ENVIRONMENT AGENCY AUSTRIA umweltbundesamt

Austria's National Air Emission Projections 2019 for 2020, 2025 and 2030

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

Scenario: With Existing Measures (WEM)

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CONTENT

1 GENERAL APPROACH

Austrian emission projections 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 scenarios "with existing measures" (WEM) were last published in 2017 in a report entitled "Austria's National Air Emission Projections 2017 for 2020, 2025 and 2030" (UMWELTBUNDESAMT 2017).

This year's report provides updated emission projections for the WEM scenario, based on new energy scenarios and an update of policies and measures (PAMs).

A national air pollution control programme, as required under the NEC Directive (EU) 2016/2284, is currently in preparation, as well as the final National Energy and Climate Plan, as required under the Governance Regulation (EU) 2018/1999. It will not be possible to have a clear picture of the planned measures before the negotiations have been completed. As the National Energy and Climate Plan will have a significant effect on the air pollution regime, a scenario 'with additional measures' has not been prepared for reporting in March 2019.

The scenario 'with existing measures' includes all PAMs implemented by 1 January 2018. The status and current degree of implementation of measures have been assessed at expert level in consultation with the Federal Ministry of Sustainability and Tourism. Information on national policies and measures included in the scenarios can be found in Chapter 3.

Furthermore, to consider fuel export in vehicle tanks, we have evaluated the fuel options 'fuel sold' and 'fuel used'.

The air pollutant projections are fully consistent with current GHG emission projections under the EU Monitoring Regulation (UMWELTBUNDESAMT 2019c).

The report further outlines relevant background information in order to enable an understanding of the key socio-economic assumptions used in the preparation of the projections. For the purpose of comparison, emission data from the National Air Emission Inventory of March 2019 (UMWELTBUNDESAMT 2019a) are 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 2010 and, under the amendment in 2012, also on emission ceilings for the year 2020. Austria signed the Gothenburg Protocol but has not ratified it. For this reason, the targets are 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 for Austria. The obligation to comply with the ceilings for 2010 has been transposed into national law through the Air Emission Ceilings Act ('*Emissionshöchstmengengesetz-Luft')*[3]. The revised NEC Directive (2016/2284/EU) lays down further national emission reduction obligations (additionally for the pollutant $PM_{2.5}$) for the years 2020 and 2030 and has been 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 (MS) shall prepare and biennially update their national emission projections and pursuant to Article 10 (2), MS shall provide their national emission inventories and projections to the Commission and to the European Environment Agency.

According to Article 22 of the revised Guidelines 2014[5] for reporting emission data under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP), Parties shall report emissions from road transport on the basis of 'fuel sold' and may voluntarily calculate emissions based on 'fuel used' in the geographic area of the Party. Furthermore Article 23 states that some parties (including Austria) may choose to use national emission total calculated on the basis of fuel used as a basis for compliance with their respective emission ceilings.

According to the revised NEC Directive (2016/2284/EU) Article 10 (2), reporting under NEC shall be consistent with reporting to the Secretariat of the LRTAP Convention. Furthermore, Annex IV (Part 1 (4)) states that emissions from road transport shall be calculated and reported on the basis of 'fuel sold'. However, MS having the choice to use national emission total calculated on the basis of 'fuel used' as a basis for compliance under the LRTAP convention may keep this option in order to ensure coherence between international and Union law.

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1 Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution to Abate Acidification, Eutrophication and Ground-level Ozone, http://www.unece.org/fileadmin/DAM/env/lrtap/full%20text/Informal_document_no_17_No23_Consolidated_text_checked_DB_10Dec2012_-_YT_-_10.12.2012.pdf

2 Directive 2001/81/EC of the European Parliament and the Council of 23 October 2001 concerning national emission ceilings for certain pollutants, OJ L309/22, 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

5 http://ceip.at/fileadmin/inhalte/emep/2014_Guidelines/ece.eb.air.125_ADVANCE_VERSION_reporting_guidelines_2013.pdf

This report provides emissions projection data based on 'fuel sold' as well as on 'fuel used', the latter in compliance with the NEC Directive.

Over the last decade, Austria has experienced a considerable amount of fuel exports in vehicle tanks, as fuel prices in Austria were lower than in the neighbouring countries. Most of the fuel was used by heavy-duty vehicles for long-distance transport (inside and outside the EU). This is of relevance for NO_X emissions only.

Annex I of the NEC Directive (2001/81/EC) determines 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. Emissions ceilings from 2020 onwards are stated in the Annex II of the revised NEC Directive (2016/2284/EU) (see Table 1).

Table 1: Emission ceilings according to NEC Directive 2001/81/EC and revised NEC Directive 2016/2284/EU.

Year	from 2010 onwards*	from 2020 to 2029**	from 2030 onwards**
Obligation under:	NEC Directive (2001/81/EC)	revised NEC Directive (2016/2284/EU)	revised NEC Directive (2016/2284/EU)
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 emissions ceiling in kt per year*

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

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 2019 (UMWELTBUNDESAMT 2019a).

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 energy scenarios 2019 (AEA 2018, HAUSBERGER & SCHWINGSHACKL 2018, TU WIEN & ZEU 2018, WIFO 2018).

The air pollutant projections are fully consistent with the historical emission data from the Austrian Emission Inventory (submission March 2019) up to the latest available data year 2017.

Emission factors and underlying parameters are described in the methodological sub-chapters 4 of this report.

1.3 Underlying Models

Model calculations are based on custom-made methodologies for the individual sectors. Emissions from fuel combustion and industrial processes are based on the National Energy Balance of Statistics Austria (2018) and on an econometric input-output model (DYNK) of the Austrian Institute of Economic Research (WIFO 2018), supported by calculations carried out using the bottom-up models TIMES (Austrian Energy Agency, AEA 2018), INVERT/EE-Lab (Energy Economics Group of the Technical University of Vienna and the Zentrum für Energiewirtschaft und Umwelt (e-think), TU WIEN & ZEU 2018) and NEMO & GEORG (Graz University of Technology, TU GRAZ 2018).

The agricultural scenario is based on the PASMA model of the Austrian Institute of Economic Research (WIFO & BOKU 2018). Projections for solvents und waste were modelled by Umweltbundesamt.

A detailed description of the models is provided in a report entitled "GHG Projections and Assessment of Policies and Measures in Austria", submitted under the Monitoring Mechanism Regulation (MMR) in 2019 (UMWELTBUNDESAMT 2019c).

The following table presents the main data sources used for the activity data in this report, as well as information on the institution carrying out the actual calculations.

Table 2: Main data sources for activity data and emission values.

Sector	Data Sources for Activity Data	Emission Calculation
Energy	National Energy Balance of Statistics Austria, macro-economic model DYNK of the Austrian Institute of Economic Research (WIFO), bottom-up models TIMES (AEA), INVERT/EE-Lab (Vienna University of Technology, Zentrum für Energiewirtschaft und Umwelt (e-think)) as well as NEMO & GEORG (Graz University of Technology)	Umweltbundesamt (energy providers, manufacturing industries, residential and commercial sector, parts of the transport sector) Graz University of Technology (transport sector)
Industry	Austrian Institute of Economic Research (macroeconomic model DYNK) Solvents: as above, expert judgements,VOC Directive	Umweltbundesamt
Agriculture	Austrian Institute of Economic Research (agriculture model PASMA) (Wifo & Boku 2018).	Umweltbundesamt
Waste	Landfill database, 'EDM' (national database on waste amounts, deposited and treated) Federal Waste Management Plan Expert judgement by Umweltbundesamt on waste amounts expected to be pre-treated in mechanical-biological treatment plants population scenarios (Statistik Austria 2018c)	Umweltbundesamt

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 3. Methodological assumptions are included in Chapter 4. Further assumptions about key input parameters can be found in UMWELTBUNDESAMT (2019c).

Table 3: Key input parameters for emission projections (UMWELTBUNDESAMT 2019c).

Year	2015	2020	2025	2030
GDP [billion € 2016]	351	386	414	444
GDP real growth rate [%]	1.1%	~ 1.5%	~ 1.5%	~ 1.5%
Population [1 000]	8 630	8 942	9 158	9 331
Stock of dwellings [1 000]	3 831	3 992	4 126	4 230
Heating degree days	3 238	3 204	3 171	3 118
Exchange rate [US$/€]	1.2	1.2	1.2	1.2
International coal price [€ 2016/GJ]	2.0	2.6	3.2	3.8
International oil price [€ 2016/GJ]	8.0	13.9	15.7	17.3
International natural gas price [€ 2016/GJ]	7.0	8.9	9.6	10.5
CO_2 certificate price [€ 2016/t CO_2]	7.8	15.5	23.3	34.7

2 MAIN RESULTS

The following table shows Austria´s national total emissions according to Austria's inventory and projections based on 'fuel sold' as well as on 'fuel used'. Emissions have to be reported based on 'fuel sold' under the UNECE LRTAP Convention as well as under the NEC Directive 2016/2284/EU. With respect to compliance with the emission ceilings for 2010 under the NEC Directive, Austria reports emissions and projections based on 'fuel used'. When referring to emissions based on 'fuel used', 'fuel exports in the vehicle tank' are not considered. The revised NEC Directive sets ceilings 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 except NH_3. The most substantial reduction (about 64% for 'fuel sold' and 55% for 'fuel used') from 2005 until 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 the other pollutants are in the range of 27% to 48%; NH_3 emissions, however, are projected to increase by 14-15% (see Table 4).

Table 4: Austrian national total emissions in kt and trend in comparison with the base year 2005 in % based on (a) ***fuel sold*** *and (b)* ***fuel used*** *(Source: Umweltbundesamt).*

Pollutant [kt]	Emission inventory 2018				Emission scenario			Type of scenario
	1990	2005	2010	2017	2020	2025	2030	
NO_x	219.33	237.87	183.14	144.71	126.62	99.29	84.49	fuel sold
		0%	*-23%*	*-39%*	*-47%*	*-58%*	*-64%*	
	204.33	178.66	152.51	131.48	116.74	93.31	80.21	fuel used
		0%	*-15%*	*-26%*	*-35%*	*-48%*	*-55%*	
SO_2	73.76	25.47	15.86	12.81	13.58	13.41	13.31	fuel sold
		0%	*-38%*	*-50%*	*-47%*	*-47%*	*-48%*	
	72.98	25.42	15.83	12.78	13.55	13.36	13.27	fuel used
		0%	*-38%*	*-50%*	*-47%*	*-47%*	*-48%*	
NMVOC	324.40	156.10	137.17	120.19	120.37	116.00	111.85	fuel sold
		0%	*-12%*	*-23%*	*-23%*	*-26%*	*-28%*	
	322.24	152.16	135.55	119.30	119.57	115.27	111.16	fuel used
		0%	*-11%*	*-22%*	*-21%*	*-24%*	*-27%*	
NH_3	65.19	62.70	65.70	69.09	69.47	70.51	71.57	fuel sold
		0%	*5%*	*10%*	*11%*	*12%*	*14%*	
	65.15	62.17	65.40	68.85	69.22	70.24	71.28	fuel used
		0%	*5%*	*11%*	*11%*	*13%*	*15%*	
$PM_{2.5}$	26.37	22.21	19.19	15.61	14.94	13.42	12.16	fuel sold
		0%	*-14%*	*-30%*	*-33%*	*-40%*	*-45%*	
	25.87	20.62	18.49	15.38	14.79	13.33	12.09	fuel used
		0%	*-10%*	*-25%*	*-28%*	*-35%*	*-41%*	

2.1 Nitrogen Oxides NO_x

In 1990, national total NO_x emissions amounted to 219.3 kt (including fuel exports in the vehicle tank, i.e. based on 'fuel sold'). After an all-time high between 2003 and 2005, emissions have since been following a continuously decreasing trend. In 2017, NO_x emissions amounted to 144.7 kt and were about 34.0% lower than in 1990.

Compared to 2005 levels, emissions in 2017 were about 39.2% lower. When considering inland fuel consumption without 'fuel exports in the vehicle tank', NO_x emissions amounted to only 131.5 kt in 2017, corresponding to a 26.4% decrease since 2005. The gradual replacement of vehicles with new vehicles with lower fuel consumption and lower NO_x emissions (and well-functioning after-treatment devices) contributed to the decreasing trend in the last few years.

The main source of NO_x emissions in Austria (with a share of 92.1% in 2017) is Sector *1.A Fuel Combustion Activities.* Within this sector, 1.A.3.b *Road transport* ('fuel sold') accounts for the highest share (48.9%) of the total NO_x emissions. Further major sources are 1.A.2 *Industry* (19.3%), 1.A.4 Other Sectors (13.8%) and 1.A.1 *Energy Industry (7.7%).* Sector *3 Agriculture* contributes 7.5%.

In the scenario "with existing measures" (WEM) the national total emissions (including 'fuel export') are expected to decrease to 84.5 kt by 2030 (–64.4% compared to 2005). Without 'fuel export' they are expected to decrease to 80.2 kt (–55.1% compared to 2005).

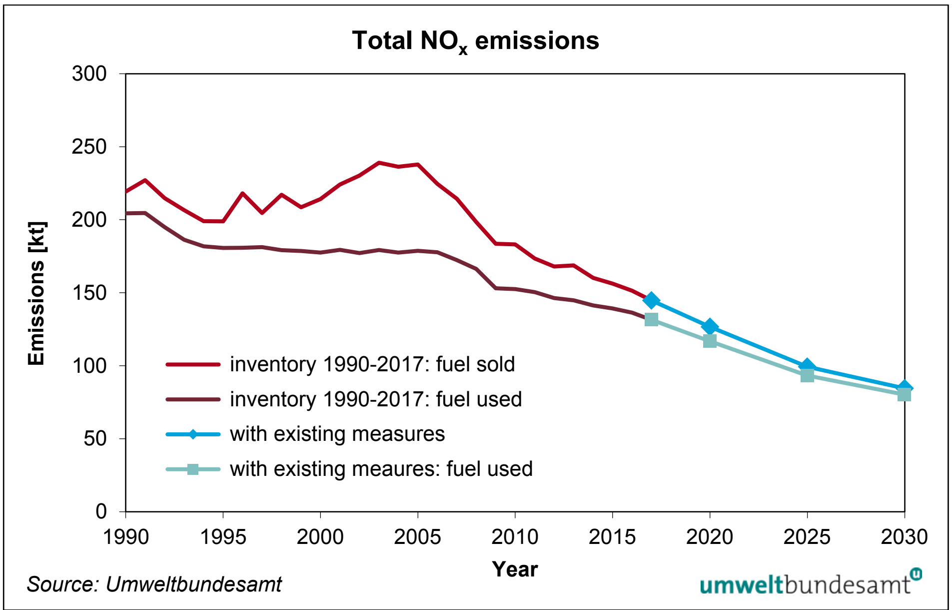

Figure 1: Historical (1990 to 2017) and projected emissions (2020–2030) of NO_x based on (a) ***fuel sold*** *and (b)* ***fuel used****.*

The main drivers for the NO_x emissions trend until 2030 are expected to be road transport, households and the energy industry. The decrease of the emissions from the Manufacturing Industries is less pronounced.

