

For our Environment

11th annual meeting of the Task Force on Techno-economic issues

Emissions of natural-gas and fuel-oil fired medium combustion plants in Germany

Stockholm, 08.10.2025
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Agenda

1. CONTENT AND BACKGROUND OF THE PROJECT

2. MEASUREMENT RESULTS

3. BEST AVAILABLE TECHNIQUES

4. REGULATIONS IN 6 EUROPEAN COUNTRIES

5. EMISSIONS PROGNOSIS FOR GERMANY 2030

Content and background of the project

Content of the project

- 100 emission measurements at medium combustion plants (MCPs): NO_x, CO, dust, TOC, methane, smoke number
 - 78 for natural gas combustion, 28 for light fuel oil combustion
 - partly at dual fuel burners
 - rated thermal input 1-10 MW
 - Focus on existing plants (only 5 new plants)
- Calculation of emission factors (for emissions reporting)
- Calculation of the total emissions in Germany 2020
- Emissions prognosis for 2030
- Determination of best available techniques (BAT)
- Evaluation of regulations in 6 European countries

Content and background of the project

Situation in Germany before the entry into force of the Medium Combustion Plants Directive (MCPD)

Natural-gas and light fuel-oil fired MCPs of 1 to 10 MW did not need a licence.

No regular NO_x measurements obligatory

NO_x emission limit values (ELV) only at test stand

CO ELV for safety reasons, having nothing to do with BAT

CO (and smoke number) measurements every 2 years by chimney sweepers

→ Very few measurement results available

Content and background of the project

Situation in Germany after the implementation of the MCPD

Regular NO_x measurements every 3 years

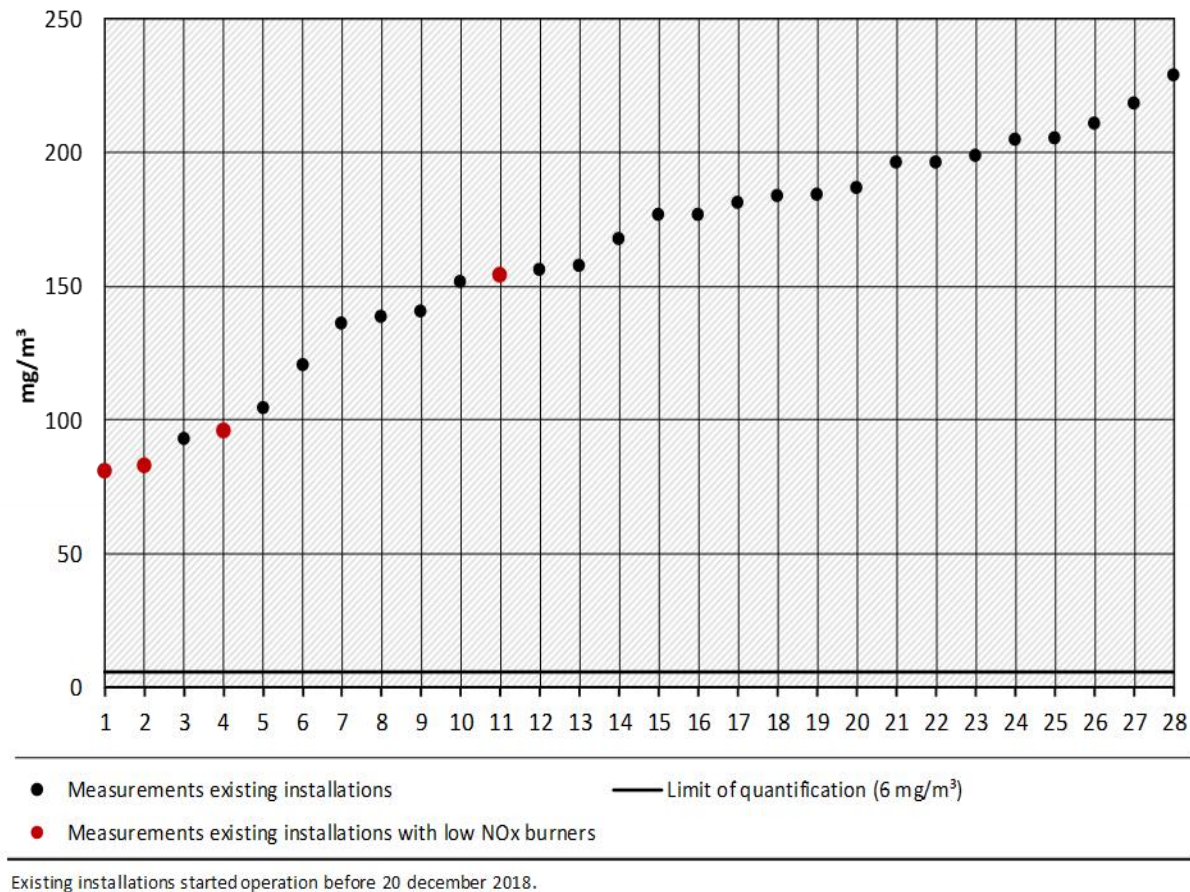
- for existing plants beginning in 2025,
- for new plants beginning with the start of operation.

