German Environment Agency

Umwelt Bundesamt

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IAM activities in Germany

Evaluation of emission reduction scenarios with the REM-CALGRID (RCG) model

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Overview

1 EMISSION PROJECTIONS (NO_X AND $PM_{2.5}$)

1.1 Compliance with emission reduction commitments and comparison with GAINS scenarios

1.2 Important drivers

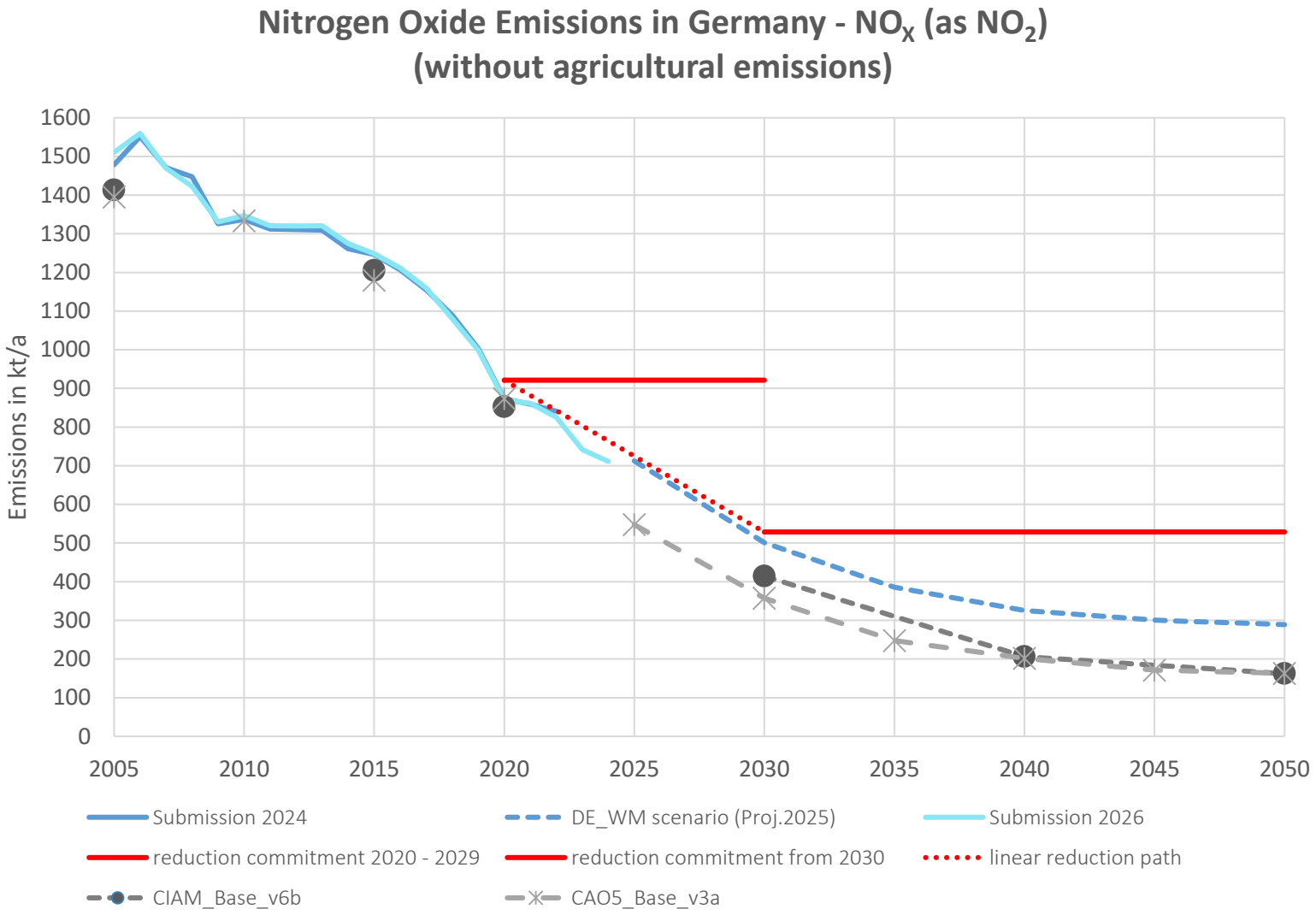
2 EVALUATION OF SCENARIOS WITH THE REM-CALGRID MODEL

2.1 NO_2 – annual mean concentrations, model run 2030

2.2 $PM_{2.5}$ – annual mean concentrations, model run 2030

3 CONCLUSIONS AND OUTLOOK

NO_X emissions in Germany – compliance with NERCs and comparison with GAINS scenarios



Source: UBA 2026

- Current projections (reported in 2025) are based on submission 2024 and energy projections 2024 (dark blue lines).
- Work on new projections based on 2026 submission (light blue line) and current energy projections has just started.
- Compliance of NERCs, but compliance margin is very small.
- Differences between GAINS-BL and national projections mainly in the industrial and in the transport sector.