NO_x emissions from *Road Transport* (especially cars and heavy-duty vehicles) are projected to decrease by 69.9% (i.e. 49.5 kt) from 2017 to 2030. This decline is based on the following assumptions:

- modernisation of the vehicle fleet in combination with decreasing specific emission factors and introduction of the latest emission classes Euro VI (HDV), Euro 6d_temp and EURO 6d (PC)
- an increased share of e-mobility by 2030 as a substitute for conventionally fuelled cars

Emissions from 1.A.4. *Other Sectors* (households, commercial and agriculture) are projected to decrease by 30.1% (i.e. 6.0 kt) from 2017 to 2030. This is mainly due to a modernisation of (and decline in emissions from) non-road mobile machinery (NRMM, or so-called off-road vehicles) and a switch to low-emission technology. It is not assumed that there will be a switch from fossil to electric propulsion in these categories. Mobile sources in households and agriculture (off-road) show a decrease by 49.3% (–0.21 kt) by 2030. Stationary sources decrease by 28.7% (–3.21 kt) by 2030 because of a decrease in the use of fuel oil, ongoing stock replacement with condensing boilers and the effects of 'eco-design' provisions for the installation of new heating systems.

Reduced fuel inputs of coal and oil to thermal power stations are responsible for lower emissions in 1.A.1 *Energy Industry* (–29.1%, i.e. –3.25 kt) by 2030.

Emissions from 1.A.2 Manufacturing Industries and Construction decreased by 18.0% between 2005 and 2017 due to the installation of primary and secondary NO_x abatement measures. More of these measures will be implemented until 2030, but the effect is expected to be offset by an increase of emissions due to economic growth.

Table 5: Austrian national NO_x emissions in kt and trend based on (a) 'fuel sold' and (b) 'fuel used' (Source: Umweltbundesamt).

NFR	Description	Emission inventory 2017* [kt]				Emission scenario [kt]			Type of scenario
		1990	2005	2010	2017	2020	2025	2030	
	Total	**219.33**	**237.87**	**183.14**	**144.71**	**126.62**	**99.29**	**84.49**	**fuel sold**
		204.33	**178.66**	**152.51**	**131.48**	**116.74**	**93.31**	**80.21**	**fuel used**
1 A 1	**Energy Industries**	17.78	14.43	13.07	11.15	9.60	8.50	7.90	
1 A 2	**Manufacturing Industries and Construction**	33.03	34.04	32.29	27.91	27.78	26.66	26.38	
1 A 3 a, c, d, e	**Off-Road Transport**	3.42	4.90	4.11	3.47	3.53	3.38	3.28	
1 A 3 b	**Road Transportation**	119.34	147.47	100.34	70.76	55.08	32.74	21.28	fuel sold
		104.34	88.27	69.71	57.53	45.20	26.76	17.00	fuel used
1 A 4	**Other Sectors**	29.32	26.11	22.95	19.97	18.82	16.27	13.96	
1 A 5	**Other**	0.07	0.09	0.08	0.08	0.08	0.07	0.08	
1 B	**Fugitive Emissions**	IE	IE	IE	IE	IE	IE	IE	
2A,B,C, H,I,J,K,L	**Industrial Processes**	4.24	0.67	0.52	0.45	0.47	0.48	0.49	
2D, 2G	**Solvent and Other Product Use**	0.03	0.02	0.03	0.02	0.02	0.02	0.02	
3 B	**Manure Management**	0.63	0.60	0.59	0.57	0.55	0.53	0.52	
3 D	**Agricultural Soils**	11.33	9.44	9.12	10.30	10.66	10.61	10.56	
3 F, I	**Field Burning and other agriculture**	0.03	0.02	0.02	0.01	0.01	0.01	0.01	
5	**Waste**	0.10	0.05	0.02	0.02	0.02	0.02	0.02	

** Data source: Austrian Emission Inventory 2019 (UMWELTBUNDESAMT 2019b)*

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

2.2 Sulphur Dioxide SO_2

In 1990, national total SO_2 emissions amounted to 73.8 kt. Since then, emissions have decreased quite steadily. By the year 2017, emissions had decreased by 82.6% compared to 1990 (amounting to 12.8 kt), mainly due to lower emissions from residential heating, combustion in industry and energy industries. A sharp decrease observed in 2008 was due to a further reduction of the sulphur content to 10ppm in domestic heating oil. In 2017, emissions were about 49.7% lower than 2005.

The main source of SO_2 emissions in Austria is NFR Sector *1.A Fuel Combustion Activities* with 95.2% in 2017. Within this sector, the main contributors to the total SO_2 emissions are *1.A.2 Manufacturing Industries* with 72.2% (about half of the emissions arise from iron and steel industry), *1.A.1 Energy Industries* with 10.0% and *1.A.4 Other Sectors* (residential heating) with 10.5% of the total emissions.

In the scenario "with existing measures" (WEM) the national total emissions including 'fuel export' are expected to decrease to 12.2 kt by 2030 (–48% compared to 2005). Without 'fuel export' they are expected to decrease to 13.1 kt (–48% compared to 2005).

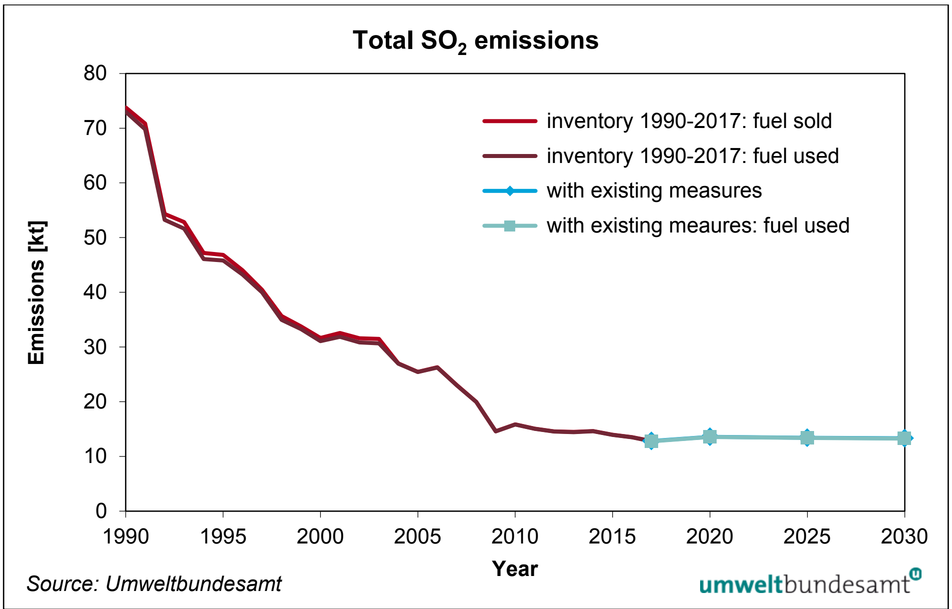

Figure 2: Historical (1990 to 2017) and projected emissions (2020–2030) of SO_2 based on (a) ***fuel sold*** *and (b)* ***fuel used****.*

Total SO_2 emissions are expected to increase slightly over the period from 2017 to 2030. A large part of appropriate mitigation measures (e.g. reduction of sulphur content in liquid fuels, waste gas treatment) have already been implemented. Therefore, the remaining reduction potential remains small.

Minor effects can be expected at the sectoral level from 2017 to 2030: emissions from *Energy Industries* (1.A.1) are expected to decrease due to less fuel input (–29.2%, i.e. 0.38 kt) and those from *Other Sectors* (1.A.4) are expected to decrease (–28.5%, i.e. 0.38 kt) by 2030 due to a shift from fossil fuels (oil, coal) to renewables. Emissions from *Manufacturing Industries and Construction* (1.A.2) are expected to increase (+13.8%, i.e.1.27 kt).

Table 6: Austrian national SO_2 emissions in kt and trend based on (a) fuel sold and (b) fuel used (Source: Umweltbundesamt).

NFR	Description	Emission inventory 2017* [kt]				Emission scenario [kt]			Type of scenario
		1990	2005	2010	2017	2020	2025	2030	
	Total	**73.76**	**25.47**	**15.86**	**12.81**	**13.58**	**13.41**	**13.31**	**fuel sold**
		72.98	**25.42**	**15.83**	**12.78**	**13.55**	**13.36**	**13.27**	**fuel used**
1 A 1	**Energy Industries**	14.06	6.70	2.76	1.29	1.25	1.05	0.91	
1 A 2	**Manufacturing Industries and Construction**	17.90	10.30	9.73	9.25	10.12	10.32	10.52	
1 A 3 a, c, d, e	**Off-Road transport**	0.34	0.18	0.18	0.16	0.16	0.16	0.17	
1 A 3 b	**Road Transportation**	4.78	0.16	0.12	0.14	0.14	0.14	0.14	fuel sold
		4.00	0.10	0.09	0.10	0.10	0.10	0.10	fuel used
1 A 4	**Other Sectors**	32.66	7.28	2.29	1.35	1.29	1.11	0.97	
1 A 5	**Other**	0.01	0.01	0.01	0.02	0.01	0.01	0.02	
1 B	**Fugitive Emissions**	2.00	0.04	0.05	0.04	0.03	0.02	0.01	
2A,B,C, H,I,J,K,L	**Industrial Processes**	1.93	0.72	0.70	0.56	0.56	0.56	0.56	
2D, 2G	**Solvent and Other Product Use**	0.00	0.01	0.01	0.00	0.00	0.00	0.00	
3 B	**Manure Management**	NA	NA	NA	NA	NA	NA	NA	
3 D	**Agricultural Soils**	NA	NA	NA	NA	NA	NA	NA	
3 F, I	**Field Burning and Other Agriculture**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5	**Waste**	0.07	0.06	0.01	0.01	0.01	0.01	0.01	

** Data source: Austrian Emission Inventory 2019 (UMWELTBUNDESAMT 2019b)*

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

2.3 Non-Methane Volatile Organic Compounds (NMVOCs)

In 1990, Austria's total NMVOC emissions amounted to 324.4 kt. Emissions have decreased steadily since then and by the year 2017 emissions had decreased by 63.0% to 120.2 kt (compared to 1990). In 2017, emissions were about 23.0% lower than in 2005.

The main reasons for the emission reductions is the implementation of EU Directives relating to the use of solvents (e.g. "The Paints Directive"), the modernisation of boilers in households and the usage of catalytic converters in petrol fuelled cars together with a shift to diesel fuelled cars.

The main sources of NMVOC emissions in Austria are NFR *2.D.3 Solvent Use* with a share of 30.5% in 2017, 1.A.4 *Other Sectors* (24.7%) and 3.B *Manure Management* (22.6%).

In the scenario 'with existing measures' (WEM) the national total emissions including 'fuel export' are expected to decrease to 111.9 kt by 2030 (–28.3% compared to 2005). Without 'fuel export' they are expected to decrease to 111.2 kt (–26.9% compared to 2005).

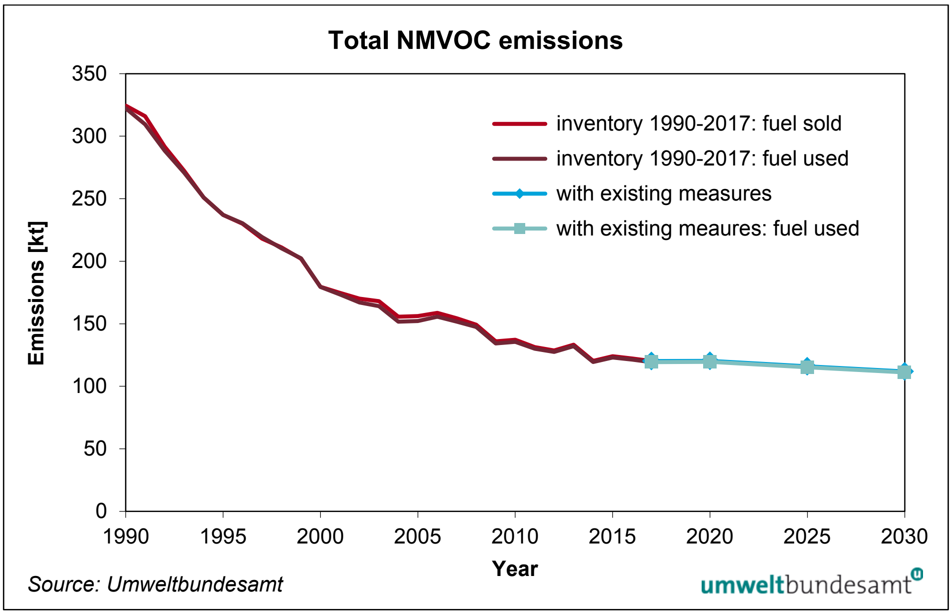

Figure 3: Historical (1990 to 2017) and projected emissions (2020–2030) of NMVOC based on (a) ***fuel sold*** *and (b)* ***fuel used****.*

Total NMVOC emissions are projected to decrease by 6.9% until 2030 (compared to 2017). The largest reduction is expected to be achieved in Sector 1.A.4 (mainly households and commercial), with a decrease of 27.7% (i.e. 8.2 kt) from 2017 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 buildings sector (see also 'ecodesign' requirements in Chapter 3), as well as a decrease in the use of fuelwood as a source of energy.

Emissions in the sector *Road Transport* are projected to fall by 35.8% (i.e. 3.01 kt) by 2030, especially owing to state-of-art exhaust gas treatment (regulated catalytic converter) and an increased share of diesel and electric vehicles.

On the other hand, emissions from *2.D.3 'Solvent Use'* are expected to increase by 6.1% by 2030 (i.e.2.2 kt) due to an increase in the consumption of solvents. Emission regulations for the relevant sectors have been enacted at EU level (while some of the legal requirements in Austria are even stricter). The requirements for paints and varnishes have been harmonised at EU level; existing regulations do not provide a further tightening of emission standards. The model for calculating emissions has been revised: calculations are now based on solvent balances from companies, and linked to economic projections for each NACE code.

Emissions in Agriculture are projected to increase by 2.9% (i.e. 1.01 kt) by 2030, mainly caused by the developments of livestock in Austria.

Table 7: Austrian national NMVOC emissions in kt and trend based on (a) fuel sold and (b) fuel used (Source: Umweltbundesamt).

