Additional measures that have not yet been implemented are assigned to the WAM scenario

NO_x reduction in pulp and paper production through an optional amendment of the 13th BImSchV:

According to the existing 13th BImSchV (as of 2017), different maximum amounts of NO_x emissions are permitted according to the production process (sulphate and sulphite process) and the size of the plant (measured in RTI in MW) in pulp and paper production. An optional amendment of the 13th BImSchV would result in reductions in the emission factor in the NFR sector 2.H.1.

It is assumed for the sulphite process that all four plants > 50 MW located in Germany are operated with RTI of 50-300 MW.

In the sense of a conservative estimate of the reduction potential, a maximum current emission factor of 300 mg/Nm^3 for all plants according to the 13th BImSchV is assumed for the further calculation of the reduction potential. The NO_x emission factor for the sulphite process will be taken over from the 2022 submission in 2020, which is 2 kg/t. The new emission factor results from the current emission factor (2 kg/t) and the maximum emission value proposed in the amendment (85 mg/Nm^3) divided by the calculated mean value of the currently applicable law (300 mg/Nm^3). This results in an emission factor of 0.57 kg/t for 2025, 2030 and 2035 as shown in (6).

```
  (6) NOx emission factor (sulphite process) = (2 kg/t * 85 mg/Nm^3) / 300 mg/Nm^3 = 0.57
kg/t
```

In the field of the sulphate process there are two plants > 50 MW with different boiler sizes in Germany. To calculate the reduction potential, the percentage distribution of the two plants per boiler size was calculated according to a combustion heat output in the range of 100-300 MW and more than 300 MW over all time series (2006 to 2018). For this purpose, the emission values of the individual years for the individual location or the individual plant are divided by the annual activity of both plants for each considered time series. The data basis for the calculation is the 2022 submission. This results in the estimates of the proportionate use of the various plant sizes for the past years up to 2018 with the plant-size-specific maximum emissions according to the daily mean value with 250 mg/Nm^3 for the plant with a thermal output of 100-300 MW and 200 mg/Nm^3 for the plant with more than 300 MW. The mean value of the current NO_x emissions from the sulphate process results from the sum of the maximum permitted emissions per boiler size multiplied by the current proportionate NO_x emissions. Equation (7) indicates the calculation.

```
  (7) implied NOx emission factor (sulphate process) = 0.36 t/a * 250 mg/Nm^3 + 0.64 t/a *
200 mg/Nm^3 = 217.78 mg/Nm^3
```

The implied emission factor for the sulphate process will be taken over from the 2022 submission in 2020. The new emission factor results from the emission factor according to the current status and the maximum emission value proposed in the optional amendment of the 13th BImSchV divided by the calculated mean value of the applicable law. This results in an emission factor of 0.68 kg/t for 2025 to 2040, as shown in equation (8).

```
  (8) implied NOx emission factor (sulphate process) = (1.75 kg/t * 85 mg/Nm^3) / 217.78
mg/Nm3 = 0.68 kg/t
```

NO_x reduction in refineries through an optional amendment of the 13th BImSchV:

An optional amendment of the 13th BImSchV would lead to emission reductions in the area of refineries and is assigned to the WAM scenario. It causes a reduction in the emission factors in the affected time series of the NFR sector 1.A.1.b. A distinction must be made between refinery plants and the fuel input used by them. For plants using raw petrol (naphtha), light heating oil or other petroleum products, the proposed NO_x limit value is set to 85 mg/Nm^3 and adopted as the maximum emission level. When using heavy fuel oil, there is a so-called bell-rule applicable for the plants, whereby individual parts of the plant are allowed to exceed the limit value of 85 mg/Nm^3 if other parts of the plant fall below the limit value and the plant emission is on annual average not above the limit value.

For plants using raw petrol (naphtha), light heating oil or other petroleum products as fuel, the new maximum emission level corresponds to the limit value of 85 mg/Nm^3 NO_x. Consequently, only the conversion factor of the specific flue gas volume for heavy fuel oil or light heating oil (Table 1) has to be used to convert to kg/TJ NO_x. The conversion is carried out for all source groups as shown in (9) using the example of refinery underfiring in LCP with light heating oil as fuel.

```
  (9) implied NOx emission factor (refinery underfiring with light heating oil) = 85 mg/Nm^3
/ 3.49 = 24.4 kg/TJ
```

This results in NO_x emission factors of 24.4 kg/TJ for light heating oil and 25.1 kg/TJ for other petroleum products for 2025 to 2040.

