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Austria's National Air Emission Projections 2023 for 2025 and 2030

Pollutants: NO_x, SO_2, NMVOC, NH_3 and $PM_{2.5}$

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ENVIRONMENT AGENCY AUSTRIA

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Scenarios: With Existing Measures (WEM) &
With Additional Measures (WAM)
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CONTENT

1 GENERAL APPROACH

Austrian projections for the emission of the pollutants nitrogen oxides (NO_x), sulphur dioxide (SO_2), non-methane volatile organic compounds (NMVOC), ammonia (NH_3) and particulate matter ($PM_{2.5}$) for the scenario 'with existing measures' (WEM) were last published in 2021 in a report entitled 'Austria's National Air Emission Projections 2021 for 2020, 2025 and 2030' (ENVIRONMENT AGENCY AUSTRIA, 2021).

This year's report provides fully updated emission projections for the WEM scenario and the WAM scenario, based on energy balances and updated policies and measures (PAMs).

Two scenarios were modelled: 'with existing measures' includes all measures implemented by 1 January 2022; 'with additional measures' includes planned policies and measures that were reported under the National Air Pollution Control Programme (BMK, 2023b) and in the Integrated National Energy and Climate Plan for Austria (BMK, 2023a), which is currently available as a draft and subject to a national public consultation.

The status of the implementation of measures has been defined at expert level in consultation with the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK). Information on national policies and measures included in the scenarios can be found in Chapter 3.

The air pollutant projections are fully consistent with current GHG emission projections reported under Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action (ENVIRONMENT AGENCY AUSTRIA, 2023c).

The report further outlines relevant background information to enable a better understanding of the key socio-economic assumptions used in the preparation of the projections. For comparison purposes, emission data from the National Air Emission Inventory of March 2023 (ENVIRONMENT AGENCY AUSTRIA, 2023b) have been included as well.

1.1 Legal background

Upon signing the UNECE Gothenburg Protocol to the Convention on Long-Range Transboundary Air Pollution of 1 December 1999[1], the EU agreed on national emission ceilings for nitrogen oxides (NO_x), sulphur dioxide (SO_2), ammonia (NH_3) and non-methane volatile organic compounds (NMVOC) for the year

[1] Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution to Abate Acidification, Eutrophication and Ground-level Ozone, https://unece.org/environment-policy/air/protocol-abate-acidification-eutrophication-and-ground-level-ozone

2010 and, under the amendment in 2012, also on emission reduction commitments for the year 2020. Austria signed the Gothenburg Protocol but did not ratify it. For this reason, the targets were not binding for Austria. However, the Directive of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants (NEC Directive 2001/81/EC)[2] stipulates national emission ceilings for these air pollutants, which are relevant to Austria. The obligation to comply with the ceilings for 2010 was transposed into national law through the Air Emission Ceilings Act (*Emissionshöchstmengengesetz-Luft*)[3]. The revised NEC Directive (EU) 2016/2284 lays down national emission reduction obligations (additionally for the pollutant $PM_{2.5}$) for the years 2020 and 2030 and was transposed into national law by the Air Emissions Act 2018 (*Emissionsgesetz-Luft 2018*)[4].

Pursuant to Article 8(1) of the revised NEC Directive, Member States must prepare and biennially update their national emission projections. In addition, pursuant to Article 10(2), Member States must submit their national emission inventories and projections to the Commission and to the European Environment Agency.

This report provides emission projections data based on 'fuel sold' to check compliance with the emission reduction commitments of the NEC Directive.

Annex I to NEC Directive 2001/81/EC determined national emission ceilings for certain atmospheric pollutants. By the year 2010, Member States had to limit their annual national emissions of these pollutants to an amount not exceeding these emission ceilings. Directive 2001/81/EC was repealed by the revised NEC Directive. Emission reduction commitments from 2020 onwards are stated in Annex II to the revised NEC Directive (EU) 2016/2284 (see Table 1).

Table 1: National emission ceilings and emission reduction commitments for Austria according to NEC Directive 2001/81/EC and NEC Directive (EU) 2016/2284, respectively.

	From 2010 onwards*	**From 2020 to 2029****	**From 2030 onwards****
Obligation under:	**Directive 2001/81/EC**	**Directive (EU) 2016/2284**	**Directive (EU) 2016/2284**
NO_x	103 kt	37%	69%
SO_2	39 kt	26%	41%
NMVOC	159 kt	21%	36%
NH_3	66 kt	1%	12%
$PM_{2.5}$	-	20%	46%

* *Absolute emission ceiling in kt per year, in force until 31 December 2019*

** *Reduction compared to base year 2005 in %*

2 Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants, OJ L 309/22, 27 November 2001. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2001:309:0022:0030:EN:PDF

3 Bundesgesetz über nationale Emissionshöchstmengen für bestimmte Luftschadstoffe (Emissionshöchstmengengesetz-Luft, EG-L), BGBl. I Nr. 34/2003

4 Bundesgesetz über nationale Emissionsreduktionsverpflichtungen für bestimmte Luftschadstoffe (Emissionsgesetz-Luft 2018 – EG-L 2018), BGBl. I Nr. 75/2018

1.2 Data structure of projections and national inventory

Where reasonable and applicable, emissions were calculated and projected on the basis of the methodologies used in the Austrian Inventory. These are described in Austria's National Inventory Report 2023 (ENVIRONMENT AGENCY AUSTRIA, 2023a).

The Austrian Inventory is based on the SNAP (Selected Nomenclature for sources of Air Pollution) nomenclature and has to be converted into the current reporting format as required under the LRTAP Convention, i.e. the NFR (Nomenclature for Reporting) format. Projections have thus been calculated on the basis of the SNAP nomenclature and subsequently converted into the NFR format. Emissions from energy-related sectors (NFR 1.A) are calculated on the basis of 2023 energy scenarios (HAUSBERGER/SCHWINGSHACKL, 2023 and E-THINK, 2023).

The air pollutant projections are fully consistent with the historical emission data from the Austrian Emission Inventory (March 2023 submission) up to the latest available data year of 2021.

Emission factors and underlying parameters are described in the methodology detailed in Chapter 4 of this report.

1.3 Underlying models

Model calculations are based on custom-made methodologies for the individual sectors.

- Energy forecasts (fuel combustion) are based on the National Energy Balance (STATISTICS AUSTRIA, 2022a) and on an econometric input-output model (MIO-ES), supported by calculations carried out using the following bottom-up models:
  - INVERT/EE-Lab (e-think Energy Research (E-THINK, 2023)): domestic heating and hot water supply;
  - NEMO & GEORG (SCHWINGSHACKL & REXEIS, 2022): energy demand and emissions of transport (incl. off-road).
- Forecasts of emissions from industrial processes and solvent emissions are based on expert judgements by the Environment Agency Austria and on projections for the respective gross value added (NACE code).
- In the agricultural sector, the following models were used:
  - For the activity data calculation (livestock, crop yields, mineral fertilisers, agriculture area), the PASMA model of the Austrian Institute of Economic Research (WIFO) (WIFO & BOKU, 2023) was used;

- For the determination of the economic impact on the overall economy, the PASMA results were transferred to ADAGIO, WIFO's world input-output model, with econometrically estimated behavioural equations;
- For the emission calculation, the agriculture model of the Austrian GHG Inventory was used. Existing measures of agricultural practice projected for Austria were taken into account.
- Projections for waste (expert judgements on waste amounts and waste treatment) were prepared by the Environment Agency Austria.

A detailed description of the models is provided in a report entitled 'GHG Projections and Assessment of Policies and Measures in Austria 2023', submitted under the Governance Regulation (Regulation (EU) 2018/1999) in 2023 (ENVIRONMENT AGENCY AUSTRIA, 2023c).

1.4 General socio-economic assumptions

Data used for general socio-economic assumptions, which form the basis of Austria's emission projections, can be found in Table 2. Methodological assumptions are included in Chapter 4. Further assumptions about key input parameters are set out in ENVIRONMENT AGENCY AUSTRIA, 2023c.

Table 2: Key input parameters for emission projections (ENVIRONMENT AGENCY AUSTRIA, 2023c).

Year	Scenario	2020	2021	2025	2030	2035	2040	2050
GDP [€ billion, 2020]	both	381	402	439	466	497	533	599
GDP real growth rate [%]	both	-6.5	5.9	1.6	1.1	1.6	1.4	1.1
Population [1 000]	both	8 917	8 961	9 114	9 251	9 360	9 470	9 626
Stock of dwellings [1 000]	both	3 982	4 008	4 112	4 207	4 295	4 380	4 497
Heating degree days	both	3 311	3 301	3 260	3 210	3 160	3 110	3 010
Exchange rate [US$/€]	both	1.2	1.2	1.2	1.2	1.2	1.2	1.2
International coal price [€/GJ, 2020]	both	1.6	3.7	3.1	3.1	3.1	3.3	3.7
International oil price [€/GJ, 2020]	both	6.4	10.5	15.4	15.4	15.4	16.2	19.7
International natural gas price [€/GJ, 2020]	both	3.1	15.1	13.2	11.3	11.3	11.3	11.8
CO_2 certificate price [€/t CO_2, 2020]	both	24.0	54.0	80.0	80.0	82.0	85.0	160.0

2 MAIN RESULTS

The following table shows Austria's national total emissions and projections based on 'fuel sold' in accordance with the reporting provisions under the UNECE LRTAP Convention as well as under the revised NEC Directive (EU) 2016/2284. Emissions from fuel sold were also the basis for compliance with Austria's emission reduction commitments under NEC Directive 2001/81/EC.

NEC Directive (EU) 2016/2284 sets emission reduction commitments for five air pollutants: nitrogen oxides (NO_x), sulphur dioxide (SO_2), non-methane volatile organic compounds (NMVOC), ammonia (NH_3) and particulate matter ($PM_{2.5}$).

The scenario 'with existing measures' results in significant emission reductions by 2030 for all pollutants. The most substantial reduction (about 67%) from 2005 to 2030 is projected for NO_x, provided that the latest and new emission standards for road vehicles meet their specifications under real-world driving conditions. Emission reductions for most of the other pollutants are in the range of 37% to 56%; NH_3 emissions, however, are projected to decrease by just 8% (see Table 3).

Compared to the WEM scenario, the 'with additional measures' scenario leads to higher emission reductions for all pollutants, with the greatest change noticeable for the pollutant NH_3.

Table 3: Austrian national total emissions trend in kt in comparison with the base year 2005 in % based on fuel sold for the scenarios 'with existing measures' and 'with additional measures' (source: Environment Agency Austria).

Pollutant [kt]	Emission Inventory 2023					Emission Scenario			
						WEM		WAM	
	1990	2005	2010	2020	2021	2025	2030	2025	2030
NO_x*	218.95	247.85	206.02	124.47	122.64	100.28	82.16	98.15	76.9
		0%	*-17%*	*-50%*	*-51%*	*-60%*	*-67%*	*-60%*	*-69%*
SO_2	73.70	25.89	15.99	10.41	10.87	11.20	11.45	11.10	10.33
		0%	*-38%*	*-60%*	*-58%*	*-57%*	*-56%*	*-57%*	*-60%*
NMVOC*	334.05	157.17	137.90	110.53	110.83	102.95	98.73	102.00	97.47
		0%	*-12%*	*-30%*	*-29%*	*-35%*	*-37%*	*-35%*	*-38%*
NH_3	69.27	62.70	65.15	65.53	65.85	62.27	57.62	58.46	51.13
		0%	*4%*	*5%*	*5%*	*-1%*	*-8%*	*-7%*	*-18%*
$PM_{2.5}$	27.26	22.75	19.89	13.35	13.94	12.64	12.39	12.65	12.21
		0%	*-13%*	*-41%*	*-39%*	*-44%*	*-46%*	*-44%*	*-46%*

** NO_x and NMVOC emissions in sub-sectors 3.B and 3.D are included in the sums and should not be taken into account when checking compliance with emission reduction commitments.*

Compliance with national emission reduction commitments

According to Article 4(3) of NEC Directive (EU) 2016/2284, emissions of NO_x and NMVOC from the source categories NFR 3.B (manure management) and 3.D (agricultural soils) are not taken into account for compliance purposes. The following table meets this requirement.

With regard to the achievement of the 2030 targets, Austria will comply for all pollutants in the 'with additional measures' scenario.

Table 4: Austrian national total emissions in kt for compliance purposes in comparison with the 2030 target and the scenarios 'with existing measures' and 'with additional measures' (source: Environment Agency Austria).

Pollutant [kt]	Emission Inventory 2023			*Emission Scenario*				Target	Difference From Target	
				WEM		WAM			WEM	WAM
	2005	2020	2021	*2025*	*2030*	*2025*	*2030*	2030	2030	2030
NO_x	237.09	113.63	111.63	89.74	72.11	88.01	68.30	73.50	-1.39	-5.20
	0%	-52%	-53%	-62%	-70%	-63%	-71%	-69%	-1%	-2%
NMVOC	118.82	75.13	75.47	70.12	68.83	69.96	69.03	76.05	-7.22	-7.01
	0%	-37%	-36%	-41%	-42%	-41%	-42%	-36%	-6%	-6%
SO_2	25.89	10.41	10.87	11.20	11.45	11.10	10.33	15.28	-3.82	-4.94
	0%	-60%	-58%	-57%	-56%	-57%	-60%	-41%	-15%	-19%
NH_3	62.70	65.53	65.85	62.27	57.62	58.46	51.13	55.17	2.45	-4.04
	0%	5%	5%	-1%	-8%	-7%	-18%	-12%	4%	-6%
$PM_{2.5}$	22.75	13.35	13.94	12.64	12.39	12.65	12.21	12.28	0.11	-0.07
	0%	-41%	-39%	-44%	-46%	-44%	-46%	-46%	0%	0%

2.1 Nitrogen oxides (NO_x)

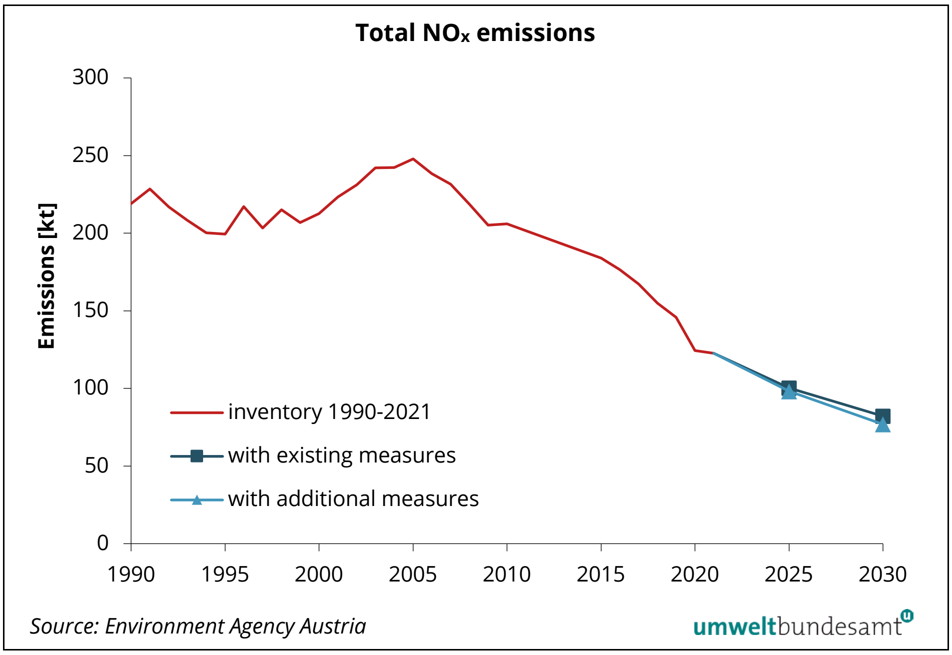
Austria's total NO_x emissions amounted to 218.9 kt in 1990 and 122.6 kt in 2021, meaning a decrease of 44.0% over the period. Since 2005, an emission reduction of about 50.5% has been achieved.

The majority of Austria's national NO_x emissions comes from fuel combustion activities. At 44.4%, road transport accounted for the biggest share of Austria's total NO_x emissions in the year 2021. In the years 2003 to 2005, NO_x emissions from road transport peaked and have since decreased continuously. They have been reduced by 65.0%. In particular, emissions from heavy-duty vehicles (trucks and busses) have fallen due to improvements in exhaust after-treatment technology.

In the scenario **'with existing measures'**, the national total emissions are expected to decrease to 82.2 kt by 2030 (-66.9% compared to 2005).

The main drivers of the NO_x emissions trend over the period to 2030 are expected to be road transport, households and the energy industry. Contrary to the overall trend, emissions from manufacturing industries are expected to remain stable.

Figure 1: Historical (1990—2021) and projected NO_x emissions for WEM and WAM (2022—2030) based on fuel sold.



NO_x emissions from road transport (NFR 1.A.3.b.) are projected to decrease by 63.7% (i.e. -34.7 kt) from 2021 to 2030. In particular, heavy-duty vehicles are forecast to fall by 78.8%, while emissions from passenger cars will decrease by 57.1%.

This decline is based on the following assumptions:

- vehicle fleet turnover in combination with decreasing specific emission factors for Euro VI (HDVs), Euro 6d_temp and EURO 6d (PCs);
- from 2025 onwards, we will see substantial registrations of new BEVs (battery electric vehicles) of over 100 000 cars per year. 2035 will be the first year with 100% BEV registrations in the PC and LDV sectors.

Emissions from NFR 1.A.4. Other Sectors (households, commercial and agriculture) are projected to decrease by 28.1% (i.e. -5.4 kt) from 2021 to 2030. This is mainly due to a modernisation of (and decline in emissions from) non-road mobile machinery (NRMM, known as off-road vehicles) and a switch to low-emission technology. A transition from fossil to electric propulsion systems in these categories is partly assumed. Mobile sources in households and agriculture (off-road) show a decrease of 37.6% (-2.3 kt) by 2030. Stationary sources are expected to fall by 23.7% (-3.1 kt) by 2030 because of a decline in the use of gas oil, ongoing stock replacement with condensing boilers and the impact of eco-design provisions for the installation of new heating systems.

Reduced inputs of gas and oil to fuel thermal power stations and a decrease in oil and gas extraction are responsible for lower emissions in NFR 1.A.1 Energy Industries (-26.8%, i.e. -3.8 kt) by 2030 compared to 2005.

Emissions from NFR 1.A.2 Manufacturing Industries and Construction decreased by 27.5% between 2005 and 2021 due to the installation of primary and secondary NO_x abatement measures. More of these measures will be implemented by 2030, but the effect is expected to be offset by an increase in emissions due to economic growth.

In the scenario **'with additional measures'**, the national total emissions are expected to decrease to 76.9 kt by 2030 (-69.0% compared to 2005).

NO_x emissions from road transport (especially cars and heavy-duty vehicles) are projected to fall by 65.5% (i.e. -35.7 kt) from 2021 to 2030.

Emissions from NFR 1.A.4. Other Sectors (households, commercial and agriculture) are projected to decline by 28.7% (i.e. -5.5 kt) from 2021 to 2030. Mobile sources in households and agriculture (off-road) show a decrease of 37.6% (i.e. -2.3 kt) by 2030. Stationary sources are expected to fall by 24.6% (i.e. -3.3 kt) by 2030 because of a further reduction in the use of gas oil for heating.

Reduced inputs of coal and oil to fuel thermal power stations and a higher consumption of biomass in NFR 1.A.1 Energy Industries results in a decrease of 27.8% (i.e. -4.0 kt) by 2030 compared to 2005.

Table 5: Austrian national NO_x emissions in kt and trend based on 'fuel sold' (source: Environment Agency Austria).