NFR	Description	Emission inventory 2017* [kt]				Emission scenario [kt]			Type of scenario
		1990	2005	2010	2015	2020	2025	2030	
	Total	**324.40**	**156.10**	**137.17**	**120.19**	**120.37**	**116.00**	**111.85**	**fuel sold**
		322.24	**152.16**	**135.55**	**119.30**	**119.57**	**115.27**	**111.16**	**fuel used**
1 A 1	**Energy Industries**	0.33	0.26	0.39	0.39	0.39	0.39	0.39	
1 A 2	**Manufacturing Industries and Construction**	1.68	1.77	1.44	1.13	1.07	1.02	1.00	
1 A 3 a, c, d, e	**Off-Road transport**	1.19	1.28	1.08	0.56	0.73	0.67	0.64	
1 A 3 b	**Road Transportation**	87.29	20.73	12.28	8.40	7.23	6.18	5.39	fuel sold
		85.12	16.78	10.65	7.50	6.43	5.45	4.70	fuel used
1 A 4	**Other Sectors**	46.86	30.71	30.97	29.63	29.87	25.66	21.43	
1 A 5	**Other**	0.01	0.02	0.02	0.02	0.02	0.02	0.02	
1 B	**Fugitive Emissions**	15.49	3.34	2.45	2.29	2.20	2.00	1.82	
2A,B,C, H,I,J,K,L	**Industrial Processes**	4.01	3.03	3.21	3.43	3.41	3.46	3.49	
2D, 2G	**Solvent and Other Product Use**	114.52	54.87	46.24	36.77	37.38	38.25	39.00	
3 B	**Manure Management**	35.57	28.25	27.86	27.12	27.60	27.89	28.19	
3 D	**Agricultural Soils**	17.18	11.66	11.08	10.35	10.36	10.37	10.39	
3 F, I	**Field Burning and Other Agriculture**	0.12	0.09	0.07	0.06	0.06	0.05	0.05	
5	**Waste**	0.16	0.11	0.09	0.06	0.05	0.05	0.04	

** Data source: Austrian Emission Inventory 2019 (UMWELTBUNDESAMT 2019b)*

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

2.4 Ammonia (NH_3)

In 1990, national total NH_3 emissions amounted to 65.1 kt; emissions slightly increased over the period from 1990 to 2017. In 2017, emissions were 6.0% above 1990 levels, amounting to 69.1 kt.

The main source of ammonia is the agricultural sector, contributing 93.4% of the total NH_3 emissions in 2017. Agricultural NH_3 emissions mainly result from animal husbandry and the application of organic and mineral N fertilisers.

The sub-sector 3.B *Manure Management* has a share of 44.5% in Austria's total NH_3 emissions in 2017. The emissions result from animal husbandry and the storage of manure. Within manure management cattle has the highest share with 59.8%. Emissions are related to livestock numbers but also to housing systems and manure treatment (e.g., NH_3 emissions from loose housing systems are considerably higher than those from tied housing systems). Since 1990, emissions from agriculture have increased by 3.8%, mainly due to higher emissions from cattle resulting from a continued increase of loose housing systems after 2005 for reasons of animal welfare.

The sub-sector 3.D *Agricultural Soils* (with a share of 49.0%) ha the largest share in the national total NH_3 emissions in 2017. These emissions result from the application of mineral N fertilisers as well as organic fertilisers (including animal manure, sewage sludge, digestate 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) the national total emissions including 'fuel export' are expected to increase to 71.6 kt by 2030 (+14.1% compared to 2005). Without 'fuel export' they are expected to increase to 71.3 kt (+14.6% compared to 2005).

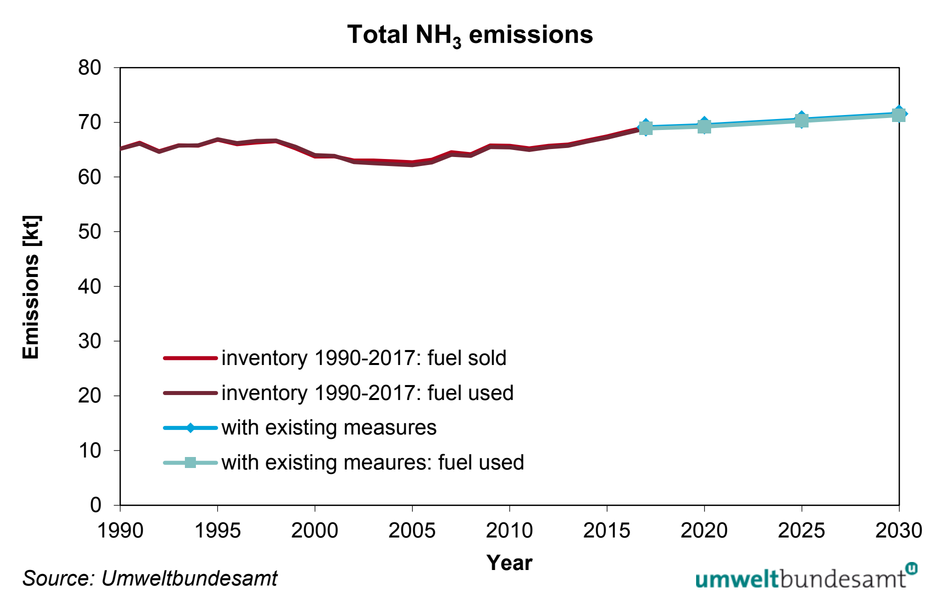

Figure 4: Historical (1990 to 2017) and projected emissions (2020–2030) of NH_3 based on (a) ***fuel sold*** *and (b)* ***fuel used****.*

For the period between now and 2030, the NH_3 emission trend (+3.6%) is expected to closely follow the development of livestock in Austria (+3.7% cattle compared to 2017). Based on national forecasts for agricultural production in Austria (WIFO & BOKU 2018), animal numbers of dairy cattle are expected to increase. The rise in the number of cattle in loose housing systems (to comply with animal welfare regulations) offsets the reduction effects of implemented abatement measures, resulting in an increase in emissions of 2.2% (i.e. 0.67 kt) in the sub-sector 3.B *Manure Management.* Furthermore, emissions in sub-sector 3.D *Agricultural Soils* are projected to increase by 4.9% (i.e. 1.7 kt) by 2030, due to an increase in the quantity of animal manure applied as organic fertiliser, as well as mineral fertiliser (urea).

Table 8: Austrian national NH_3 emissions in kt and trend based on (a) fuel sold and (b) fuel used (Source: Umweltbundesamt).

NFR	Description	Emission inventory 2017* [kt]				Emission scenario [kt]			Type of scenario
		1990	2005	2010	2017	2020	2025	2030	
	Total	**65.19**	**62.70**	**65.70**	**69.09**	**69.47**	**70.51**	**71.57**	fuel sold
		65.15	**62.17**	**65.40**	**68.85**	**69.22**	**70.24**	**71.28**	fuel used
1 A 1	**Energy Industries**	0.19	0.32	0.48	0.44	0.44	0.44	0.44	
1 A 2	**Manufacturing Industries and Construction**	0.33	0.43	0.41	0.39	0.39	0.39	0.39	
1 A 3 a, c, d, e	**Off-Road Transport**	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
1 A 3 b	**Road Transportation**	1.10	2.48	1.69	1.28	1.29	1.37	1.43	fuel sold
		1.06	1.96	1.39	1.03	1.04	1.10	1.15	fuel used
1 A 4	**Other Sectors**	0.63	0.63	0.60	0.57	0.58	0.55	0.52	
1 A 5	**Other**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
1 B	**Fugitive Emissions**	IE	IE	IE	IE	IE	IE	IE	
2A,B,C, H,I,J,K,L	**Industrial Processes**	0.27	0.07	0.09	0.11	0.11	0.11	0.11	
2D, 2G	**Solvent and Other Product Use**	0.07	0.06	0.06	0.05	0.05	0.05	0.05	
3 B	**Manure Management**	27.66	27.73	29.32	30.74	30.59	30.99	31.41	
3 D	**Agricultural Soils**	34.52	29.49	31.44	33.87	34.36	34.94	35.54	
3 F, I	**Field Burning and Other Agriculture**	0.04	0.03	0.03	0.01	0.01	0.01	0.01	
5	**Waste**	0.37	1.45	1.58	1.62	1.63	1.64	1.65	

* *Data source: Austrian Emission Inventory 2019 (UMWELTBUNDESAMT 2019b)*

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

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

National total $PM_{2.5}$ emissions amounted to 26.4 kt in 1990 and have decreased steadily ever since: from 1990 to 2017, emissions (with 'fuel exports') decreased by 40.8% to 15.6 kt. Emissions from fuel used amounted to 25.9 kt in 1990 and decreased to 15.4 kt in 2017 (–40.5%).

In 2017, $PM_{2.5}$ emissions in Austria mainly arose from combustion activities in the energy sector, which accounted for 84.4% of the national total emissions. Within this sector, *1.A.4 Other Sectors* (52.1%), *1.A.3 Transport* (19.1%), *1.A.2 Industry* (7.1%) are the main contributors to $PM_{2.5}$ emissions. Sector *2 IPPU* is responsible for 11.2%.

In Sector 1.A.4 (mainly households and commercial), substantial emission reductions have been achieved as a result of the replacement of old installations with new low emission heating systems, a decrease in the use of fuelwood as a source of energy, the installation of energy-saving combustion plants, by connecting buildings to district heating networks or to other public energy and heating networks.

The reduction in *1.A.3 Transport* since 2005 has been due to improvements in drive and exhaust gas after-treatment technologies and tax incentives (fuel consumption-based car registration tax: lower tax rates for diesel passenger cars equipped with particulate filter systems).

In the scenario "with existing measures" (WEM) the national total emissions including 'fuel export' are expected to decrease to 12.2 kt by 2030 (–45.2% compared to 2005). Without 'fuel export' they are expected to decrease to 12.1 kt (–41.4% compared to 2005).

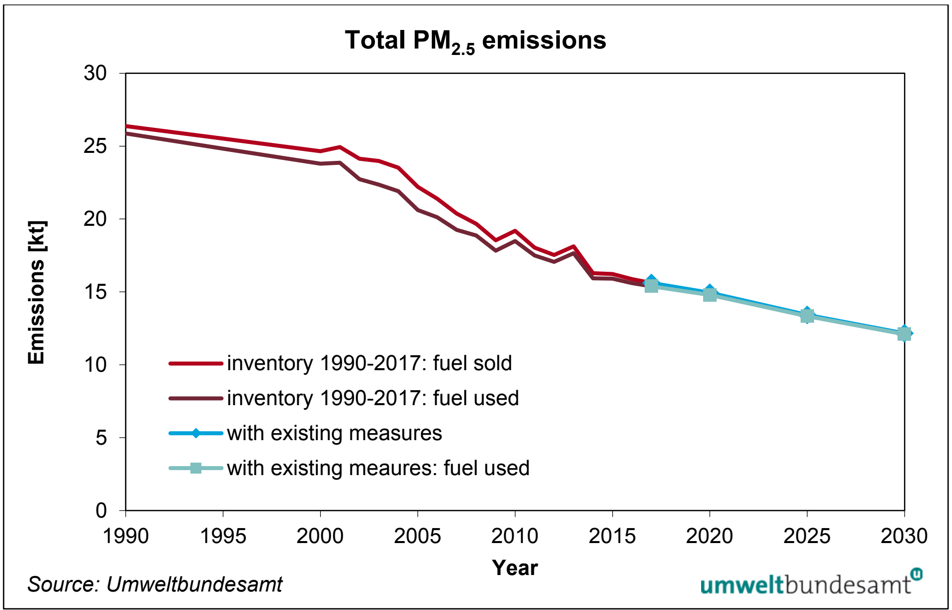

Figure 5: Historical (1990 to 2017) and projected emissions (2020–2030) of $PM_{2.5}$ based on (a) ***fuel sold*** *and (b)* ***fuel used****.*

In the WEM scenario, $PM_{2.5}$ emissions of *1A4 Other Sectors* are expected to decrease by 31.4% (i.e. 2.6 kt) by 2030 compared to 2017. $PM_{2.5}$ emission reductions are mainly due to an increased efficiency of buildings and heating systems and a trend away from manually fed fuel wood boilers and ovens. A decreasing energy demand for solid fuel (fuel wood, coal) is also responsible for $PM_{2.5}$ reductions. Furthermore, projected emission factors for new boilers in buildings are lower for future installations (see also 'ecodesign' requirements in Chapter 3).

Total $PM_{2.5}$ emissions of the sector *Road Transport* (including 'fuel export') are expected to decrease by about 30.9% (i.e. 0.80 kt) compared to 2017. Without 'fuel export' they are expected to decrease by about 27.3% (i.e. 0.65 kt) compared to 2017. Whereas exhaust emission from cars and trucks are expected to decrease by 2030 (due to penetration of vehicles fitted with filters), emissions from automobile road abrasion are set to increase slightly because of an increase in the total vehicle kilometres driven.

In the sector *Energy Industries* a slight decrease in $PM_{2.5}$ emissions is generally due to a decrease in biomass usage for electricity and heat generation.

Emissions from 1 A 2 *Manufacturing Industries and Construction* decreased by 45.0 % between 2005 and 2017 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.

Mobile sources in industry (off-road) show a decrease by 80.7% (i.e. 0.13 kt) by 2030, mainly due to penetration of industrial off-road machinery fitted with particulate filters.

Table 9: Austrian national $PM_{2.5}$ emissions in kt and trend based on (a) fuel sold and (b) fuel used (Source: Umweltbundesamt).

NFR	Description	Emission inventory 2017* [kt]				Emission scenario [kt]			Type of scenario
		1990	**2005**	**2010**	**2017**	**2020**	**2025**	**2030**	
	Total	**26.37**	**22.21**	**19.19**	**15.61**	**14.94**	**13.42**	**12.2**	fuel sold
		25.87	**20.62**	**18.49**	**15.38**	**14.79**	**13.33**	**12.1**	fuel used
1 A 1	**Energy Industries**	0.83	0.79	1.17	0.94	0.96	0.92	0.88	
1 A 2	**Manufacturing Industries and Construction**	1.97	2.02	1.71	1.11	1.15	1.15	1.18	
1 A 3 a, c, d, e	**Off-Road Transport**	0.76	0.72	0.52	0.38	0.40	0.39	0.37	
1 A 3 b	**Road Transportation**	5.22	6.85	4.45	2.60	2.17	1.87	1.79	fuel sold
		4.72	5.26	3.74	2.37	2.02	1.78	1.72	fuel used
1 A 4	**Other Sectors**	13.02	8.85	8.78	8.13	7.93	6.74	5.57	
1 A 5	**Other**	0.02	0.02	0.02	0.02	0.02	0.02	0.02	
1 B	**Fugitive Emissions**	0.11	0.09	0.07	0.06	0.06	0.05	0.05	
2A,B,C, H,I,J,K,L	**Industrial Processes**	3.29	1.83	1.37	1.36	1.25	1.26	1.26	
2D, 2G	**Solvent and Other Product Use**	0.52	0.46	0.47	0.40	0.40	0.41	0.42	
3 B	**Manure Management**	0.13	0.11	0.11	0.11	0.11	0.11	0.11	
3 D	**Agricultural Soils**	0.14	0.15	0.14	0.14	0.13	0.13	0.13	
3 F, I	**Field Burning and Other Agriculture**	0.14	0.12	0.10	0.06	0.06	0.06	0.06	
5	**Waste**	0.23	0.21	0.29	0.31	0.32	0.32	0.32	

** Data source: Austrian Emission Inventory 2019 (UMWELTBUNDESAMT 2019b)*

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 overlaps and possible gaps were discussed.

