Measures that have already been implemented or measures whose implementation has been decided are assigned to the WM scenario.

Reductions in large combustion plants through implementation of the 13th and 17th BImSchV as well as minimum requirements of recent BAT conclusions:

Measures for large combustion plants (LCP) that have already been implemented through the 13th and 17th BImSchV or do have future reduction effects from the existing regulations as well as minimum requirements of recent BAT conclusions are considered in the WM scenario. The amendment of the 17th BImSchV, part of the WAM scenario of the NAPCP 2023, has been implemented on 13th February 2024 and future mitigation potential is estimated in the current WM scenario.

The measures affect time series of NFR sectors under 1.A.1 and 1.A.2 and lead to a reduction in the emission factors. Potential mitigation effects emerge from BAT conclusions according to Directive 2010/75/EU (amended by Directive (EU) 2024/1785). If the current inventory submission 2024 shows that the emissions in the time series are already below the upper ends of the specified emission ranges and thus the statutory maximum limit values will be fulfilled, these will be updated unchanged. In the case of time series above the upper range, the maximum permitted annual limit values are used as a result of the measure in the sense of a conservative estimation and the emission factors of the pollutants for each source group are recalculated.

The calculations always follow the same procedure. Important elements are the specific limit values of the 13th and 17th BImSchV as well as the distribution of the plants according to their rated thermal input (RTI) in megawatts (MW). In addition, it is assumed that all new and existing plants correspond at least to the standard of the upper range of the associated BAT conclusions. The lower emission factor out of both calculations is than compared with the reference value. If the recalculated emission factor of the source category under consideration is greater than the current reference value, the reference value from the 2024 submission will be updated unchanged. If the reference value is higher, the new value is set and projected[1)].

According to expert estimates, the plant inventory is split as in Table 5 according to the RTI (in MW). These (cumulative) proportions are necessary for the calculation of the mean values in relation to the upper range of limit values for each source category and pollutant.

Table 5: Proportionate inventory of LCPs according to their power range

RTI in MW	Proportion
<100	4.5 %
100-300	14.5 %
300-1000	68 %
>1000	13 %

The limit values of LCP are set according to their power ranges. The table shows the estimated proportion of LCP in Germany in relation to the RTI provided.

Example 1

The concrete procedure is illustrated using the example of NO_x emissions from the use of raw lignite as fuel for heat generation in public district heating plants.

The specific BAT-associated emission levels for lignite can be found in Commission Implementing Decision (EU) 2017/1442 BAT 20. With a reference oxygen of 6 %, the plants are differentiated according to size and specified with the emission levels in mg/Nm^3. The upper end of the emission levels is interpreted as a maximum limit value and converted into kg/TJ using the specific conversion factor of 2.40 (see Table 4). The calculated maximum limit value is therefore averaged for each plant size, taking into account the number of plants, and thus, the estimated value for the necessary NO_x emission factor for compliance with the maximum limit value is calculated in accordance with the BAT conclusions. The necessary data can be found in Table 6. This shows the plants subdivision according to their RTI with the assigned maximum limit values as annual averages in mg/Nm^3 and kg/TJ.

Table 6: Emission limit values (annual averages) when using raw lignite in existing plants

Plant size according to RTI in MW	max limit value in mg/m^3	max limit value in kg/TJ	Proportion
<100	270	112.70	4.5 %
100-300	180	75.13	14.5 %
>300	175	73.04	81 %

The LCP emission limit values for the use of raw lignite are regulated in (EU) 2017/1442 BAT 20. There are separate limit values for each RTI of the plant. The upper range is shown here as a limit value for existing plants as annual averages in mg/Nm^3 and kg/TJ.

The implied emission factor is calculated in (1).

```
  (1) emission factor (lignite) = 112.70 kg/TJ * 4.5 % + 75.13 kg/TJ * 14.5 % + 73.04 kg/TJ * 81 % = 75.13 kg/TJ
```

The comparison with the current submission 2024 shows that the calculated emission factor (75.13 kg/TJ) is lower than that of the reference value from 2022 (76.8 kg/TJ). Thus from 2025 onwards the emission factor will be replaced by the new value and used for the projection.

This procedure is analogous for the evaluation of all source groups and pollutants.