New ELVs for NO_x and CO

Fuel	Plant type	NO _x [mg/Nm ³]	CO [mg/Nm ³]	Smoke number	Exhaust gas heat loss
Natural gas	New plants	100	80	-	9 %
	Existing plants	150	110	-	9 %
Fuel oil	New plants	200	80	1	9 %
	Existing plants	200	150	1	9 %

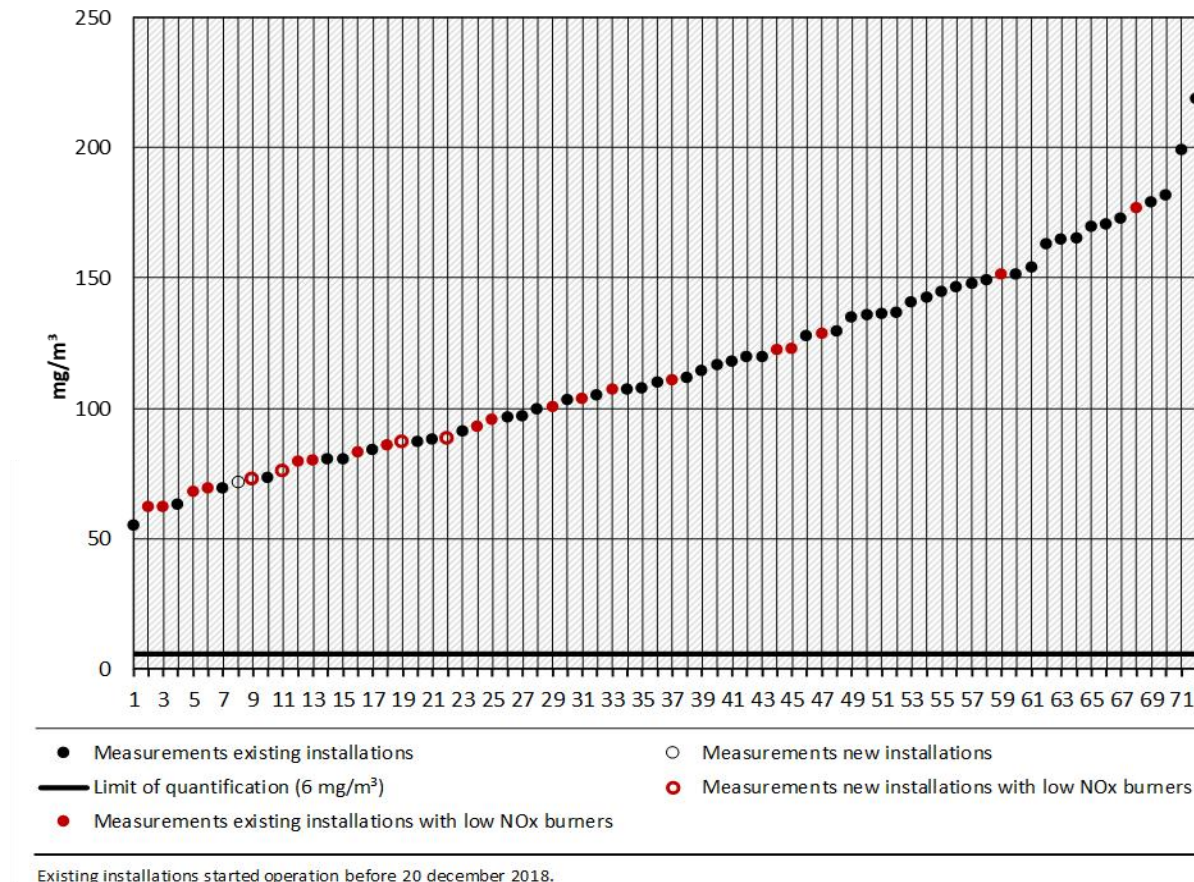
Measurement results – fuel oil combustion - NO_x