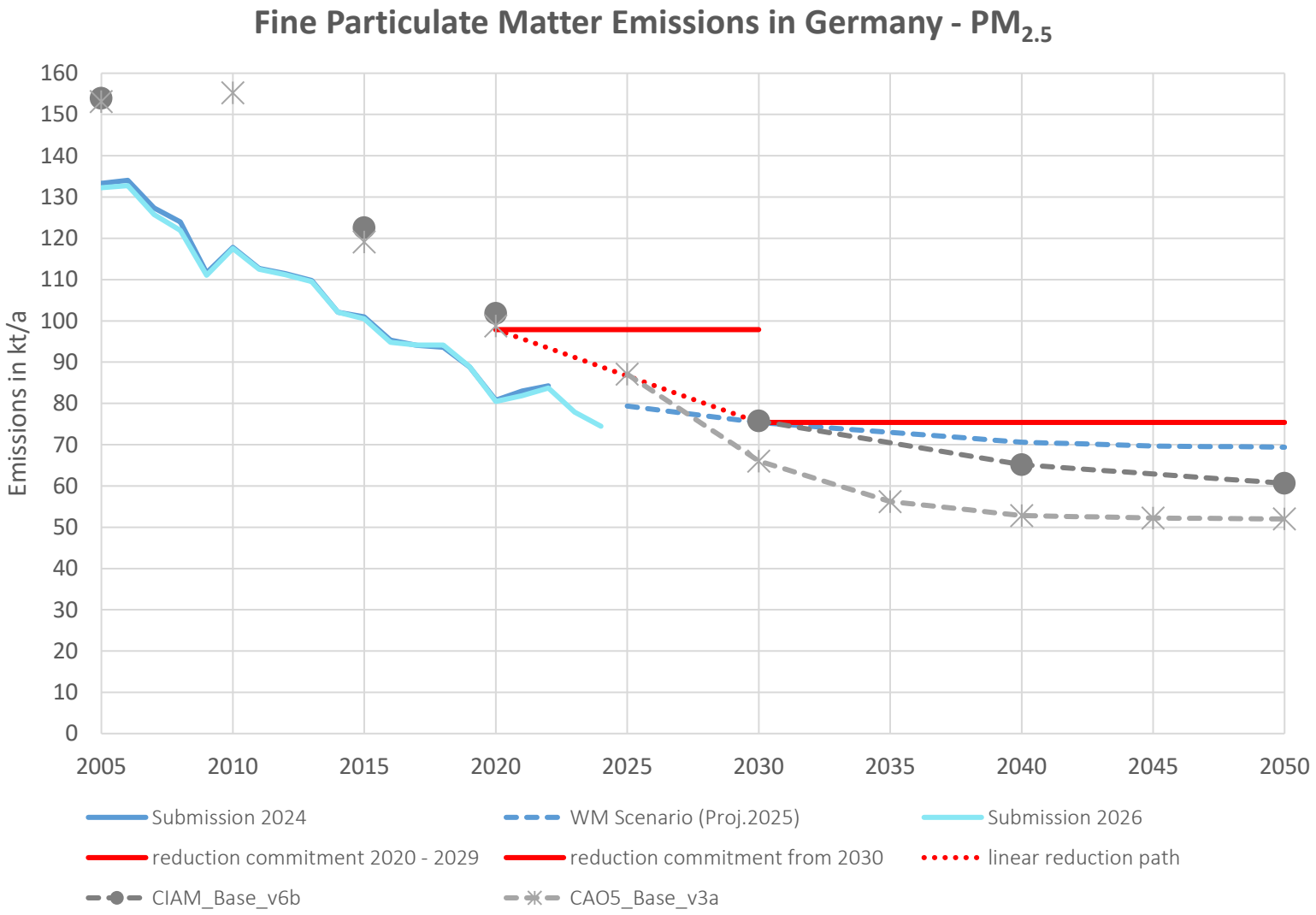
→ from our point of view the GAINS BL is very optimistic

- Ongoing consultations with IIASA

NO_X emissions – important drivers

- The transport sector plays a key role, particularly the development of the electric vehicle share in total mileage. A weakening of the internal combustion engine phase-out or of the regulations on CO_2 fleet emission standards could make it more difficult to comply with national emission reduction commitments for NO_X.
- New traffic emission factors from the Handbook of Emission Factors for Road Transport (HBEFA) 5.1 available since autumn 2025. → inventory recalculations
- Current projections assume that, from 2030 onwards, the energy sector operates without coal-fired power generation. More recent energy projection indicates a slower coal phase-out, which could make it more difficult to comply with national NO_x emission reduction commitments.
- Decarbonisation in the industrial sector has potential for reducing NO_X emissions.