Example 2

According to the Commission Implementing Decision (EU) 2017/1442 of 31st July 2017 on Conclusions on Best Available Techniques (BAT) according to Directive 2010/75/EU of the European Parliament and of the Council for large combustion plants, the maximum permissible pollutant emission for NO_x while using heavy fuel oil in plants <100 MW is 270 mg/Nm^3 and in plants >100 MW is 110 mg/Nm^3 as yearly average for existing plants with more than 1,500 operating hours per year (BAT 28).

13th BImSchV in the version of 2021 sets limit values for NO_x as 270 ng/Nm^3 in plants <100 MW with more than 1500 operating hours per year and 400 mg/Nm^3 in plants <100 MW with less than 1,500 operating hours per year. For existing plants >100 MW 270 mg/Nm^3 and for new plants >100 MW 110 mg/Nm^3 are set. The values are converted into kg/TJ according to the specific flue gas volume of heavy fuel oil (Table 4).

Assuming a 50% share of plants within each size class, lacking specific data, from 2030 onwards a projected implied NO_x emission factor of 58.0 kg/TJ results after conversion as indicated in equation (2).

```
  (2) emission factor (heavy fuel oil) = (400 mg/Nm³ / 3.39) * 4.5 % * 0.5 + (270 mg/Nm³ / 3.39) * 4.5 % * 0.5 + (270 mg/Nm³ / 3.39) * 95.5 % * 0.5 + (110 mg/Nm³ / 3.39) * 95.5 % * 0.5 = 58.0 kg/TJ.
```

Thus, the maximum emission quantity is applicable law and is below the inventory emission factor for the reference year 2022 under conservative assumptions and therefore assigned to the WM scenario for 2030 and beyond. The emission factor for 2025 was linearly interpolated between 2022 and 2030.

Special features of the evaluation of the emission factors

When using liquid fuels (specified in the database as “other mineral oil products”) in LCP, the specific conversion factor of 3.39 (see Table 4) is used for the assessment of NO_x emissions, analogous to heavy fuel oil.

When calculating the potential SO_2 emissions from source group “Mitverbrennung in öffentlichen Fernheizwerken” and “Mitverbrennung in öffentlichen Kraftwerken” for other liquid fuels, a clear distinction is made in the 17th BImSchV between existing plants and new plants. The implied emission limit value of existing plants is 78.44 kg/TJ. It is assumed that by 2040 all plants will correspond to the latest technology and will therefore from 2040 onwards retain at least the limit value for new plants, estimated at 61.81 kg/TJ.

Reduction in large combustion plants burning lignite through the coal phase-out:

The German Coal Power Generation Termination Act (“Kohleverstromungsbeendigungsgesetz”) from August 2020, last modified in December 2023, stipulates to gradually phase out coal power plants burning lignite until 31st December 2038, in the Rhenish coalfields until 31st March 2030.

However, the electricity market simulation assumes a market-driven coal exit until 2031. As a result, there is no further mitigation potential of an accelerated coal phase-out, as estimated in the WAM scenario of the NAPCP 2023. Projection of the activity rates was taken from the WEM scenario (MMS) of the “Treibhausgas-Projektionen 2024 für Deutschland” and disaggregated to the German lignite mining districts within the project as shown in Table 7.

Table 7: Primary energy use for lignite in LCP (>50 MW) according to the WEM scenario of the “Treibhausgas-Projektionen 2024 für Deutschland” in the years 2022 to 2040

District	**Primary Energy Use 2022**	**Primary Energy Use 2025**	**Primary Energy Use 2030**	**Primary Energy Use 2035**	**Primary Energy Use 2040**
	in TJ	**in TJ**	**in TJ**	**in TJ**	**in TJ**
Lausitz	365,425	272,958	0	0	0
Central Germany	176,494	160,652	1,885	0	0

District	Primary Energy Use 2022	Primary Energy Use 2025	Primary Energy Use 2030	Primary Energy Use 2035	Primary Energy Use 2040
	in TJ	in TJ	in TJ	in TJ	in TJ
Rhineland	521,039	283,443	6,028	0	0
Total	**1,062,958**	**717,053**	**7,913**	**0**	**0**

Emission factors of public heating and thermal power plants for NO_x are therefore reassessed. When calculating the NO_x emission factors as a result of the phase-out, the districts of Central Germany, Lausitz and Rhineland are considered separately. The individual districts will be subdivided into their existing power plants.