NFR	Description	Emission Inventory 2023* [kt]					Scenario [kt]		Type of Scenario
		1990	2005	2010	2020	2021	2025	2030	
	Total	218.95	247.85	206.02	124.47	122.64	100.28	82.16	WEM
		218.95	247.85	206.02	124.47	122.64	98.15	76.89	WAM
1.A.1	Energy Industries	17.78	14.30	12.80	9.93	9.99	10.58	10.47	WEM
		17.78	14.30	12.80	9.93	9.99	10.23	10.33	WAM
1.A.2	Manufacturing Industries and Construction	33.04	33.98	32.15	24.30	24.63	23.97	23.72	WEM
		33.04	33.98	32.15	24.30	24.63	23.46	21.31	WAM
1.A.3.a, c, d, e	Off-Road Transport	4.01	6.03	5.11	2.36	2.76	3.59	3.74	WEM
		4.01	6.03	5.11	2.36	2.76	3.56	3.70	WAM
1.A.3.b	Road Transport	116.17	155.57	121.32	58.25	54.50	35.77	19.79	WEM
		116.17	155.57	121.32	58.25	54.50	35.05	18.79	WAM
1.A.4	Other Sectors	29.81	26.32	23.65	18.21	19.20	15.27	13.81	WEM
		29.81	26.32	23.65	18.21	19.20	15.14	13.69	WAM
1.A.5	Other	0.07	0.09	0.08	0.05	0.05	0.05	0.05	WEM
		0.07	0.09	0.08	0.05	0.05	0.05	0.05	WAM
1.B	Fugitive Emissions	IE	IE	IE	IE	IE	IE	IE	WEM
		IE	IE	IE	IE	IE	IE	IE	WAM
	Industrial Processes	4.24	0.67	0.52	0.46	0.44	0.46	0.46	WEM

NFR	Description	Emission Inventory 2023* [kt]					Scenario [kt]		Type of Scenario
		1990	2005	2010	2020	2021	2025	2030	
2.A,B,C, H,I,J,K, L		4.24	0.67	0.52	0.46	0.44	0.46	0.38	WAM
2.D, 2.G	Solvent and Other Product Use	0.03	0.03	0.03	0.02	0.02	0.02	0.02	WEM
		0.03	0.03	0.03	0.02	0.02	0.02	0.02	WAM
3.B	Manure Management	0.67	0.60	0.59	0.58	0.58	0.53	0.45	WEM
		0.67	0.60	0.59	0.58	0.58	0.53	0.41	WAM
3.D	Agricultural Soils	12.97	10.16	9.74	10.26	10.43	10.00	9.59	WEM
		12.97	10.16	9.74	10.26	10.43	9.61	8.17	WAM
3.F, I	Field Burning and Other Agriculture	0.03	0.02	0.02	0.00	0.00	0.00	0.00	WEM
		0.03	0.02	0.02	0.00	0.00	0.00	0.00	WAM
5	Waste	0.12	0.07	0.03	0.04	0.04	0.04	0.04	WEM
		0.12	0.07	0.03	0.04	0.04	0.04	0.04	WAM

* *Data source: Austrian Emission Inventory 2023 (ENVIRONMENT AGENCY AUSTRIA, 2023b)*

IE: included elsewhere; NA: not applicable; NO: not occurring

2.2 Sulphur dioxide (SO_2)

In 2021, SO_2 emissions amounted to 10.9 kt. Emissions have decreased by 85.2% since 1990 (73.7 kt) and by 58.0% since 2005.

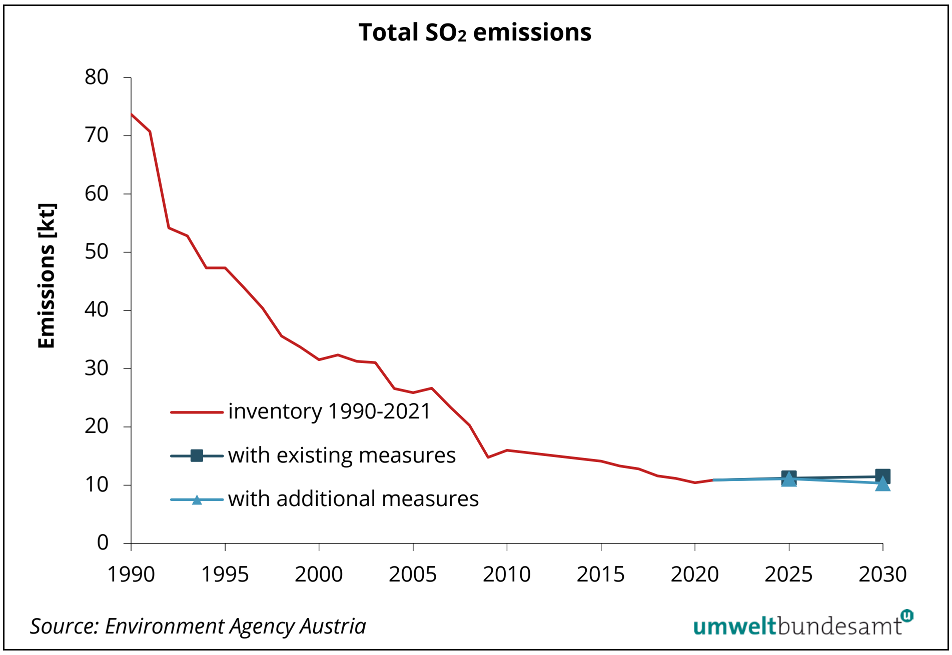
This decline is mainly due to a reduction in the sulphur content in mineral oil products and fuels (as prescribed by the Austrian Fuel Ordinance (*Kraftstoffverordnung*), the installation of desulphurisation units in plants (in accordance with the Clean Air Act for Steam Boilers (*Emissionsschutzgesetz für Kesselanlagen*)) and an increased use of low-sulphur fuels such as natural gas.

From 2020 to 2021, SO_2 emissions rose by 4.4% (+0.5 kt), mainly because emissions rose by 7.0% (+0.3 kt) in the iron and steel industry (NFR 1.A.2.a), which accounts for the largest share of SO_2 emissions (43%), as a result of increased production of pig iron and steel. Compared to the previous year, SO_2 emissions also increased significantly in the residential (NFR 1.A.4.b.1) and commercial/institutional heating sectors (NFR 1.A.4.a.1) due to a higher consumption of heating oil, coal and firewood (cooler weather compared to 2020). In the oil refinery sector (NFR 1.A.1.b), a rise in SO_2 emissions could also be observed.

In the scenario **'with existing measures' (WEM)**, the national total SO_2 emissions are projected to reach 11.4 kt by 2030. Compared to 2005, this is a reduction of 55.8%. Compared to 2021, however, this means an increase of 5.3% (i.e. 0.58 kt). Appropriate mitigation measures (e.g. reduction of the sulphur content in liquid fuels, waste gas treatment) have largely already been implemented. The reduction potential is therefore only minor.

The highest decrease by 2030 is expected in NFR 1.A.4 Other Sectors (-26.7%; -0.4 kt) mainly due to a further shift in residential heating from solid and liquid fossil fuels (coal, oil) towards the use of heat pumps, district heat and biomass heating systems in gradually more energy-efficient buildings. Emissions from manufacturing industries and construction (NFR 1.A.2) are expected to increase by 10.0% (+0.7 kt).

Figure 2: Historical (1990—2021) and projected SO_2 emissions for WEM and WAM (2022—2030) based on fuel sold.



In the scenario **'with additional measures' (WAM),** national total emissions are expected to decrease to 10.3 kt by 2030 (-60.1% compared to 2005).

Minor effects can be expected at the sectoral level over the period from 2021 to 2030: emissions from other sectors (NFR 1.A.4) are expected to decrease by 2030 (WEM: -26.7%, i.e. -0.40 kt; WAM: -28.9%, i.e. -0.43 kt) due to a further shift from fossil fuels (oil, coal) to renewables.

Table 6: Austrian national SO_2 emissions in kt and trend based on 'fuel sold' (source: Environment Agency Austria).

NFR	Description	Emission Inventory 2023* [kt]					Scenario [kt]		Type of Scenario
		1990	2005	2010	2020	2021	2025	2030	
	Total	73.70	25.89	15.99	10.41	10.87	11.20	11.45	WEM
		73.70	25.89	15.99	10.41	10.87	11.10	10.33	WAM
1.A.1	Energy Industries	14.07	6.71	2.74	1.04	1.14	1.25	1.35	WEM
		14.07	6.71	2.74	1.04	1.14	1.33	1.51	WAM
1.A.2	Manufacturing Industries and Construction	17.83	10.12	9.40	7.26	7.38	7.94	8.12	WEM
		17.83	10.12	9.40	7.26	7.38	7.78	6.87	WAM
1.A.3.a, c, d, e	Off-Road Transport	0.36	0.19	0.18	0.08	0.09	0.13	0.15	WEM
		0.36	0.19	0.18	0.08	0.09	0.13	0.15	WAM

NFR	Description	Emission Inventory 2023* [kt]					Scenario [kt]		Type of Scenario
		1990	2005	2010	2020	2021	2025	2030	
1.A.3.b	Road Transport	4.77	0.16	0.13	0.12	0.13	0.12	0.11	WEM
		4.77	0.16	0.13	0.12	0.13	0.12	0.10	WAM
1.A.4	Other Sectors	32.66	7.88	2.77	1.27	1.50	1.12	1.10	WEM
		32.66	7.88	2.77	1.27	1.50	1.11	1.07	WAM
1.A.5	Other	0.01	0.01	0.01	0.01	0.01	0.01	0.01	WEM
		0.01	0.01	0.01	0.01	0.01	0.01	0.01	WAM
1.B	Fugitive Emissions	2.00	0.04	0.05	0.02	0.03	0.02	0.01	WEM
		2.00	0.04	0.05	0.02	0.03	0.02	0.01	WAM
2.A,B,C, H,I,J,K,L	Industrial Processes	1.93	0.72	0.70	0.58	0.59	0.59	0.59	WEM
		1.93	0.72	0.70	0.58	0.59	0.59	0.59	WAM
2.D, 2.G	Solvent and Other Product Use	0.00	0.01	0.01	0.00	0.00	0.00	0.00	WEM
		0.00	0.01	0.01	0.00	0.00	0.00	0.00	WAM
3.B	Manure Management	NA	NA	NA	NA	NA	NA	NA	WEM
		NA	NA	NA	NA	NA	NA	NA	WAM
3.D	Agricultural Soils	NA	NA	NA	NA	NA	NA	NA	WEM
		NA	NA	NA	NA	NA	NA	NA	WAM
3.F, I	Field Burning and Other Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	WEM
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	WAM
5	Waste	0.07	0.06	0.01	0.02	0.02	0.02	0.02	WEM
		0.07	0.06	0.01	0.02	0.02	0.02	0.02	WAM

* *Data source: Austrian Emission Inventory 2023 (ENVIRONMENT AGENCY AUSTRIA, 2023b)*

IE: included elsewhere; NA: not applicable; NO: not occurring

2.3 Non-methane volatile organic compounds (NMVOC)

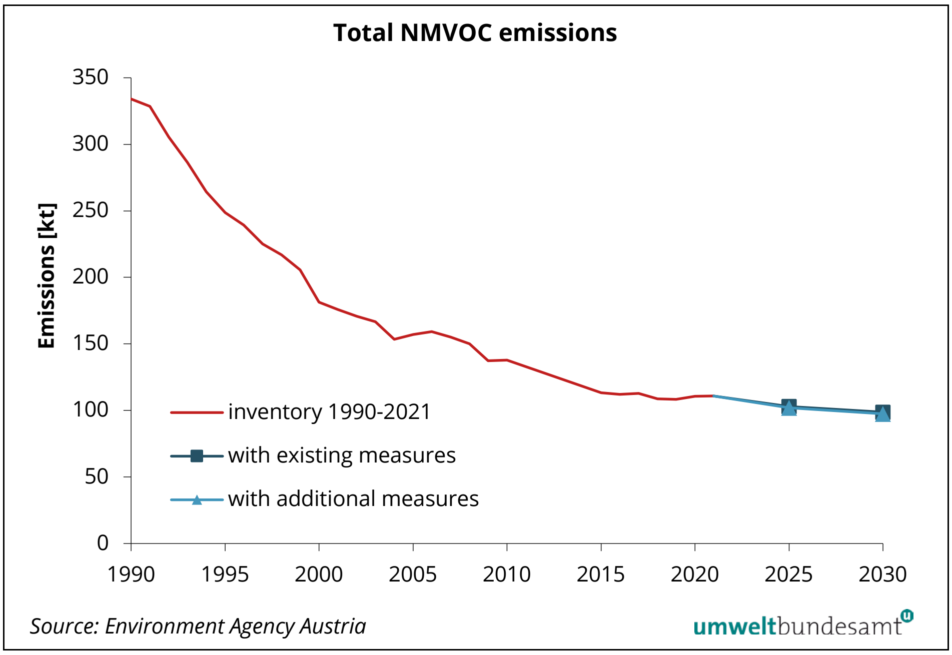
Emissions of non-methane volatile organic compounds amounted to 334.1 kt in 1990 and 110.8 kt in 2021. This corresponds to a reduction of 66.8%. From 2020 to 2021, NMVOC emissions increased by 0.3 kt (+0.3%).

The largest reductions since 1990 have been achieved in the road transport sector due to an increased use of catalytic converters and diesel cars. Currently, the road transport sector (NFR 1.A.3.b.) accounts for only a small share (3.4%) of Austria's total NMVOC emissions.

In 2021, the main sources of NMVOC emissions in Austria were NFR 2.D.3 Solvent Use with a share of 31.2%, the agricultural sector (NFR 3) with 31.9% and NFR 1.A.4.b.1 Residential Stationary Heating with 22.7% of the total NMVOC emissions.

In the scenario **'with existing measures' (WEM)**, national total NMVOC emissions are expected to decrease to 98.7 kt by 2030 (-37.2% compared to 2005).

Figure 3: Historical (1990—2021) and projected NMVOC emissions for WEM and WAM (2022—2030) based on fuel sold.



Total NMVOC emissions are projected to decrease by 10.9% by 2030 (compared to 2021). The largest reduction is expected to be achieved in NFR 1.A.4 Other Sectors (mainly households and commercial), with a decrease of 25.7% (i.e. -7.5 kt) over the period from 2021 to 2030. This is mainly due to a trend towards low-emission technologies (heating types) and projected lower emission factors for new boilers in the building sector (see also eco-design requirements in Chapter 4.1.3) as well as a decline in the use of fuel wood as a source of energy.

Emissions in road transport (NFR 1.A.3) are projected to fall by 22.9% (i.e. -0.9 kt) by 2030, owing to state-of-the-art exhaust gas treatment (regulated catalytic converter) in earlier years and a substantial share of electric vehicles in the long term causing zero direct emissions.

On the other hand, emissions from NFR 2.D.3 Solvent Use are expected to increase by 5.1% by 2030 (i.e. 1.8 kt) due to projected economic growth resulting in an increase in solvent use. Emission regulations for the relevant sectors have been enforced at EU level, with some of the legal requirements in Austria being even stricter. The requirements for paints and varnishes have been harmonised at EU level, and existing regulations do not forsee a further tightening of emission standards. Calculations are based on solvent balances from companies and linked to economic projections for the respective sub-sectors, coupled with expert judgement on the actual increase of solvent use, taking into account the offset due to new technologies.

Emissions from agriculture are projected to decrease by 15.4% (i.e. 5.5 kt) by 2030 compared to 2021, mainly caused by livestock developments in Austria.

In the scenario **'with additional measures' (WAM)**, the national total emissions are expected to decrease to 97.5 kt by 2030 (-38.0% compared to 2005).

NMVOC emissions from agriculture are projected to fall by 19.6% (i.e. -6.9 kt) from 2021 to 2030, mainly due to assumed livestock developments in Austria.

Table 7: Austrian national NMVOC emissions in kt and trend based on 'fuel sold' (source: Environment Agency Austria).

NFR	Description	Emission Inventory 2023* [kt]					Scenario [kt]		Type of Scenario
		1990	2005	2010	2020	2021	2025	2030	
	Total	334.05	157.17	137.90	110.53	110.83	102.95	98.73	WEM
		334.05	157.17	137.90	110.53	110.83	102.00	97.47	WAM
1.A.1	Energy Industries	0.32	0.24	0.35	0.30	0.31	0.31	0.31	WEM
		0.32	0.24	0.35	0.30	0.31	0.31	0.31	WAM
1.A.2	Manufacturing Industries and Construction	1.68	2.06	1.94	0.97	0.96	0.89	0.88	WEM
		1.68	2.06	1.94	0.97	0.96	0.89	0.88	WAM
1.A.3.a, c, d, e	Off-Road Transport	1.53	1.79	1.45	0.51	0.62	0.67	0.65	WEM
		1.53	1.79	1.45	0.51	0.62	0.67	0.65	WAM
1.A.3.b	Road Transport	96.36	20.26	10.11	3.95	3.75	3.50	2.89	WEM
		96.36	20.26	10.11	3.95	3.75	3.43	3.24	WAM
1.A.4	Other Sectors	48.49	33.64	34.79	26.60	29.33	23.08	21.79	WEM
		48.49	33.64	34.79	26.60	29.33	23.00	21.66	WAM
1.A.5	Other	0.01	0.02	0.01	0.01	0.01	0.01	0.01	WEM
		0.01	0.02	0.01	0.01	0.01	0.01	0.01	WAM
1.B	Fugitive Emissions	15.59	3.46	2.57	2.03	2.02	2.16	2.01	WEM
		15.59	3.46	2.57	2.03	2.02	2.15	1.99	WAM
2.A,B,C, H,I,J,K,L	Industrial Processes	4.36	3.56	3.72	3.84	3.86	3.90	3.93	WEM
		4.36	3.56	3.72	3.84	3.86	3.90	3.93	WAM
2.D, 2.G	Solvent and Other Product Use	114.61	53.63	44.99	36.86	34.57	35.55	36.32	WEM
		114.61	53.63	44.99	36.86	34.57	35.55	36.32	WAM
3.B	Manure Management	33.52	26.95	27.03	25.91	26.03	24.60	22.60	WEM
		33.52	26.95	27.03	25.91	26.03	24.11	21.47	WAM
3.D	Agricultural Soils	17.37	11.40	10.82	9.50	9.33	8.23	7.31	WEM
		17.37	11.40	10.82	9.50	9.33	7.93	6.97	WAM
3.F, I	Field Burning and Other Agriculture	0.06	0.04	0.03	0.00	0.00	0.00	0.00	WEM
		0.06	0.04	0.03	0.00	0.00	0.00	0.00	WAM
5	Waste	0.17	0.12	0.10	0.06	0.06	0.05	0.05	WEM
		0.17	0.12	0.10	0.06	0.06	0.05	0.05	WAM

* *Data source: Austrian Emission Inventory 2023 (ENVIRONMENT AGENCY AUSTRIA, 2023b)*

IE: included elsewhere; NA: not applicable; NO: not occurring

2.4 Ammonia (NH_3)

Ammonia emissions amounted to 65.8 kt in 2021. Since 1990, NH_3 emissions have decreased by 4.9%, although they have increased by 5.0% since 2005.

The main source of NH_3 emissions is the agricultural sector with a share of 94.1% in 2021. Within the agricultural sector, about 51% of NH_3 emissions result from manure management (NFR 3.B) and 49% from agricultural soils (NFR 3.D).

There was a fall of 7.0% in NH_3 emissions from the agricultural sector between 1990 and 2021. This reduction can be explained mainly by declining cattle numbers, more efficient feeding and an increased application of low-emission spreading techniques (e.g. band spreading, trailing shoe, rapid incorporation of manure).

Agricultural NH_3 emissions mainly arise from animal husbandry and the application of organic and mineral N fertilisers.

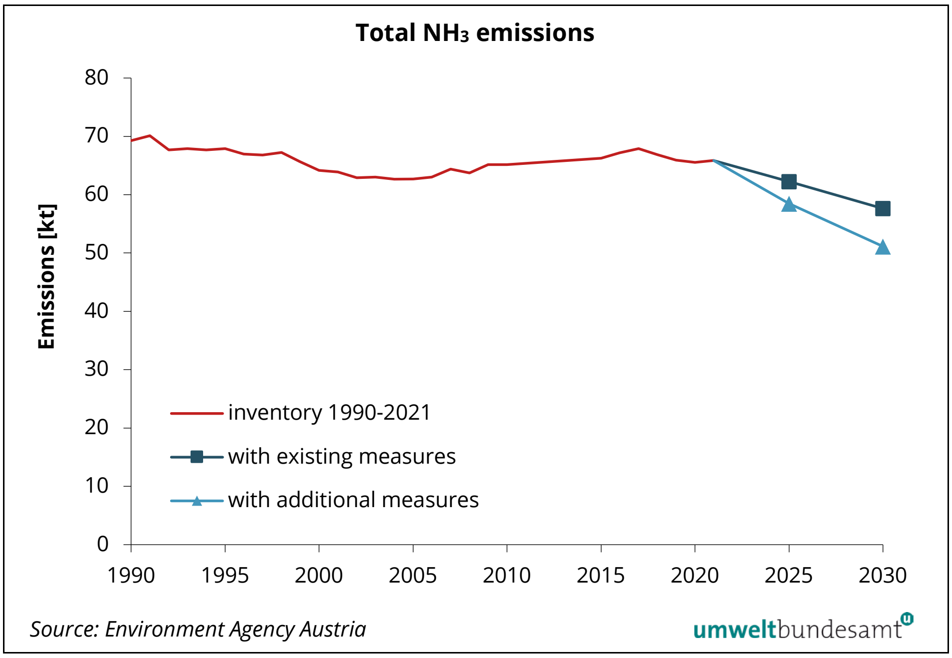
Within NFR 3.B Manure Management, emissions result from animal husbandry and the storage of manure. In manure management, cattle accounts for the highest share (62.6% in 2021). Levels of emissions depend on livestock numbers, but also on housing systems and manure treatment (e.g. NH_3 emissions from loose housing systems are considerably higher than those from tied housing systems). Since 2005, NH_3 emissions from agriculture have increased by 7.8%, mainly due to higher emissions from cattle, which are increasingly housed in loose housing systems for animal welfare reasons.

