8	9.2	14.3	15.1	14.3
Porous-rock reservoirs	Billion m³	5.2	8.5	12.5	12.4	12.1	9.8	8.6	8.6

Most of the gas extracted in Germany is moved via pipelines from gas fields and their pumping stations (either on land or off the coast). Imported gas is also transported mainly via pipelines.

The emission factor for underground natural gas storage was derived via surveys of operators and analysis of statistics on accidents / incidents [9], and it is valid for porous storage and cavern-storage facilities. The NMVOC split factor have been obtained from the research project [10] described on chapter 6.

Table 6: NMVOC content of natural gas, mean values from [11]

1990	2000	2010	2020
2,57%	2,87%	3,43%	3,50%

1.B.2.b.v - Distribution

The emissions caused by gas distribution have decreased slightly, even though gas throughput has increased considerably and the distribution network has been enlarged considerably with respect to its size in 1990. One important reason for this improvement is that the gas-distribution network has been modernised, especially in eastern Germany. In particular, the share of grey cast-iron lines in the low-pressure network has been reduced, with such lines being supplanted by low-emissions plastic pipelines. Another reason for the reduction is that fugitive losses in distribution have been reduced through a range of technical improvements (tightly sealing fittings such as flanges, valves, pumps, compressors) undertaken in keeping with emissions-control provisions in relevant regulations (TA Luft (1986) and TA Luft (2002)).

Table 7: Length of natural gas distribution network, in [km]

1990	1995	2000	2005	2010	2015	2020	2022
282,612	366,987	362,388	402,391	471,886	474,570	503,543	529,000

Pipeline network

The calculation was carried out using the Tier 3 method, on the basis of the available network statistics of the German Association of Energy and Water Industries (BDEW) [12] and of own surveys. In the early 1990s, emissions from distribution of town gas were also taken into account in calculations. In 1990, the town gas distribution network accounted for a total of 16 % of the entire gas network. Of that share, 15 % consisted of grey cast-iron lines and 85 % consisted of steel and ductile cast-iron lines. The emission factors have been obtained from the research project [13] with using the split factor described on chapter 6..

Storage reservoirs

Man-made above-ground storage facilities, for storage of medium-sized quantities of natural gas, help meet and balance rapid fluctuations in demand. In Germany, spherical and pipe storage tanks, and other types of low-pressure containers, are used for this purpose. Results from a relevant research project [14] have made it possible to derive new country-specific emission factors for this area. The emissions have been calculated in accordance with the Tier 2 method.

Liquefied natural gas (LNG)

Natural gas can be liquefied, at a temperature of -161°C, for ease of transport. The liquefaction process is highly energy-intensive, however, and is normally used only in connection with long-distance transports. Germany did not have LNG terminals before 2022. Gas imports arrive mostly in gaseous form, via long-distance pipelines, and they are included in 1.B.2.b.iv. Germany now has one natural gas liquefaction facility and two satellite LNG storage facilities. Since the storage and transfer processes at those facilities are subject to the most stringent standards possible, emissions there can be ruled out. Gas can escape only in connection with maintenance work, and the gas quantities involved are extremely small. The quantities do not exceed more than a few hundred kilograms [15].

In the 1990s, town gas (=coal gas) was supplied to households via distribution systems in East Germany and West-Berlin. The composition of coal gas varied in the different regions, consisting of hydrogen, carbon monoxide, methane and nitrogene.

1.B.2.b.vi - Post-Meter Emissions

The category describes emissions from leakage in the industrial sector and in the residential and institutional/commercial sectors as well as from natural gas-powered vehicles.

Leakage in the industrial sector and in the residential and institutional/commercial sectors

The activity data is based on own surveys.

Table 8: Number of gas meters in the residential and institutional / commercial sector, in Millions

1990	1995	2000	2005	2010	2015	2020	2022
10.3	12.7	12.8	13.3	12.9	13.0	13.1	13.1

The emission factors are country-specific, and they were determined via the research project by DVGW and GWI [16]. They include start-stopp loses at all enduser devices. The study covers methane only. The appropriate NMVOC factor was derived from the publication [17] (refer to chapter 6).

Natural-gas-powered vehicles, and CNG fuelling stations

Use of vehicles running on natural gas continues to increase in Germany. Such vehicles are refuelled at CNG fuelling stations connected to the public gas network. In such refuelling, compressors move gas from high-pressure on-site tanks. Some 900 CNG fuelling stations are now in operation nationwide. In keeping with the stringent safety standards applying to refuelling operations and to the tanks themselves, the pertinent emissions are very low. In the main, emissions result via tank pressure tests and emptying processes.

Table 9: Number of natural-gas-powered vehicles

1990	1995	2000	2005	2010	2015	2020	2022
-.-	-.-	7,500	28,500	90,000	97,804	100,807	100,690

Recalculations

For more details please refer to the super-ordinate chapter 1.B - Fugitive Emissions from fossil fuels

Planned improvements

No further improvements are planned.

References

[1], [3] WEG (2008). Report of the Association of Oil and Gas Producing “Erdgas – Erdöl. Entstehung-Suche-Förderung”, Hannover, 34 S. External Link, PDF
[2] EXXON (2014). Förderung von Erdgas in Deutschland.
[4] BVEG (2022). Statistischer Jahresbericht 2021 External Link
[5] Zöllner, S. (2014). Überführung der Bestands- und Ereignisdaten des DVGW in die Emissionsdatenbank des Umweltbundesamts.
[6] GASUNIE (2014). Verdichterstationen.
[7] Ohlen, N. v. (2019). Umsetzungsbericht zum Netzentwicklungsplan Gas 2018-2028 der Fernleitungsnetzbetreiber. External Link, PDF
[8] Grosse, C. (2019). Qualitätsprüfung der Texte für den nationalen Inventarbericht und Datenerhebung in der Quellgruppe.1.B.2.b (PNr. 1252 30).
[9], [14], [15] Langer, B. u. (2012). Ermittlung von Emissionsfaktoren und Aktivitätsraten im Bereich IPCC (1996) 1.B.2.b.iii (Bericht Nr. M96023/01, UBA FKZ 360 16 035).
[10], [11], [13], [17] Boettcher, C. (2022) Aktualisierung der Emissionsfaktoren für Methan für die Erdgasbereitstellung, published by UBA External Link
[12] German Association of Energy and Water Industries (BDEW) (2016). 2016 Gas Statistics “Gasstatistik 2016”.
[16] Entwicklung der Methanemissionen in der Gasanwendung, published by DVGW and GWI (2022) External Link