For each power plant, the total activity rate and the emission factors for NO_x for the years 2004 to 2017 in TJ or kg/TJ according to the 2020 submission are adopted as data basis. In order to take into account fluctuations in the emission factors, the emission factors are averaged per plant over the last years, in which no new blocks went into operation (e.g. Block R of Boxberg IV in the Lausitz district started continuous operation in 2012). In addition, the mean value for all power plants in a district is calculated for the formation of the implied emission factor by weighting according to their activity rates. Hence, each district is assigned a current implied emission factor. With the shutdown of the last block of a power plant, this plant is considered to be shut down and from this point in time it is no longer included in the calculation of the implied emission factor of a specific district.

Reduction in small combustion installations through the 1st BImSchV and funding programmes:

The amendment of the Building Energy Act (Gebäudeenergiegesetz – GEG) of 16th October 2023 was assumed to further incentivise the use of solid biomass for heat generation in the building sector. Hence, potential increase in PM emissions was estimated in the WAM scenario of the NAPCP 2023. Estimation of the potential effects of the GEG was incorporated in the WEM scenario (MMS) of the "Treibhausgas-Projektionen 2024 für Deutschland" and is therefore part of the current WM scenario.

On the other hand, reductions of dust emission factors from small combustion installations are assumed in the NFR sectors 1.A.4 and 1.A.5 through the implementation of the 1st BImSchV flanked by several funding programmes, last the "Bundesförderung effiziente Gebäude" (BEG)[2]. The calculation of the future emission factors is based on the projection of the "Energiewende" scenario (EWS) from Tebert et al. (2016)[1], while the current underlying projection is containing a greater use of solid biomass in 2030 than the EWS. The developments in the area of small combustion installations, in particular the development of fuel use and the existing plant inventory, are difficult to assess and emission calculation is fraught with uncertainties. According to expert assessments, with an increase of solid biomass use, the implied emission factor will further decrease as the share of newer and cleaner installations will go up.

Based on the inventory, a distinction is only made between households ("Haushalte" (HH)) and commerce, trade, services ("Gewerbe, Handel, Dienstleistungen" (GHD)), but the calculation of the emissions factors is further sub-divided in several installation type categories of local space heaters and solid fuel boilers, with different emission limit values set by the 1st BImSchV and additional funding requirements changing from time to time. Resulting emission factors for TSP (total suspended particles) used in the WM scenario are shown in Table 8.

Table 8: TSP emission factors in small combustion installations for solid biomass in the WM scenario

sub-sector	2022 in kg/TJ	2025 in kg/TJ	2030 in kg/TJ	2040 in kg/TJ	2050 in kg/TJ
households (HH)	59.5				
1st BImSchV + funding		47.2	44.7	39.4	39.4
commerce, trade, services (GHD)	37.4				
1st BImSchV + funding		26.8	25.4	22.7	22.7

For calculation of $PM_{2.5}$ and PM_{10} emission factors, specific shares per installation type category were used. For 2030 the proportions of PM_{10} and $PM_{2.5}$ in TSP (total suspended particles) are given in Table 9.

Table 9: Proportions of PM_{10} and $PM_{2.5}$ in TSP in 2030 for solid biomass small combustion installations

sub-sector	PM_{10}/TSP in %	$PM_{2.5}$/TSP in %
households (HH)	95	88
commerce, trade, services (GHD)	98	93

Reduction in industrial processes through low-dust filter technology in sinter plants:

The assumed potential for reducing dust emissions from sinter plants is taken from the final report of the UBA project LUFT

2030 (Jörß et al., 2014)[2)], where measure P 009 results in dust emissions of less than 10 mg/Nm³ due to better filter technology, which was assumed to correspond to 66.7 g dust per ton sinter. The affected time series are assigned to the NFR sector 2.C.1. According to the LUFT 2030 project, this technology also causes new split factors for the calculation of $PM_{2.5}$ and PM_{10}.

The emission factor for PM_{10} is calculated by dividing the emission factor for dust by the split factor for PM_{10} (0.9). Consequently, the emission factor for $PM_{2.5}$ is calculated by dividing the emission factor for dust by the split factor for $PM_{2.5}$ (0.84).