Ammonia emissions from NFR 3.D Agricultural Soils occur as a result of the application of mineral N fertilisers as well as organic fertilisers (including animal manure, sewage sludge, digestates from biogas plants and compost). Another source of NH_3 emissions is urine and dung deposited on pastures by grazing animals.

In the scenario **'with existing measures' (WEM)**, national total emissions are expected to decrease to 57.6 kt by 2030 (-8.1% compared to 2005). For the period between 2021 and 2030, NH_3 emissions show a 12.5% reduction.

Declining animal numbers and existing measures such as the increased use of low-emission manure spreading techniques in the agricultural sector are the main reasons for decreased emissions in 2030. National forecasts for agricultural production in Austria (WIFO & BOKU, 2023) show that cattle numbers will fall by 13% between 2021 and 2030. Pig numbers will decrease at a much higher rate because the output price and input cost ratio is less favourable. Poultry numbers will decline at a rate similar to the number of pigs until 2030. In accordance with Austria's CAP-SP, the share of low-emission spreading techniques will be increased significantly in the coming years (see Chapter 4.5).

Figure 4: Historical (1990—2021) and projected NH_3 emissions for WEM and WAM (2022—2030) based on fuel sold.



In the scenario **'with additional measures' (WAM)**, national total emissions are expected to decrease to 51.1 kt by 2030 (-18% compared to 2005).

For the period between 2021 and 2030, national total NH_3 emissions will decrease by 22.3%.

The main reason for the emission reductions is the projected decline in livestock numbers. In the WAM scenario, cattle numbers are projected to fall by 15% between 2021 and 2030 (WIFO & BOKU, 2023). Pig and poultry numbers are expected to decrease as well, by 18% and 21%, respectively.

Additional measures listed in the Austrian NAPCP and NECP as well as the obligatory measures regulated by Austria's Ammonia Reduction Ordinance (*Ammoniakreduktionsverordnung*) are responsible for the falling trend. The analyses at sub-sector level show that the lower livestock numbers and additional measures in animal feeding, animal husbandry and slurry storage will reduce emissions by 21% (i.e. -6.53 kt) in the sub-sector NFR 3.B Manure Management between 2021 and 2030. Emissions in the sub-sector NFR 3.D Agricultural Soils are expected to decrease by 26% (i.e.
-8.00 kt) by 2030, mainly due to lower emissions from manure spreading as a result of the lower livestock numbers and an increased use of low-emission manure application techniques. Furthermore, according to the Austrian NECP and NAPCP, there will be a reduced need for mineral N fertilisers due to improved nitrogen management.

Table 8: Austrian national NH_3 emissions in kt and trend based on 'fuel sold' (source: Environment Agency Austria).

NFR	Description	Emission Inventory 2023* [kt]					Scenario [kt]		Type of Scenario
		1990	2005	2010	2020	2021	2025	2030	
	Total	69.27	62.70	65.15	65.53	65.85	62.27	57.62	WEM
		69.27	62.70	65.15	65.53	65.85	58.46	51.13	WAM
1.A.1	Energy Industries	0.20	0.31	0.46	0.43	0.44	0.44	0.44	WEM
		0.20	0.31	0.46	0.43	0.44	0.44	0.44	WAM
1.A.2	Manufacturing Industries and Construction	0.33	0.43	0.42	0.39	0.40	0.40	0.40	WEM
		0.33	0.43	0.42	0.39	0.40	0.40	0.40	WAM
1.A.3.a, c, d, e	Off-Road Transport	0.01	0.01	0.01	0.01	0.01	0.01	0.01	WEM
		0.01	0.01	0.01	0.01	0.01	0.01	0.01	WAM
1.A.3.b	Road Transport	0.80	2.58	1.85	0.89	0.94	1.02	0.95	WEM
		0.80	2.58	1.85	0.89	0.94	0.99	0.92	WAM
1.A.4	Other Sectors	0.63	0.67	0.68	0.60	0.68	0.55	0.55	WEM
		0.63	0.67	0.68	0.60	0.68	0.54	0.52	WAM
1.A.5	Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	WEM
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	WAM
1.B	Fugitive Emissions	IE	0.00	0.00	0.00	0.00	0.00	0.00	WEM
		IE	0.00	0.00	0.00	0.00	0.00	0.00	WAM
2.A,B,C, H,I,J,K,L	Industrial Processes	0.27	0.07	0.09	0.10	0.09	0.09	0.09	WEM
		0.27	0.07	0.09	0.10	0.09	0.09	0.09	WAM
2.D, 2.G	Solvent and Other Product Use	0.07	0.06	0.06	0.06	0.06	0.05	0.05	WEM
		0.07	0.06	0.06	0.06	0.06	0.05	0.05	WAM
3.B	Manure Management	29.66	28.29	29.79	31.26	31.56	30.41	28.07	WEM
		29.66	28.29	29.79	31.26	31.56	29.15	25.03	WAM
3.D	Agricultural Soils	36.91	29.16	30.59	30.56	30.40	28.05	25.79	WEM
		36.91	29.16	30.59	30.56	30.40	25.52	22.40	WAM
3.F, I	Field Burning and Other Agriculture	0.03	0.02	0.02	0.00	0.00	0.00	0.00	WEM
		0.03	0.02	0.02	0.00	0.00	0.00	0.00	WAM
5	Waste	0.37	1.09	1.17	1.24	1.27	1.26	1.27	WEM
		0.37	1.09	1.17	1.24	1.27	1.26	1.27	WAM

* *Data source: Austrian Emission Inventory 2023 (ENVIRONMENT AGENCY AUSTRIA, 2023b)*

IE: included elsewhere; NA: not applicable; NO: not occurring

2.5 Fine Particulate Matter ($PM_{2.5}$)

Since 1990, $PM_{2.5}$ emissions have decreased by 48.9%. The decline since 2005 is estimated at 38.7%.

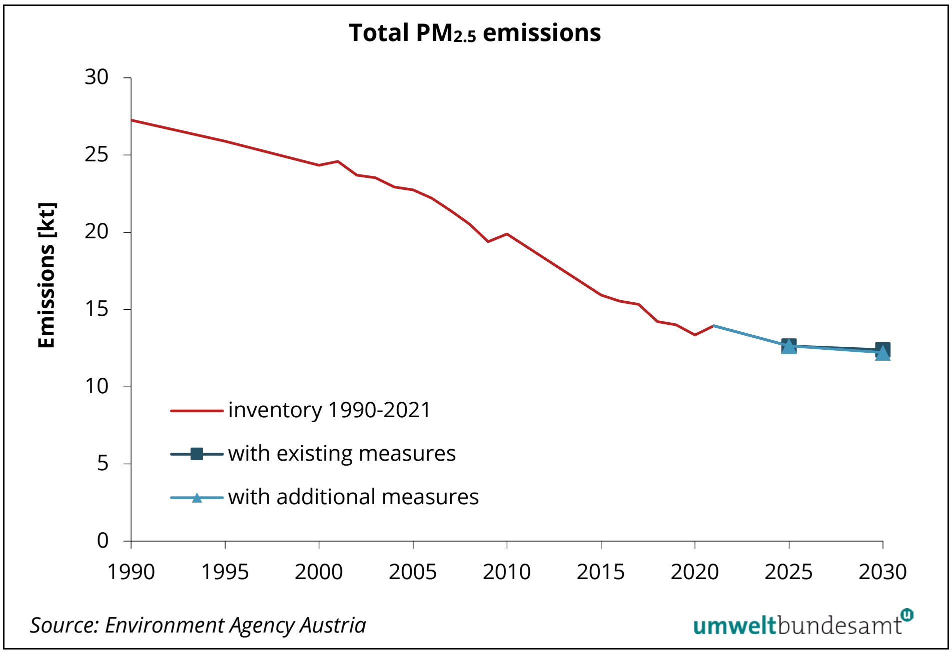
The largest falls were achieved through reduced coal consumption in households (NFR 1.A.4.b.1) and improved vehicle exhaust after-treatment technologies in road transport (NFR 1.A.3.b).

From 2020 to 2021, $PM_{2.5}$ emissions increased by 0.6 kt (+4.5%) due to higher biomass consumption from residential heating (NFR 1.A.4.b.1) because of the colder weather and the higher demand for heating.

With a share of about 45.1%, the residential stationary sector (NFR 1.A.4.b.1) was the main source of total $PM_{2.5}$ emissions in 2021. The change in emissions between 2020 and 2021 by +9.4% was due to the increased volume of biomass used for heating because of the colder weather in 2021. To some extent, the overall decreasing trend of NFR 1.A.4.b.1 Residential Stationary Heating since 2005 can also be explained by efficiency improvements through thermal renovation and a switch to modern biomass boilers and stoves (improvements in fuel combustion technologies).

In the scenario **'with existing measures' (WEM)**, the national total emissions are expected to decrease to 12.4 kt by 2030 (-45.5% compared to 2005).

Figure 5: Historical (1990—2021) and projected $PM_{2.5}$ emissions for WEM and WAM (2022—2030) based on fuel sold.



In the WEM scenario, $PM_{2.5}$ emissions of NFR 1.A.4 Other Sectors are expected to decrease by 21.8% (i.e -1.6 kt) in 2030 compared to 2021. $PM_{2.5}$ emission reductions are mainly due to a trend away from manually fed fuel wood boilers and wood stoves. Furthermore, biomass heating systems will be used in gradually more energy-efficient buildings. Thus, a declining energy demand for fuel wood (and coal) is responsible for $PM_{2.5}$ reductions. This is also supported by the impact of eco-design provisions for the installation of new heating systems.

Total $PM_{2.5}$ emissions from the road transport sector (NFR 1.A.3.b) are expected to decrease by about 19.3% (i.e. -0.4 kt) compared to 2021. Whereas exhaust emissions from cars and trucks are expected to fall by 2030 (due to a higher penetration of vehicles fitted with filters and an increased share of BEVs), emissions from automobile road abrasion and vehicles (tyres, brake wear) are set to increase slightly because of an increase in total vehicle kilometres driven.

In the energy industries sector (NFR 1.A.1), an increase in $PM_{2.5}$ emissions has been noted for 2030 compared to 2021 (+31.5%; +0.3 kt), generally due to a rise in biomass usage for electricity and heat generation.

Emissions from NFR 1.A.2 Manufacturing Industries and Construction decreased by 65.7% between 2005 and 2021 due to the installation of electrostatic precipitators and bag filters. By 2030, more of these devices will be in use, but the effect will be offset by an increase in emissions due to economic growth.

In the scenario **'with additional measures' (WAM)**, national total emissions are expected to decrease to 12.3 kt by 2030 (-46.1% compared to 2005).

$PM_{2.5}$ emissions from NFR 1.A.4 Other Sectors are expected to fall by 22.7% (i.e. -1.69 kt) by 2030 compared to 2021. Total $PM_{2.5}$ emissions from the road transport sector (including 'fuel exports') are expected to decrease by about 25.0% (i.e. -0.49 kt) compared to 2021.

Due to higher inputs of biomass in energy consumption, $PM_{2.5}$ emissions in the NFR 1.A.2 and NFR 2 sectors are slightly higher than in the WEM scenario.

Table 9: Austrian national $PM_{2.5}$ emissions in kt and trend based on 'fuel sold' (source: Environment Agency Austria).

NFR	Description	Emission Inventory 2023* [kt]					Scenario [kt]		Type of Scenario
		1990	2005	2010	2020	2021	2025	2030	
	Total	27.26	22.75	19.89	13.35	13.94	12.64	12.39	WEM
		27.26	22.75	19.89	13.35	13.94	12.65	12.21	WAM
1.A.1	Energy Industries	0.85	0.80	1.10	0.96	1.00	1.19	1.32	WEM
		0.85	0.80	1.10	0.96	1.00	1.27	1.35	WAM
1.A.2	Manufacturing Industries and Construction	1.88	1.85	1.52	0.70	0.63	0.72	0.75	WEM
		1.88	1.85	1.52	0.70	0.63	0.70	0.70	WAM
1.A.3.a, c, d, e	Off-Road Transport	0.70	0.66	0.52	0.29	0.31	0.37	0.38	WEM
		0.70	0.66	0.52	0.29	0.31	0.36	0.37	WAM
1.A.3.b	Road Transport	5.70	7.21	4.89	2.01	1.96	1.73	1.58	WEM
		5.70	7.21	4.89	2.01	1.96	1.66	1.47	WAM
1.A.4	Other Sectors	13.31	9.02	9.15	6.88	7.45	6.09	5.82	WEM
		13.31	9.02	9.15	6.88	7.45	6.06	5.76	WAM
1.A.5	Other	0.02	0.02	0.02	0.01	0.01	0.01	0.01	WEM
		0.02	0.02	0.02	0.01	0.01	0.01	0.01	WAM
1.B	Fugitive Emissions	0.11	0.09	0.07	0.05	0.05	0.05	0.05	WEM
		0.11	0.09	0.07	0.05	0.05	0.05	0.04	WAM
2.A,B,C, H,I,J,K,L	Industrial Processes	3.56	2.07	1.52	1.46	1.53	1.53	1.53	WEM
		3.56	2.07	1.52	1.46	1.53	1.56	1.57	WAM
2.D, 2.G	Solvent and Other Product Use	0.53	0.49	0.50	0.40	0.40	0.40	0.38	WEM
		0.53	0.49	0.50	0.40	0.40	0.40	0.38	WAM
3.B	Manure Management	0.13	0.11	0.11	0.11	0.11	0.11	0.09	WEM
		0.13	0.11	0.11	0.11	0.11	0.11	0.09	WAM
3.D	Agricultural Soils	0.14	0.15	0.14	0.14	0.14	0.13	0.13	WEM
		0.14	0.15	0.14	0.14	0.14	0.13	0.13	WAM
3.F, I	Field Burning and Other Agriculture	0.07	0.06	0.05	0.00	0.00	0.00	0.00	WEM
		0.07	0.06	0.05	0.00	0.00	0.00	0.00	WAM
5	Waste	0.25	0.23	0.31	0.34	0.34	0.33	0.34	WEM
		0.25	0.23	0.31	0.34	0.34	0.33	0.34	WAM

* *Data source: Austrian Emission Inventory 2023 (ENVIRONMENT AGENCY AUSTRIA, 2023b)*

IE: included elsewhere; NA: not applicable; NO: not occurring

3 POLICIES AND MEASURES (PAMS)

For all sectors, reduction measures were identified and emissions projected through specifically designed models. The methodology used for the projections and emission calculations is described in the respective chapters. Consistency between the sector models was ensured by regular expert meetings where potential overlaps and gaps were identified and discussed.

Compared to the last submission in 2021, reporting on policies and measures has improved further. Additional measures in the WAM scenario are based on the National Climate and Energy Plan (BMK, 2023a) and the National Air Pollution Control Programme (BMK, 2023b).

The Austrian air pollutant projections are consistent with current GHG emission projections under the EU Governance Regulation (EU) 2018/1999. A detailed description of the individual measures for GHGs is provided in the report submitted under the Governance Regulation in 2023 (ENVIRONMENT AGENCY AUSTRIA, 2023c).

Measures to reduce GHG emissions and air pollutants have been identified and are considered in the scenarios. There is strong interaction between the measures for GHG emissions and those for air pollutants. Either they have impacts across a number of sectors (cross-cutting measures) or they target specific sectors and form the basis for Austria's air pollutant projections.

3.1 Cross-cutting measures

- EU Emissions Trading System (WEM)
  - The system covers CO_2 emissions from large emitters in the industrial sectors, from energy and heat supply to aircraft operators as well as N_2O emissions from the chemical industry. The EU ETS also has positive side-effects for SO_2 and NO_x in that it encourages operators to upgrade their facilities in order to reduce emissions and increase efficiency.
- Domestic Environmental Support Scheme (WEM)
  - The objective of this funding scheme is to protect the environment and to reduce pressures such as air pollution, greenhouse gas and noise emissions, and waste generation.
- Austrian Climate and Energy Fund (WEM)
  - The main objective of this fund is to provide subsidies for research in—and the implementation of—climate-friendly technology and thus to produce positive side-effects for air pollution.
- CO_2 certification scheme for fossil fuels (WAM)
  - The National Emissions Certificate Trading Act (*Nationales Emissionszertifikatehandelsgesetz*, NEHG 2022) covers energy-related greenhouse gas

emissions that have been produced by the non-ETS sectors (buildings, transport, agriculture, waste and small industrial plants). The objective of this law is to establish cost transparency for CO_2 emissions. Entities placing energy sources in circulation on the Austrian market, known as trading participants, must acquire emissions certificates for fossil energy sources such as petrol, gas oil (diesel), heating oil, natural gas, liquefied gas, coal and kerosene (Annex 1 to the law).

3.2 Energy industries (NFR 1.A.1) and manufacturing industries and construction (NFR 1.A.2)

- Increased share of renewable energy in power supply and district heating (WEM)
  - Increasing the share of renewable energy in power supply and district heating is the main purpose of this policy designed to reduce the impacts of energy systems on the climate. Beyond the traditional use of large-scale hydropower for electricity generation, quantitative targets have been set for increasing the share of wind power, photovoltaics, small hydropower plants and biomass/biogas in electricity generation in the Renewable Energy Expansion Act (*Erneuerbaren-Ausbau-Gesetz*). These targets are to be achieved by fixed feed-in tariffs. Investment support has been granted for biomass-based district heating systems (see PaM Domestic Environmental Support Scheme).
- Increased energy efficiency in energy and manufacturing industries (WEM)
  - An increase in energy efficiency in the energy and manufacturing industries is essential if the growing demand for fuel is to be reduced, along with environmental impacts. In compliance with EU legislation, Austria transposed the Energy Efficiency Directive 2012/27/EU and prepared a National Energy Efficiency Action Plan in 2017 with quantitative targets for final and primary energy consumption in 2020.
- Further enhancement of renewable energy in power supply and district heating (WAM)
  - A further increase in the share of renewable energy in power supply and district heating, to be achieved by 2030, is the main purpose of this policy designed to reduce the impacts of energy systems on the climate. Beyond the traditional use of large-scale hydropower for electricity generation, quantitative targets will be set in the Renewable Energy Expansion Act for increasing the share of wind power, photovoltaics, small hydropower plants and biomass/biogas in electricity generation in the next decade.
  - Investment support for biomass-based district heating systems will continue to be granted via the Domestic Environmental Support Scheme. Funding for this scheme has recently been increased considerably. Additional support will be granted for innovative district heating systems

  (e.g. deep geothermal energy) (see PaM Domestic Environmental Support Scheme).
- Further enhancement of energy efficiency in the energy industries (WAM)
  - A further increase in energy efficiency in the energy and manufacturing industries is essential for the achievement of climate and energy goals. Based on EU legislation, Austria adopted an Energy Efficiency Act (*Energieeffizienzgesetz*) and prepared National Energy Efficiency Action Plans in 2014 and 2017, respectively, with quantitative targets for final and primary energy consumption in 2020. The Energy Efficiency Action Plans have since been integrated into the National Energy and Climate Plan. In 2023, the Energy Efficiency Act was amended with a more ambitious goal for reducing final energy consumption by 2030. The draft of the Austrian National Energy and Climate Plan was published in summer 2023.
  - Furthermore, support through the Domestic Environmental Support Scheme in the 'non-ETS industry' sector was increased in 2021 (see PaM Domestic Environmental Support Scheme).
  - Financial support for heat and power cogeneration based on fossil fuels will no longer be granted from 2021 onwards.
- Further enhancement of renewables in gas supply (WAM)

Austria intends to increase the share of renewables in its final energy demand. As natural gas is the predominant fuel in the 'energy industries' sector, it is essential to raise the share of renewable gas in the national gas grid. This includes subsidy and investment schemes for the production of biogas and hydrogen as well as the construction of distribution infrastructure.