Nitrogen oxides measured values - fuel oil plants (standardised, 3 % reference oxygen content, average of three measurements, usually 30 minutes each)



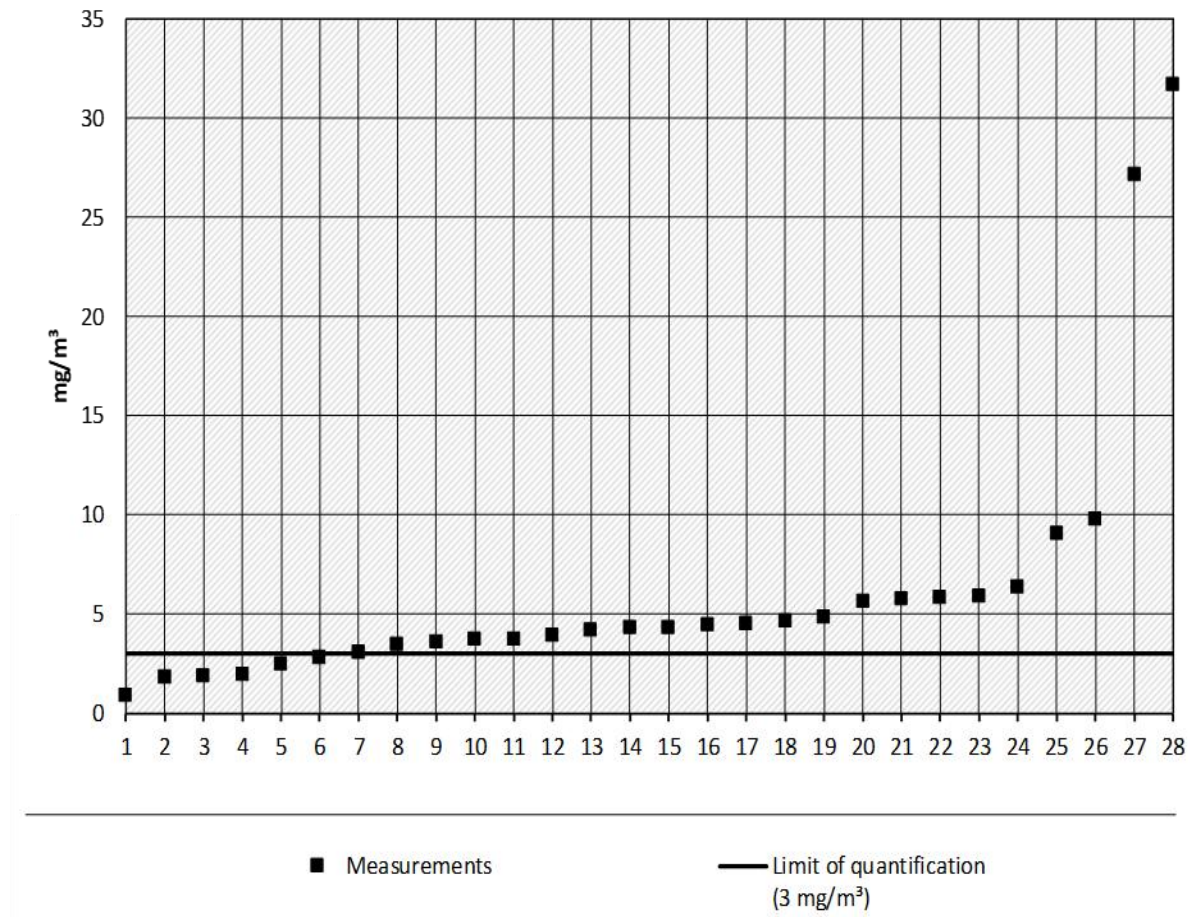
Measurement results – natural gas combustion - NO_x