For a total of twelve plants with heavy fuel oil as fuel input the bell-rule is applied. First of all, the emission limit value according to the current 13th BImSchV and its specific RTI is assigned to each plant and the mean value is calculated across all plants (274.75 mg/Nm^3). The bell-rule allows parts of plants to exceed the maximum emission level if another part of the plant emits proportionally less. The estimated percentage reduction, taking into account the bell-rule, is calculated as shown in (10) by setting the limit value of 85 mg/Nm^3 NO_x in relation to the mean value of the current emission limit values.

```
  (10) percentage NOx emission reduction (refineries) = 1 - (85 mg/Nm^3 / 274.75 mg/Nm^3) =
0.69
```

A calculated reduction of approximate 69 per cent is assumed for the bell. The projected emission factors for the concerned source categories for 2025 to 2040 are now derived from the current emission factor of the source category under consideration from the 2022 submission minus the proportional reduction.

The conversion is carried out in the same way for all source groups as shown in (11) for the refinery underfiring in LCP with light heating oil as fuel.

```
  (11) NOx emission (refinery underfiring with light heating oil) = [400 mg/Nm^3 * (1 -
0.69)] / 3.39 = 36.5 kg/TJ
```

NO_x reductions in other large combustion plants through an optional amendment of the 13th BImSchV:

Emissions from other LCPs, which emerge from the energy balances, but cannot be clearly assigned to a specific fuel use or fuel mix and also show a reduction potential by an optional amendment of the 13th BImSchV are assigned to the NFR sector 1.A.1.c and a reduction in the NO_x emission factor was calculated.

The NO_x emission factors for all non-gaseous materials other than coal for electricity and heat generation are considered and the maximum emission amount for NO_x is assumed to be 85 mg/Nm^3. According to the 13th BImSchV, only plants with more than 1500 operating hours per year are taken into account for which the new limit value of 85 mg/Nm^3 NO_x applies. Table 13 shows the estimated relative and absolute plant split of the LCP according to its annual operating time assuming an equal fuel use distribution.

Table 13: Estimated relative and absolute plant split of LCP according to annual operating hours

operation time	RTI in MW	proportion
< 1500 h/a	46573	17.8 %
> 1500 h/a	214990	82.2 %
total	261563	100 %

The emission factors will be recalculated for 2025 to 2040. First, the limit value of 85 mg/Nm^3 is converted into kg/TJ using the specific conversion factor (Table 1). The new emission factor results from the sum of the reduction for the 82.2 per cent of the fuel use with an operating time of more than 1500 h/a and the unchanged value from the 2022 submission for the 17.8 per cent of the fuel use with less than 1500 h/a operating time, that is not obliged to be reduced by the optional amendment of the 13th BImSchV.

The calculation is shown using the example of the source category of electricity generation in large industrial power plants using other liquid fuels (reference value in 2020: 42.5 kg/TJ) in (12), whereby the procedure is analogous for all other source categories.

```
  (12) NOx emission factor (electricity generation in large industrial power plants) = (85
mg/Nm^3 / 3.39) * 82.2 % + 42.5 kg/TJ * 17.8 % = 28.2 kg/TJ
```

Emission reduction in small combustion installations by tightening the emission limits of the Ecodesign Regulations (EU) 2015/1185 and (EU) 2015/1189:

Through amendment of the Commission regulation (EU) 2015/1189 with regard to ecodesign requirements for solid fuel boilers, it was assumed that requirements for placing on the market and putting into service solid biomass boilers regarding emissions of particulate matter will be set at 2,5 mg/m^3 TSP from January 1st, 2027 (measured according to VDI 2066 Sheet 1, May 2021 edition and based on 13 % reference oxygen content).

Through amendment of the Commission regulation (EU) 2015/1185 with regard to ecodesign requirements for solid fuel local space heaters, it was assumed that requirements for placing on the market and putting into service solid biomass local space heaters regarding emissions of particulate matter will be set at 20 mg/m^3 TSP from January 1st, 2029 (measured according to VDI 2066 Sheet 1, May 2021 edition and based on 13 % reference oxygen content).