3.3 Transport (NFR 1.A.3)

- Increased share of renewable energy sources in road transport (WEM)
  - Implementation of the Renewable Energy Directives (Directive 2009/28/EC and Directive (EU) 2018/2001) on the promotion of the use of energy from renewable sources.
  - EU CO_2 reduction targets for PCs, LDVs and HDVs—regulation subsequent to Regulation (EU) 2019/631 and tightening CO_2 emission standards for passenger cars and light commercial vehicles (meaning no new vehicle registrations with a conventional combustion engine from 2035). For HDVs, implementation of the existing Regulation (EU) 2019/1242.
- Increased fuel efficiency in road transport (WEM)
  - Supported by the following instruments: air quality induced speed limits to tackle local air quality problems and the Eco-Driving Initiative of the National Action Programme for Mobility Management '*klimaaktiv mobil*' to save fuel.

  - Fiscal policy instruments: fuel tax increase in 2011 and greening the truck toll in 2010.
- Modal shift in passenger and freight transport (WEM)
  - The promotion of a modal shift towards active and environmentally friendly modes of transport (cycling and walking) is a cornerstone of the '*klimaaktiv mobil*' initiative for mobility management and awareness. It is a funding programme for businesses, communities and associations and includes target group-oriented counselling programmes, awareness-raising initiatives, partnerships, and training and certification initiatives.
  - The instruments for boosting the share of public transport are the Austrian Federal Railways Framework Plan 2022—2027 and nationwide and regional public transport tickets.
  - The instruments for achieving a shift in the modal split towards rail transport and navigation are the Austrian Federal Railways Framework Plan 2022—2027, rail freight subsidies, the promotion of corporate rail connections for freight transport and the Danube Action Plan until 2022.
- Further promotion of renewable energy in the transport sector (WAM)
  - Renewable Energy Directive REDIII (directive subsequent to Directive (EU) 2018/2001 in negotiation after the trilogue of 30 March 2023)[5] with an energy target of 29% (energy content), taking into account electricity for road and other land transport and the current blending of biofuels.
- Further enhancement of fuel efficiency in road transport (WAM)
  - CO_2 tax (cross-cutting measure).
  - CO_2 emission-dependent toll for heavy traffic on the high-level road network according to the possibilities of the new Directive (EU) 2022/362 on infrastructure charges, amending Directive 1999/62/EC.
- Further modal shift to environmentally friendly modes of transport (WAM)
  - The basis for modelling measures to promote active mobility modes are the budget funds for cycling and walking as well as mobility management in the NEKP financing table.
  - Service contracts of the Austrian Federal Railways and private railways: increased financing from 2025 according to the NEKP financing table.
  - Austrian Federal Railways Framework Plan 2023—2028: financing until 2028 according to the NEKP financing table (WEM=WAM).
  - Urban regional railways: according to the NEKP financing table, more subsidies per year from the federal government than in the WEM.
  - Austria Climate Ticket for public transport: according to the NEKP financing table, saturation by 2026 has been assumed.

[5] https://www.consilium.europa.eu/en/press/press-releases/2023/03/30/council-and-parliament-reach-provisional-deal-on-renewable-energy-directive/#:~:text=The%20provisional%20agreement%20gives%20the,the%20transport%20sector%20by%202030

  - Potential traffic shift from road to rail through additional services and/or changed cost structure beyond the impact of the Austrian Federal Railways Framework Plan 2023—2028.
- Further enhancement of clean energy sources for transport (WAM)
  - With the EURO 7 proposal, the standards that succeed EURO 6 for PCs and LDVs (Regulation (EC) No 715/2007) and EURO VI for HDVs (Regulation (EC) No 595/2009) are combined in one legal act.
  - Proposal by the European Commission of February 2023 to tighten Regulation (EU) 2019/1242 of 20 June 2019 setting CO_2 emission standards for new HDVs.
  - Funding programs 'Emission-free buses and infrastructure' (EBIN) and 'Emission-free commercial vehicles and infrastructure' (ENIN) plus decarbonisation.
  - SAF minimum blending quotas for aviation according to the provisional agreement in the trilogue on 25 April 2023 regarding the draft ReFuel EU Aviation Regulation.

3.4 Other sectors (NFR 1.A.4)

- **Climate-neutral new buildings (WEM)**
  In the WEM scenario, the full implementation of Directive 2010/31/EU sets the nearly zero-energy building standard for new buildings. High-efficiency alternative heating systems have to be considered, if available. Requirements relating to the renewable share support the installation of solar appliances. At the federal level, bans apply to heating systems for solid and liquid fossil fuels. In the case of subsidies from the Housing Support Scheme (*Wohnbauförderung*), additional funding is granted if stronger standards than the minimum criteria for energy efficiency of the building envelope and for the choice of heating systems are met.
  - OIB Guideline 6—Energy Savings and Thermal Insulation, 2019 edition (OIB-330.6-026/19)
  - Oil Boiler Installation Prohibition Act (*Ölkesseleinbauverbotsgesetz* – ÖKEVG 2019)
  - Constitutional Art. 15a Agreement on Measures in the Building Sector to reduce Greenhouse Gas Emissions (Federal—State)
  - Funding programmes to support renewable heating systems and to improve the thermal energy efficiency of the building envelope of new buildings:
    - Domestic Environmental Support Scheme (*Umweltförderung im Inland*)
    - Housing Support Scheme (*Wohnbauförderung*)
    - Austrian Climate and Energy Fund (*Klima- und Energiefonds*)

- **Thermal improvement of building stock (WEM)**
  In the WEM scenario, the full implementation of Directive 2010/31/EU maintains a mandatory energy performance building standard for major renovation. In the case of subsidies from the Housing Support Scheme (*Wohnbauförderung*), additional funding is granted if stronger standards than the minimum criteria for energy efficiency of the building envelope are met. An obligation to have energy performance certificates applies when renting, leasing or selling buildings.
  - OIB Guideline 6—Energy Savings and Thermal Insulation, 2019 edition (OIB-330.6-026/19)
  - Constitutional Art. 15a Agreement on Measures in the Building Sector to reduce Greenhouse Gas Emissions (Federal—State)
  - Funding programmes to improve the thermal energy efficiency of the building envelope of existing buildings:
    - Domestic Environmental Support Scheme (*Umweltförderung im Inland*)
    - Housing Support Scheme (*Wohnbauförderung*)
    - Austrian Climate and Energy Fund (*Klima- und Energiefonds*)
    - Building Renovation Initiative for Commercial/Institutional Buildings (*Sanierungsoffensive für Betriebe*)
    - Building Renovation Initiative for Residential Buildings (*Sanierungsoffensive für Private*)
    - Act on the Presentation of an Energy Performance Certificate (*Energieausweis-Vorlage-Gesetz 2012* – EAVG 2012)

- **Replacement of fossil fuels in building stock (WEM)**
  In the WEM scenario, the full implementation of Directive 2010/31/EU maintains that, for buildings undergoing replacement of heating systems (alongside or without thermal renovation of the building envelope), high-efficiency alternative systems have to be considered, if available. Requirements relating to the renewable share support the installation of solar appliances. In the case of subsidies from the Housing Support Scheme (*Wohnbauförderung*), additional funding is granted if stronger standards than the minimum criteria for the choice of heating systems are met. It is assumed that the focus programme Stepping Out of Oil and Gas (*Raus aus Öl und Gas*) will maintain higher subsidy rates until 2025 for the exchange of fossil fuel heating systems. This bonus will be phased out by 2040.
  - OIB Guideline 6—Energy Savings and Thermal Insulation, 2019 edition (OIB-330.6-026/19)
  - Constitutional Art. 15a Agreement on Measures in the Building Sector to reduce Greenhouse Gas Emissions (Federal—State)
  - District Heating and Cooling Act (Wärme- und Kälteleitungssausbaugesetz)
  - Funding programmes for replacement of fossil fuel heating systems to support renewable heating systems in existing buildings:
    - Domestic Environmental Support Scheme (*Umweltförderung im Inland*)

  - Housing Support Scheme (*Wohnbauförderung*)
  - Austrian Climate and Energy Fund (*Klima- und Energiefonds*)
  - Stepping Out of Oil and Gas (*Raus aus Öl und Gas*) as a focus programme of the Building Renovation Initiative for Residential Buildings (*Sanierungsoffensive für Private*)

- **Energy efficiency measures in buildings (WEM)**
  An increase in energy efficiency in electricity demand in buildings is a further policy target, which is to be achieved using far-reaching instruments at EU level. Special attention is given here to the eco-design requirements (Directive 2005/32/EC) for products that use energy and mandatory labelling of household appliances according to their energy consumption (see the instrument Energy Labelling of Space and Water Heating Products below), supported by awareness-raising measures at national level to inform people about energy-efficient products and advice provided by regional energy agencies. Furthermore, the eco-design standard emission requirements impact the NO_x, NMVOC and $PM_{2.5}$ emission factors for new installations of heating systems.
  - Eco-Design Ordinance (Ökodesign-*Verordnung 2007* – ODV 2007)
  - Energy Labelling of Space and Water Heating Products (*Elektrotechnikgesetz 1992*)
  - Funding programmes to improve the energy efficiency of existing buildings
  - Domestic Environmental Support Scheme (*Umweltförderung im Inland*)
  - Austrian Climate Protection Initiative (*klimaaktiv*):
    - e5-communities: consultancy for communities to promote climate policies
    - energy-saving: education, information and advice for consumers and commercial enterprises on reducing energy consumption
    - renewable energy: provide know-how and support networking for committed companies and associations
  - Consultancy service and information campaigns

- **Further enhancement of climate-neutral new buildings (WAM)**
  In the WAM scenario, advanced building codes, additional federal bans on gaseous fossil fuel use for heating purposes and adaptations to funding programmes apply.
  - Tightening of building standards according to OIB Guideline 6—Energy Savings and Thermal Insulation, 2023 edition (OIB-330.6-036/23).
  - The installation of gaseous, liquid or solid fossil fuel boilers in newly constructed buildings will not be permitted as of 2023 according to the Renewable Heat Act (*Erneuerbare-Wärme-Gesetz*, Government Bill No. 1773 (repealing Federal Law Gazette I No. 6/2020). As transitional agreements apply, full effectiveness of the restrictions for natural gas heating systems in new buildings is expected by 2024.

  - From 2021 until 2035, nominal funding budgets for new buildings to support energy efficiency of the building envelope are set to drop against the WEM scenario. This reflects a shift towards funding of thermal renovation in the WAM scenario. Within the same time span, the funding of heating systems in new buildings is set to rise against the WEM scenario. This supports the restriction of natural gas heating systems in new buildings (Renewable Heat Act) in the WAM scenario. After 2035, funding in the WAM scenario is set to decline further, as in the WEM scenario.

- **Further thermal** improvement **of building stock (WAM)**
  In the WAM scenario, advanced building codes, concerted thermal renovation planning, weak obligations for thermal renovation and adaptations to funding programmes apply.
  - Tightening of building standards according to OIB Guideline 6—Energy Savings and Thermal Insulation, 2023 edition (OIB-330.6-036/23).
  - Concerted thermal renovation planning for single steps towards major renovation guarantees that any construction measure relating to applicable building components results in thermal improvement of the building envelope. Furthermore, a weak obligation for thermal renovation of roofs and top floor ceilings applies.
  - From 2021 until 2035, nominal funding budgets for existing buildings to support energy efficiency of the building envelope are set to rise against the WEM scenario. This reflects a shift towards funding of thermal renovation in the WAM scenario alongside the overall increase in funding. After 2035, funding in the WAM scenario is set to decline further, as in the WEM scenario.

- **Further replacement of fossil** fuels **in building stock (WAM)**
  In the WAM scenario, the obligation to replace liquid and solid fossil fuel heating systems in existing buildings and the restriction of gaseous fossil fuel use for heating purposes apply, among other things. Furthermore, energy prices rise against the WEM scenario (see chapter on 'CO_2 taxation' cross-cutting measure) and adaptations to funding programmes are assumed.
  - Tightening of building standards according to OIB Guideline 6—Energy Savings and Thermal Insulation, 2023 edition (OIB-330.6-036/23).
  - The Renewable Heat Act (Government Bill No. 1773) outlines the phasing out of fossil fuels for heating purposes in existing buildings by 2040.
    - General decommissioning requirement for fossil fuel heating systems
    - Age-related decommissioning requirement for liquid or solid fossil fuel central heating systems
    - Renewable energy commandment for fossil fuel central heating systems
    - Replacement requirement for decentralised fossil fuel heating systems

- From 2021 until 2035, nominal funding budgets to support renewable heating systems in existing buildings are set to rise against the WEM scenario. After 2035, funding in the WAM scenario is set to decline further, as in the WEM scenario.

3.5 Industrial processes and product use (NFR 2)

2.D.3 Solvent and other product use

The Austrian Ordinance on Solvents 2005 (*Lösungsmittelverordnung*, Federal Law Gazette II No. 398/2005) transposes the EU Decorative Paints Directive 2004/42/EC. It limits the solvent content in paints and varnishes as well as vehicle refinishing products to reduce VOC emissions.

The Austrian Ordinance on VOC Emissions from Installations (*VOC-Anlagen-Verordnung*, Federal Law Gazette II No. 301/2002) transposes the Industrial Emissions Directive 2010/79/EU regarding industrial activities with relevant solvent use. Installations must either comply with VOC emission limits or work out a reduction plan for VOC emissions. Additionally, all installations with an annual solvent use above a certain threshold are obliged to provide a balance on solvent use as well as emissions to authorities on an annual basis.

3.6 Agriculture (NFR 3)

Implementation of EU agricultural policies (WEM)

Agricultural policy according to the CAP Strategic Plan (Regulation (EU) 2021/2115) was implemented in 2023. This includes the agri-environmental programme and subsidies for investments relevant to air pollution control.

Austria's CAP Strategic Plan (CAP-SP) 2023—2027 was approved in September 2022. Under the Austrian CAP-SP (BML, 2022), a total of 98 interventions are jointly programmed and implemented. For more information, please refer to Chapter 4.5.

Assumptions (manure amounts 2021—2027) for low-loss application of manure and biogas slurry and solid-liquid separation are based on figures provided in the CAP-SP and are therefore included in the WEM scenario.

Feeding strategies and herd management (WAM)

Further optimisations of feed rations and feed quality result in reduced nitrogen surpluses and thus lead to lower reactive nitrogen emissions (NH_3, N_2O, NO_x, N_2) along the entire farm manure chain.

According to Austria's NAPCP and NECP, the following animal feed-related measures are intended to reduce the nitrogen excretion rates for cattle and pigs by 2030 compared to the WEM scenario:

- Implementing feeding strategies;
- Adapting the feed to animal requirements (e.g. reducing the crude protein content of the feed, multiphase feeding);
- Raising awareness (education and advisory services);
- Promoting marketing opportunities for older cattle. Longer use and lower mortality mean lower emissions, but this requires that meat from older cattle can be sold on the market;
- Making progress in breeding (digestibility, lifetime performance).

In the NAPCP, the measures listed above are assigned to package 5 (see Table 10).

Promotion of grazing (WAM)

On pastures, animals excrete faeces and urine separately, and urea infiltrates the soil faster, which reduces ammonia emissions. Grazing also means that less nitrogen is used in livestock feed. In addition, grazing is particularly beneficial from an animal welfare perspective.

With reference to Austria's NAPCP and NECP, the intention is to expand the grazing of dairy & suckling cows by 2030.

In the NAPCP, this measure is assigned to package 3 (see Table 10).

Reduction in emissions from manure management (WAM)

Additional measures, as listed in Austria's NAPCP, will further reduce losses of N species emissions (NH_3, N_2O, NO_x, N_2) along the entire farm manure chain.

- Increased low-emission design of cattle, pig and chicken houses by 2030.
- The share of animal manure treated in biogas plants will be increased significantly by 2030, according to the Austrian NECP.

Furthermore, under the Austrian Ammonia Reduction Ordinance, which entered into force on 1 January 2023, solid covers for slurry storage will be mandatory from 2028 onwards (except for storage capacities below 240 m^3).

In the NAPCP, the measures listed above are assigned to packages 1, 3 and 4 (see Table 10).

Low-emission application of inorganic and organic fertilisers (WAM)

Mineral fertilisers

With reference to Austria's NAPCP and NECP, amounts of mineral fertilisers will be reduced further by improving nitrogen management and precision farming methods. The Austrian Agri-environmental Programme ÖPUL already includes some effective instruments, which will be developed further or expanded.

- Improvement of demand-oriented dosage through fertiliser planning, soil testing and increased awareness raising (building on existing training and advisory services) in order to increase nitrogen efficiency and reduce losses.
- Legal regulations within the framework of the Nitrate Action Programme: the programme was amended, and additional obligations have to be met from 1 January 2023 onwards.
- Promotion of smart farming measures within the framework of the National Digitalisation Action Programme (e.g. precision farming technologies).
- Further development and expansion of ÖPUL measures that contribute to a reduced use of nitrogen mineral fertilisers, e.g. complete renunciation of mineral fertilisers, organic farming.
- Nitrogen fixation through cultivation of legumes, reducing the need for mineral fertilisers.
- Reduction of soil erosion and nitrogen losses (e.g. catch crops, environmentally sound crop rotations, mulch and no-till).
- Reduction of fertiliser use, e.g. through targeted measures in areas with increased pollution or risk situations.

Furthermore, according to the Austrian Ammonia Reduction Ordinance, urea may only be applied as fertiliser to agricultural soils if either urease inhibitors are used or it is incorporated within 4 hours.

Organic fertilisers

Since 1 January 2023, the immediate incorporation (within 4 hours) of liquid manure, digestate and drainless sewage sludge as well as poultry manure in agricultural soils has been mandatory under the Austrian Ammonia Reduction Ordinance (except for agricultural holdings with less than 5 ha of cropland).

The measures 'increased use of low-emission application techniques for cattle and pig slurry' and 'solid-liquid separation' according to the Austrian CAP-SP and listed in the NAPCP are included in the WEM scenario of this report.

In the NAPCP, the measures listed above are assigned to packages 1 and 2 (see Table 10).

Table 10: WAM measures according to the National Air Pollution Control Programme.

No.	Name and brief description of an individual strategy/measure or a package of strategies/measures:
1	Austria's Ammonia Reduction Ordinance
2	Optimised application of inorganic and organic fertilisers
3	Enhancement of animal husbandry (housing and grazing)
4	Treatment of manure (manure management)
5	Feeding strategies

3.7 Waste (NFR 5)

- Reduce emissions from waste treatment through further implementation of the Landfill Directive and by avoiding emissions from anaerobic treatment of biogenic waste through covered storage facilities (WEM).

4 METHODOLOGY

4.1 Stationary fuel combustion activities (NFR 1.A)

Total energy demand and production was evaluated on the basis of energy scenarios developed by a consortium made up of the Centre of Economic Scenario Analysis and Research (CESAR), e-think Energy Research and the Institute for Thermodynamics and Sustainable Engines at the Graz University of Technology. The scenarios were developed using several models:

- econometric input-output data (MIO-ES);
- domestic heating and domestic hot water supply (INVERT/EE-Lab);
- public electrical power and district heating supply (MIO-ES);
- energy demand and emissions of transport (NEMO & GEORG).

The econometric input-output model MIO-ES combines a private consumption module with an energy and environment module. Important input parameters are energy prices, population and household income (CESAR, 2020). This model was also used to calculate the energy sector.

The software package INVERT/EE-Lab (E-THINK, 2023) was used for modelling energy consumption in domestic heating and domestic hot water supply. INVERT/EE-Lab is based on a stochastic, non-recursive, myopic and economic algorithm, with the objective function to minimise costs. The basic algorithm applies the principle of the INVERT model. It enables a calculation of the energy demand for heating (space heating and hot water) in apartment buildings and in buildings of the public or private service sector, while also including the effects of various funding instruments. The main inputs for the calculation are:

- availability of resources;
- market penetration of different technologies;
- maximum replacement and refurbishment periods;
- minimum and maximum lifetime of technical installations.

The results produced by the different models were exchanged and adjusted within several modelling cycles. Environment Agency Austria experts combined the data produced by the different models and included additional calculations for:

- energy inputs for the iron and steel industry;
- production of electric power and district heating in industry;
- use of waste as a fuel in power plants and industry;
- energy input of compressor stations;
- total energy demand;
- electricity demand in the transport sector.

This chapter describes the methodology used for emission projections for stationary fuel combustion in the NFR 1.A.1, 1.A.2 and 1.A.4 sectors. The methodology applied to determine emission factors is described in the Austrian Inventory Report (ENVIRONMENT AGENCY AUSTRIA, 2023a). Data on energy demand have been split according to the sub-sectors of the Austrian Air Emission Inventory.

4.1.1 Energy industries (NFR 1.A.1)

This chapter describes the methodology used for emission projections for stationary fuel combustion in the energy and transformation industries.

The MIO-ES model was used, which provides fuel-specific activity data on energy industries (i.e. electricity and heat production, including waste incineration). The data were multiplied by the same fuel-specific emission factors as those used in the Austrian Inventory.