The calculated emission factors are assumed to be fully achieved in practice in the year 2030 and are used for the WM scenario.

Reduction in medium combustion plants through implementation of the 44th BImSchV:

Medium combustion plants (MCP), including gas turbines and combustion engine plants are regulated by the national 44th BImSchV, which implemented the MCP directive (EU) 2015/2193 into national law and entered into force in June 2019, and are therefore part of the WM scenario. The underlying limit values of the emission calculation are taken from the 44th BImSchV. The measure leads to a reduction in the emission factors of the affected time series in several NFR sectors under 1.A.

The data basis for the calculation is the submission 2024. The source categories are reassessed separately according to the pollutants and the relevant fuel inputs. The expected average years in service plants are taken into account (see Table 11) as well as a distinction between old and new plants and the rated thermal input (RTI) of the plants in MW (see Table 10). Table 10 shows the plant split for various fuels taking into account the RTI.

Table 10: Proportional plant split of the MCP according to fuel consumption and RTI

Plant split according to fuel consumption	RTI in MW	Proportion
Biomass	1-5	11 %
	5-20	30 %
	20-50	59 %
Lignite	1-20	95.8 %
	20-50	4.2 %
Hard coal	1-20	90.2 %
	20-50	9.8 %
Heavy fuel	5-20	68.0 %
	20-50	32.0 %
The limit values of the MCP are specified in the 44th BImSchV according to their performance ranges. The table shows the estimated proportion of MCP in Germany in relation to the RTI provided and the fuel input used.		

Table 11: Expected service life of MCP according to type of plant, pollutant and fuel use

	Expected average service life
Combustion plants - solid fuels	20 years
Combustion plants – liquid and gaseous fuels	15 years
gas and steam turbines (GuD) and gas turbines (GT)	22 years
internal combustion engines - biogas	5 years
internal combustion engines – other fuels	10 years

The new emission factors are always calculated according to the same pattern. The limit values of the 44th BImSchV are weighted for each RTI range of the plants and calculated for old and new plants. Assuming that a constant rate of existing plants, depending on the assumed average lifetime, is renewed or upgraded annually, the weighting of the limit values for new plants for the projections in 2025, 2030, 2035, 2040, 2045 and 2050 is increased or, depending on the expected average lifetime of the plant category, only the limit values for new plants are taken into account.

If the current emission factor from the 2022 submission undercuts the calculated value, the current reference value is kept for the projection because it is already below the 44th BImSchV and thus complies with the limit values. The recalculated values for the time series, reflecting the maximum permitted limit values, are assigned to time series in all other cases where the current emission factor is above the 44th BImSchV.

Example:

The exact procedure is exemplified by the NO_x emission factors when using other solid biomass (than wood) as fuel. The procedure is in principle the same for all pollutants and fuels.

The basis for the calculation is the maximum annual average amount of NO_x emissions per cubic meter permitted in the 44th BImSchV §10 (4) and (15) when using other solid biomass (than wood) as fuel (Table 12). After conversion with the specific conversion factor for lignite, assumed as similar to other solid biomass, of 2.39 (see Table 4), the limit values for old and new plants are available in kg/TJ. Table 12 shows the NO_x limit values as annual average for solid biomass according to the RTI range for old and new plants in mg/Nm³ and kg/TJ.

Table 12: NO_x limit values for other solid biomass (than wood) in MCP according to the RTI for old and new plants

Fuel	**Plant**	**NO_x limit value according to 44th BImSchV in mg/Nm³**			**NO_x limit value in kg/TJ**		
		RTI in MW			RTI in MW		
		1-5	>5	>20	1-5	>5	>20
other solid biomass (than wood)	existing	600		370	250.4		154.4
other solid biomass (than wood)	new	370	300	200	154.4	125.2	83.5

Limit values for solid biomass in MCP for old and new plants according to the 44th BImSchV in mg/Nm^3 and kg/TJ.

It is assumed that the average service life of the plants is 20 years (Table 11). In addition, it is assumed that a constant annual renewal of the plant will be implemented after the 44th BImSchV comes into force in 2019 and that the limit values for new plants getting greater weight each year.