Nitrogen oxides measured values – natural gas plants (standardised, 3 % reference oxygen content, average of three measurements, usually 30 minutes each)



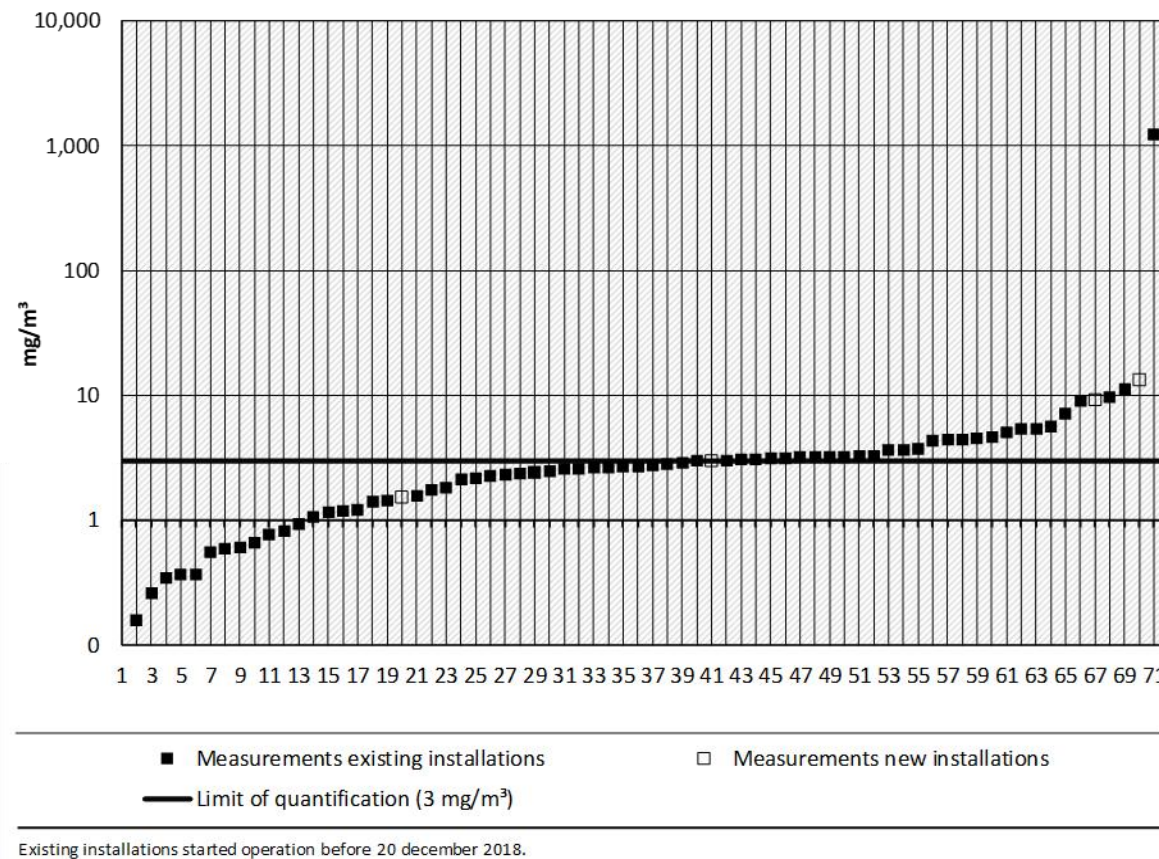
Measurement results – fuel oil combustion - CO