Compared to the last submission in 2017, reporting on policies and measures has improved, although the number of reported policies and measures has decreased, as only measures for the 'with existing measures' (WEM) scenario are reported. This is due to the fact that the climate and energy strategy, which will also form the basis for a 'with additional measures' (WAM) scenario for air pollutants, is still under development.

The Austrian projections of air quality pollutants are fully consistent with current GHG emissions projections under the EU Monitoring Mechanism Regulation (UMWELTBUNDESAMT 2019c).

3.1 GHG PAMs

A detailed description of the individual measures included in the WEM scenario for GHGs is provided in a report entitled "GHG Projections and Assessment of Policies and Measures in Austria", submitted under the Monitoring Mechanism Regulation (MMR) in 2019 (UMWELTBUNDESAMT 2019c).

For the GHG scenarios 15 measures have been identified. These measures are considered in the WEM scenario. They are either of a cross-cutting nature or target specific sectors and represent the basis for Austria's air pollutant projections.

Cross-cutting measures

- EU Emission Trading Scheme (WEM): The system covers CO_2 emissions from large emitters in the industrial sectors, from energy and heat supply and aircraft operators, as well as N_2O emissions from the chemical industry. The EU ETS also has positive side-effects on SO_2 and NO_x by in that it encourages operators to upgrade their facilities 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 as well as greenhouse gas and noise emissions and waste generation.
- Austrian Climate and Energy Fund (WEM): Although the main objective of this fund is to provide subsidies for research in – and for the implementation of – climate friendly technology, it is also expected to deliver positive side effects on air pollution.

Energy Industries (1.A.1) and Manufacturing Industries and Construction (1.A.2)

- Increase the share of renewable energy in power supply and district heating (WEM): Here the effects of the Green Electricity Act 2012 and the Feed-In Tariff Ordinance are considered, which foresee expansion targets for hydropower, wind power, photovoltaics and biomass/biogas by 2020. Existing legal provisions under which support of green electricity is granted are effective only until 2020. Although it is very likely that there will be some form of support thereafter (currently a more market-based amendment to the Green Electricity Act is under discussion), this has not been taken into account in the WEM scenario.
- Increase energy efficiency in the energy and manufacturing industries (WEM): This includes the implementation of the Energy Efficiency Act in response to the Energy Efficiency Directive 2012/27/EU, the National Energy Efficiency Action Plan 2017 and the promotion of combined heat and power.

Transport (1.A.3)

- Increase the share of clean energy sources for road transport (WEM): Here, the implementation of the Renewables Directives (2009/28/EC and 2018/2001/EC) on the promotion of the use of energy from renewable sources and the Action Plan for electric mobility as well as the e-mobility offensive laid down in the national climate and energy strategy (#mission2030).
- Increase fuel efficiency in road transport (WEM), implemented by the following instruments: fuel tax increase in 2011, greening the truck toll, mobility management and awareness raising – 'klimaaktiv mobil' fuel saving initiative and introduction of speed limits to tackle air quality problems.
- Modal shift to environmentally friendly transport modes (WEM): The objective of this measure is to achieve a shift in the modal split towards environmentally friendly transport modes through the following instruments: mobility management and awareness – 'klimaaktiv mobil' initiative and the promotion of corporate feeder lines for freight transport.

Other Sectors (1.A.4)

- Increased energy efficiency in buildings (WEM) by improving building standards according to OIB (Austrian Institute of Construction Engineering) Guideline No 6 on energy saving and thermal insulation, through national and funding programmes (e.g. Housing Support Scheme) and building renovation initiatives for private, commercial and industrial buildings, and through implementation of the recast Energy Performance of Buildings Directive (including the Energy Certification Providing Act).
- An increased share of renewable energy for space heating (WEM): by stepping up the replacement of heating systems; through implementation of the District Heating and Cooling Act and by providing subsidies for wood heating systems and solar heating systems.
- Increased energy efficiency in residential electricity demand (WEM): This measure includes ecodesign requirements (Directive 2006/32/EC) for energy using products, the effects of the implementation of the Energy Efficiency Directive (2012/27/EU), and energy labelling for household appliances.

Industrial Processes and Product Use (2)

- Decrease emissions from solvent and other product use (WEM), to be achieved through the implementation of the Solvents Ordinance, to reduce VOC emissions from paints and varnishes, and through the limitation of VOC emissions from the use of organic solvents in industrial installations. The implementation of EU legislation targeting the reduction of F-gas emissions also falls within the scope of this sector, but not relevant for air pollution.

In the scenario the Deco-Paint-Directive (Directive 2004/42/EC) has been fully implemented, as well as Commission Directive 2010/79/EU on the adaptation to technical progress of Annex III to Directive 2004/42/EC on the limitation of emissions of volatile organic compounds.

Agriculture (3)

- The implementation of EU agricultural policies in Austria puts *inter alia* a focus on environmentally sound farming practices in Austria's mostly small agricultural holdings. The instruments listed below have been taken into account in the current WEM scenario:
- Programme for rural development 2014–2020 ('Österr. Programm für die Entwicklung des Ländlichen Raums 2014–2020')
  - The Austrian Agri-Environmental Programme allocates funding for specific actions for the period 2014–2020.
  - The implementation of this policy includes e.g. improved feeding, covering of manure storage, low-loss application of manure and biogas slurry, promotion of organic farming, promotion of grazing, reduced usage of mineral fertilisers.
- Common Agricultural Policy (CAP) ('Gemeinsame Europäische Agrarpolitik'):
  - Implementation of the CAP 2013 reform (in particular the abolition of sugar quota and suckling cow premiums)
  - Internal convergence of direct payments ('regional premium' scheme instead of historical payments)
  - Land is maintained in good agricultural and ecological condition ('cross compliance' and requirements are to be met for 'greening' (in particular the crop rotation requirement);
  - Programme for rural development 2014–2020 (see above). Assumed to be maintained over the entire projection period.

Waste (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.

3.2 PAMs specifically designed to address air pollutants

In addition to policies and measures (PAMs) designed to combat climate change, this chapter lists assumptions regarding the instruments and the concrete implementation of PAMs which have been specifically designed to address air pollution. Besides existing regulations for emissions of air pollutants for different kinds of plants in the energy and manufacturing industries and in the waste sector, which partly go beyond EU requirements, the main focus is on updated emission factors for transport and ecodesign requirements for heating appliances in buildings.

Transport (1.A.3)

No national PAMs that are specifically designed for air pollutants – besides those included in the GHG projections – have been identified for road transport. Measures related to transport activities and the modal split affect both GHG emissions and air pollution; technical requirements with the aim to tackle air pollution in the transport sector have already been implemented through EU legislation.

WEM uses the latest assumptions for emission factors for all relevant pollutants from the 'HBEFA Version 3.3_draft'[6] (January 2017), the same version as the one used for WEM17. The draft version of 'HBEFA V3.3' does not include the effects of changing ambient temperature on emission factors. The test cycles used for calculating the emission factors for the HBEFA (Handbook of Emission Factors in Road Transport) always represent real-world driving conditions (INFRAS 2017).

Emission factors for PM (exhaust), CO and HC from road transport are also based on the 'HBEFA V3.3_draft'. All emission factors correspond to the current state of knowledge for present and future vehicle technologies available on the market, although – as the past has shown – some uncertainty is associated with the development of emission factors, especially with regard to **NO_x from diesel vehicles**. In diesel engines, low NO_x emissions come with trade-offs for low fuel consumption, system cost and drivability.

Other Sectors (1 A 4)

Ecodesign standard emission requirements for the placing on the market and putting into service of space heaters and combination heaters[7], water heaters and hot water storage tanks[8], solid fuel local space heaters[9], local space heaters[10] and solid fuel boilers[11] have entered (or will enter) into force by 1st January 2018 (814/2013, 2015/1188), 26th September 2018 (813/2013), 1st January 2020 (2015/1189) and 1st January 2022 (2015/1185) respectively.

[6] HBEFA … Handbook Emission Factors for Road Transport

[7] Commission Regulation (EU) No 813/2013

[8] Commission Regulation (EU) No 814/2013

[9] Commission Regulation (EU) 2015/1185

[10] Commission Regulation (EU) 2015/1188

[11] Commission Regulation (EU) 2015/1189

NO_x in mg/kWh$_{input}$ based on GCV	Space heaters and combination heaters	
	Gaseous fuels	***Liquid fuels***
Fuel boiler space heaters	56	120
Fuel boiler combination heaters	56	120
Cogeneration space heaters with external combustion	70	120
Cogeneration space heaters with internal combustion	240	420
Heat pump space heaters and heat pump combination heaters with external combustion	70	120
Heat pump space heaters and heat pump combination heaters with internal combustion	240	420

Table 10: Space heaters and combination heaters standard emission thresholds for NO_x (according to Reg 813/2013), (Source: Umweltbundesamt).

NO_x in mg/kWh$_{input}$ based on GCV	**Water heaters**	
	Gaseous fuels	***Liquid fuels***
Conventional water heaters	56	120
Heat pump water heaters with external combustion	70	120
Solar water heaters	70	120
Heat pump water heaters with internal combustion	240	420

Table 11: Water heaters standard emission thresholds for NO_x (according to Reg 814/2013), (Source: Umweltbundesamt).

in mg/m³ at 13 % O_2	**Solid fuel local space heaters**			
	PM	**OGC**	**CO**	**NO_x**
Open fronted	50	120	2 000	:
Closed fronted (other than pellets)	40	120	1 500	:
Closed fronted (pellets)	20	60	300	:
Cookers	40	120	1 500	:
Solid biomass	:	:	:	200
Solid fossil fuels	:	:	:	300

Table 12: Solid fuel local space heaters standard emission thresholds for PM, OGC, CO and NO_x (according to Reg 2015/1185), (Source: Umweltbundesamt).

NO_x in mg/kWh$_{input}$ based on GCV	**Local space heaters**
Liquid and gaseous fuels, open fronted	130
Liquid and gaseous fuels, closed fronted	130
Liquid and gaseous fuels, luminous	200
Liquid and gaseous fuels, tube	200

Table 13: Local space heaters standard emission thresholds for NO_x (according to Reg 2015/1188), (Source: Umweltbundesamt).

in mg/m³ at 10 % O_2	**Solid fuel boilers**			
	PM	**OGC**	**CO**	**NO_x**
Solid fuels, automatically stoked	40	20	500	:
Solid fuels, manually stoked	60	30	700	:
Solid biomass	:	:	:	200
Solid fossil fuels	:	:	:	350

Table 14: Solid fuel boilers standard emission thresholds for PM, OGC, CO and NO_x (according to Reg 2015/1189), (Source: Umweltbundesamt).

Until the implementation of the ecodesign regulations, corresponding national emission standards apply, as laid down in the Article 15a of the Austrian Constitution (Agreement between the federal provinces concerning the placing on the market of small-scale combustion equipment and the inspection of heating appliances and block heat and power plants).

Since the ecodesign regulations fall within the scope of Article 114 of the Treaty on the Functioning of the European Union, Member States are in principle not allowed to keep national requirements that are more stringent than those established under EU legislation. Therefore, the ecodesign regulations will, once the transposition deadline expires, overrule the partly more stringent Austrian requirements of the Article 15a Agreement.

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 of the Environment Agency Austria (Umweltbundesamt), the Austrian Institute of Economic Research ('Wirtschaftsforschungsinstitut', WIFO), the Austrian Energy Agency, the Energy Economics Group of the Vienna University of Technology, the Zentrum für Energiewirtschaft (e-think) and the Institute for Internal Combustion Engines and Thermodynamics at the Graz University of Technology. The scenarios were developed with the help of several models:

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

In addition, several parameters were calculated endogenously, e.g. pipeline compressors and industrial autoproducers.

The econometric input-output model DYNK combines a private consumption module with an energy and environment module. Important input parameters are energy prices, population and household income (WIFO 2018).

For projecting the electricity and district heat generation a model based on TIMES has been used. The model has been adapted especially for Austria. It is based on available capacities for all types of power plants, combined with energy prices and the demand for electricity and district heating (taken from the INVERT/EE-Lab model). Subsidies (e.g. granted under the Green Electricity Act) and fees (e.g. emission allowances) also constitute important input parameters (AEA 2018).

For modelling energy consumption in domestic heating and domestic hot water supply, the software package INVERT/EE-Lab (TU WIEN & ZEU 2018) was applied. INVERT/EE-Lab is based on a stochastic, non-recursive, myopic and economic algorithm, with the objective function to minimise costs. The basic algorithm is based on the principle of the INVERT model. It allows the 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. Umweltbundesamt 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 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 Sectors 1.A.1, 1.A.2 and 1.A.4. The methodology applied for the determination of emission factors is described in the Austrian Inventory Report (UMWELTBUNDESAMT 2019a). The data on energy demand have been split according to the sub-sectors of the Austrian Air Emission Inventory.

4.1.1 Energy Industry (NFR 1 A 1)

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

A model based on TIMES was used which provides fuel-specific activity data on energy industries (i.e. electricity and heat production including waste incineration). These data were multiplied by the same established 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 (UMWELTBUNDESAMT 2019a) by the respective emission factors. The latter were determined for power plants and waste incineration facilities on a plant-specific basis for each fuel type, taking into account expansions, the commissioning of new plants and the closing of existing facilities.

The only refinery operating in Austria installed an SNOX plant in November 2007, thereby significantly reducing its emissions of SO_2 and NO_x. As no other changes are expected for 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 can be found in the cited literature (UMWELTBUNDESAMT 2003a, b, c, BMLFUW 2004 and UMWELTBUNDESAMT & BMLFUW 2002).

As regards electricity and heat production, it has been assumed that coal and oil-fired plants will have been shut down by 2030. For gas plants it has been assumed in the WEM scenario that inputs will slowly decrease until 2050. It has been assumed that there will be no changes of the emission factor for gas plants until 2050.

For installations using solid biomass, emission factors have been reported in the literature for various plant sizes (UMWELTBUNDESAMT 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, oil and gas exploration and refineries do not change over time.

NMVOC and NH_3

NMVOC and NH_3 emissions are assumed to remain constant at 2015 levels (UMWELTBUNDESAMT 2019b). This simple approach has been chosen because their share in the total emissions is less than 1%.

4.1.2 Manufacturing Industry and Combustion (NFR 1 A 2)

This chapter describes the methodology used for emission projections for stationary fuel combustion in the manufacturing industry. A methodological description of the emission projections for mobile sources in NFR 1 A 2 is given in Chapter 4.2.1.

SO_2 and NO_x

To estimate SO_2 and NO_x emissions, a combined assessment of the NFR Sectors 1.A.2 and 2 has been performed (UMWELTBUNDESAMT 2003a, c, UMWELTBUNDESAMT 2007a and UMWELTBUNDESAMT 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 (UMWELTBUNDESAMT 2019c) and by incorporating recent data from environmental impact statements on facility expansions and the opening and closing of facilities. For compiling the emission projections, emissions factors from the latest inventory and, if available, plant specific data were used.