According to the assumption in 2025 (6 years after the regulation came into force) there is a proportion of 6/20 which fulfil the requirements of new plants and 14/20 which adhere to the limit values of existing plants. In 2030, eleven years after the 44th BImSchV was introduced, the proportion of new plants is 11/20 compared to 9/20 existing plants. After 16 years in 2035, the limit value for new plants is included in the calculation with 16/20. From 2040 only the limit value for new plants is assumed, as it is 21 years after the 44th BImSchV has entered into force.

Taking into account the plants proportions per size measured in RTI in WM (Table 10), a new emission factor of 166.8 kg/TJ for 2025 results, as shown in (3).

```
  (3) emission factor (other solid biomass than wood in 2025) = 14/20 * {(11 % + 30 %) * 250.4 kg/TJ + 59 * 154.4 kg/TJ} + 6/20 * {11 % * 154.4 kg/TJ + 30 % * 125.2 kg/TJ + 59 % * 83.5 kg/TJ} = 166.8 kg/TJ.
```

Since the maximum reference value from the 2024 submission for the year 2022 (137.5 kg/TJ) is already below the calculated limit, it will be kept constant for the year 2025. For 2030 as well, as the calculated limit of 144.3 kg / TJ in 2030 is still above the reference emission factor in 2022. The procedure for calculating the emission factor in 2035 is identical and is shown in (4).

```
  (4) emission factor (other solid biomass than wood in 2035) = 4/20 * {(11 % + 30 %) * 250.4 kg/TJ + 59 % * 154.4 kg/TJ} + 16/20 * {11 % * 154.4 kg/TJ + 30 % * 125.2 kg/TJ + 59 % * 83.5 kg/TJ} = 121.8 kg/TJ
```

In 2035 the newly calculated limit value will be below the reference value, so that the calculated one is assumed as the new implied NO_x emission factor.

Special Feature:

When calculating the NO_x emission factors for using lignite and hard coal as fuel, the plant split is only differentiated according to the RTI of less than 20 MW and greater than 20 MW. The limit values given in the 44th BImSchV are differentiated according to 1-5 MW, 5-20 MW and more than 20 MW.

As a result, the assumption was made that the plant split between 1-5 MW and 5-20 MW in equal proportions would be valued with a factor of 0.5.

According to the 44th BImSchV § 16, the emission limit values for combustion engines will only apply from 1st of January 2025 on, so that the assumption of the partial renewal of plants will only apply from 2025 on. As a result, the reference values from the 2022 submission will be kept constant for 2025 and calculation of implied emission factors considering the limit values for new plants starts from the year 2025.

[1] Tebert et al. (2016): Tebert, C., Volz, F., Töfke, K. (2016): Development and update of emission factors for the National Inventory regarding small and medium-size combustion plants of households and small consumers, on behalf of the Umweltbundesamt, Project-Nr. 3712 42 313 2
[2] Jörß et al. (2014): Jörß, W., Emele, L., Scheffler, M., Cook, V., Theloke, J., Thiruchittampalam, B., Dünnebeil, F., Knörr, W., Heidt, C., Jozwicka, M., Kuenen, J.J.P., Denier van der Gon, H.A.C., Visschedijk, A.J.H., van Gijlswijk, R.N., Osterburg, B., Laggner, B., Stern, R., Handke, V. (2014): Luftqualität 2020/2030: Weiterentwicklung von Prognosen für Luftschadstoffe unter Berücksichtigung von Klimastrategien, on behalf of the Umweltbundesamt, Project-Nr. 3710 43 219, UBA-Texte 35/2014, https://www.umweltbundesamt.de/publikationen/luftqualitaet-20202030-weiterentwicklung-von; ISSN 1862-4804, Dessau-Roßlau, July 2014
[1]
Methodology and calculations for large combustion plants are based on Jakobs, H., Schneider, C., Handke, V. (2019): NEC-Richtlinie: Weiterentwicklung von Prognosen für Luftschadstoffe für nationale Luftreinhalteprogramme, Project-Number FKZ 3716512020, on behalf of the German Environment Agency (UBA).
[2]
https://www.energiewechsel.de/KAENEF/Redaktion/DE/FAQ/FAQ-Uebersicht/Richtlinien/bundesfoerderung-fuer-effiziente-gebaeude-beg.html