SO_2, NO_x and $PM_{2.5}$

Projected emissions of SO_2, NO_x and $PM_{2.5}$ were calculated by multiplying projected energy data (ENVIRONMENT AGENCY AUSTRIA, 2023a) by the respective emission factors. The latter were determined based on the Austrian Inventory.

The only refinery operating in Austria installed an SNOX system in November 2007, thereby significantly reducing its emissions of SO_2 and NO_x. As no other changes are expected over the next few years, emission projections have been based on current emission levels.

A detailed description of the methodologies used for Austria's emission projections for the energy industries sector can be found in the following literature: ENVIRONMENT AGENCY AUSTRIA, 2003 a/b/c; BMLFUW, 2004; and ENVIRONMENT AGENCY AUSTRIA & BMLFUW, 2002.

For gas-fired power plants in the WEM scenario, it has been assumed that inputs will slowly decrease in the years to 2050. The assumption has been made that there will be no changes to the emission factor for gas-fired plants until 2050.

For installations using solid biomass, emission factors for various plant sizes have been provided in the literature (ENVIRONMENT AGENCY AUSTRIA, 2007b). Emission factors have not been changed for the time period considered in the WEM scenario.

It has been assumed that the emission factors for waste incineration plants, for oil and gas exploration and for refineries will not change over time.

For the WAM scenario, the same methodology was used. Only energy input is different in the WAM scenario.

NMVOC and NH_3

NMVOC and NH_3 emissions are assumed to remain constant at 2021 levels (ENVIRONMENT AGENCY AUSTRIA, 2023b). This simple approach has been chosen because the share of these emissions in total emissions is less than 1%.

4.1.2 Manufacturing industries and construction (NFR 1.A.2)

This chapter describes the methodology used for emission projections for stationary fuel combustion in the manufacturing industries. A methodological description of emission projections for mobile sources in NFR 1.A.2 is given in Chapter 4.2.

SO_2 and NO_x

SO_2 and NO_x emissions have been estimated for the NFR 1.A.2 and NFR 2 sectors combined (ENVIRONMENT AGENCY AUSTRIA, 2003a/c; ENVIRONMENT Agency AUSTRIA, 2007a; and ENVIRONMENT AGENCY AUSTRIA, 2009). The following industrial activities have been identified as major emission sources:

- production in the cement, glass, magnesia, lime and other mineral industries;
- iron and steel production;
- pulp and paper production;
- process emissions from the chemical industry;
- wood processing industry;
- food industry;
- production of non-ferrous metals;
- other sectors of the manufacturing industries.

Projected emissions were calculated on the basis of trends observed in energy scenarios (ENVIRONMENT AGENCY AUSTRIA, 2023c) and by incorporating recent data from environmental impact statements on facility expansions and the opening and closing of facilities. Emission factors from the latest inventory and, if available, plant-specific data were used for compiling emission projections.

For the WAM scenario, the same methodology was used. Only energy input is different in the WAM scenario.

NMVOC and NH_3

NMVOC and NH_3 emissions from stationary sources are assumed to remain constant at 2021 levels (ENVIRONMENT AGENCY AUSTRIA, 2023a). This simple approach has been chosen because the share of these emissions in total emissions is less than 1% for each source.

$PM_{2.5}$

Projected emissions were calculated on the basis of trends observed in energy scenarios (ENVIRONMENT AGENCY AUSTRIA, 2023c) and by incorporating recent data from environmental impact statements on facility expansions and the opening and closing of facilities.

Projections for process emissions from quarries, construction activities and the wood industry are based on an extrapolation of past trends.

For the WAM scenario, the same methodology was used. Only energy input is different in the WAM scenario.

4.1.3 Other sectors (NFR 1.A.4)

This chapter describes the methodology used in the WEM scenario and the WAM scenario for emission projections for stationary fuel combustion in the small combustion sector (1.A.4.a Commercial/Institutional, 1.A.4.b Residential (households), and 1.A.4.c Agriculture/Forestry/Fishing). A methodological description of emission projections for mobile sources in NFR 1.A.4 is given in Chapter 4.2.

Activities

A comprehensive model for buildings (INVERT/EE-Lab) has been used to calculate energy consumption for stationary sources separately for the residential and commercial sub-sectors (E-THINK, 2023). Inputs for mobile sources in agriculture were derived with the econometric input-output model MIO-ES. A detailed description of these models can be found in ENVIRONMENT AGENCY AUSTRIA, 2023c; E-THINK, 2023; and CESAR, 2020.

Emissions

SO_2, NO_x, NMVOC, NH_3 and $PM_{2.5}$ emissions were calculated based on energy demand for stationary sources in the 1.A.4.a, 1.A.4.b and 1.A.4.c sub-sectors. A description of the methods and emission factors used for these calculations can be found in the Austrian Informative Inventory Report (ENVIRONMENT AGENCY AUSTRIA, 2023b).

There are twenty-two technology-dependent and fuel-dependent main sub-categories (heating types) for stationary fuel consumption in 1.A.4 Other Sectors, as presented in the following table.

Table 11: Heating types of category 1.A.4 Other Sectors—stationary sources (source: Environment Agency Austria).

No.	Heating type	Fuel
#1	Fuel oil boilers	Light fuel oil, medium fuel oil, heavy fuel oil, diesel, petroleum, other petroleum products
#2	Gas oil stoves	Gas oil
#3	Vapourising burners	Gas oil
#4	Yellow burners	Gas oil
#5	Blue burners with conventional technology	Gas oil
#6	Blue burners with low temperature or condensing technology	Gas oil
#7	Natural gas convectors	Natural gas
#8	Atmospheric burners	Natural gas, biogas, sewage sludge gas and landfill gas
#9	Forced-draught natural gas burners	Natural gas, biogas, sewage sludge gas and landfill gas
#10	LPG stoves	Liquefied petroleum gases
#11	LPG boilers	Liquefied petroleum gases
#12	Wood stoves and cooking stoves	Fuel wood
#13	Tiled wood stoves and masonry heaters	Fuel wood
#14	Mixed-fuel wood boilers	Fuel wood
#15	Natural-draught wood boilers	Fuel wood
#16	Forced-draught wood boilers	Fuel wood
#17	Wood chips boilers with conventional technology	Wood waste
#18	Wood chips boilers with oxygen sensor emission control	Wood waste
#19	Pellet stoves	Wood waste
#20	Pellet boilers	Wood waste
#21	Coal stoves	Hard coal and hard coal briquettes, lignite and brown coal, brown coal briquettes, coke, peat
#22	Coal boilers	Hard coal and hard coal briquettes, lignite and brown coal, brown coal briquettes, coke, peat, industrial waste

In addition, the whole fuel consumption of charcoal is based on combustion in devices similar to *#12 Wood stoves and cooking stoves* and is calculated separately. A fuel-dependent emission factor is applied for each technology.

Furthermore, NO_x, NMVOC and $PM_{2.5}$ emission factors have been revised for projected years, based on eco-design standard emission requirements for the installation of new space heaters and combination heaters[6], water heaters and hot water storage tanks[7], solid fuel local space heaters[8], local space heaters[9] and solid fuel boilers[10]. The eco-design regulations are assumed to have entered into force by 1 January 2018 (814/2013, 2015/1188), 26 September 2018 (813/2013), 1 January 2020 (2015/1189) and 1 January 2022 (2015/1185), respectively, gradually replacing existing national emission requirements (Constitutional Art. 15a Agreement).

The adaptation of emission factors to new installations has been based on a comparison of ambition levels between national and EU-wide regulations. The replacement rate has been based on the national emission factor for new installations of the year 2021 (ENVIRONMENT AGENCY AUSTRIA, 2023b) in order to provide conversion factors that reflect the impact of eco-design policies on new heating systems. Prior to the eco-design provisions entering into force, the revised emission factors follow a linear path approximating the full effect of a phased introduction of the eco-design provisions on manufacturers, distributors and sellers of heating products. This is because market participants may at first have to adapt to the new market environment, as Member States are not allowed to maintain more stringent national requirements during the transitional period.

National energy projections display the final energy demand for space heaters and combination heaters, water heaters, solid fuel local space heaters, local space heaters and solid fuel boilers by year of installation.

The share of new installations is expected to shift gradually towards low-emission technologies for the WEM and WAM scenarios.

Table 12: Share of 1.A.4 heating type in the different fuel categories for new installations 2022—2030 (source: Environment Agency Austria).

Fuel category	No.	Heating type	Share of heating type [% TJ]		
			1.A.4.a and 1.A.4.b		
			2022	2025	2030
Fuel oil	#1	Fuel oil boilers	100	100	100
Gas oil	#2	Gas oil stoves	2.0	1.5	0.8
	#3	Vapourising burners	1.0	0.8	0.4
	#4	Yellow burners	5.0	4.4	3.5
	#5	Blue burners with conventional technology	5.0	4.4	3.5
	#6	Blue burners with low temperature or condensing technology	87	89	92

6 Commission Regulation (EU) No 813/2013

7 Commission Regulation (EU) No 814/2013

8 Commission Regulation (EU) 2015/1185

9 Commission Regulation (EU) 2015/1188

10 Commission Regulation (EU) 2015/1189

Fuel category	No.	Heating type	Share of heating type [% TJ]		
			1.A.4.a and 1.A.4.b		
			2022	2025	2030
Gas	#7	Natural gas convectors	5.0	4.2	2.8
	#8	Atmospheric burners	45	43	38
	#9	Forced-draught natural gas burners	50	53	59
LPG	#10	LPG stoves	5.0	3.8	1.9
	#11	LPG boilers	95	96	98
Fuel wood	#12	Wood stoves and cooking stoves	10	8.8	6.9
	#13	Tiled wood stoves and masonry heaters	15	14	12
	#14	Mixed-fuel wood boilers	5.0	4.4	3.5
	#15	Natural-draught wood boilers	15	14	13
	#16	Forced-draught wood boilers	55	58	64
Wood chips	#17	Wood chips boilers with conventional technology	5.0	4.4	3.5
	#18	Wood chips boilers with oxygen sensor emission control	95	96	97
Wood pellets	#19	Pellet stoves	10	9.4	8.5
	#20	Pellet boilers	90	91	92
Coal	#21	Coal stoves	2.0	1.5	0.8
	#22	Coal boilers	98	98	99

It is assumed that new installations with lower emission factors will be used as a substitute for stocks with average 2021 emission characteristics, or will increase overall stocks.

Emission factors

It is assumed that NO_x emission factors will decrease for natural gas, biogas, sewage sludge gas and landfill gas as well as for gas oil (due to an increased use of blue burners and forced-draught burners with condensing boiler technology). Blended hydrogen is assumed to have the same emission factors as natural gas.

Besides the shift towards low-emission technologies, it is assumed that solid biomass emission factors by heating type (except pellet stoves) will drop slightly due to minor differences in ambition levels between eco-design provisions and intermediate national regulations. A noticeable decrease in natural gas, biogas, sewage sludge gas, landfill gas and blended hydrogen emission factors by heating type is expected because of tighter eco-design requirements.

Additionally, a minor increase in heating oil emission factors by heating type and a noticeable increase in coal emission factors by heating type are expected because of a weakening of existing national regulations.

Overall effects on NO_X emissions highly depend on projected installation rates for new heating systems by heating type and actual fuels used. Table 13 lists the implied NO_x emission factors for projections in the WEM scenario.

Table 13: Implied NO_x emission factors in the WEM scenario for coal, oil, natural gas, fuel wood, wood chips and wood pellets (source: Environment Agency Austria).

In kg/TJ	2021	2025	2030
	1.A.4.a.1		
Coal	100	100	100
Oil	33	33	33
Natural gas	39	38	37
Fuel wood	81	81	82
Wood chips	82	82	81
Wood pellets	60	60	60
	1.A.4.b.1		
Coal	94	94	94
Oil	34	34	34
Natural gas	36	35	34
Fuel wood	101	99	97
Wood chips	83	82	81
Wood pellets	60	60	60

Table 14 lists the implied NO_x emission factors for projections in the WAM scenario.

Table 14: Implied NO_x emission factors in the WAM scenario for coal, oil, natural gas, biogas, sewage sludge gas and landfill gas, fuel wood, wood chips and wood pellets (source: Environment Agency Austria).

In kg/TJ	2021	2025	2030
	1.A.4.a.1		
Coal	100	100	100
Oil	33	33	33
Natural gas	39	38	38
Biogas, sewage sludge gas and landfill gas	150	148	147
Hydrogen	NO	NO	38
Fuel wood	81	81	82
Wood chips	82	82	81
Wood pellets	60	60	60
	1.A.4.b.1		
Coal	94	94	94
Oil	34	34	34
Natural gas	36	35	35
Biogas, sewage sludge gas and landfill gas	150	149	148
Hydrogen	NO	NO	35

In kg/TJ	2021	2025	2030
Fuel wood	101	99	97
Wood chips	83	82	81
Wood pellets	60	60	60

A decrease in NMVOC emission factors for solid biomass and coal is assumed from 2018 onwards due to existing national regulations imposing standard emission thresholds for Organic Gaseous Compounds (OGCs) on new installations and subsequent eco-design requirements, which will be less stringent for solid fuel local space heaters. The eco-design provisions have almost no effect on the NMVOC emission factors for heating oil. For all fuels, the impact of the assumed shift towards low-emission technologies in newly installed heating systems is noticeable. Blended hydrogen is assumed to cause no NMVOC emissions.

Overall effects on NMVOC emissions highly depend on projected installation rates for new heating systems by heating type and actual fuels used. Table 15 lists the implied NMVOC emission factors for projections in the WEM scenario.

Table 15: Implied NMVOC emission factors in the WEM scenario for coal, oil, natural gas, fuel wood, wood chips and wood pellets (source: Environment Agency Austria).

In kg/TJ	2021	2025	2030
	1.A.4.a.1		
Coal	0.54	0.54	0.54
Oil	0.44	0.44	0.41
Natural gas	0.56	0.55	0.53
Fuel wood	344	340	331
Wood chips	109	95	84
Wood pellets	33	31	29
	1.A.4.b.1		
Coal	299	299	299
Oil	0.45	0.44	0.42
Natural gas	0.55	0.54	0.52
Fuel wood	389	384	375
Wood chips	111	98	88
Wood pellets	33	31	30

Table 16 lists the implied NMVOC emission factors for projections in the WAM scenario.

Table 16: Implied NMVOC emission factors in the WAM scenario for coal, oil, natural gas, biogas, sewage sludge gas and landfill gas, fuel wood, wood chips and wood pellets (source: Environment Agency Austria).

In kg/TJ	2021	2025	2030
	1.A.4.a.1		
Coal	0.54	0.54	0.54
Oil	0.44	0.44	0.44
Natural gas	0.56	0.55	0.55
Biogas, sewage sludge gas and landfill gas	0.56	0.55	0.55
Hydrogen	NO	NO	0
Fuel wood	344	339	329
Wood chips	109	96	85
Wood pellets	33	31	29
	1.A.4.b.1		
Coal	299	299	299
Oil	0.45	0.45	0.45
Natural gas	0.55	0.54	0.54
Biogas, sewage sludge gas and landfill gas	0.55	0.54	0.54
Hydrogen	NO	NO	0
Fuel wood	389	384	374
Wood chips	111	97	88
Wood pellets	33	31	30

It is assumed that $PM_{2.5}$ emission factors will decrease for solid biomass and coal due to the eco-design requirements which, in general, outreach existing national regulations for standard $PM_{2.5}$ emission thresholds. For both fossil fuels and biomass, there is an evident shift towards low-emission technologies in new installations of heating systems. Blended hydrogen is assumed to cause no $PM_{2.5}$ emissions.

Overall effects on $PM_{2.5}$ emissions highly depend on projected installation rates for new heating systems by heating type and actual fuels used. Table 17 lists the implied $PM_{2.5}$ emission factors for projections in the WEM scenario.

Table 17: Implied $PM_{2.5}$ emission factors in the WEM scenario for coal, oil, natural gas, fuel wood, wood chips and wood pellets (source: Environment Agency Austria).

In kg/TJ	2021	2025	2030
	1.A.4.a.1		
Coal	44	44	44
Oil	1.7	1.7	1.6
Natural gas	0.47	0.45	0.44
Fuel wood	81	80	76
Wood chips	47	44	42
Wood pellets	16	16	16
	1.A.4.b.1		
Coal	90	90	90
Oil	1.7	1.7	1.6
Natural gas	0.46	0.45	0.43
Fuel wood	82	80	77
Wood chips	47	45	43
Wood pellets	15	16	15

Table 18 lists the implied $PM_{2.5}$ emission factors for projections in the WAM scenario.

Table 18: Implied $PM_{2.5}$ emission factors in the WAM scenario for coal, oil, natural gas, biogas, sewage sludge gas and landfill gas, fuel wood, wood chips and wood pellets (source: Environment Agency Austria).

In kg/TJ	2021	2025	2030
	1.A.4.a.1		
Coal	44	44	44
Oil	1.7	1.7	1.7
Natural gas	0.47	0.46	0.45
Biogas, sewage sludge gas and landfill gas	0.47	0.46	0.45
Hydrogen	NO	NO	0
Fuel wood	81	79	75
Wood chips	47	45	42
Wood pellets	16	16	16
	1.A.4.b.1		
Coal	90	90	90
Oil	1.7	1.7	1.7
Natural gas	0.46	0.45	0.45
Biogas, sewage sludge gas and landfill gas	0.46	0.45	0.45
Hydrogen	NO	NO	0
Fuel wood	82	80	77
Wood chips	47	45	43
Wood pellets	15	16	15

All emission factors dependent on heating type for 1.A.4.c Agriculture/Forestry/Fishing were set constant at the level of the latest national emission inventory (ENVIRONMENT AGENCY AUSTRIA, 2023b).

NFR 1.A.4.a.1 bonfires & open fire pits, 1.A.4.b.1 barbecues

In addition to emissions from boilers and stoves, this sector includes emissions from bonfires and open fire pits as well as from barbecues. Projected $PM_{2.5}$ emissions have been estimated by extrapolating from 2021 emissions using projected population statistics (STATISTICS AUSTRIA, 2022a).

4.2 Mobile fuel combustion activities (NFR 1.A)

This chapter describes the methodology used for estimating emissions from NFR 1.A.3 Transport and from mobile sources under NFR 1.A.2.g, 1.A.4 and 1.A.5.

The scenario comprises different approaches in each NFR source category.

1.A.3.a—Aviation

Projections for energy consumption in the aviation sector are based on expert judgement in line with the Austrian aviation industry. The energy demand for aviation fuels (kerosene and different types of SAF (sustainable aviation fuels)) have been estimated, taking into account national long-term GDP forecasts, fleet turnover with more energy-efficient planes and higher load capacities as well as assessments of national airport and airline experts regarding the capacities on the ground and in the air.

- Major driving forces:
  - Traffic growth in aviation is closely linked to GDP growth, which could not be stopped by economic downturns, terrorist attacks, extreme weather or even 'great recessions' such as in 2008—2009. Even after COVID-19 triggered flight restrictions and the brutal invasion of Ukraine resulted in closed airspaces, air traffic has steadily recovered in the direction of pre-pandemic levels.

1.A.3.b—Road transport

The calculation of transport emissions is based on two models:

- **NEMO—Emission model for road transport**
  From the 2015 submission onwards, projections for the time series up to 2040 have been based on the network emission model NEMO (DIPPOLD ET AL., 2012; HAUSBERGER ET AL.; 2015a, 2015b; SCHWINGSHACKL/REXEIS, 2022). The energy consumption and emissions of the different vehicle categories are calculated by multiplying the yearly road performance per vehicle

category (km/vehicle and year) by the specific energy use (g/km) and by the emission factors in g/km. NEMO models the road performance and emissions per vehicle size, age and motor type based on dynamic vehicle-specific drop-out and road performance functions. To determine the fuel consumption and emissions of domestic road transport, the vehicle stock and total annual road performance (mileage driven per year) of the vehicle categories should be recorded as precisely as possible by national statistics. Vehicle registrations are updated yearly. It is fully capable of depicting the upcoming variety of possible combinations of propulsion systems (internal combustion engine, hybrid, plug-in hybrid, electric propulsion, fuel cell, etc.) and alternative fuels (CNG, biogas, FAME, ethanol, GTL, BTL, H2, etc.).

In addition, NEMO has been designed so that it is suitable for all the main application fields in the simulation of energy consumption and emission output using a road section-based model approach. As there is no complete road network for Austria on a high-resolution spatial level as yet, the old methodology based on categorising traffic activities into 'urban', 'rural' and 'motorway' has been applied with the NEMO model. For more details, see the chapter on methodology in 3.2.12.2. Road Transport of Austria's National Inventory Report 2023 (Environment Agency Austria, 2023a/b).

