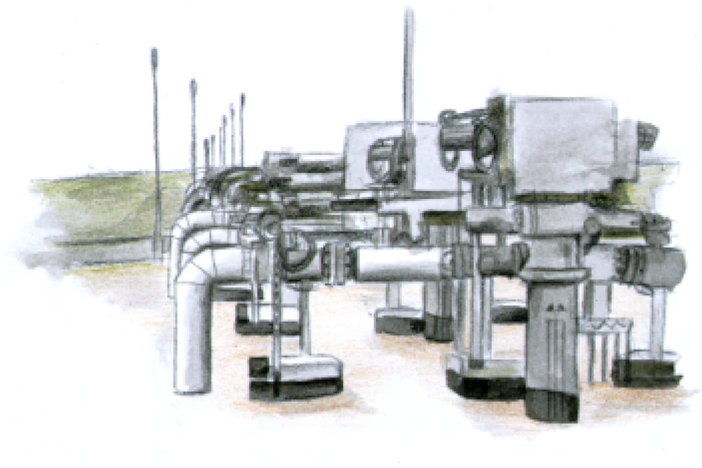
1.B.2.b - Natural Gas



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

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

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.

activity data	Unit	1990	1995	2000	2005	2010	2015	2018	2019
produced quantities of natural gas	Billion m³	15.3	19.1	20.1	18.8	12.7	8.6	6.3	6.1

Source of emission factor	Substance	Unit	Value
Natural gas production	NMVOC	kg/ 1000 m³	0.005

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.

	Unit	1990	1995	2000	2005	2010	2015	2018	2019
Sulphur production from natural gas production	kt	915	1,053	1,100	1,050	832	628	420	460

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 WEG report [1] on sour-gas processing.

Source of emission factor	Substance	Unit	Value
Treatment of sour gas	NMVOC	kg/ 1000 m³	0.004
Treatment of sour gas	CO	kg/ 1000 m³	0.043
Treatment of sour gas	NOx	kg/ 1000 m³	0.011
Treatment of sour gas	SO2	kg/ 1000 m³	0.14

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 [4)].

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 [5)]. At present, the compressors involved have a total power output of about 2,585 MW [6)]. 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 [7)].

	Unit	1990	1995	2000	2005	2010	2015	2018	2019
Length of transmission pipelines	km	22,696	28,671	32,214	34,086	35,503	34,270	34,996	34,476
Cavern reservoirs	Billion m³	2.8	4.8	6.1	6.8	9.2	14.3	12.4	15.3
Porous-rock reservoirs	Billion m³	5.2	8.5	12.5	12.4	12.1	9.8	9.1	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 [8)], and it is valid for porous storage and cavern-storage facilities. It is seen as very conservative. The emission factor for the compressor systems and the sliding sleeve hubs has been obtained from the research project [9)].

Source of emission factor	Substance	Unit	Value
Long-distance high-pressure pipeline	NMVOC	kg/km	3,973
Compressors	NMVOC	kg/MW	550
Sliding sleeve hub	NMVOC	kg/m³	825
Systems for regulating and measuring gas pressure	NMVOC	kg/No	13,7
Cavern reservoirs	NMVOC	kg/ 1000 m³	0,001
Porous-rock reservoirs	NMVOC	kg/ 1000 m³	0,001

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)).

	Unit	1990	1995	2000	2005	2010	2015	2018	2019
Distribution network of natural gas	km	246,710	366,987	362,388	402,391	471,886	474,57	488,292	493,175
Number of natural-gas-powered vehicles	No	-.-	-.-	7,500	28,500	90,000	97,804	96,531	98,460

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) [10)] 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 for the distribution network were verified in 2012 [11)] and 2014 [12)].

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 [13] 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.

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 [14]. 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.

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 has no LNG terminals at present [15]. 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 [16].

Source of emission factor	Substance	Unit	Value
Low-pressure pipeline made of steel and ductile cast iron	NMVOC	kg/km	9.3
Low-pressure plastic pipeline	NMVOC	kg/km	1,275
Low-pressure grey-cast-iron pipeline	NMVOC	kg/km	11,125
Medium-pressure pipeline made of steel and ductile cast iron	NMVOC	kg/km	5,175
Medium-pressure plastic pipeline	NMVOC	kg/km	0.7
High-pressure pipeline made of steel and ductile cast iron	NMVOC	kg/km	1.55
High-pressure plastic pipeline	NMVOC	kg/km	0.008
Above-ground storage facilities	NMVOC	kg/ 1000 m³	0.125

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 - Distribution

The category describes emissions from leakage in the industrial sector and in the residential and institutional/commercial sectors. The activity data is based on results of the German Association of Energy and Water Industries (BDEW) [17] and of own surveys. The BDEW gas statistics appear with a time lag of up to three years. Data of the Working Group on Energy Balances (AGEB) [18] is used to bridge the resulting gap.

activity data	Unit	1990	1995	2000	2005	2010	2015	2018	2019
Gas meters in the residential and institutional / commercial sector	Million	10.3	12.7	12.8	13.3	12.9	13	13.1	13.1
Energy consumption of the industry	TWh	323	361	370	399	335	377	391	426.5

The emission factors are country-specific, and they were determined via the research project "Methane emissions via gas use in Germany from 1990 to 1997, with an outlook for 2010" (Methanemissionen durch den Einsatz von Gas in Deutschland von 1990 bis 1997 mit einem Ausblick auf 2010) Fraunhofer ISI (2000) [19)]. To receive appropriate NMVOC emission factors the gas composition was considered.

Source of emission factor	Substance	Unit	Value
Gas meters and fittings in the residential and institutional/commercial sectors	NMVOC	m^3 / No	0.045
Fittings in industrial facilities	NMVOC	m^3/ m^3	0.00001025

Recalculations

will be published later - in meantime please refer to chapter 8.1 "recalculations"

Planned improvements

Emission factors from natural gas transmission will be updated according to results of the UNEP OGMP 2.0 measurement programm (1.B.2.b.iv)

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