$PM_{2.5}$ emissions in Germany – compliance with NERCs and comparison with GAINS scenarios



Source: UBA 2026

- Compliance of NERCs, but compliance margin is small.
- Differences between GAINS BL and national data, as the national data do not account for condensables. When condensables are added in the sector stationary combustion (using a condensable factor by TNO), the national data and GAINS are in good agreement in historical years.
- Differences in the projection years mainly due to a significantly higher use of wood fuels in small combustion installations in our national assumptions.
- Further differences in the sector road transport (non-exhaust emissions) and in the offroad sector.

$PM_{2.5}$ emissions – important drivers

- Most significant source categories for $PM_{2.5}$: small combustion installations (solid biomass) and industrial processes (including handling of bulk products)
- The sectors energy and transport are less important for $PM_{2.5}$, in the transport sector non-exhaust emissions are dominant.
- Consideration of condensables (and applying a static factor or a dynamic factor for historic years and projection years relating to the change in the installations structure)

Evaluation of scenarios with the REM-Calgrid model – Input data

Base run 2022

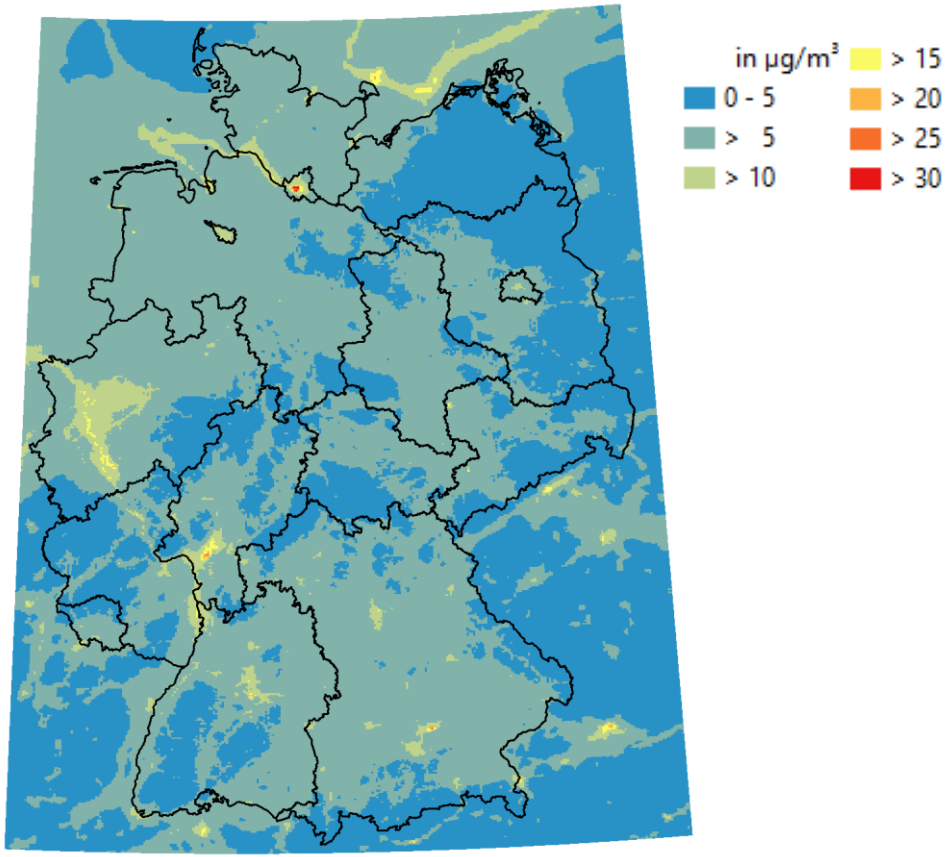
- Model: REM-Calgrid (RCG), version 5.0
- Meterology 2022 (ICON model of the German Meterological Service)
- Gridded emissions 2022: for Germany: Gridding Tool GRETA 1.6.0.1, for Europe: CAMS Version 8.0
- Conditions at the boundary of the European modelling domain are based on observations (longterm statistics)
- Bias correction with optimal interpolation (OI)
- Resolution 2 km x 2 km

Scenario

- Same meteorology used as in the base run (year 2022)
- Emission projections 2030 (and 2035) for Germany → gridding with GRETA Tool, for Europe gridded CAMS version 8.0 with GNFR specific scaling based on GAINS-Baseline scenario v6b (Oct. 2025)
- Bias correction of modelling results 2030 based on OI from base run