- **KEX tool**

  The KEX tool is used in projections to map the future development of domestic fuel demand in road transport based on GDP, population and fuel prices, and to calculate the quantities of exported fuel in motor vehicles abroad in the future. The KEX tool has been developed for estimating the change in domestic fuel demand and the export of fuels in motor vehicles (MOLITOR ET AL., 2004; MOLITOR ET AL., 2009). As independent variables, the KEX tool uses GDP, population, export quotas, and domestic and foreign gasoline and diesel prices. The KEX tool estimates the amount of fuel purchased in Austria and used abroad, and this has recently been refined using a methodology that estimates the domestic traffic fuel consumption using linear regression analysis. Equations were discovered that can depict the trend in the coming years as precisely as possible by specifying the most significant variables (STADLOBER, 2023; HAUSBERGER/SCHWINGSHACKL, 2023). When it comes to fleet development, the KEX tool includes a very simplified statistical tool, while NEMO includes predefined technologies for new vehicle registrations, their market penetration and the effects on consumption and emissions. For more details, see the chapter on methodology in 3.2.12.2. Road Transport of Austria's National Inventory Report 2023 (ENVIRONMENT AGENCY AUSTRIA, 2023).

- Major driving forces:
  - Development of international (wholesale) fuel import prices for crude oil and
  - Fuel price differences between Austria and neighbouring countries due to different taxation.

1.A.2.f, 1.A.3.c, 1.A.3.d, 1.A.4.b, 1.A.4.c, 1.A.5—Mobile sources

The calculation of transport emissions is based on a model:

- **GEORG—Emission model for off-road**

  Energy consumption and emissions of Non-Road Mobile Machinery (NRMM) or off-road in Austria are calculated using the GEORG model (*Grazer Emissionsmodel für Off Road Geräte*) (HAUSBERGER, 2000). GEORG has a part for fleet models, which simulates the actual age and size distribution of NRMM stock via age-dependent and size-dependent drop-out rates (i.e. the probability that a vehicle will have been scrapped by the following year). Using this approach, the number of vehicles in each mobile source category is calculated according to the year of the vehicles' first registration and their propulsion systems (gasoline 4-stroke, gasoline 2-stroke, diesel > 80 kW, diesel < 80 kW).

  For more details, see the chapter on methodology in 3.2.13.2 Other Sectors—Mobile Combustion of Austria's National Inventory Report 2023 (ENVIRONMENT AGENCY AUSTRIA, 2023b).
- Major driving forces:
  - Operating hours of machines and vehicles—dependent on GDP and the production index in the industry sector, demand for passenger and freight transport in the railway sector, weather extremes and resulting harvests and wood production in the agriculture and forestry sector, household income in the household sector, and demand for passenger and freight transport on the Danube for navigation, and
  - Share of electrification or alternative non-fossil combustion fuels in new registrations.

Special considerations for $PM_{2.5}$

NFR.1.A.3.b.vii Road transport—automobile road abrasion

Projected $PM_{2.5}$ emissions from road abrasion and tyre and brake wear have been modelled with NEMO according to the trend in total mileage per vehicle category per year (SCHWINGSHACKL/REXEIS, 2022).

NFR 1.A.3.c Railways—abrasion and brake wear

$PM_{2.5}$ emissions from rail abrasion and rail brake wear have been extrapolated from 2021 emissions.

NFR 1.A.5.b Military mobile machinery

Ground operations: $PM_{2.5}$ emissions from ground operations of military vehicles have been extrapolated from 2021 emissions and projected fuel consumption.

Aviation operations: $PM_{2.5}$ emissions from military aviation operations have been extrapolated from 2021 emissions.

4.2.1 Emission factors (WEM)

NO_x emission factors

As NO_x is the most significant air pollutant in the transport sector, the underlying emission factors for NO_x, which have been used for the projections across the different EURO classifications, are presented in more detail below. The test cycles used for calculating the emission factors for the Handbook of Emission Factors in Road Transport (HBEFA) always represent real-world driving conditions.

PCs, LDVs, HDVs according to HBEFA Version V4.2

According to the latest amendments to European legislation[11], where the nomenclature for emission classes has been changed to Euro 6a/b and Euro 6d_temp and Euro 6d, there were no changes in the WEM scenario. A detailed analysis of the current HBEFA Version V4.2 can be found in a technical study by INFRAS (2022).

Since the Euro 6d-TEMP stage, vehicle emissions must be tested on the road in addition to laboratory testing. The RDE test is performed during vehicle operation using a portable emissions monitoring system (PEMS).

The following tables show the assumed phase-in periods for each emission standard and vehicle category for all new vehicle registrations. EURO 7, still under discussion, has not been considered yet in the WEM scenario.

Table 19: Phase-in periods for EURO classes for new registrations (passenger cars and light-duty vehicles) (source: Environment Agency Austria).

PCs/LDVs	WEM	
	from	until
EURO 4	2005	2008
EURO 5	2009	2013
EURO 6a/b	2014	2018
EURO 6d_temp	2018	
EURO 6d	2020	

[11] Regulation (EC) No 692/2008 on type-approval of motor vehicles (WLTP implementation pending) plus two RDE (real driving emissions) packages—Regulation (EU) 2016/427 and Regulation (EU) 2016/646; Regulation (EU) 2017/1154, Regulation (EU) 2018/1832

Table 20: Phase-in periods for EURO classes for new registrations (heavy-duty vehicles) (source: Environment Agency Austria).

HDVs	WEM	
	from	until
EURO 4	2006	2008
EURO 5	2009	2013
EURO 6	2014	

4.2.1.1 Details of NO_x emission factors

The tables below show the emission factors used for Austria's 2023 emission projections, by vehicle category (HBEFA Version V4.2).

Table 21: Comparison of NO_x emission factors for petrol passenger cars (PCs) (source: Environment Agency Austria).

NO_x Passenger Cars Petrol	NEMO HBEFA V4.2
PRE ECE	1.89
G-Kat 87-90	1.24
EURO 1	1.21
EURO 2	0.56
EURO 3	0.20
EURO 4	0.13
EURO 5	0.06
EURO 6a/b	0.06
EURO 6c	0.03
EURO 6d_temp	0.04
EURO 6d	0.04

Table 22: Comparison of NO_x emission factors for diesel passenger cars (PCs) (source: Environment Agency Austria).

NO_x Passenger Cars Diesel	NEMO HBEFA V4.2
EURO 1	0.81
EURO 2	1.07
EURO 3	1.39
EURO 4	0.99
EURO 5	0.96
EURO 6a/b	0.57
EURO 6c	0.29
EURO 6d_temp	0.07
EURO 6d	0.06

Table 23: Comparison of NO_x emission factors for diesel light-duty vehicles (LDVs) (source: Environment Agency Austria).

NO_x Light-Duty Vehicles Diesel	**NEMO HBEFA V4.2**
EURO 1	1.65
EURO 2	1.42
EURO 3	2.09
EURO 4	1.86
EURO 5	1.66
EURO 6a/b	0.71
EURO 6c	0.51
EURO 6d_temp	0.12
EURO 6d	0.10

Table 24: Comparison of NO_x emission factors for heavy-duty vehicles (HDVs) (source: Environment Agency Austria).

NO_x Heavy-Duty Vehicles Diesel	**NEMO HBEFA V4.2**
Pre EURO	16.19
Euro-I	10.80
Euro-II	10.57
Euro-III	8.58
Euro-IV EGR	6.75
Euro-IV SCR	3.56
Euro-V EGR	7.90
Euro-V SCR	3.56
Euro-VI-ABC	0.83
Euro-VI-DE	0.34

4.2.2 Emission factors (WAM)

NO_x emission factors

As NO_x is the most significant air pollutant in the transport sector, the underlying emission factors for NO_x, which have been used for the projections across the different EURO classifications, are presented in more detail below.

EURO 7

EURO 7 was applied in NEMO for the WAM scenario. With the EURO 7 proposal, the standards subsequent to EURO 6 (Regulation (EC) No 715/2007) and EURO VI for HDVs (Regulation (EC) No 595/2009) are combined in one legal act.

Euro 7 is part of the European Green Deal and should contribute to the 'Zero Pollution' goal. By 2035, NO_x reductions are to be achieved of more than 85% (compared to 2018) for cars and LDVs and more than 80% for trucks and buses.

Overall, NO_x emissions from road vehicles are to be halved by 2035 (compared to 2018).

Scope:

- Newly registered cars, light commercial vehicles, trucks and buses as well as trailers (vehicle classes: M1, M2, M3, N1, N2, N3, O3, O4)
- EURO 7 share of new registrations is >50% from:
- 2027 (cars, light trucks), 2029 (trucks, buses)

Table 25: Phase-in periods for EURO classes for new registrations (passenger cars and light-duty vehicles) (source: Environment Agency Austria).

PCs/LDVs	WAM	
	from	until
EURO 4	2005	2008
EURO 5	2009	2013
EURO 6a/b	2014	2018
EURO 6d_temp	2018	
EURO 6d	2020	
EURO 7	2027	

Table 26: Phase-in periods for EURO classes for new registrations (heavy-duty vehicles) (source: Environment Agency Austria).

HDVs	WAM	
	from	until
EURO IV	2006	2008
EURO V	2009	2013
EURO VI	2014	2030
EURO VII	2029	

4.2.2.1 Details of NO_x emission factors

The tables below show the emission factors used for WAM projections, by vehicle category. The only difference from the WEM scenario is the integration of EURO 7 in the WAM scenario.

Table 27: NO_x EURO 7 emission factor for passenger cars (PCs) (source: Environment Agency Austria).

NO_x Passenger Cars	NEMO HBEFA V4.2
EURO 7	0.01

Table 28: NO_x EURO 7 emission factor for diesel light- duty vehicles (LDVs) (source: Environment Agency Austria).

NO_x Light-Duty Vehicles Diesel	**NEMO HBEFA V4.2**
EURO 7	0.02

Table 29: NO_x emission factor for heavy-duty vehicles (HDVs) (source: Environment Agency Austria).

NO_x Heavy-Duty Vehicles Diesel	**NEMO HBEFA V4.2**
Euro-VII	0.02

4.2.3 Other transportation—pipeline compressors (NFR 1.A.3.e)

The projected energy demand for pipeline transport up to 2030 is based on expert judgements and historical trends. For transport in pipelines, no changes to emission factors have been assumed.

4.3 Fugitive emissions (NFR 1.B)

SO_2 and NMVOC

SO_2 and NMVOC emission projections are based on average emission/activity data ratios for the period 2017—2021 as well as on projected activity data such as natural gas exploration, natural gas consumption and gasoline consumption according to the energy scenario (ENVIRONMENT AGENCY AUSTRIA, 2023c). The length of the gas distribution network has been extrapolated using the average yearly growth rate between 2017 and 2021 (75 km/year) until 2024, after which it will remain constant.

Emission reduction measures such as vapour recovery units at fuel depots and service stations had already been implemented in 2003, and no further reductions are expected due to additional measures. However, NMVOC emissions from gasoline evaporation will decrease due to lower gasoline consumption/fuelling.

Emissions from solid fuel transformation (coke ovens) are included in 1.A.2.a.

Coal production ended in 2005.

A detailed description of the methodology used for emission estimates can be found in the Austrian Informative Inventory Report (ENVIRONMENT AGENCY AUSTRIA, 2023b).

NO_x and NH_3

NH_3 emissions are not relevant for this category. According to the Austrian Air Emission Inventory, NO_x emissions from flaring in oil refineries are included in category 1.A.1.b.

$PM_{2.5}$

$PM_{2.5}$ emissions from coal handling and storage (1.B.1.a) were calculated based on coal consumption projections (ENVIRONMENT AGENCY AUSTRIA, 2023c) using the same emission factors as in Austria's National Air Emission Inventory.

The methodology is the same for the WEM and WAM scenarios. The WAM scenario considers lower gasoline production and therefore lower NMVOC emissions from refinery dispatch stations.

4.4 Industrial processes (NFR 2)

4.4.1 Industrial processes (NFR 2.A/B/C/I)

The forecast for developments in the industrial processes sector has been based on macro-economic data for the individual sub-sectors, taking into account known predictions about expansions, startup of new installations and the decommissioning of old facilities.

SO_2, NO_x and $PM_{2.5}$

SO_2, NO_x and $PM_{2.5}$ emissions that are not listed below are reported together with energy-related emissions under 1.A.2.g Other.

$PM_{2.5}$ emissions from quarries and similar activities are based on the latest national inventory and are assumed to remain constant over time. Emissions from the chemical industry are based on developments in sulphuric acid production (SO_2), nitric acid and ammonia production (NO_x) and fertiliser production (NO_x and $PM_{2.5}$). Emissions from metal production are based on the national inventory and environmental reports of Austrian enterprises. Emissions are expected to remain constant. $PM_{2.5}$ emissions from wood processing are assumed to remain constant at the level specified in the national inventory.

For WEM and WAM, the same assumptions apply.

NMVOC and NH_3

NH_3 emissions are assumed to remain constant at 2021 levels (ENVIRONMENT AGENCY AUSTRIA, 2023b) in most sub-sectors. This simple approach has been chosen because the share of NH_3 emissions in total emissions is very small.

For NMVOC emissions in the 2.H 'Other Processes' sub-sector, a more detailed approach has been used for the projections. Whereas emissions from sources such as wine, beer and spirits are projected to stay constant, emissions from the category of bread have been extrapolated according to the population scenario.

4.4.2 Solvent and other product use (NFR 2.D/G)

NFR 2.D / NMVOC

Emission projections are calculated with the same level of detail as the inventory: for every sub-category considered in the inventory, activity data are set constant in the future (e.g. where technological innovation offsets an increase in use), correlated with economic growth (particularly where it correlated in previous years) or correlated with population growth (particularly for the domestic sector), and expert judgement was applied for some sub-sectors.

Correlated with economic growth in the relevant economic sector (correlated either fully or 'partially': only a share obtained by expert judgement is correlated, the rest is set constant):

- Car repairing
- Construction and building (partially)
- Wood coating
- Other industrial paint application (partially)
- Electronic components manufacturing
- Pharmaceutical products manufacturing
- Fat, edible and non-edible oil extraction

Set constant:

- Manufacture of automobiles
- Coil coating
- Metal degreasing
- Other industrial cleaning
- Rubber processing
- Paints manufacture
- Inks manufacture
- Adhesives
- Other manufacturing
- Printing industry
- Preservation of woods

Correlated with population growth:

- Dry cleaning
- Domestic solvent use

- Domestic use of pharmaceutical products

Expert judgement:
- Textile finishing
- Other (deicing and cement industry VOC use)

As emission factors decreased in the previous decade (due to measures under the VOC Directive), it has been assumed that the directive has been implemented fully and no further emission reductions driven by it are to be expected, so emission factors are set to the latest value.

NFR 2.G / NO_x, SO_2, NH_3 and $PM_{2.5}$

Emissions arise from product use, namely tobacco smoke and fireworks. Emissions from fireworks were set constant to the mean activity of the past 5 years. For tobacco use, it was assumed that the downward trend in emissions over recent years would continue for the next ten years, and then emissions will remain constant.

4.5 Agriculture (NFR 3)

This chapter gives an overview of the European and Austrian farming policy, provides information on basic economic and technological assumptions and describes the methodologies used for the sectoral scenarios by 2040.

Emission projections are provided for sources of ammonia (NH_3), nitric oxide (NO_x), non-methane volatile organic compounds (NMVOC), sulphur dioxide (SO_2) and particulate matter ($PM_{2.5}$).

Emission calculations are based on the methodologies used in the Austrian Air Emission Inventory. Austria's Informative Inventory Report 2023 (ENVIRONMENT AGENCY AUSTRIA, 2023b) includes a comprehensive description of the methodologies used.

The EU CAP Strategic Plan

The Common Agricultural Policy (CAP) is a European Union policy with a long tradition, embedded in the EU's framework for action, which includes the goal of a climate-neutral Europe in 2050.

By the end of 2021, Austria submitted its CAP Strategic Plan (CAP-SP) 2023—2027. The plan was approved in September 2022. It includes interventions that enable participants to receive direct payments (former 1st pillar of the CAP) and measures financed by the EAFRD (former 2nd pillar of the CAP). In addition, sector programmes (fruit and vegetables, bees, wine, hops) were implemented. Since the CAP period started with a delay of three years, we assume that the programme will continue until 2030. In the Austrian CAP-SP (BML, 2022), a total of 98 interventions, based on 45 needs, are jointly programmed and implemented. According to the intervention logic, the climate-relevant interventions are assigned to objective 4 (climate) by corresponding relevant outcome indicators. Compared to the previous CAP period (2014—2020, which was extended until 2022), both climate mitigation and climate change adaptation measures have gained more weight compared to other measures. However, the volume of funds has not changed significantly.

Scenario 'with existing measures' (WEM)

The scenario is based on price projections of the OECD/FAO (OECD-FAO, 2022) for the EU, existing farm policies and the legal framework of regulations (see Chapter 3).

Scenario 'with additional measures' (WAM)

The WAM scenario takes into account the additional agricultural policy measures provided for in the National Air Pollution Control Programme (NAPCP) and the Integrated National Energy and Climate Plan (NECP) (BMK, 2023a, b) and regulated by Austria's Ammonia Reduction Ordinance (Federal Law Gazette II No. 395/2022). Additionally, the obligations according to the Federal Act on the Protection of Animals (Federal Law Gazette II No. 118/2004, last amendment: Federal Law Gazette II No. 130/2022) have also been taken into account.

For the PASMA modelling of the WAM scenario, it was assumed that the regulations in place by 2023 and those expected to become effective by 2030 will increase the costs of agricultural production by making investments more expensive. This assumption was discussed at a stakeholder workshop, and there was a consensus of opinion among agricultural experts. Higher investment costs are implemented via a higher present value for leasing stable capacity. This makes livestock production more expensive, and therefore other activities (such as crop production) become more profitable for farmers. The factor of higher costs in the WAM scenario compared to WEM is 10%. This increase seems reasonable to finance construction such as slurry tank covers, slurry separators and improved air conditioning for new investment.

Main results

Cattle numbers: WEM projections indicate that cattle numbers will decrease by 13% between 2021 and 2030. In its latest outlook for agricultural markets, the European Commission also anticipates lower beef production and a declining number of dairy cows at EU level.

In the WAM projections, cattle numbers decline slightly more strongly than in the WEM scenario (-15% between 2021 and 2030) as a result of rising investment costs making milk and meat production less profitable.

Pig numbers: The number of pigs decreases at a much higher rate because the output price and input cost ratio is less favourable. In its most recent outlook for agricultural markets, the European Commission expects lower production of pork at EU level as well.

In the WAM scenario, the number of pigs decreases at a slightly higher rate than in the WEM scenario. This is because higher investment costs to reduce emissions make pork production less favourable.

Poultry numbers: Poultry numbers decline at a similar rate until 2030 in both WEM and WAM scenarios. The modelled development of the poultry population is in contrast to the observed trends. The reason lies in the international competition for poultry meat and eggs and the comparatively high production costs in Austria.

Fertiliser application: PASMA model results indicate that mineral fertiliser application on agricultural land will increase. The reason for this is the nutrient deficit due to the declining livestock. The lower amount of organic fertiliser will be offset by higher sales of mineral fertilisers.

Activity data

As part of the preparation of national scenarios for the agricultural sector, the Environment Agency Austria commissioned the Austrian Institute of Economic Research (WIFO) and the University of Natural Resources and Life Sciences (BOKU) to prepare a modelling of the domestic agricultural sector. The results of the PASMA model (WIFO & BOKU, 2023) provide the basic activity data for both scenarios.

The PASMA model

The Positive Agricultural Sector Model Austria (PASMA), developed by the Austrian Institute of Economic Research (WIFO), maximises sectoral farm welfare and is calibrated on the basis of historical activities in arable farming, forestry, livestock breeding and agro-tourism. The method of Positive Mathematical Programming (PMP) assumes a profit-maximising equilibrium (e.g. marginal revenue equals marginal cost) in the base run and derives the coefficients of a non-linear objective function based on observed levels of production activities (WIFO & BOKU, 2023).

Assumptions about prices, yields and production

PASMA price projections are based on assumptions about the development of key indicators on global agricultural commodity and food markets (OECD-FAO, 2022). Forecasts for key economic indicators are based on KANIOVSKI ET AL. (2021), and energy prices are consistent with those assumed for the energy sector.

Several sources of market data are available that can be used as a basis for price projections. All prices but energy prices were derived from OECD-FAO outlooks for agricultural markets (OECD-FAO, 2022). A comparison of these OECD forecasts with projections of the European Commission (EUROPEAN COMMISSION, 2022) shows that international bodies have very similar assumptions about the future development of key economic indicators. Due to the type of farm sector model used in this analysis, assumptions for the Austrian economic context (e.g. GDP growth, population dynamics) are not required directly. However, they are included in the exogenous price assumptions (mainly the consumer price index). Other driving forces (prices, technology, constraints) are referenced in the following sections.