Carbon monoxide measured values - fuel oil plants (standardised, 3 % reference oxygen content, average of three measurements, usually 30 minutes each)



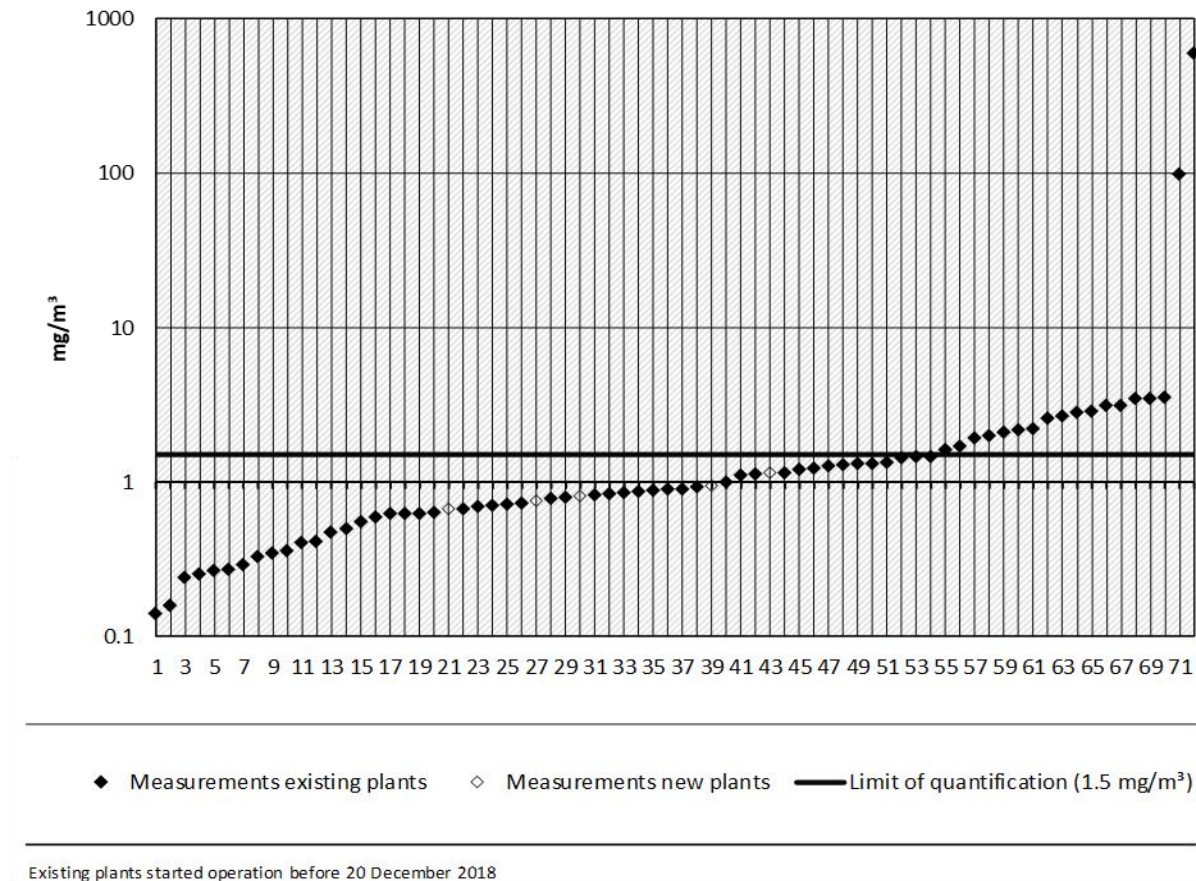
Measurement results – natural gas combustion - CO

Carbon monoxide measured values – natural gas plants (standardised, 3 % reference oxygen content, average of three measurements, usually 30 minutes each)



Measurement results – natural gas combustion - methane

Methane measured values – natural gas plants (standardised, 3 % reference oxygen content, average of three measurements, usually 30 minutes each)



Summary of important measurement results

NO_x emissions

Fuel oil: 82 % of the measured values are below the MCPD ELV.