NMVOC and NH_3

NMVOC and NH_3 emissions from stationary sources are assumed to remain constant at 2017 levels (UMWELTBUNDESAMT 2019b). This simple approach has been chosen because the share of these emissions in the 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 (UMWELTBUNDESAMT 2017a) and by incorporating recent data from environmental impact statements on facility expansions and the opening and closing of facilities.

For process emissions from quarries, construction activities and the wood industry, historical trends from the past have been extrapolated.

4.1.3 Other Sectors (NFR 1 A 4)

This chapter describes the methodology used 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 the emission projections for mobile sources in NFR 1 A 4 is given in Chapter 4.2.1.

Activities

A comprehensive model for buildings (INVERT/EE-Lab) has been used to calculate energy consumption for stationary sources separately for the sub-sectors residential and commercial (TU WIEN & ZEU 2018). Inputs to mobile sources in agriculture come from the macro-economic DYNK model. A detailed description of these models can be found in UMWELTBUNDESAMT (2017b) TU WIEN & ZEU (2018) and WIFO (2018).

Emissions

SO_2, NO_x, NMVOC, NH_3 and $PM_{2.5}$ emissions were calculated based on the energy demand for stationary sources in sub-sectors 1 A 4 a, 1 A 4 b and 1 A 4 c. A description of the methods and emission factors used for these calculations can be found in the Austrian Informative Inventory Report (UMWELTBUNDESAMT 2019b).

Twenty-two technology- and fuel-dependent main sub-categories (heating types) have been considered. They are presented in the following table:

Table 15: Heating types of category 1 A 4 Other Sectors – stationary sources (Source: Umweltbundesamt)

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, sewage sludge gas, biogas and landfill gas
#9	Forced-draft natural gas burners	Natural gas, sewage sludge gas, biogas and landfill gas
#10	LPG stoves	LPG and gas works gas
#11	LPG boilers	LPG and gas works gas
#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-draft wood boilers	Fuel wood

No.	Heating type	Fuel
#16	Forced-draft 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

For charcoal, total fuel consumption is calculated separately, as charcoal is assumed to be combusted in devices similar to wood stoves and cooking stoves.

For each technology fuel-dependent emission factors are applied.

Additionally, NO_x, NMVOC and $PM_{2.5}$ emission factors have been recalculated for future years, based on ecodesign standard emission requirements for the new installation of space heaters and combination heaters[12], water heaters and hot water storage tanks[13], solid fuel local space heaters[14], local space heaters[15] and solid fuel boilers[16]. The ecodesign regulations are assumed to have entered into force by 1st January 2018 (814/2013, 2015/1188), 26th September 2018 (813/2013), 1st January 2020 (2015/1189) and 1st January 2022 (2015/1185) respectively, gradually replacing existing national emission requirements (Article 15a Agreement).

Recalculation of the emission factors for new installations have been based on a comparison of ambition levels between national and EU-wide regulations. The exchange rate has been related to the national emission factor for new installations of the year 2017 (UMWELTBUNDESAMT 2019b) in order to provide conversion factors that reflect the impact of ecodesign policies on new heating systems. Until the ecodesign provisions enter into force, recalculated emission factors are assumed to linearly approach the full effect of a phased introduction of the ecodesign provisions on manufacturers, distributors and sellers of heating products, who may at first have to adapt to the new market environment – as Member States are not allowed to keep more stringent national requirements during the transition period.

National energy projections display *inter alia* 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.

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[12] Commission Regulation (EU) No 813/2013

[13] Commission Regulation (EU) No 814/2013

[14] Commission Regulation (EU) 2015/1185

[15] Commission Regulation (EU) 2015/1188

[16] Commission Regulation (EU) 2015/1189

The share of new installations is assumed to shift gradually towards low emission technologies.

Table 16: Share of 1 A 4 heating type in different fuel categories for new installations 2016–2050 (Source: Umweltbundesamt).

Fuel category	No.	Heating type	Share of heating type [% TJ]			
			1 A 4 a 1 A 4 c	1 A 4 a 1 A 4 c	1 A 4 b	1 A 4 b
			2016	2050	2016	2050
Fuel oil	#1	Fuel oil boilers	100%	100%	100%	100%
Gas oil	#2	Gas oil stoves	3%	2%	3%	1%
	#3	Vapourising burners	2%	:	2%	:
	#4	Yellow burners	20%	3%	10%	1%
	#5	Blue burners using conventional technology	15%	5%	15%	3%
	#6	Blue burners using low temperature or condensing technology	60%	90%	70%	95%
Gas	#7	Natural gas convectors	10%	10%	10%	5%
	#8	Atmospheric burners	60%	10%	30%	10%
	#9	Forced-draft natural gas burners	30%	80%	60%	85%
LPG	#10	LPG stoves	10%	10%	5%	5%
	#11	LPG boilers	90%	90%	95%	95%
Fuel wood	#12	Wood stoves and cooking stoves	12%	6%	4%	1%
	#13	Tiled wood stoves and masonry heaters	20%	10%	8%	5%
	#14	Mixed-fuel wood boilers	3%	:	3%	:
	#15	Natural-draft wood boilers	15%	4%	25%	4%
	#16	Forced-draft wood boilers	50%	80%	60%	90%
Wood chips	#17	Wood chips boilers with conventional technology	20%	5%	15%	5%
	#18	Wood chips boilers with oxygen sensor emission control	80%	95%	85%	95%
Wood pellets	#19	Pellet stoves	10%	5%	5%	3%
	#20	Pellet boilers	90%	95%	95%	97%
Coal	#21	Coal stoves	5%	1%	5%	1%
	#22	Coal boilers	95%	99%	95%	99%

It is assumed that new installations with lower emission factors substitute stocks with average 2017 emission characteristics or increase overall stocks.

Emission factors

NO_x emission factors are assumed to decrease for natural gas and heating oil (due to an increased use of blue burners and forced-draft burners with condensing boiler technology). Besides the shift towards low emission technologies, solid biomass emission factors are assumed to drop slightly due to minor differences in ambition levels between ecodesign provisions and intermediate national regulations. Additionally, a minor increase in heating oil emission factors and a noticeable increase in natural gas and coal emission factors are expected because of a weakening of existing national regulations.

In Table 17 the implied NO_x emission factors for the projections are listed.

in kg/TJ	2017	2020	2025	2030
1 A 4 a and 1 A 4 c				
Coal	100.2	100.2	100.2	100.2
Fuel wood	88.5	88.4	88.1	87.4
Wood chips	105.6	103.0	97.7	91.5
Wood pellets	60.0	59.9	59.8	59.7
Heating oil	39.6	39.2	38.4	37.3
Natural gas	49.1	48.5	47.3	45.3
1 A 4 b				
Coal	86.6	86.6	86.6	86.6
Fuel wood	113.5	111.4	106.3	99.3
Wood chips	102.8	100.9	96.5	90.7
Wood pellets	60.0	60.0	60.0	59.9
Heating oil	39.3	39.0	38.4	37.6
Natural gas	42.3	41.5	40.2	38.5

Table 17: implied NO_x emission factors for coal, fuel wood, wood chips, wood pellets, heating oil and natural gas (Source: Umweltbundesamt).

NMVOC emission factors are assumed to decrease for solid biomass and coal from 2017 onwards due to existing national regulations imposing standard Organic Gaseous Compounds (OGC) emission thresholds on new installations and subsequent ecodesign requirements, which will be less stringent for solid fuel local space heaters. There is almost no effect on the NMVOC emission factors for natural gas and heating oil regarding ecodesign provisions. For all fuels the impact of the assumed shift towards low emission technologies in new installations of heating systems is evident.

In Table 18 the implied NMVOC emission factors for the projections are listed.

in kg/TJ	2017	2020	2025	2030
1 A 4 a and 1 A 4 c				
Coal	2.8	2.8	2.8	2.8
Fuel wood	416.4	409.0	391.1	357.4
Wood chips	414.6	376.3	301.0	213.6
Wood pellets	33.0	32.1	30.4	29.0
Heating oil	0.7	0.7	0.6	0.5
Natural gas	0.8	0.8	0.7	0.7
1 A 4 b				
Coal	295.7	295.7	295.7	295.7
Fuel wood	422.2	411.7	388.0	356.9
Wood chips	377.7	349.7	287.1	205.9
Wood pellets	32.7	32.0	30.9	29.6
Heating oil	0.7	0.7	0.6	0.5
Natural gas	0.6	0.6	0.6	0.5

Table 18: implied NMVOC emission factors for coal, fuel wood, wood chips, wood pellets, heating oil and natural gas (Source: Umweltbundesamt).

$PM_{2.5}$ emission factors are assumed to decrease for solid biomass and coal due to the ecodesign requirements which – in general – outreach existing national regulations for standard $PM_{2.5}$ emission thresholds. For both fossil fuels and biomass a shift towards low emission technologies in new installations of heating systems shows.

In Table 19 the implied $PM_{2.5}$ emission factors for the projections are listed.

Table 19: implied $PM_{2.5}$ emission factors for coal, fuel wood, wood chips, wood pellets, heating oil and natural gas (Source: Umweltbundesamt).

in kg/TJ	2017	2020	2025	2030
1 A 4 a and 1 A 4 c				
Coal	44.5	44.5	44.5	44.5
Fuel wood	91.9	89.8	85.1	75.5
Wood chips	78.2	73.9	65.6	55.9
Wood pellets	15.9	15.9	15.9	15.9
Heating oil	2.2	2.1	2.0	1.8
Natural gas	0.7	0.7	0.6	0.6
1 A 4 b				
Coal	82.6	82.6	82.6	82.6
Fuel wood	104.8	100.4	90.0	76.2
Wood chips	74.4	71.3	64.2	55.2
Wood pellets	15.4	15.4	15.4	15.4
Heating oil	2.2	2.1	2.0	1.8
Natural gas	0.5	0.5	0.5	0.4

NFR 1 A 4 a i Bonfire & Open Fire Pits, 1 A 4 b i Barbecue

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 2017 emissions with projected population statistics (STATISTIK AUSTRIA 2018c).

4.2 Mobile Fuel Combustion Activities (NFR 1 A)

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

4.2.1 Aviation (NFR 1 A 3 a)

Projections for energy consumption in the aviation sector were carried out with the econometric input-output DYNK model of the Austrian Institute of Economic Research (WIFO 2018). Within the framework of an energy demand scenario for the different NACE sectors in Austria, the energy demand for aviation gasoline and kerosene has been estimated. The monetary demand for flight services is indirectly dependent on the population (via total consumption, employed persons), relative prices (not the tickets *per se*, but the prices of "flight services") and their trend (in the consumption mix).

- Major driving forces:
  - Flight movements and distances (dependent on international (wholesale) fuel import prices of crude oil, taxes/profit margins on fossil fuels → fuel price, GDP, ...)

4.2.2 Road and Off-road Transport (NFR 1 A 3 b-d, 1 A 2 g, 1 A 4 b-c, 1 A 5)

The calculation of transport emissions is based on different models:

NEMO – Emission model road (CRF Source Category 1 A 3 b)

- From the 2015 submission onwards, projections have been based on NEMO, the Network Emission Model (DIPPOLD/REXEIS/HAUSBERGER 2012; HAUSBERGER/SCHWINGSHACKL/REXEIS 2015a,b, 2018). NEMO has been set up according to the same methodology as GLOBEMI (the former model). It combines a detailed calculation of the fleet composition with a simulation of energy consumption and emission output on a vehicle level. 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, …) and alternative fuels (CNG, biogas, FAME, ethanol, GTL, BTL, H2, …).
- In addition, NEMO has been designed in such a way 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 as yet no complete road network for Austria on a high resolution spatial level, the old methodology with traffic activities categorised into 'urban', 'rural' and 'motorway' has been applied with the NEMO model.
- Major drivers of emissions:
  - Vehicle kilometres (dependent on GDP, fuel price, population, degree of motorisation, ...)
- For more details see 3.2.12.2. Road Transport of Austria's National Inventory Report 2019 (UMWELTBUNDESAMT 2019a).

KEX Tool (CRF Source Category 1 A 3 b)

The KEX tool is used in projections to map the future development of domestic fuel demand in road transport as a function of GDP, population and fuel prices, and to calculate future quantities of fuel exported by motor vehicles from Austria to other countries. The KEX tool was developed for estimating changes in domestic fuel demand and fuel exports 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. Whereas the NEMO model calculates domestic fuel consumption, the KEX tool estimates the amount of fuel purchased in Austria and used abroad. 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.

- Major drivers of emissions:
  - development of international (wholesale) fuel import prices of crude oil
  - fuel price differences between Austria and neighbouring countries
- For more details see 3.2.12.2. Road Transport of Austria's National Inventory Report 2019 (UMWELTBUNDESAMT 2019a).

GEORG – Emission model off-road
(CRF Source Category 1 A 2 f, 1 A 3 c, 1 A 3 d, 1 A 4 b, 1 A 4 c, 1 A 5)

- Energy consumption and off-road emissions in Austria are calculated using the GEORG model (**G**razer **E**missionsmodel für **O**ff **R**oad **G**eräte) (PISCHINGER 2000). The GEORG model consists of a fleet model part which simulates the actual age and size distribution of non-road mobile machinery (NRMM) stock using age- and size-dependent drop-out rates (i.e. the probability that a vehicle will have been scrapped by the following year). With this approach the number of vehicles in each mobile source category is calculated according to the year of the vehicles' first registration and according to the propulsion system (gasoline 4-stroke, gasoline 2-stroke, diesel > 80 kW, diesel < 80 kW).
- Major drivers of emissions:
  - Operating hours of machines (dependent on GDP, harvest, wood production, ...)
- For more details see 3.2.13.2 Other Sectors – mobile combustion of Austria's National Inventory Report 2019, (UMWELTBUNDESAMT 2019a).

Special Considerations for $PM_{2.5}$:

NFR 1 A 3 b vii R.T., Automobile road abrasion

Projected $PM_{2.5}$ emissions from road abrasion and brake wear have been estimated in a manner that is consistent with Austria's Air Emission Inventory (UMWELTBUNDESAMT 2019b). Projected passenger car and heavy duty vehicle kilometres are multiplied by emission factors (HAUSBERGER & SCHWINGSHACKL 2018).

NFR 1 A 3 c Railways abrasion and brake wear

$PM_{2.5}$ emissions from rail abrasion and rail brake wear have been extrapolated using 2017 emissions.

NFR 1 A 5 b Military mobile machinery

Ground operations: $PM_{2.5}$ emissions from ground operations of military vehicles have been extrapolated using 2017 emissions and projected fuel consumption.

Aviation operations: $PM_{2.5}$ emissions from military aviation operations have been extrapolated by means of 2017 emissions.

NO_x – Emission factors

As NO_x is the most important 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 in the following. The test cycles used for calculating the emissions factors for the HBEFA (Handbook of Emission Factors in Road Transport) always represent real-world driving conditions.

All emission factors ('HBEFA Version 3.3_draft') are presented in Chapter 5.1.2.

Passenger cars (PC) according to the 'HBEFA3.3_draft'

According to the latest amendments to European legislation[17], the nomenclature for emission classes in PC EURO 6 has been changed to Euro 6a/b. Euro 6c has become Euro 6d_temp (in HBEFA 6d1) and Euro 6d is a new emission class which is consistent with HBEFA Euro 6d2.