No OECD-FAO forecasts are available for the period after 2031. Therefore, the assumption was made that prices will follow the previous trend from this year onwards for most activities. Price estimates for farm outputs are specific to the Austrian market situation. The observed price wedge between Austrian and EU markets was assumed to prevail in the future.

Within this project, a detailed set of assumptions for technical coefficients, yields and productivity was developed in a stakeholder process, which included the expertise of farm production experts from the Austrian Chamber of Agriculture, the Austrian Agency for Health and Food Security (AGES) and participants at three meetings of the project board established for this study.

Results can be summarised as follows: productivity in livestock farming, particularly in milk production, will increase in the coming years, but at a slower pace than in the past. With regard to crop yields, the consensus was that climate change is likely to lower country averages after 2030. One outcome of the discussions was that the expected yields of crops were lowered after 2030 and that stables for livestock would be significantly more expensive than in 2020. The assumption of higher prices is justified by the fact that compliance with environmental legislation will make investments more expensive. For more information, please refer to WIFO & BOKU (2023).

Additional Assumptions for the WAM scenario

Projected activity data were mainly taken from the PASMA model (WIFO & BOKU, 2023), with milk yield data based on exogenous technology assumptions (ENVIRONMENT AGENCY AUSTRIA, 2023d). For mineral fertiliser use, a reduction of 20% was assumed compared to the WEM scenario in 2030, which corresponds to the target included in the current draft report of the Austrian NECP (see Chapter 3).

4.5.1 Manure management (NFR 3.B)

This source category includes emissions occurring during the housing and storage of livestock manure.

WEM scenario

Feed intake and N excretion

Feed intake parameters and N excretion values match those applied in Austria's Air Emission Inventory (ENVIRONMENT AGENCY AUSTRIA, 2023b). Austria-specific N excretion values for dairy cows were calculated on the basis of national feed intake estimates in line with projected milk yields (+14% from 2020 to 2040).

Manure management systems (MMS)

Data on MMS distribution are based on a comprehensive analysis of Austria's agricultural practices in 2017 (PÖLLINGER ET AL., 2018).

In the distribution of manure management systems, a continued trend towards loose housing systems has been assumed. Additionally, the trend towards liquid manure systems was taken into account.

Based on information from the CAP Strategic Plan, the share of dairy and suckling cows kept on pasture was increased slightly by 10% until 2030 and kept constant thereafter.

Other assumptions for agricultural practice, such as for the storage of farm manure or the share of farm manure treated in biogas plants, correspond to those of the OLI.

WAM scenario

Feed intake and N excretion

WAM includes additional measures for animal feeding (implementation of N-reduced feeding strategies), resulting in a slight decrease in nitrogen excretion for cattle (dairy cows and fattening heifers) and pigs in 2025 and 2030 compared to the WEM scenario.

Assumptions for lowering the crude protein surpluses were derived from the contents of typical rations according to national studies, feeding recommendations and the crude protein requirements of the animals based on their productivity.

Based on the additional measures defined in the national programmes (NECP, NAPCP) and the analyses described above, the crude protein content in feed for dairy cows and fattening heifers was reduced by 2%, for breeding sows by 3% and for fattening pigs by 5% in 2030.

Manure management systems (MMS)

The WAM scenario includes the following additional measures:

- Additional measures for low-emission barn design and manure storage, as listed in the Austrian NAPCP;
- Increased grazing of dairy & suckling cows by 30% in 2030;

- Measures regulated in the Austrian Ammonia Reduction Ordinance for the mandatory covering of slurry storage facilities from 2028 onwards;
- Increase of the share of manure treated in biogas plants to 30% of Austria's total manure volume for the relevant livestock categories of cattle, pigs and poultry by 2030, according to the Austrian NECP and NAPCP.

4.5.2 Agricultural soils (NFR 3.D)

This source category includes emissions from anthropogenic N inputs to agricultural soils.

WEM scenario

Inorganic N fertilisers

Projected data for mineral fertiliser application have been taken from WIFO & BOKU (2023).

Animal manure applied to soils

Based on projections in Austria's CAP Strategic Plan, the share of low-emission spreading techniques has been increased for the application of cattle manure to 32.3% and the application of pig manure to 75.7% until 2027. Values were kept constant thereafter.

For solid-liquid separation, available data according to the CAP Strategic Plan were used (5.2% in 2027) and extrapolated thereafter.

WAM scenario

The WAM scenario includes the following additional measures:

- Mandatory measures for the rapid incorporation of N fertilisers (inorganic and organic) regulated in the Ammonia Reduction Ordinance;
- Reduced use of mineral fertilisers by 20% by 2030 (compared to the scenario 'with existing measures') in line with the target set in Austria's draft NECP as a result of efficiency improvements and precision farming techniques, etc.

The measures 'increased use of low-emission application techniques for cattle and pig slurry' and 'solid-liquid separation' according to the Austrian CAP-SP are considered in the WEM scenario in accordance with the scenario definitions provided in Chapter 3.

4.5.3 Field burning of agricultural residues (NFR 3.F)

In Austria, a federal law restricts the burning of agricultural residues on open fields. Residue burning is only permitted occasionally and on a very small scale. For the latest inventory year, 2021, no field burning occurred in Austria at all

('NO'). Our assumption is that there will be no burning in the projected years either.

4.5.4 PM emissions from agriculture

Particle emissions from animal husbandry

Particle emissions from this source are primarily associated with dietary manipulation of forage; a smaller part arises from dispersed excrement and litter. Estimates are related to Austrian livestock projections. To maintain consistency with Austria's Air Emission Inventory (ENVIRONMENT AGENCY AUSTRIA, 2023b), emission factors from the RAINS model (LÜKEWILLE ET AL., 2001) were used.

Particle emissions from field operations

Emissions of particulate matter from field operations are linked to the use of machinery on agricultural soils. They are considered in connection with the farmed area. For the projections, the same methodology (EMEP/EEA, 2019, Tier 1) as in Austria's Annual Air Emission Inventory (ENVIRONMENT AGENCY AUSTRIA, 2023b) was used. Activity data on the projected cropland and grassland area were obtained from PASMA (WIFO & BOKU, 2023).

Particle emissions from bulk material handling

Since this source is of minor significance, $PM_{2.5}$ emissions have been extrapolated using the inventory values from 2021 onwards.

4.5.5 Uncertainties

Emission projections are fraught with a range of uncertainties. These uncertainties have to be kept in mind when considering the results of this analysis:

- **Model uncertainty:** The first uncertainty factor is related to the type of model. The PASMA model (WIFO & BOKU, 2023) is static by design, and adjustments to future situations are calculated in discrete steps using exogenous assumptions (prices, costs, technical coefficients) and endogenous coefficients (marginal costs) based on observations in the reference period. Investment costs are not considered in the model as it is based on gross margin calculations. The model assumes a swift adaptation of land uses and management and an efficient use of resources. In practice, such adaptations may be over-optimistic because farmers are not able or willing to adjust in the way the model suggests.
- **Market uncertainty:** A comparison of past OECD-FAO projections and the observed outcomes suggests that there is a considerable difference between them. The range of such uncertainties is discussed in more detail in the OECD-FAO report (2022).

- **Policy uncertainty:** Policies affect the decisions of farmers and other market participants in various ways. The range of policies is not limited to agricultural policies alone: energy policies affect energy prices and thus input costs; urban planning regimes affect decisions about developments in residential and commercial areas, which have an impact on the availability of agricultural land.

4.5.6 Sensitivity analysis

In the sensitivity analysis, the focus was placed on investment costs, as these are subject to a high degree of uncertainty. Several variants of investment costs were used and compared in the PASMA model. The final assumptions for the cost increase were determined according to the stakeholder dialogue, assuming higher construction costs than observed in the past. As a result, animal husbandry became more expensive, whereas other activities such as plant production became more profitable for farmers.

Overall, the PASMA results for Austria in 2030 are in line with the expectations of the OECD (OECD-FAO, 2022) and the European Union (EC, 2022). However, the trend for milk production in Austria deviates from the generally expected trends due to the comparative advantage of dairy production in Austria compared to other countries.

4.6 Waste (NFR 5)

4.6.1 Waste disposal on land (NFR 5.A)

NMVOC and NH_3 emissions from solid waste disposal are calculated based on their respective content in the emitted landfill gas (taking gas recovery into account). For NMVOC, a concentration of 300 mg/m³ and for NH_3 a concentration of 10 mg/m³ in the landfill gas is assumed.

For the calculation of landfill gas (mainly methane (CH_4)) arising from solid waste disposal on land, the IPCC[12] Tier 2 (First Order Decay) method is applied, taking into account historical data on deposited waste. According to this method, the degradable organic component (DOC) of waste decays over a few decades (IPCC, 2006). The Tier 2 method is recommended for the calculation of landfill emissions at national level; it consists of two equations: one for calculating the amount of methane generated, based on the amount of accumulated degradable organic carbon at landfills in a particular year, and one for calculating the methane actually emitted after subtracting the recovered and the oxidised methane.

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[12] Intergovernmental Panel on Climate Change

More detailed information on the methodology (as well as on the parameters applied) can be found in Austria's Informative Inventory Report (ENVIRONMENT AGENCY AUSTRIA, 2023b).

Projections for landfill gas emissions are calculated on the basis of predictable future trends in waste management as a result of the implementation of legal provisions at federal government level. As stipulated in the Landfill Ordinance (*Deponieverordnung*), only pre-treated waste has been deposited in landfills since 2009. Consequently, only the following landfill fractions have been taken into account for the projections:

1. Residues and stabilised waste arising from the mechanical and/or biological treatment of waste; this fraction is expected to develop in accordance with assumptions made for projected emissions from mechanical-biological treatment (MBT) plants;
2. Some minor amounts of sludge, construction waste and paper with a low TOC content (below the threshold for TOC disposal).

On the basis of the assumptions made, projected activity data were calculated as shown below:

Table 30: Past trend (1990—2020) and scenarios (2025—2050) for 'residual waste' and 'non-residual waste' activity data (source: Environment Agency Austria).

Year	Residual Waste [kt/a]	Non-Residual Waste [kt/a]	Total Waste [kt/a]
1990	1 996	649	2 644
2000	1 052	827	1 879
2005	242	390	631
2010	0.0	245	245
2015	0.0	132	132
2020	0.0	166	166
2025	0.0	190	190
2030	0.0	190	190
2035	0.0	190	190
2040	0.0	190	190
2045	0.0	190	190
2050	0.0	190	190

$PM_{2.5}$ from waste disposal on land (NFR 5.A)

Emissions from this category arise from the handling of dusty waste at landfill sites.

For the calculation of $PM_{2.5}$ emissions, only specific waste types are taken into account. The largest fraction is mineral waste (excavated soil in particular), contributing 97% (2021) of the total waste used for $PM_{2.5}$ calculations. Moreover, slags, dust and ashes from thermal waste treatment and combustion plants as well as residues from iron and steel production (slags, dust, rubble) and some construction waste are taken into account. Solidified or stabilised waste is not considered.

Emissions are calculated by multiplying the waste amount by an emission factor (the same as the one used for the Austrian Air Emission Inventory; see ENVIRONMENT AGENCY AUSTRIA, 2023b).

Table 31: Past trend (1998—2020) and scenarios (2025—2050) for dusty waste activity data in kt (source: Environment Agency Austria).

	1998	2000	2010	2020	2030	2040	2050
Total dusty waste amount	4 381	5 028	10 782	28 833	30 838	33 667	36 497

For the projections of activity data, it has been assumed that the amount of the deposited waste types considered will increase annually by 1% of the amount landfilled in 2021.

4.6.2 Biological treatment of waste—composting (NFR 5.B.1)

NH_3 emissions are calculated separately for

- waste treated in mechanical-biological treatment (MBT) plants and
- waste treated in composting plants as well as home-composted biogenic waste,

multiplying the respective emission factors by the waste amounts.

The emission factors used for the projections are the same as those described in Austria's Informative Inventory Report (ENVIRONMENT AGENCY AUSTRIA, 2023b).

Composting plants, home composting

Home-composted waste amounts are assumed to increase with population growth (STATISTICS AUSTRIA, 2022b). About 50% of the amount of the waste treated in composting plants is expected to remain constant at 2021 levels (tree loppings and wood used as structural material in the composting process), while the other 50% is expected to increase with population growth (organic waste collected from households).

Mechanical-biological treatment plants

As regards the amount of waste undergoing mechanical-biological treatment (MBT) in Austria, it is assumed that this will remain at the mean level for 2009—2021.

Table 32: Past trend and scenario for composting activity data.

[kt waste treated]	1990	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Composted organic waste	418	1 467	1 689	1 834	2 019	2 227	2 335	2 365	2 393	2 417	2 434	2 452
Mechanically-biologically treated waste	345	254	623	551	439	462	458	458	458	458	458	458

4.6.3 Anaerobic treatment of agricultural feedstock (NFR 5.B.2)

NH_3 emissions from anaerobic digestion (manure and energy crops) are reported under category NFR 5.B.2.

For further information on the methodology used, see Chapter 4.5 on the agricultural sector.

4.6.4 Waste incineration (NFR 5.C)

Given the minor contribution of pollutants from this source (NO_x, SO_2, NMVOC, NH_3) to the national total emissions (less than 1%), 2019 emission levels have been used for the forecast. A detailed description of the methodology used for estimating the emission of these pollutants can be found in the Austrian Informative Inventory Report 2023 (ENVIRONMENT AGENCY AUSTRIA, 2023b).

4.6.5 Wastewater treatment (NFR 5.D)

This category includes NMVOC emissions from the treatment of domestic wastewater (NFR 5.D.1), i.e. wastewater of domestic origin as well as commercial and industrial wastewater treated together with domestic wastewater in municipal wastewater treatment plants. In addition, NMVOC from industrial on-site treatment (NFR 5.D.2) are considered from this submission onwards (ENVIRONMENT AGENCY AUSTRIA, 2023b).

Emissions were calculated following a Tier 1 approach by multiplying the wastewater amounts by the emission factor taken from the EMEP/EEA 2019 Guidebook (15 mg/m^3 of wastewater). The most recent data on volumes of wastewater treated were taken from the Electronic Emission Register of Surface Water Bodies (*Emissionsregister – Oberflächenwasserkörper*, EMREG-OW[13]).

Treated domestic wastewater amounts are expected to increase with population growth. The volume of industrial wastewater treated on site is

[13] Federal Law Gazette II No. 29/2009: Verordnung des Bundesministers für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft über ein elektronisches Register zur Erfassung aller wesentlichen Belastungen von Oberflächenwasserkörpern durch Emissionen von Stoffen aus Punktquellen (Austrian Emissions Register Ordinance, EmRegV-OW).

expected to remain at the 2021 level. The emission factor remains the same for the whole time series.

Table 33: Past trend (1990—2020) and scenarios (2025—2050) for wastewater volumes in million m³.

	1990	2000	2010	2020	2030	2040	2050
Domestic wastewater treated (municipal and domestic wastewater treatment plants, cesspools)	640	996	1 112	1 077	1 105	1 139	1 163
Industrial wastewater treated on site	340	382	446	434	432	432	432

4.6.6 Other waste handling (NFR 5.E)

This category covers $PM_{2.5}$ emissions from vehicle fires and fires at detached houses, apartment buildings and industrial buildings.

Emissions were calculated following a Tier 2 approach, multiplying the number of fires per category by the emission factor taken from the EMEP/EEA 2019 Guidebook.

*Emissions = AD * EF*

AD activity data (number of fires)
EF emission factor

For the projection of car fires and apartment fires, the population growth (STATISTICS AUSTRIA, 2022b) was taken for extrapolation. With regard to detached houses and industrial buildings, a mean value of the number of fires reported for 2004—2021 was used to project the number of future fires. The emission factor remains the same for the whole time series.

Table 34: Number of fires: past trend (1990—2020) and scenarios (2020—2050).

	1990	2000	2010	2020	2030	2040	2050
Car fires	1 586	1 682	1 727	1 696	1 875	1 934	1 974
Accidental fires at buildings	2 995	3 066	3 545	3 306	3 362	3 390	3 410

5 RECALCULATIONS: CHANGES WITH RESPECT TO THE 2021 SUBMISSION

The changes made to the projections since the previous submission of emission projections for air pollutants in 2021 (ENVIRONMENT AGENCY AUSTRIA, 2021) are presented in this chapter. In general, there are five main factors influencing these changes:

1. Changes in base data (e.g. GHG inventory, energy balance);
2. A switch to the new EMEP/EEA Guidebook 2019, which entailed methodical changes and some considerable sectoral recalculations (e.g. for the agricultural sector) of the inventory and of emission projections because the methods had to be applied consistently to calculate past trends and emission scenarios;
3. Changes in assumptions for activity scenarios. These changes can be triggered by revised economic or technical scenarios, the inclusion of additional policies and measures, and revisions of policies or measures which become necessary because of amendments to legislation;
4. Update on new emission factors (e.g. in the transport sector);
5. Changes in the models used for activity or emission scenarios.

The following tables show a comparison of past trends in the WEM scenario for national emission totals.

Table 35: Comparison of 2021 and 2023 projections in the WEM scenario based on fuel sold—national totals (in kt) (source: Environment Agency Austria).

Total	2005	2010	2020	2021	2025	2030
			2021 Projections			
NO_x	247	204	144	138	107	87
SO_2	26	16	11	12	12	12
NMVOC	158	138	109	109	106	103
NH_3	60	63	64	64	65	66
$PM_{2.5}$	23	20	14	14	13	12
			2023 Projections			
NO_x	248	206	124	123	99	80
SO_2	26	16	10	11	11	11
NMVOC	157	138	111	111	103	99
NH_3	63	65	66	66	62	58
$PM_{2.5}$	23	20	13	14	13	12
			Difference 2023/2021			
NO_x	+1	+2	-13	-8	-8	-7
SO_2	+0	+0	-2	-1	-1	-1
NMVOC	-1	0	2	+5	-3	-4
NH_3	+3	+2	+2	+2	-3	-8
$PM_{2.5}$	0	0	-1	0	0	0

For further information on the inventory recalculations, see 'sector-specific recalculations' in Austria's Informative Inventory Report 2023 and Austria's National Inventory Report 2023.

The main changes per sector are discussed in detail in the following chapters.

5.1 Energy industries (NFR 1.A.1), manufacturing industries and construction (NFR 1.A.2) and industrial processes (NFR 2)

Table 36: Major changes between the 2021 and 2023 projections for the NFR 1.A.1, NFR 1.A.2 and NFR 2 sectors (in kt) (source: Environment Agency Austria).

Pollutant	Sector (CRF)	2005	2010	2020	2021	2025	2030
NO_x	1.A.1—Energy Industries	0.0	0.0	0.3	0.7	0.2	0.5
	1.A.2—Manufacturing Industries and Construction	0.0	0.0	-0.2	-0.3	-1.1	-0.8
	2—Industrial Processes	0.0	0.0	0.0	-0.1	0.0	0.0
SO_2	1.A.1—Energy Industries	0.0	0.0	-0.3	-0.2	-0.2	0.0
	1.A.2—Manufacturing Industries and Construction	0.0	0.0	-1.0	-1.3	-1.2	-1.2
	2—Industrial Processes	0.0	0.0	0.0	0.0	0.0	0.0
$PM_{2.5}$	1.A.1—Energy Industries	0.0	0.0	0.0	0.0	0.0	0.0
	1.A.2—Manufacturing Industries and Construction	0.0	0.0	0.0	-0.1	-0.1	-0.1
	2—Industrial Processes	0.2	0.1	0.2	0.3	0.4	0.4
NMVOC	1.A.1—Energy Industries	0.0	0.0	0.0	0.0	0.0	0.0
	1.A.2—Manufacturing Industries and Construction	0.0	0.0	0.1	0.1	0.1	0.1
	2—Industrial Processes	0.7	0.7	4.6	4.3	2.1	2.2
	2.D—Solvents	0.1	0.1	4.2	3.9	2.1	2.2

Revisions up to the year 2021 are mainly due to updates to the national energy balance. The 2021 projections used the energy balance with data up to 2019, whereas the 2023 projections used the energy balance with data up to 2021. A significant decrease in energy consumption was caused by the COVID-19 crisis in 2020 to 2022. Thus, industrial emissions have decreased. In the energy industries, the decommissioning of coal-based plants took place sooner than expected, so emissions of SO_2 are lower than previously. However, demand for power and district heating has increased more than in previous scenarios, thus emissions of NO_x (from biomass plants) are higher.