Natural gas: All new plants comply with the MCPD ELV.

98 % of the measured values for existing plants are below the MCPD ELV.

But: 21 % of the measured values are higher than the national ELV.

CO emissions

Fuel oil: CO < 40 mg/m³ in all cases

Natural gas: 2 outliers with very high CO emissions → lack of maintenance?

All other boilers: < 40 mg/m³

Methane emissions

Fuel oil: < 3 mg/m³ in all cases, 79 % below limit of quantification (LoQ)

Natural gas: 2 outliers with very high emissions (the same as for CO emissions)

All other boilers: < 4 mg/m³

Summary of important measurement results

Dust emissions

Fuel oil: $\leq 3 \text{ mg/m}^3$

Natural gas: $< 3 \text{ mg/m}^3$

TOC emissions

Fuel oil: $< 3 \text{ mg/m}^3$ in all cases

Natural gas: 2 outliers with very high TOC emissions

All other boilers: $< 4.5 \text{ mg/m}^3$

Smoke number

Fuel oil: < 1.6

Best available techniques – candidate techniques

Emission reduction techniques for gas- and oil-fired burners

Pollutant technique	NO _x	SO ₂	CO	TOC	NMVOC	Dust	Energy efficiency
Waste gas heat utilisation	x	-	x	x	x	x	X
Lambda sensor/O ₂ control	x	-	x	x	x	x	X
Low-sulphur fuels	x	X	-	-	-	-	-
Exhaust gas recirculation (external)	X	-	x	x	x	x	x
Exhaust gas recirculation (internal)	X	-	x	x	x	x	x
Low NO _x burner	X	-	-	-	-	-	-
Non-catalytic reduction (SNCR)	X	-	-	-	-	-	-
Catalytic reduction (SCR)	X	-	-	-	-	-	-

Best available techniques – candidate techniques

Flue-gas heat utilization

Condensing boilers are only used with some new plants.

Lambda sensor/O₂ control

Generally applicable, also as a retrofit

Low-sulphur, low-nitrogen fuel

Low-sulphur fuel oil is widely available, some old peak-load plants may still use old stocks.

DIN (national) standard 51603-1 defines “Extra light (EL) fuel oil low sulphur, low nitrogen”:

≤ 140 mg N per kg fuel

Best available techniques – candidate techniques

Exhaust gas recirculation (EGR)

External: outside the combustion chamber

Internal: inside the combustion chamber or the burner

Retrofit only possible for external EGR

Low NO_x burner

Generally applicable, also as a retrofit

Principle: Lowering the temperature in the "flame root" and exhaust gas recirculation

Low NO_x burners can generally be used except for reverse flame boilers.

Retrofit possible with some exceptions

Difficulties can arise because the low NO_x burner generally has a lower output than a standard burner installed in the same boiler due to the reduced flame temperature. If the output leads to an undersupply of the connected heat users, the burner may not be fit for purpose.

Best available techniques – candidate techniques

Selective non-catalytic reduction (SNCR)

Injection of urea or NH_3 into the exhaust gas

Temperature window 900-1050 °C (may not be achieved at part load)

In Germany only used for heavy fuel oil boilers

Selective catalytic reduction (SCR)

Catalyst that selectively reduces nitrogen oxides to inert nitrogen (N_2).

Exhaust gas temperature of at least around 350 °C for the reaction.