EURO6a/b

Actual measurement data (i.e. real-world driving conditions plus chassis dynamometer) on 25 EURO 6 vehicles was analysed. The emission behaviour of all single vehicles was assessed by taking into account the shares of the produced vehicle models in the European registration statistics. In the NEMO model based on the HBEFA V3.3_draft only the emission factors for ambient conditions at 20°C are used. For the HBEFA3.3 (final version, not implemented yet) additional correction factors which take the influence of ambient temperature (ca. +25-30% for Austria) into account are under development.

EURO6d

From a set of actual EURO 6 measurement data, 6 vehicles which already fulfil the final RDE (real driving emissions) provisions (EURO6d final) were selected. These vehicles were used to produce the EURO6d emission factors.

EURO6d-temp

Emission factors for the interim emission standard ("EURO6d_temp") were generated by weighting the emission intensity of EURO6a/b and EURO6d. The weighting factors were defined in relation to the conformity factors of RDE legislation.

Light duty vehicles (LDV)

Not updated (as LDVs were not part of the HBEFA3.3_draft update). Nevertheless, available measurement data indicate that the real-world emission factors for LDVs for EURO5 and EURO6 are higher than specified in HBEFA3.2. This will be updated in HBEFA4. Emissions are therefore probably underestimated in the current scenario.

Heavy duty vehicles (HDV)

Not updated (not part of the HBEFA3.3_draft update).

A detailed description of all underlying assumptions can be found in a technical study by TU Graz (HAUSBERGER & SCHWINGSHACKL 2017).

The following tables show the assumed introduction periods for each emission standard and vehicle category for all new vehicle registrations:

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[17] Regulation (EC) No. 692/2008 on type-approval of motor vehicles (WLTP implementation is pending) plus two RDE (real drive emission) packages – Regulation (EC) 2016/427 and 2016/646.

Table 20: Introduction periods of EURO-classes in new registrations (passenger cars and light duty vehicles), (Source: Umweltbundesamt).

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

Table 21: Introduction periods of EURO-classes in new registrations (heavy duty vehicles), (Source: Umweltbundesamt).

HDV	WEM	
	from	until
EURO 4	2006	2008
EURO 5	2009	2013
EURO 6	2014	2030

4.2.2.1 Details on NO_x emission factors

The tables below show the emission factors used for the 2019 projections by vehicle category. They are in line with those used in the 2017 projections.

Table 22: Comparison of NO_x emission factors for diesel passenger cars (PC), (Source: Umweltbundesamt).

NO_x	NEMO HBEFA V.3.3_draft[18]
PRE ECE	1.014
ECE15/01	1.014
ECE15/02	1.014
ECE15/03	1.014
ECE15/04	1.014
US 83	0.748
Legal Act A	0.770
EURO 2	0.815
EURO 3	0.857
EURO 4	0.567
EU4+DPF	0.567
EURO 5	0.695
EURO 6a/b	0.421
EURO 6d_temp	0.197
EURO 6d	0.127

[18] HBEFA 3.3_draft incl. the latest measurement results for updates on NO_x emissions factors; excl. the influence of ambient temperature on the NOx emission level of diesel vehicles. Current measurements from the roller test stand show that some brands and models have a significantly higher NO_x output at ambient temperatures of around 0° C compared to the standard temperature of 23° C. This effect can be due to, among other things, reducing or switching off the exhaust gas recirculation. This is expected to increase the corresponding emission levels by an additional 25% to 30% in the next version of the HBEFA.

Table 23: Comparison of NO_x emission factors for diesel light duty vehicles (LDVs), (Source: Umweltbundesamt).

NO_x	NEMO HBEFA V.3.3_draft
PRE ECE	1.78
ECE15/01	1.78
ECE15/02	1.78
ECE15/03	1.78
ECE15/04	1.78
US 83	1.56
Gesetz A	1.59
EURO 2	1.41
EURO 3	1.14
EURO 4	0.93
EURO 5	0.86
EURO 6	0.30
EURO 6c	0.16

* *Emission factors for LDV were not updated in the HBEFA Version 3.3_draft.*

Table 24: Comparison of NO_x emission factors for heavy duty vehicles (HDVs), (Source: Umweltbundesamt).

NO_x	NEMO HBEFA V.3.3_draft
1980s	14.11
Euro-I	9.67
Euro-II	9.84
Euro-III	7.73
Euro-IV EGR	5.40
Euro-IV SCR	3.11
Euro-V EGR	3.97
Euro-V SCR	2.02
Euro-VI 2014–2015	0.30
Euro-VI 2050	0.19

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 in the emission factors have been assumed.

4.3 Fugitive Emissions (NFR 1 B)

SO_2 and NMVOC

SO_2 and NMVOC emission projections for fugitive emissions are based on average emission/activity data ratios for the period 2012-2016, as well as on projected activity data such as natural gas exploration, natural gas consumption and gasoline consumption according to the energy scenario (WIFO 2018). The length of the gas distribution network has been extrapolated using the average yearly growth rate between 2012 and 2016 (238 km/year).

Emission reduction measures such as the introduction of vapour recovery units at fuel depots and service stations had already been implemented in 2003. No further reductions are expected.

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 (UMWELTBUNDESAMT 2019b).

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) have been calculated on the basis of projections for coal consumption (WIFO 2018) and emission factors as used in Austria's National Air Emissions Inventory.

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 (WIFO 2018), 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 of 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.

NMVOC and NH_3

NH_3 emissions are assumed to remain constant at 2017 levels (UMWELTBUNDESAMT 2019b) in most sub-sectors. This simple approach has been chosen because the share of NH_3 emissions in the total emissions is very small.

For NMVOC emissions in the sub-sector 2.H 'Other Processes' 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 bread have been extrapolated according to the population scenario.

4.4.2 Solvent and Other Product Use (NFR 2 D/G)

NMVOCs

Methodology of the Austrian Air Emission Inventory

Emission projections for 2015–2030 are calculated based on the emissions of the latest inventory year, and assuming a correlation with population growth or economic growth in some sub-sectors, or a continuation of the trend in others. In some cases, a constant development has been assumed (e.g. where technological innovation offsets an increase in use – see below for more details).

Source data for the Austrian Air Emissions Inventory come from surveys (WINDSPERGER et al. 2002a, 2002b, 2004; WINDSPERGER & SCHMID-STEJSKAL 2008, WINDSPERGER ET AL, 2018) as well as import-export statistics (foreign trade balance) and production statistics provided by Statistik Austria, as well as from data reported under the VOC Directive.

In order to determine the quantity of solvents used for the various applications in Austria, a bottom-up and a top-down approach were combined. The top-down approach provided the total quantities of solvents used in Austria, whereas the amounts of solvents used in different applications and the solvent emission factors were calculated on the basis of the bottom-up approach. Emissions reported under the VOC Directive were used for all those sectors where this was possible (extrapolating emissions by taking into account the number of employees in the relevant sector, to include those installations that are below the threshold for reporting). By combining the results from the bottom-up and the top-down approach, the quantities of solvents used per year and the solvent emissions from the different applications were determined. This approach was finalised in Austria's National Air Emissions Inventory 2018 (UMWELTBUNDESAMT 2019b).

Projections

The trend in the quantities of solvents (substances) and solvent-containing products, i.e. the relationship between imports and exports and the production of solvents was based on activity data (solvent use) in the different sub-categories

(SNAPs). These were related to economic growth (where SNAPs had been linked to NACE codes), or population growth (in the domestic sector). Economic growth was taken into account, when a correlation between historic activity data and growth could be determined and for some cases expert judgement were applied.

Emission factors for substances, linked to the different SNAPs, are based on plant specific data. These emission factors were calculated from the solvent balances of companies. For emissions caused by products only the included solvents in the product is the activity. Over the past years, the calculation model has been fundamentally revised and therefore information on the solvent content of products has been updated.

As EFs decreased in the past few years due to measures under the VOC Directive, a conservative approach has been adopted, which means that no further measures will be implemented and the EFs are therefore assumed to remain constant.

Most of the demand for solvents comes from the paint and coatings industry but also from households (cleaners, disinfectants, personal care products) and from the printing industry. Besides the paints used in the sub-sector "Construction and buildings", most consumer products are coated with paint. Furthermore, solvents are used in many industrial cleaning applications such as cleaning for maintenance purposes and cleaning in the manufacturing process. Solvents are also used for the cleaning of high-precision mechanical parts such as ball bearings.

Up to 2030, the emission scenarios reflect emissions from Car manufacturing, Car repairing, Construction and buildings, Wood coating Degreasing, Rubber processing, Manufacturing of Pharmaceuticals, which are based on economic growth data (via the respective NACE codes), and include assumptions for emissions from Coil coating, Paints, Inks and Glue Manufacturing, Adhesives and other manufacturing, as well as printing, which are expected to remain constant. For Other Industrial Paint applications, Metal Degreasing, Textile finishing, Preservation of Wood, and Application of Glues and Adhesives, expert judgement was applied based on BAT documents and trends over the past few years and on knowledge of the key drivers in the sectors. Domestic solvent use was based on population growth.

NO_x, SO_2 and NH_3

According to the Austrian inventory, NO_x. SO_2 and NH_3 emissions from solvent use do not occur in Austria. All emissions are caused by product use. NO_x, SO_2 and NH_3 emissions from product use (i.e. tobacco smoke and fireworks) were calculated by multiplying emissions of the latest inventory year (2017; submission 2019) by the projected number of inhabitants (population) in Austria until 2030 (STATISTIK AUSTRIA 2018c).

$PM_{2.5}$

$PM_{2.5}$ emissions from product use (i.e. tobacco smoke and fireworks) were calculated by multiplying emissions of the latest inventory year (2017; submission 2019) by the projected number of inhabitants (population) in Austria until 2030 (STATISTIK AUSTRIA 2018c).

4.5 Agriculture (NFR 3)

Agricultural activities and emissions have been projected for sources of ammonia (NH_3), nitric oxide (NO_x), non-methane volatile organic compounds (NMVOC), sulphur dioxide (SO_2) and particulate matter ($PM_{2.5}$).

Activity data

The results obtained from the Positive Agricultural Sector Model Austria (PASMA), developed by the Austrian Institute of Economic Research (WIFO), provide the basic activity data (WIFO & BOKU 2018).

The PASMA model maximises sectoral farm welfare and is calibrated on the basis of historical crops, forestry, livestock, and farm tourism activities, using the Positive Mathematical Programming (PMP) method. This method assumes a profit-maximising equilibrium (e.g. marginal revenue equals marginal cost) in the base run and derives coefficients of a non-linear objective function on the basis of observed levels of production activities.

Economic assumptions

Price estimates are specific to the Austrian market situation. Apart from milk price projections all estimates are derived from OECD-FAO outlooks on agricultural markets (OECD-FAO 2018). Based on previously observed price wedges between the EU and Austria, estimates for the coming periods were made. In the previous analysis (WIFO & BOKU 2015), lower milk prices were assumed for Austria than those forecast by OECD-FAO (2014) for the EU. The reasoning behind this deviation was that for countries, which are likely to expand their milk production, lower prices may prevail over a long period until a new equilibrium is established. Market reports do not confirm this assumption. Milk prices in Austria have been slightly higher than in most other EU countries (e.g. AMA 2018). In Austria the market for organic products is very important and many organic products are sold at a premium price.

Other exogenous economic assumptions for Austria (e.g. GDP or population size) are not necessary but they are embedded in exogenous price assumptions. Other driving forces are prices, technology and constraints.

Other assumptions

- Increase in milk yield per cow from +3% (2020) to +13% (2035) relative to 2017
- Loss of agricultural land following a long-term trend

Main results

The number of cattle is expected to increase slightly. This is not consistent with the declining trend observed over the last few decades but consistent with the previous scenarios (WIFO & BOKU 2015). However, the number of cattle in the current projections (WIFO & BOKU 2018) is significantly lower than expected in 2015. This is mainly due to different price assumptions. Lower levels of projected milk yields per cow are a second explanation. The Rural Development Programme and the coupled alpine farming premium are favourable for extensive cattle production even when premiums are lower than previously assumed. The availability of grassland and relatively high beef prices make production attractive.

Decreasing prices for pork lead to falling numbers of pigs. This result is in line with expectations of pig production experts, who expect a decline in production mainly due to limitations in production facilities. This is in contrast to the results in 2015, which indicated a sharp increase. The reason for the difference between 2018 and 2015 lies in the price projections. According to the most recent OECD/ FAO projections prices for pork will be significantly lower.

According to the model results, poultry production will decrease. This result is not consistent with the observed trend of increasing numbers of heads. Following international projections (EC 2017), one would expect growing numbers of poultry as well. The model result is the consequence of relative prices.Relatively high feed costs (mainly soya meal) make the production of poultry meat unprofitable. Furthermore, poultry and egg producers in Austria have to cope with considerably higher costs than producers in other countries.

The sale of mineral nutrients is likely to decline very slightly. This result is consistent with a long-term trend but not consistent with observations of more recent sales data. According to the results of the 2015 projections, the amount of nutrient sales was expected to decline significantly, which can be explained by prices and livestock numbers. Relative prices of inputs and outputs are such that it is now more profitable to use purchased inputs than in the projections of 2015. In the 2015 projections, the number of livestock is higher than in the current submission. The model assumes that manure is a well-suited substitute for mineral fertiliser with cheap trade options within NUTS-3 regions and therefore a smaller amount of mineral fertiliser is needed.

Scenario 'with existing measures' (WEM)

WEM uses price projections of OECD/FAO from 2018 for the EU, the existing legal framework of regulations in agriculture and farm policies after the reform following the proposals of the European Commission from mid-2018 onwards.

Emission Calculation

Emissions are calculated on the basis of the methodologies used in Austria's Annual Air Emissions Inventory. A comprehensive description can be found in Austria's Informative Inventory Report (IIR) 2019 (UMWELTBUNDESAMT 2019b).

Feed intake and N excretion

The feed intake parameters and N excretion values applied here are the same as the ones applied in Austria's Annual Air Emission Inventory (UMWELTBUNDESAMT 2019b). Data for dairy cows were calculated on the basis of projected milk yields.

Animal Waste Management Systems (AWMS)

Data on AWMS distribution are based on a comprehensive analysis of Austria's agricultural practices in 2017 (PÖLLINGER et al. 2018).

For 2030 the share of cattle kept in tie stall housing systems was adjusted downwards by 25% (due to provisions on animal welfare). The share varies according to cattle sub-categories; in 2017 it was in a range of 13-37% (PÖLLINGER et al. 2018). The shares of liquid and solid waste within the tie stall housing systems remain unchanged – they are the same as in the national inventory.

Taking into account the trend towards liquid systems, the share of loose housing systems/liquid for 2030 has been increased.

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 together with the farmed areas. For the projections, the same emission factors have been applied as in Austria's Annual Air Emission Inventory (UMWELTBUNDESAMT 2019b).