Emission factors have been adapted, mainly to take account of the impact of measures but partly also to incorporate the recalculations of the latest inventory.

NFR 2.D—Solvent and other product use

Recalculations for the year 2020 onwards were mainly due to new reports from installations that became available and were included in the inventory. Additionally, information on activity data for Road Paving with Asphalt for the whole time series was updated in the inventory.

As SNAPs were better aligned with economic sectors, the projections were also updated and based on updated assumptions for the economic sectors in question.

5.2 Transport (NFR 1.A.3)

Table 37: Major changes between the 2021 and 2023 projections for the NFR 1.A.3 sector, in kt (fuel sold) (source: Environment Agency Austria).

Pollutant	Sector (NFR)	2005	2010	2020	2021	2025	2030
NO_x	1.A.3—Transport	0.1	1.3	-13.2	-10.4	-6.4	-6.3
	1.A.3.a—Civil aviation	0.0	0.0	-0.8	-0.6	0.1	0.3
	1.A.3.b.1—Passenger cars	0.5	0.1	-12.2	-10.0	-4.0	-2.8
	1.A.3.b.2—Light-duty vehicles	0.0	0.0	-0.8	-0.7	-1.1	-1.2
	1.A.3.b.3—Heavy-duty vehicles	-0.6	1.1	1.6	1.7	-1.0	-2.2
	1.A.3.b.4—Mopeds & motorcycles	0.0	0.0	0.0	-0.1	0.0	-0.1
	1.A.3.c—Railways	0.0	0.0	-0.1	-0.1	0.0	-0.1
	1.A.3.d—Navigation	0.0	0.0	-0.8	-0.4	-0.3	-0.2
	1.A.3.e—Pipeline compressors	0.1	0.1	-0.1	-0.2	-0.1	-0.1
NMVOC	1.A.3—Transport	-0.2	-0.1	-0.9	-0.8	-0.2	-0.3
	1.A.3.a—Civil aviation	0.0	0.0	-0.1	-0.1	0.0	0.0
	1.A.3.b.1—Passenger cars	0.0	0.0	-0.6	-0.6	-0.4	-0.6
	1.A.3.b.2—Light-duty vehicles	0.0	0.0	0.0	0.0	0.0	0.0
	1.A.3.b.3—Heavy-duty vehicles	-0.1	0.0	0.0	0.0	0.0	0.1
	1.A.3.b.4—Mopeds & motorcycles	0.0	0.0	0.0	-0.1	-0.1	-0.1
	1.A.3.c—Railways	0.0	0.0	0.0	0.0	0.0	0.0
	1.A.3.d—Navigation	0.0	0.0	-0.2	-0.1	0.2	0.2
	1.A.3.e—Pipeline compressors	0.0	0.0	0.0	0.0	0.0	0.0

For the year 2020, the difference between the 2021 and 2023 projections is due to the slump in activities caused by the pandemic. The 2021 submission for the transport sector included a modelling result that had already been estimated before 2020. The differences in the years 2025 to 2040 are due to a revision of the share of BEVs in new car registrations and the reduced amount of fossil fuels needed, which was much more conservative in the old projection.

5.3 Other sectors (NFR 1.A.4)

Table 38: Major changes between the 2021 and 2023 projections for the NFR 1.A.4 sector in kt (source: Environment Agency Austria).

Pollutant	Sector (NFR)	2005	2010	2020	2021	2025	2030
NO_x	1.A.4—Other Sectors	-0.2	-0.3	-0.4	1.2	-0.9	-0.2
	1.A.4.a.1—Commercial/Institutional: Stationary	-0.1	0.0	-0.1	0.1	-0.1	-0.1
	1.A.4.b.1—Residential: Stationary	-0.2	-0.2	-0.3	1.1	-0.6	0.2
	1.A.4.c.1—Agriculture/Forestry/Fishing: Stationary	0.0	0.0	0.0	0.0	-0.1	0.0
NMVOC	1.A.4—Other Sectors	-0.1	0.0	-0.8	2.7	-1.2	0.6
	1.A.4.a.1—Commercial/Institutional: Stationary	0.0	0.0	0.1	0.1	0.2	0.2
	1.A.4.b.1—Residential: Stationary	-0.1	0.0	-0.4	2.8	-0.7	1.0
	1.A.4.c.1—Agriculture/Forestry/Fishing: Stationary	0.0	0.0	0.0	0.2	-0.1	0.0
$PM_{2.5}$	1.A.4—Other Sectors	0.0	0.0	-0.2	0.6	-0.1	0.5
	1.A.4.a.1—Commercial/Institutional: Stationary	0.0	0.0	0.0	0.0	0.1	0.1
	1.A.4.b.1—Residential: Stationary	0.0	0.0	-0.2	0.5	-0.1	0.5
	1.A.4.c.1—Agriculture/Forestry/Fishing: Stationary	0.0	0.0	0.0	0.0	0.0	0.0

In the 2023 submission, NEC emissions have been subject to significant changes, compared to the 2021 submission, to both the inventory and the projected years starting from 2021. There are several reasons for this:

- Minor revision of the national energy balances for former inventory years 2005 and 2010 for mobile sources of NFR 1.A.4;
- The recalculation in the years 2005, 2010 and 2020 is predominantly due to the revision of the energy demand model for space heating. Minor changes to air pollutant emissions of NFR 1.A.4.a.1 and NFR 1.A.4.b.1 occur because of updated heating stock data and newly allocated shares of combustion technologies per energy carrier (updated energy demand model for space heating). In particular, lower NO_x emissions occur because of higher shares of new technologies, which are considered with lower NO_x emissions than conventional equipment (see ENVIRONMENT AGENCY AUSTRIA, 2023b for further details):
  - New blue burners with low temperature or condensing technology (heating type #6),
  - New forced-draught natural gas boilers (heating type #9),
  - Advanced mixed-fuel wood boilers (heating type #14);
- Updates to the NMVOC inventory for mobile sources of NFR 1.A.4.b.2 in the years 2020 and 2021 and in the corresponding projected years 2025 and 2030 contribute to changes for NFR 1.A.4 compared to the 2021 submission;

- The difference in the year 2021 is due to emerging trends in activity data (energy consumption) for the inventory data year, in particular a higher fuel consumption of biomass because of a more intense heating period;
- The INVERT/EE-Lab model for NFR 1.A.4.a.1 and NFR 1.4.A.b.1 was updated with recent statistical data relating to building stock and thermal building quality. The model was recalibrated against the new energy balance.

5.4 Agriculture (NFR 3)

Table 39: Major changes between the 2021 and 2023 projections for the NFR 3 sector (in kt) (source: Environment Agency Austria).

Pollutant	Sector (NFR)	2005	2010	2020	2021	2025	2030
NH_3	3—Agriculture	3.0	2.7	2.7	2.5	-1.9	-7.6
	3.B.1.a	0.2	0.2	0.3	0.4	0.2	-0.1
	3.B.1.b	1.1	1.2	1.6	1.8	1.2	0.2
	3.B.4.e	0.0	0.0	0.0	0.0	-0.1	-0.5
	3.B.3	0.7	0.5	0.2	0.2	-0.2	-0.7
	3.B.4.g	0.0	0.0	0.3	0.3	0.3	0.0
	3.D	1.1	0.8	0.2	-0.1	-3.1	-6.0
NO_x	3—Agriculture	0.7	0.6	0.5	0.7	0.3	-0.2
	3.D	0.7	0.6	0.5	0.7	0.3	-0.1
NMVOC	3—Agriculture	-1.1	-0.7	-0.8	-0.9	-3.7	-6.9
	3.B	-1.2	-0.8	-0.5	-0.4	-2.1	-4.4

Activity data projections

Emission calculations are based on projected activity data obtained from the PASMA model (WIFO & BOKU, 2023). Since the last study (WIFO & BOKU, 2018), the PASMA model has been updated on the basis of a new inventory time series (1990—2020) and new legal and economic conditions affecting prices, costs and technical coefficients in the sectoral agriculture projections.

Within the 2022 inventory submission, Austria revised its agriculture inventory substantially. New updated and representative values for nitrogen and energy intake and the excretion of nitrogen (Nex) and volatile solids (Vsex), based on a new country-specific study (HÖRTENHUBER ET AL., 2022; HÖRTENHUBER ET AL., 2023), have been included in the inventory. The application of improved methodologies, taking into account detailed data on animal feeding, resulted in increased NH_3 and NO_x emissions, especially in the first years of the time series. Improvements to the enteric CH_4 emission calculations in Austria's greenhouse gas inventory led to lower NMVOC emissions for the entire time series. Detailed information on the inventory revision for the 2022 submission can be found in Austria's Informative Inventory Report 2022 (ENVIRONMENT AGENCY AUSTRIA, 2022a) and in Austria's National Inventory Report 2022 (ENVIRONMENT AGENCY AUSTRIA, 2022b).

The new WEM scenario considers the CAP Strategic Plan for the first time, putting more emphasis on reducing air pollutants and greenhouse gas emissions. Furthermore, energy prices are estimated to be significantly higher, and the cost of investments is increasing at a higher rate, mainly because of improved animal welfare standards and the price surge observed.

5.5 Waste (NFR 5)

Table 40: Major changes between the 2021 and 2023 projections for the NFR 5 sector (in kt) (source: Environment Agency Austria).

Pollutant	Sector (NFR)	2005	2010	2020	2021	2025	2030
NH_3	5—Waste	-0.35	-0.39	-0.41	-0.38	-0.40	-0.40

Compared to the 2021 projections, major revisions were carried out for NFR 5.B Biological Waste Treatment. Amounts of home-composted waste (part of NFR 5.B.1) were re-estimated by applying a new methodology developed for the Federal Waste Management Plan 2023[14], delivering a more plausible result than previously estimated. This was done in view of a future reporting obligation regarding home-composted quantities to the European Commission (home composting is to be included in the AT recycling rate for municipal waste).

Only minor revisions were reported for the NFR 5.A and NFR 5.D categories as new data became available for the annual inventory (deposited amounts, wastewater volumes, 2020 connection rate), slightly changing the basis for extrapolation.

Moreover, NMVOC emissions from industrial on-site wastewater treatment were estimated for the first time, slightly increasing emissions from wastewater treatment (NFR 5.D).

[14] https://www.bmk.gv.at/themen/klima_umwelt/abfall/aws/bundes_awp/bawp2023.html

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Federal Law Gazette I No. 6/2020 Bundesgesetz über die Unzulässigkeit der Aufstellung und des Einbaus von Heizkesseln von Zentralheizungsanlagen für flüssige fossile oder für feste fossile Brennstoffe in Neubauten (Ölkesseleinbauverbotsgesetz – ÖKEVG 2019).

Federal Law Gazette II No. 395/2022: Verordnung der Bundesministerin für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie über Maßnahmen im Bereich der Luftreinhaltung zur Erreichung der nationalen Emissionsreduktionsverpflichtungen für Ammoniak (Ammoniakreduktionsverordnung).

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ANNEX: NATIONAL PROJECTION ACTIVITY DATA

Table 41: Assumptions about general economic parameters—with existing measures and with additional measures (source: Environment Agency Austria).

	Unit	2020	2021	2025	2030
1. Gross Domestic Product	Value (€ billion)	381	402	439	466
2. Population	Thousand people	8917	8961	9114	9251
3. International coal prices	€(2020)/GJ	2	4	3	3
4. International oil prices	€(2020)/GJ	6	10	15	15
5. International gas prices	€(2020)/GJ	3	15	13	11

Table 42: Assumptions for the energy sector—with existing measures (source: Environment Agency Austria).

	Unit	2020	2021	2025	2030
Total gross domestic consumption*					
1.—Oil (fossil)	Petajoule (PJ)	464	494	493	466
2.—Gas (fossil)	Petajoule (PJ)	306	324	297	265
3.—Coal	Petajoule (PJ)	105	108	107	106
4.—Biomass without liquid biofuels (e.g. wood)	Petajoule (PJ)	209	230	233	252
5.—Liquid biofuels (e.g. bio-oils)	Petajoule (PJ)	18	19	18	17
6.—Solar*	Petajoule (PJ)	13	15	34	59
7.—Other renewable (wind, geothermal, etc)	Petajoule (PJ)	172	173	493	466
Total electricity production by fuel type*					
8.—Oil (fossil)	GWh	504	529	492	523
9.—Gas (fossil)	GWh	9804	10403	9049	4721
10.—Coal	GWh	2323	2068	1970	1985
11.—Renewable	GWh	55614	53108	68500	83400

* *Solar thermal and PV*

Table 43: Assumptions for the energy sector — with additional measures (source: Environment Agency Austria).

	Unit	2020	2021	2025	2030
Total gross domestic consumption*					
1.—Oil (fossil)	Petajoule (PJ)	464	494	482	429
2.—Gas (fossil)	Petajoule (PJ)	306	324	285	195
3.—Coal	Petajoule (PJ)	105	108	107	81
4.—Biomass without liquid biofuels (e.g. wood)	Petajoule (PJ)	209	230	239	279
5.—Liquid biofuels (e.g. bio-oils)	Petajoule (PJ)	18	19	23	32
6.—Solar*	Petajoule (PJ)	13	15	38	79

7.—Other renewable (wind, geothermal, etc)	Petajoule (PJ)	172	173	214	275
Total electricity production by fuel type*					
8.—Oil (fossil)	GWh	504	529	486	542
9.—Gas (fossil)	GWh	9 804	10 403	9 137	3 979
10.—Coal	GWh	2 323	2 068	1 966	1 325
11.—Renewable	GWh	55 614	53 108	68 321	91 265

* *Solar thermal and PV*

Table 44: Assumptions for the industrial sector—with existing measures (source: Environment Agency Austria).

	Unit	2020	2021	2025	2030
12. The share of the industrial sector in GDP and growth rate (e.g. iron & steel, other metals, cement, coke production, pulp and paper, petroleum refining)	Growth rate (%) per year				
Metal Industry	%	-9.5%	12.5%	2.9%	2.0%
Pulp & Paper	%	-9.7%	11.7%	3.0%	2.1%
Non-Metallic Minerals	%	-6.6%	8.5%	1.3%	1.1%
Chemical Industry	%	-10.0%	11.7%	3.0%	2.0%
Machine Construction	%	-9.5%	11.5%	2.6%	1.6%
Vehicle Construction	%	-10.2%	11.8%	3.0%	2.0%
Food and Drink	%	-6.5%	7.6%	2.7%	1.7%
Other Industry	%	-4.5%	6.5%	1.6%	1.2%

Table 45: Assumptions for the industrial sector—with additional measures (source: Environment Agency Austria).

	Unit	2020	2021	2025	2030
12. The share of the industrial sector in GDP and growth rate (e.g. iron & steel, other metals, cement, coke production, pulp and paper, petroleum refining)	Growth rate (%) per year				
Metal Industry	%	-9.5%	12.5%	3.0%	2.1%
Pulp & Paper	%	-9.7%	11.7%	3.0%	2.1%
Non-Metallic Minerals	%	-6.6%	8.5%	1.4%	1.2%
Chemical Industry	%	-10.0%	11.7%	3.0%	2.0%
Machine Construction	%	-9.5%	11.5%	2.8%	1.7%
Vehicle Construction	%	-10.2%	11.8%	3.0%	2.0%
Food and Drink	%	-6.5%	7.6%	2.7%	1.7%
Other Industry	%	-4.5%	6.5%	2.0%	1.5%

Table 46: Assumptions for the transport sector—with existing measures (source: Environment Agency Austria).

	Unit	2020	2021	2025	2030
15. Passenger person kilometres*	Million km	103 026	107 593	133 246	132 456
16. Growth of freight tonne kilometres*	Million tonne-km	138 770	146 443	145 717	155 346
17. Fleet turnover assumptions (vehicle replacement)					
17a. Passenger cars**	% of new vehicles per year	4%	4%	6%	6%
17b. Light-duty vehicles**	% of new vehicles per year	8%	12%	8%	8%
17c. Heavy trucks**	% of new vehicles per year	12%	14%	13%	13%

* *incl.. fuel export, excl. int. aviation/navigation*

** *new registrations compared to fleet stock in previous year in %*

Table 47: Assumptions for the transport sector—with additional measures (source: Environment Agency Austria).

	Unit	2020	2021	2025	2030
15. Passenger person kilometres*	Million km	99 944	104 465	119 548	114 524
16. Growth of freight tonne kilometres*	Million tonne-km	138 211	145.484	141 136	147 678
17. Fleet turnover assumptions (vehicle replacement)					
17a. Passenger cars**	% of new vehicles per year	4%	4%	6%	6%
17b. Light-duty vehicles**	% of new vehicles per year	8%	12%	8%	8%
17c. Heavy trucks**	% of new vehicles per year	12%	14%	13%	14%

* *incl.. fuel export, excl. int. aviation/navigation*

** *new registrations compared to fleet stock in previous year in %*

Table 48: Assumptions for residential and commercial or tertiary buildings sector—with existing measures (source: Environment Agency Austria).

	Unit	2020	2021	2025	2030
20a. The rate of change of floor space for tertiary buildings*	%	0.80%	0.80%	0.80%	0.80%
20b. The rate of change to floor space for dwellings*	%	1.23%	1.11%	0.96%	0.91%
21a. The number of dwellings in the tertiary sector**	Number	154 841	156 072	161 097	167 605
21b. The number of employees in the tertiary sector	Number	NE	NE	NE	NE
21c. The number of dwellings in the residential sector***	Number	3 982 000	4 015 276	4 139 987	4 274 352

* *Ratio of conditioned floor area (in commercial buildings or permanently occupied dwellings) between given year and previous year*

** *No information available on 'dwellings in the tertiary sector'. Substitute indicator: Number of commercial buildings in the tertiary sector*

*** *Number of permanently occupied dwellings*

Table 49: Assumptions for residential and commercial or tertiary buildings sector—with additional measures (source: Environment Agency Austria).

	Unit	2020	2021	2025	2030
20a. The rate of change of floor space for tertiary buildings*	%	0.80%	0.80%	0.80%	0.80%
20b. The rate of change of floor space for dwellings*	%	1.23%	1.11%	0.96%	0.91%
21a. The number of dwellings in the tertiary sector**	Number	154 841	156 072	161 097	167 605
21b. The number of employees in the tertiary sector	Number	NE	NE	NE	NE
21c. The number of dwellings in the residential sector***	Number	3 982 000	4 015 276	4 139 987	4 274 352

* *Ratio of conditioned floor area (in commercial buildings or permanently occupied dwellings) between given year and previous year*

** *No information available on 'dwellings in the tertiary sector'. Substitute indicator: Number of commercial buildings in the tertiary sector*

*** *Number of permanently occupied dwellings*

Table 50: Assumptions for the agricultural sector—with existing measures (source: Environment Agency Austria).

	Unit	2020	2021	2025	2030
23. Beef cattle	1 000 heads	1 331	1 344	1 261	1 156
24. Dairy cows	1 000 heads	525	526	500	474
25. Sheep	1 000 heads	394	402	362	269
26. Pigs	1 000 heads	2 496	2 479	2 272	2 063
27. Poultry	1 000 heads	19 750	19 750	18 904	16 283
28. Synthetic fertiliser	kt N	107	111	109	111

Table 51: Assumptions for the agricultural sector—with additional measures (source: Environment Agency Austria).

	Unit	2020	2021	2025	2030
23. Beef cattle	1 000 heads	1 331	1 344	1 247	1 128
24. Dairy cows	1 000 heads	525	526	495	459
25. Sheep	1 000 heads	394	402	360	260
26. Pigs	1 000 heads	2 496	2 479	2 253	2 025
27. Poultry	1 000 heads	19 750	19 750	18 754	15 682
28. Synthetic fertiliser	kt N	107	111	101	89

Table 52: Assumptions for the waste sector—with existing measures (source: Environment Agency Austria).

	Unit	2020	2021	2025	2030
31. Municipal solid waste disposed of in landfills*	Tonnes	165 576	197 067	163 991	163 991

* *The unit 'tonne of MSW' comprises all waste disposed of in mass landfills. It includes mainly pre-treated MSW as the disposal of untreated MSW has been prohibited in Austria since 2009.*

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This report covers the results for projections of the air pollutants SO2, NOx, non-methane NMVOC, NH3 and particulate matter (PM2.5) under the scenarios "with existing measures" (WEM) and "with additional measures" (WAM). It updates the previous projections for air pollutants published in 2021 (REP-0769).

The scenarios WEM and WAM result in significant emission reductions from 2005 to 2030 for all pollutants. The most substantial reduction, about 67% for WEM and about 69% for WAM, is projected for the pollutant NOx. Emission reductions for the other pollutants range from 8% to 56% in the scenario WEM and from 18% to 60% in the scenario WAM.

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