Generally applicable, also as a retrofit, but expensive → in DE not used for boilers as MCPs

Regulations in European countries

Workshop with presentations from AT, BE, DK, DE, NL,CH

Direct comparison of ELVs not possible, differences:

- Addition/subtraction/no consideration of measurement uncertainty
- Measurement duration (30 to 90 minutes)
- Compliance with ELV of all measured values/average of measured values
- Measurement periods: every 3 months – every 3 years

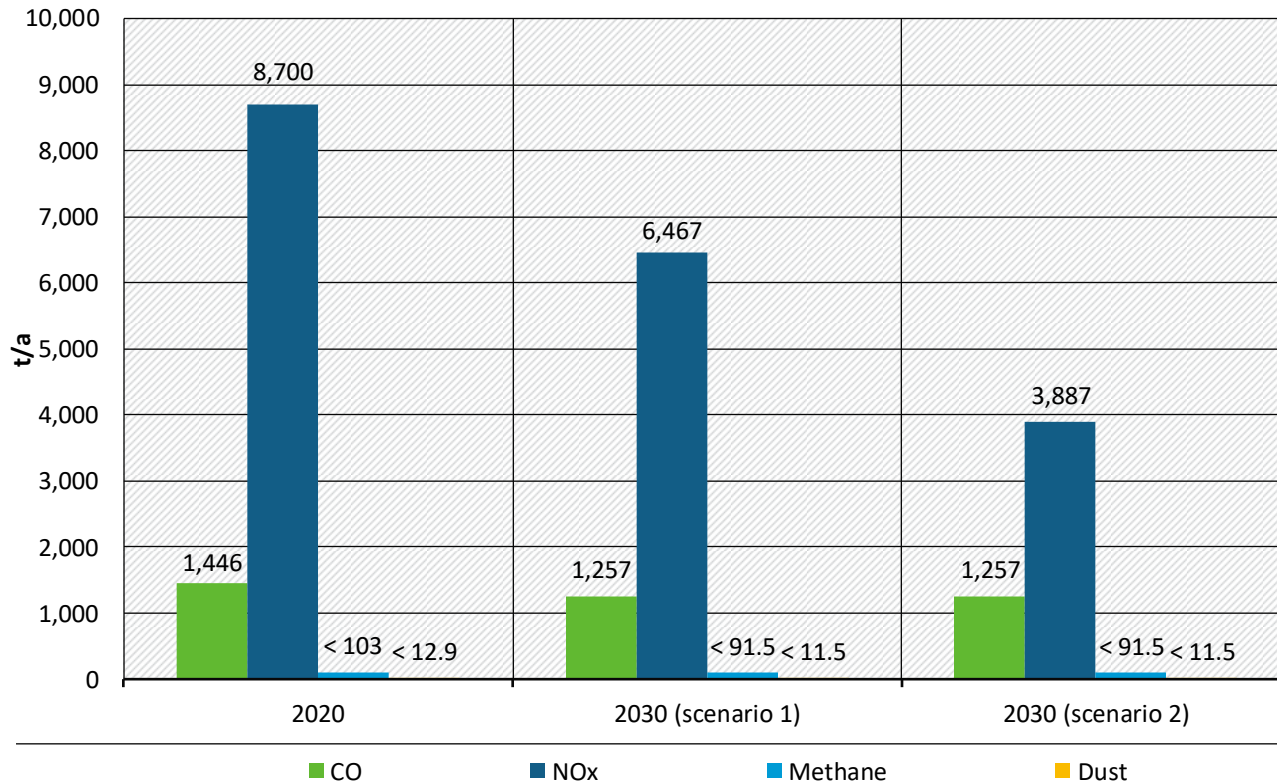
Nationally used techniques

Low NO_x burners are BAT in the 6 participating countries:

- In AT, BE (Flanders), NL also for existing plants
- In DE only for new plants

NL has the strictest regulation: ELV of 70 mg/m³ NO_x– which implies obligatory use of low-NO_x burners - for new and existing plants.

Emissions prognosis for Germany 2030



Note: Methane, dust with "<" as measurement results were partly below the limit of quantification (LOQ) and used for the emission factor with half the LOQ.

Scenario 1: with German ELVs, scenario 2: with Dutch NO_x ELV

Thank you for your attention!

For further information

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<https://www.umweltbundesamt.de/publikationen/determination-of-emission-factors-emissions-in-2020>