Activity data on projected cropland and grassland area have been obtained from the Positive Agricultural Sector Model Austria (PASMA), developed by the Austrian Institute of Economic Research (WIFO) (WIFO & BOKU 2018).

Particle Emissions from Bulk Material Handling

Because this source is of minor importance, $PM_{2.5}$ emissions have been extrapolated by using inventory values from 2017 onwards.

Particle Emissions from Animal Husbandry

Particle emissions from this source are primarily associated with the manipulation of forage; a smaller part arises from dispersed excrement and litter. Wet meadows and mineral particles of soil are assumed to be negligible, which is why particle emissions from free-range animals are not included.

Estimates of particle emissions from animal husbandry are related to Austrian livestock projections. The emission factors are the same as those used in Austria's Air Emission Inventory (UMWELTBUNDESAMT 2019b).

4.6 Waste (NFR 5)

NMVOCs and NH_3 from 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 (after taking gas recovery into account). For NMVOCs 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[19] 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 slowly throughout 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 the calculation of the amount of methane generated based on the amount of accumulated degradable organic carbon at landfills in a particular year, and one for the calculation of the methane actually emitted after subtracting the recovered and the oxidised methane.

More detailed information on the methodology (as well as on the parameters applied) can be found in Austria's Informative Inventory Report (UMWELTBUNDESAMT 2019b).

Projections of 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, only pre-treated waste has been deposited 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 the assumptions made for projected emissions from 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, the following projected activity data were calculated:

Table 25: Past trend (1990–2015) and scenarios (2020–2030) activity data for landfilled "Residual waste" and "Non-residual Waste", (Source: Umweltbundesamt).

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	141	141
2025	0.0	141	141
2030	0.0	141	141

[19] Intergovernmental Panel on Climate Change

A detailed description of the methodology used for the calculation of landfill gas emissions can be found in Austria's National Inventory Report (UMWELTBUNDESAMT 2019a).

$PM_{2.5}$ from Waste Disposal on Land (NRF 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 (in particular excavated soil), contributing 97% (2017) 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 wastes are taken into account.

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 UMWELTBUNDESAMT 2019a).

Table 26: Past trend (1998–2015) and scenarios (2020–2030) activity data for dusty waste landfilled (Source: Umweltbundesamt).

[kt waste handled at landfills]	1998	2000	2005	2010	2015	2020	2025	2030
Total dusty waste amount	4 381	5 028	10 502	10 782	25 149	28 029	29 390	30 751

For projections of activity data, it has been assumed that the amount of the deposited waste types considered will increase annually by 1% (compared to the amount landfilled in 2017).

NH_3 from Biological Treatment of Waste – Composting (NFR 5.B.1)

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

by 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 (UMWELTBUNDESAMT 2019a).

Composting plants, home composting

Home-composted waste amounts are assumed to increase in accordance with population growth. Amounts of waste treated in composting plants are partly expected to remain constant at 2017 level (loppings and woodused as structural material in the composting process), partly to increase with population growth (organic waste collected from households).

Mechanical-biological treatment plants

As regards the amounts of waste undergoing mechanical-biological treatment (MBT) in Austria, it is assumed that they will remain on the same level as in 2017. The impact of the BREF document for waste treatments issued in 2018 on the activities of existing MBT plants will be small.

It is assumed that none of the plants will be closed in response to the BREF conclusions and that the amounts of waste treated remain on the level of 2017.

Table 27: Past trend and scenario – activity data for composting.

[kt waste treated]	1990	2000	2005	2010	2015	2020	2025	2030
Composted organic waste	418	1 467	2 375	2 523	2 718	2 883	2 933	2 974
Mechanically-biologically treated waste	345	254	623	551	439	414	414	414

NH_3 from anaerobic treatment of agricultural feedstock (NFR 5.B.2)

NH_3 emissions from anaerobic digestion (manure and energy crops) have been considered for the first time and reported under category 5.B.2.

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

NO_x, SO_2, NMVOC and NH_3 from Waste Incineration (NFR 5.C)

Because of the small contribution of these pollutants to the national total emissions (less than 1%), 2015 emission levels have been used for the forecast. A detailed description of the methodology used for emission estimates can be found in the Austrian Informative Inventory Report 2019 (UMWELTBUNDESAMT 2019b).

NMVOC from Wastewater Treatment (NFR 5.D)

In this category NMVOC emissions from domestic wastewater handling (5.D.1) are included; covering wastewater of domestic origin as well as commercial and industrial wastewater treated together with domestic wastewater in municipal wastewater treatment plants.

Emissions were calculated following the Tier 1 approach by multiplying the wastewater amounts by the emission factor taken from the EMEP/EEA 2016 Guidebook (15 mg/m^3 wastewater). Most recent data on volumes of wastewater treated in municipal wastewater treatment plants were taken from the Electronic Emission Register of Surface Water Bodies ('Emissionsregister – Oberflächenwasserkörper' – 'EMREG-OW'[20]).

- In the activity data projections, treated wastewater amounts are expected to increase in line with population growth. The emission factor remains the same for the whole time series.

[20] BGBl. II Nr. 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 (EmRegV-OW).

Table 28: Past trend (1990–2015) and scenarios (2020–2030) of wastewater volumes.

[Million m³ wastewater treated]	1990	2000	2005	2010	2015	2020	2025	2030
Domestic wastewater treated (municipal and domestic wastewater treatment plants, cesspools)	812	1 072	1 079	1 137	1 060	1 111	1 138	1 160

$PM_{2.5}$ from Waste Disposal on Land (NRF 5.A)

Emissions from this category arise from fire of cars, detached and undetached houses, apartment buildings and industrial buildings.

Emissions were calculated following the Tier 2 approach by multiplying the number of fires per category with the emission factor taken from the EMEP/EEA 2016 Guidebook.

*Emissions = AD * EF*

AD .... activity data (number of fires)

EF..... emission factor

In the activity data projections, it has been assumed that the number of fires will remain on the same level as in 2017. The emission factor remains the same for the whole time series.

Table 29: Past trend (1990–2015) and scenarios (2020–2030) of number of fires.

[number of fires]	1990	2000	2005	2010	2015	2020	2025	2030
Car fires	1373	1682	1759	1727	1584	1540	1540	1540
Fires of buildings (industrial buildings, detached/ undetached houses, apartments)	2995	3066	2617	3545	3674	3303	3303	3303

5 RECALCULATIONS: CHANGES WITH RESPECT TO THE SUBMISSION 2017

The changes made to the projections since the previous emission projections of air pollutants in 2017 (UMWELTBUNDESAMT 2017b) 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 2016, which entailed methodical changes and partly considerable sectoral recalculations (e.g. for the agriculture sector) of the inventory and of emission projections, with the methods having to be applied consistently when calculating past trends and emission scenarios.
3. Changes in the 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 and scenarios for national emission totals.

Table 30: Comparison of projections 2017 and 2019 in the scenarios based on fuel sold – national totals (in kt), (Source: Umweltbundesamt).

Total	2005	2010	2017	2020	2025	2030
Projections 2017						
NO_x	238	181	133	114	93	82
SO_2	26	17	15	14	14	14
NMVOC	137	119	112	109	105	103
NH_3	65	67	68	70	70	70
$PM_{2.5}$	22	19	16	15	14	13
Projections 2019						
NO_x	238	183	145	127	99	84
SO_2	25	16	13	14	13	13
NMVOC	156	137	120	120	116	112
NH_3	63	66	69	69	71	72
$PM_{2.5}$	22	19	16	15	13	12
Difference 2019/2017						
NO_x	0	2	11	13	6	2
SO_2	0	-1	-2	0	0	0
NMVOC	19	18	8	12	11	9
NH_3	-3	-1	1	-1	0	1
$PM_{2.5}$	0	0	0	0	0	-1

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

5.1.1 Energy Industry (NFR 1 A 1), Manufacturing Industry and Combustion (NFR 1 A 2) and Industrial Processes (NFR 2)

Table 31: Major changes between the projections 2015 and 2019 for Sectors 1A1, 1A2 and 2 (in kt), (Source: Umweltbundesamt).

Pollutant	Sector (CRF)	2005	2010	2015	2020	2025	2030
NO_x	1 A 1 – Energy industries	0.1	0.1	0.2	0.6	0.1	0.1
	1 A 2 – Manufacturing Industries and Construction	0.3	0.1	-0.5	1.1	0.8	0.4
	2 – Industrial Processes	-1.0	-1.3	-1.3	-1.3	-1.3	-1.3
SO_2	1 A 1 – Energy industries	0.0	0.0	-0.1	0.2	0.2	0.1
	1 A 2 – Manufacturing Industries and Construction	0.2	-0.2	-1.3	-0.2	-0.1	0.0
	2 – Industrial Processes	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2
$PM_{2.5}$	1 A 1 – Energy industries	0.0	0.0	-0.1	0.0	0.0	0.1
	1 A 2 – Manufacturing Industries and Construction	-0.1	-0.8	-0.9	-0.9	-0.9	-0.9
	2 – Industrial Processes	0.0	0.0	0.1	0.0	0.0	0.0
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	-0.2	-0.5	-0.3	-0.3	-0.3	-0.3
	2 – Industrial Processes	-16.5	-20.2	-29.9	-30.5	-31.4	-32.8
	2 D – Solvents	-14.9	-18.6	-28.1	-28.6	-29.5	-30.9

Revisions up to the year 2015 are mainly due to updates of the national energy balance. For the 2017 projections the energy balance with data up to 2015 was used, whereas for the projections in 2019 the energy balance with data up to 2017 has been used. Hence, energy demand and thus the emissions are different in the current projections. Other revisions are due to recent developments on European electricity markets, i.e. the reduced profitability of gas and coal power plants and a drastic change in the profitability of photovoltaic installations over the last couple of years.

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

Based on a new study on emissions from the wood industry (IÖ 2018), the biomass emission factors for other industries have been adapted in the national inventory and thus for the projections accordingly. Process emissions of the fibreboard industry are no longer reported separately.

Based on plant-specific data from the glass industry, emission factors have been adapted in the national inventory and changed accordingly in the projections.

2 D – Solvents and other product use

New data and methods were applied for the years from 2000 onwards, and mainly data available from reports under Directive 1999/13/EC (VOC Solvents Directive)[21] were implemented in the model. On the other hand, the statistical data used for estimating solvent use in Austria was revised for the years from 2000 onwards: import-export/production statistics were screened for streams that had not

[21] VOC-Anlagen-Verordnung (VAV), BGBl. II Nr. 301/2002 vom 26.7.2002

been considered previously as well as for streams that had been included although they did not constitute to solvent use. In addition, fluctuations in the timeline (i.e. significant differences between years) were checked and evaluated. Several changes resulted in the revision of the top-down data. Substance uses that do not constitute to solvent use are uses where the substance is not emitted, i.e:

- substances used only to carry out synthesis in chemical processes without a solvent relevance such as aromatic compounds – excluded from solvent sum
- substances that are used both as solvents and as basic substances for chemical synthesis (where only the amount used as a solvent is considered for the model) – included in the solvent balance, but with the amount used for the synthesis deducted as a 'non-solvent' use
- substances used as solvents in closed synthesis processes that are safely collected and destroyed – included in the solvent management plan, but accounted for by using an emission factor of 0.

Further changes to the methodology include: for products containing solvents, such as paints and glues, a balance of imports and exports is compiled, and the solvent content is estimated. Emission factors have been established on a SNAP basis, combining information from the solvent balances provided by companies and expert judgement. Emissions were then calculated by multiplying activity data by the respective EF. For those SNAPs where only the solvent content was estimated, an EF of 95% was applied.

5.1.2 Transport (1 A 3)

Table 32: Major changes between the projections 2017 and 2019 for Sector 1A3, in kt (fuel sold), (Source: Umweltbundesamt).

Pollutant	Sector (CRF)	2005	2010	2017	2020	2025	2030
NO_x	**1 A 3 – Transport**	0.6	2.0	10.9	9.7	4.4	1.4
	1 A 3 a – Civil Aviation	0.0	0.0	0.1	0.1	0.1	0.1
	1 A 3 b 1 – Passenger cars	-0.8	4.2	14.1	10.8	4.5	1.1
	1 A 3 b 2 – Light duty vehicles	0.1	0.1	0.3	0.2	0.2	0.2
	1 A 3 b 3 – Heavy duty vehicles	1.2	-2.4	-3.5	-1.5	-0.5	-0.1
	1 A 3 b 4 – Mopeds & Motorcycles	0.0	0.0	0.1	0.0	0.0	0.0
	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	-0.1	0.0	0.0	0.0
	1 A 3 e – Pipeline compressors	0.0	0.0	0.0	0.1	0.1	0.1
NMVOC	**1 A 3 – Transport**	2.5	2.3	1.4	1.3	1.2	1.3
	1 A 3 a – Civil Aviation	0.0	0.0	-0.3	-0.2	-0.2	-0.3
	1 A 3 b 1 – Passenger cars	-0.3	0.1	0.2	0.1	0.3	0.6
	1 A 3 b 2 – Light duty vehicles	-0.2	0.0	0.1	0.1	0.0	0.0
	1 A 3 b 3 – Heavy duty vehicles	0.0	-0.1	-0.1	0.0	0.0	0.0
	1 A 3 b 4 – Mopeds & Motorcycles	1.9	1.7	1.3	1.0	0.8	0.6
	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	0.0	0.0	0.0
	1 A 3 e – Pipeline compressors	0.0	0.0	0.0	0.0	0.0	0.0

NO_x and NMVOC emissions for WEM in the 2019 submission are higher than in the 2017 submission, for several reasons:

The majority of the higher NO_x emissions in 2030 can be explained by updated assumptions regarding the shares of the different propulsion systems in new PC registrations and their respective efficiency rates.

This has a major impact on updated estimates of the electric mobility trend. The 2017 submission reflected a very optimistic outlook, whereas the current WEM19 is much more conservative. The share of EVs in all new PC registrations in 2030 is thus only 25% (2035: 32%) compared to 35% in the former submission. The main reason for this more conservative outlook for the development of the EV fleet in Austria (compared to the 2017 submission) is the delayed and insufficient availability (or even unavailability) of a number of EV models that had been announced in earlier years and were expected to be suitable for the mass market.

Increased NMVOC emissions of mopeds and motorcycles are caused by an increase in yearly mileage as included in one of the last inventory submissions.

5.1.3 Other Sectors (NFR 1 A 4)

Table 33: Major changes between the projections 2017 and 2019 for Sector 1A4 in kt (Source: Umweltbundesamt).