NO_2 annual mean concentrations, scenario run 2030

RCG model run 2030, meteorology 2022, with OI

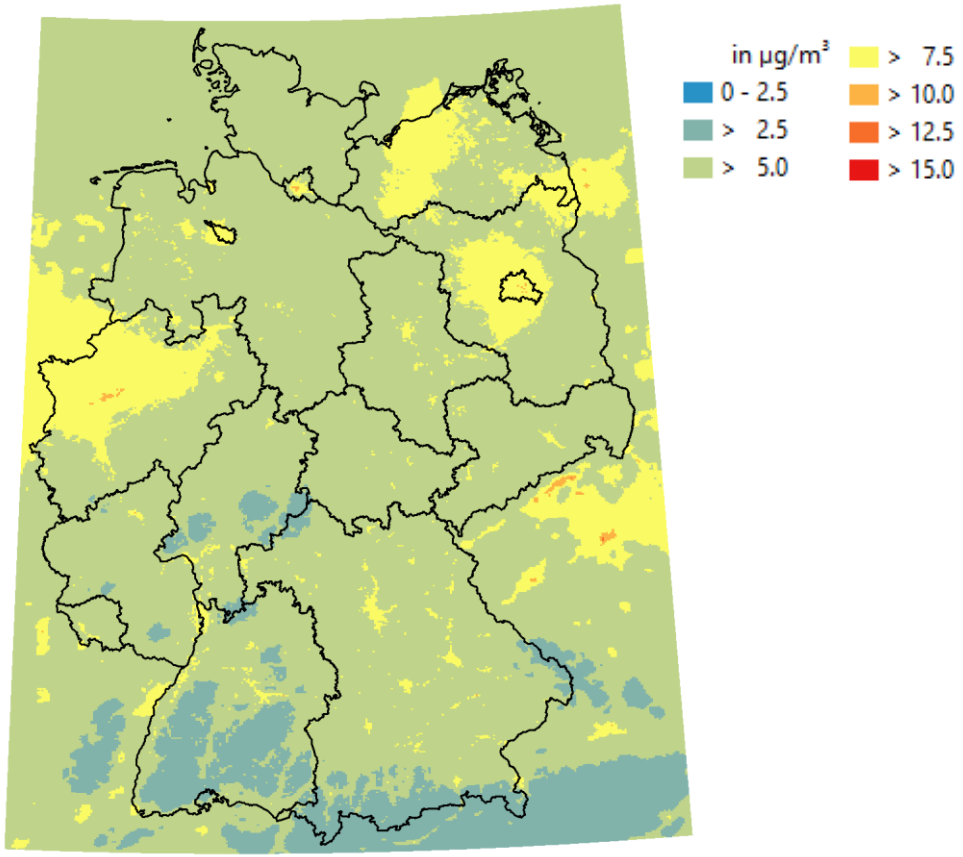


- The model run for 2030 shows that in some regions in Germany annual mean background concentrations will be around 20 µg/m³ (> 20 µg/m³: orange colour).
  → Risk for non-compliance with the new air quality limit values.

- Preliminary evaluations for 2035 (with 2020 and 2022 meteorology) show attainment of air quality limit values.

$PM_{2.5}$ annual mean concentrations, scenario run 2030

RCG model run 2030, meteorology 2022, with OI



- The model run for 2030 shows that in some regions in Germany annual mean background concentrations will be around 10 µg/m³ (> 10 µg/m³: orange colour).
  → Risk for non-compliance with the new air quality limit values.

- 2022 was a moderate year with typical weather conditions for Central Europe. In years with more extreme/unfavourable meterological conditions, the $PM_{2.5}$ pollution would be higher.
- Preliminary evaluations for 2035 (with 2020 and 2022 meteorology) show attainment of air quality limit values.

Conclusions

- According to current emission projections Germany is in compliance with the NERCs for all pollutants. However, for NO_X and $PM_{2.5}$ the compliance margin is very small.
- Moreover, developments such as a slower coal phase-out or a later phase out of combustion engines could jeopardise compliance.
- Modelling results show that compliance with the stricter air quality limit values of the new Air Quality Directive 2024/2881 in 2030 could be difficult in some regions in Germany, meaning that the discussion on further air pollution control measures at both the local and national level could regain relevance.
- Preliminary evaluations for 2035 (with 2020 and 2022 meteorology) show attainment of air quality limit values.

Outlook

- Currently consultations with IIASA
- Work on new emission projections (to be reported in 2027) has already started. New projections will consider
  - Updated energy projections
  - Updated emission factors for road transport from the Handbook of Emission Factors for Road Transport, HBEFA 5.1

- Future modelling work:
  - Consider more realistic boundary conditions for the European domain as they can have great influence on the modelled concentrations e. g. CAMS EAC4 dataset
  - Analysis for other meteorological years (more „extreme“ years)
  - Further improvement of the scenario - Bias correction also considering FAIRMODE activities and results

Thank you for your attention!

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https://www.umweltbundesamt.de/en/topics/air