Considering these assumptions as well as the potentially increased biomass use described above, a potential emission reduction of 1.4 kt $PM_{2.5}$ in 2030 compared to the WM scenario in combination with a potentially increased biomass use in the building sector due to the proposed amendment of the building energy act (described above) was quantified. The absolute emission mitigation potential in 2030 depends on the projected biomass use as well as the year, when the proposed amendment applies for new installations. Less stricter requirements regarding particle emissions in the national law will basically increase the mitigation potential of the proposed amendment of the EU ecodesign regulations.

Reduction in agriculture through a bundle of measures quantified as an agricultural package:

Despite compliance with the reduction obligation for ammonia in the WM scenario, additional measures are necessary for three reasons:

- safety buffer due to the uncertainties of the assumed emission reductions in the WM scenario,
- safety buffer due to exceptions to various regulations for small and very small farms and
- compensation for the potentially increased ammonia emissions from a measure of the climate protection program 2030: 70 % of liquid manure from cattle and pig farming should be digested in biogas plants by 2030, which leads to potential additional emissions in 2030 compared to the WM scenario of 12.8 kt NH_3.

For these reasons, three additional measures to reduce ammonia emissions in the agricultural sector, plus the previously mentioned emission-increasing climate protection measure, were summarized in an agricultural package of measures in the WAM scenario.

a) Increase in the share of technically gas-tight stored digestion residues to 100 % by 2030

b) System-integrated measures in dairy cattle housing systems
In dairy farms approximately every 15 years the floors of dairy cattle barns are renewed as part of the regular exchange or renovation. It is assumed, that by financial incentives (at the moment funding of up to 50 % of the costs is possible) low emission floor systems or coverings would be established more and more. Available systems can reduce emissions of ammonia by 25 %[1)].
It is assumed, that until 2030 50 % of all dairy cattle floor systems will be renewed and 50 % of these will be equipped with low emission systems with the help of agricultural investment subsidies. Therefore, in 2030 for 25 % of the slurry-based systems for dairy cattle the emission factor was reduced by 25 %.
The implementation of this measure will be further driven in the scope of the 4th BImSchV (immission control permission following the law on assessment of the effects on the environment – UVPG[2)] or equivalent regulations). Further regulations for dairy farming in the near future are conceivable.

c) Increased application of liquid manure on tilled fields or grassland with injection, slot technology or acidification technology
In 2030 25 % of the liquid manure currently applied on tilled fields or grassland with other technology was added to the proportion of liquid manure applied on tilled fields or grassland using injection or slot technology or acidification technology. This assumption probably requires further political implementation, e.g. via funding. The low emission application of 25 % of the liquid manure previously applied on tilled fields or grassland with other technology in 2030 is an ambitious goal, since the applicability of these technologies on locations with a high clay content or moorland, on slopes and in small farms will only be given to a limited extent.

The expected ammonia emission reduction of these three measures (in addition to the WM scenario) in 2030 is 3.4 kt (12.8 kt additional ammonia emissions due to more slurry digestion in biogas plants and 16.2 kt emission reduction due to the three additional mitigation measures of the WAM scenario).

The main uncertainty in the quantification of the reduction potential lies in the achievement of the assumed degree of implementation in practice by 2030. With the regular update of the emission projections for air pollutants for reporting in accordance with Directive (EU) 2016/2284 by March 15th, 2025 at the latest, the measure and the assumptions for evaluating its reduction potential will be re-examined.

In addition, the amount of ammonia emissions from the previous year will be checked annually in the future. This should be carried out for ammonia emissions from agriculture as part of the previous year's estimate of greenhouse gas emissions in accordance with Section 5 Paragraph 1 of the Federal Climate Protection Act. The previous year's estimate is based on current statistics on important activity data for the previous year (livestock, N-mineral fertiliser sales) and must be submitted annually by March 15th. If the ammonia emissions of the previous year's estimate are above the linear target path according to NEC Directive (EU) 2016/2284, the BMEL, in consultation with the BMUV, will develop a bundle of agricultural measures, that will assure compliance with the linear target path as soon as possible. Because of uncertainties in the emission projections a minimum gap of 10 kt is agreed. If the previous year’s estimate in the following year has again a gap of 10 kt or more, the bundle of agricultural measures enters into force immediately.

1)
Chapter 5 in
https://www.ktbl.de/fileadmin/user_upload/Artikel/Emissionen/Foerderfaehige_Techniken_zur_Emissionsminderung_in_Stallbauten_2._Auflage.pdf
2)
https://www.gesetze-im-internet.de/uvpg/UVPG.pdf