Pollutant	Sector (NFR)	2005	2010	2017	2020	2025	2030
NO_x	**1 A 4 – Other Sectors**	-0.3	1.2	1.8	2.4	1.7	0.9
	1 A 4 a 1– Commercial/Institutional: Stationary	-0.3	-0.5	-0.3	0.0	-0.1	-0.1
	1 A 4 b 1 – Residential: stationary	0.6	1.1	1.6	1.5	1.4	1.1
	1 A 4 c 1 – Agriculture/Forestry/Fishing: Stationary	-0.4	-0.2	-0.3	-0.3	-0.3	-0.4
NMVOC	**1 A 4 – Other Sectors**	-5.1	-1.1	0.6	4.2	4.1	2.8
	1 A 4 a 1– Commercial/Institutional: Stationary	0.1	0.6	-0.2	0.8	0.6	0.3
	1 A 4 b 1 – Residential: stationary	-4.6	-1.6	1.1	3.6	4.3	3.7
	1 A 4 c 1 – Agriculture/Forestry/Fishing: Stationary	-0.5	0.3	0.4	0.6	0.2	-0.2
$PM_{2.5}$	**1 A 4 – Other Sectors**	0.6	1.2	1.0	1.4	0.8	0.1
	1 A 4 a 1– Commercial/Institutional: Stationary	0.1	0.1	-0.1	0.1	0.0	-0.1
	1 A 4 b 1 – Residential: stationary	0.7	1.1	1.2	1.4	0.9	0.4
	1 A 4 c 1 – Agriculture/Forestry/Fishing: Stationary	-0.1	0.0	0.0	0.0	0.0	-0.1

The underlying INVERT/EE-Lab model has been updated with recent statistical data on building stock and thermal building quality (TU WIEN & ZEU 2019). Emerging trends in activity data (energy consumption) over the recent inventory data years (in particular a major shift of natural gas from the commercial sector 1 A 4 a and the industrial sector 1 A 2 to the residential sector 1 A 4 b), which form the basis for the projections (and the model calibration), account for some of the differences to the previous 2017 projections.

Another important change has been made to the pollutants NO_x, NMVOC and $PM_{2.5}$, due to a remodelling of emissions from 1 A 4 in both the projections and the inventory (2005 and 2010). Emissions are now based on a new energy demand model for space heating. The model considers more detailed technologies with an improved time series consistency. Assumptions on the share of new installations have been included in the projections, implying a constant shift towards low emission technologies (heating types) within the fuel category. Additionally, ecodesign provisions are assumed to modify the average emission levels of several new heating installations in the future .

NO_x, NMVOC and $PM_{2.5}$ emissions were recalculated based on new installations with lower emission factors from 2018 onwards, substituting boiler stocks with average 2017 emission characteristics or increasing overall boiler stocks.

Both changes cause major shifts in the resulting overall stock emission factors. Further details on ecodesign standard emission requirements and implied emissions factors are provided in Chapter 3.1 and Chapter 4.1.3.

5.1.4 Agriculture (NFR 3)

Table 34: Major changes between the projections 2017 and 2019 for Sector 3 (in kt), (Source: Umweltbundesamt).

Pollutant	Sector (NFR)	2005	2010	2017	2020	2025	2030
NH_3	**3 – Agriculture**	-2.8	-1.5	0.5	-1.3	-0.4	0.4
	3 B 1 a	-0.3	-0.1	0.4	-0.2	-0.4	-0.5
	3 B 1 b	-0.2	0.0	0.5	0.4	0.9	1.5
	3 B 4 e	0.1	0.1	0.2	0.1	0.1	0.1
	3 B 3	-0.2	-0.3	-0.5	-0.7	-1.2	-1.7
	3 B 4 g	-0.1	-0.1	0.0	-0.1	0.1	0.3
	3 D	-2.4	-1.6	-0.7	-1.2	-0.6	0.0
NO_x	**3 – Agriculture**	0.1	0.0	0.0	0.4	0.7	0.9
	3 D	-0.2	-0.2	-0.2	0.2	0.4	0.7
NMVOC	**3 – Agriculture**	38.8	37.9	36.5	37.0	37.3	37.7
	3 B	28.2	27.9	27.1	27.6	27.9	28.2

Main improvements of the Austrian Air Emission Inventory

Update of activity data

AWMS data (3.B, 3.D)

The research project 'Animal husbandry and manure management systems in Austria (TIHALO I, AMON et al. 2007)' was followed by a new study (TIHALO II, PÖLLINGER et al. 2018). For this project, as for the previous one, a comprehensive survey on agricultural practices in Austria has been carried out. For the 2019 submission the results of this survey (data on livestock feeding, management systems and practices, application techniques) were implemented in Austria's emission inventory resulting in revisions for NH_3 and NO_x emissions in all animal related emission sources.

The following inventory updates have an impact on Austria's ammonia inventory:

- Increased share of loose housing systems (cattle)
- Increased share of liquid systems (cattle & swine)
- Consideration of the 'grooved floor' system for cattle housings (liquid system)

- Consideration of the 'partly slatted floor' system for pig housings (liquid system)
- Consideration of the 'manure belt' system for poultry housings (solid system)
- Consideration of N2 losses from manure storage
- Consideration of the following low-emission manure spreading techniques: trailing hose, trailing shoe, injector (liquid manure)
- Consideration of liquid manure amounts diluted before spreading (50% dilution)
- Consideration of rapid incorporation of solid manure (within 12h and within 4h)
- Consideration of humid conditions before application (timing)
- Improved calculations for non-key animals (sheep, goats and poultry)

Livestock data (3.B, 3.D)

In response to a recommendation under the NEC Review 2018, Austria split its piglet numbers (<20 kg) into suckling piglets (<8 kg) and weaned piglets (8–20 kg). The share of suckling and weaned piglets was calculated on the basis of daily weight gain and official livestock data (STATISTIK AUSTRIA 2018b). This approach was accepted under the NEC Review 2018 and used for all inventory years.

Land use data (3.D)

Cropland and grassland area for the years 2014, 2015 and 2016 has been slightly revised, according to the final results of the farm structure survey 2016.

Detailed raw material and energy balances (3.D.a.2.c)

Estimates have been updated on the basis of newly available raw material balances for the years 2015 and 2016 (E-Control 2018). Based on the new AWMS data (PÖLLINGER et al. 2018), NH_3 and NO_x emissions have been revised slightly upwards for all reporting years.

Methodological changes

Manure Management (3.B) – NH_3

The main reason for the changes to the NH_3 emissions was the implementation of new and updated information on Austria's agriculture practices obtained from PÖLLINGER et al. (2018), e.g. an increased share of loose housing systems. As a consequence, NH_3 emissions from manure management have been revised upwards for the whole time series.

Manure Management (3.B) – NO_x

Calculations of NO_x emissions have been improved by applying the Tier 2 methodology according to the 2016 EMEP/EEA Guidebook. The use of a mass flow approach based on the concept of a flow of TAN through the manure management system has resulted in higher emissions for the whole time series.

Manure Management (3.B) – NMVOC

Following a recommendation under the NEC Review 2018, Austria revised its calculations according to the 2016 EMEP/EEA 2016 Tier 2 methodology for all livestock categories. The improved calculations resulted in higher emissions for the whole time series.

Agricultural Soils (3.D) – NH_3

3.D.a.1 Mineral fertiliser application

The calculation method for NH_3 emissions from mineral fertiliser application has been improved. The EMEP/EEA 2016 Tier 2 methodology based on more detailed activity data (fertiliser types) has been used for the first time. A review of historical fertiliser data was carried out as part of the revision, resulting in a correction of the 1990–1995 fertiliser amounts.

3.D.a.2.a Animal manure applied to soils

NH_3 emissions have been revised downwards for the entire time series. The reasons are improvements carried out in the manure management sector (e.g. updated AWMS data, taking N_2 losses into account for the first time, improved calculations of NO_x emissions, see above) resulting in smaller N amounts available for application, and also taking specific low-emission application techniques (as described above) into account.

Agricultural Soils (3.D) – NO_x

3.D.a.2.a Animal manure applied to soils

Taking N_2 losses and improved NO_x calculations into account in the manure management sector resulted in smaller N amounts available for application. This has resulted in lower NO_x emissions for the whole time series.

Agricultural Soils (3.D) – NMVOC

3.D.a.2.a Animal manure applied to soils

NMVOC emissions from manure application have been estimated based on the 2016 EMEP/EEA Tier 2 methodology for the first time. The calculations have resulted in a considerable change to the amount of emissions.

3.D.a.3 Urine and dung deposited by Grazing Animals

For the first time NMVOC emissions from grazing animals have been estimated. Calculations are based on the 2016 EMEP/EEA Tier 2 methodology.

Additional data sources

Biological treatment of waste (5.B) – NH_3

NH_3 emissions from anaerobic digestion in biogas facilities (5.B.2) have been submitted for the first time in the current submission. Calculations were carried out according to the Tier 1 methodology of the 2016 EMEP/EEA Guidebook. Emissions were calculated in sector *3 Agriculture* but have been reported under sector *5 Waste*.

For more details see Austria's Informative Inventory Report (IIR) 2019 (UMWELTBUNDESAMT 2019b).

Revisions of the sectoral projection model

Activity data projections

Projected activity data are based on the results of calculations carried out using the Positive Agricultural Sector Model Austria (PASMA), developed by the Austrian Institute of Economic Research (WIFO) (WIFO & BOKU 2018).

- In contrast to the data used in the previous projections (WIFO & BOKU 2015), the results obtained from the new model indicate that cattle numbers are expected to be significantly lower than it was projected in previous projections. This result is driven by different price assumptions and lower levels of expected milk yields per cow. Furthermore, swine and pork production will decrease. The reason for the difference compared to previous projections is the expected price for pork, which will be significantly lower than projected in 2015. The amount of mineral nutrient sales, likely to decline significantly according to previous projections, is now expected to decline only slightly in the very long run. The reason for these differences is that it is more profitable to use purchased inputs than in the projections of 2015. Furthermore, due to the smaller numbers of livestock according to 2018 data, a higher amount of mineral fertiliser is needed.

Among these numerous revisions, the strongest impact was due to the implementation of the new data on agricultural practices in Austria. In the case of NMVOC, the methodological changes were primarily responsible for the revisions.

5.1.5 Waste (NFR 5)

Pollutant	Sector (CRF)	2005	2010	2017	2020	2025	2030
NH_3	**5 – Waste**	0.2	0.4	0.4	0.4	0.4	0.4

Table 35: Major changes between projections 2017 and 2019 for Sector 5 (in kt), (Source: Umweltbundesamt).

The recalculation for NH_3 in Sector 5B2 is due to the inclusion of NH_3 emissions from anaerobic treatment of agricultural feedstock in the waste sector for the first time.

For further information on the recalculation see Chapter 5.1.4 (agriculture sector).

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ANNEX: NATIONAL PROJECTION ACTIVITY DATA

Table 36: Assumptions on general economic parameters (Source: Umweltbundesamt).

	Unit	2017	2020	2025	2030
1. Gross Domestic Product	Value (billion €)	361	386	414	444
2. Population	Thousand people	8 797	8 942	9 158	9 331
3. International coal prices	€/GJ	3	3	3	4
4. International oil prices	€/GJ	8	14	16	17
5. International gas prices	€/GJ	6	9	10	10

Table 37: Assumptions for the energy sector – with existing measures (Source: Umweltbundesamt).

	Unit	2017	2020	2025	2030
Total gross inland consumption*					
1. – Oil (fossil)	Petajoule (PJ)	515	539	539	526
2. – Gas (fossil)	Petajoule (PJ)	326	297	285	280
3. – Coal	Petajoule (PJ)	131	125	112	106
4. – Biomass without liquid biofuels (e.g. wood)	Petajoule (PJ)	211	222	222	222
5. – Liquid biofuels (e.g. bio-oils)	Petajoule (PJ)	21	22	24	32
6. – Solar*	Petajoule (PJ)	12	14	19	24
7. – Other renewable (wind, geothermal etc)	Petajoule (PJ)	172	188	196	201
Total electricity production by fuel type*					
8. – Oil (fossil)	GWh	322	200	207	212
9. – Gas (fossil)	GWh	12 144	8 645	7 454	7 015
10. – Coal	GWh	3 997	4 197	2 959	2 209
11. – Renewable	GWh	50 919	56 020	57 984	59 762

** Solarthermal and PV*

Table 38: Assumptions for the industry sector – with existing measures (Source: Umweltbundesamt).

	Unit	2017	2020	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	%	4.3%	2.8%	1.3%	1.1%
Pulp & Paper	%	5.2%	4.2%	2.6%	2.6%
Non-metallic Minerals	%	3.4%	2.3%	1.6%	1.5%
Chemical Industry	%	5.5%	4.6%	3.0%	3.1%
Machine Construction	%	4.6%	4.3%	2.7%	2.7%
Vehicle Construction	%	4.5%	4.0%	2.2%	2.3%
Food and Drink	%	3.8%	3.3%	2.1%	2.2%
Other Industry	%	1.7%	5.1%	4.3%	2.1%

Table 39: Assumptions for the transport sector – with existing measures (Source: Umweltbundesamt).

	Unit	2017	2020	2025	2030
15. Passenger person kilometres*	million km	118 227	119 416	123 693	127 984
16. Growth of freight tonne kilometres*	million tonne-km	78 861	81 656	88 733	95 096
17. Fleet turnover assumptions (vehicle replacement)					
17a. Passenger cars**	% of new vehicles per year	6%	6%	6%	6%
17b. Light duty vehicles**	% of new vehicles per year	9%	9%	8%	8%
17c. Heavy trucks**	% of new vehicles per year	10%	10%	8%	8%

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

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

Table 40: Assumptions for buildings residential and commercial or tertiary sector– with existing measures, (Source: Umweltbundesamt).

	Unit	2017	2020	2025	2030
20a. The rate of change of floor space for tertiary buildings *	%	0.82%	0.88%	0.88%	0.81%
20b. The rate of change of floor space for dwellings*	%	1.10%	0.93%	0.65%	0.55%
21a. The number of dwellings in the tertiary sector**	Number	192 615	197 365	205 663	213 751
21a. The number of dwellings in the tertiary sector**	Number	3 888 631	3 992 168	4 126 423	4 229 832

** Ratio of conditioned floor area in commercial buildings between given year and previous year*

*** Number of permanently occupied dwellings*

Table 41: Assumptions for the agriculture sector (Source: Umweltbundesamt).

	Unit	2017	2020	2025	2030
23. Beef cattle	1 000 heads	1 400	1 428	1 439	1 450
24. Dairy cows	1 000 heads	543	550	557	565
25. Sheep	1 000 heads	401	374	375	376
26. Pigs	1 000 heads	2 820	2 762	2 736	2 710
27. Poultry	1 000 heads	15 772	14 662	13 999	13 336
28. Synthetic fertilizer	kt N	120	128	126	123

Table 42: Assumptions for the waste sector– with existing measures (Source: Umweltbundesamt).

	Unit	2017	2020	2025	2030
31. Municipal solid waste disposed to landfills*	tonnes	151 866	140 603	140 603	140 603

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

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This report covers the results for projections of the air pollutants sulphur dioxide (SO_2), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC), ammonia (NH_3) and particulate matter ($PM_{2.5}$) under the scenario "with existing measures" (WEM). It updates the previous projections for air pollutants published in 2015 (REP-0556). The WEM scenario results in significant reductions in emissions from 2005 to 2030 for all pollutants except NH_3. The most substantial reduction (about 64%) is projected for the pollutant NO_x. Emission reductions for the other pollutants range from 27% to 48%; NH_3 emissions, however, are projected to increase by 15%.

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