ENVIRONMENT AGENCY AUSTRIA umweltbundesamt

# Austria's National Air Emission Projections 2017 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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# 1 GENERAL APPROACH

The 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) und "with additional measures" (WAM) were last published in 2015 in the report entitled "Austria's National Air Emission Projections 2015 for 2015, 2020 and 2030" (UMWELTBUNDESAMT 2015).

This year's report provides an update of the emission projections for the WEM scenario only, which is based on the new energy scenarios (UMWELTBUNDESAMT 2017a) and an update of policies and measures (PAMs).

Currently – at the beginning of the year 2017 – the national climate and energy strategy is in preparation. A clear picture of planned measures cannot be anticipated before the process of negotiations has been completed. As it will also have a significant effect to the air pollution regime, a scenario 'with additional measures' has not been prepared for reporting in March 2017.

The scenario 'with existing measures' includes all PAMs implemented by 30 May 2016. The status and current implementation of measures have been defined at expert level in consultation with the Federal Ministry of Agriculture, Forestry, Environment and Water Management. 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 additionally evaluated the fuel options 'fuel sold' and 'fuel used'.

The air pollutant projections are fully consistent with the current GHG emission projections under the EU Monitoring Regulation (UMWELTBUNDESAMT 2017c).

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 2017 (UMWELTBUNDESAMT 2017b) 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 with the amendment in 2012 also on emission ceilings for the year 2020. Austria signed the Gothenburg Protocol but to date has not ratified it. For this reason the targets are not binding for Austria. However, the Directive of the Eu-

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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

ropean 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 ceiling 2010 has been transposed into national law through the Emission Ceilings Act – Air ('*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.

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[4] 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 should 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 fuels used as a basis for compliance under the LRTAP convention may keep this option in order to ensure coherence between international and Union law.

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

In the last decade, Austria experienced a considerable amount of fuel being exported 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). The issue 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. The emissions ceilings from 2020 onwards are stated in the Annex II of the revised NEC Directive (2016/2284/EU) (see Table 1).

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[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. Nr. 34/2003

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

*Table 1: Emission ceilings according to the NEC Directive 2001/81/EC and the 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 projection and national inventory

Where reasonable and applicable, emissions were calculated and projected on the basis of the methodology used in the Austrian Inventory. These are described in Austria's National Inventory Report 2017 (UMWELTBUNDESAMT 2017b).

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 2017 (UMWELTBUNDESAMT 2017a).

The air pollutant projections are fully consistent with the historical emission data from the Austrian Emission Inventory (submission March 2017) up to the latest available data year 2015.

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 and on an econometric input-output model (DYNK) of the Austrian Institute of Economic Research (WIFO 2017), supported by calculations carried out with the bottom-up models TIMES (Austrian Energy Agency, AEA 2017), INVERT/EE-Lab (Energy Economics Group of the Technical University of Vienna, TU WIEN 2017) and NEMO & GEORG (Technical University of Graz, TU GRAZ 2017).

Projections for agriculture have been calculated by the Austrian Institute of Economic Research (WIFO & BOKU 2015) in cooperation with Umweltbundesamt. 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 MMR (UMWELTBUNDESAMT 2017c).

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) as well as NEMO & GEORG (Graz University of Technology) | Umweltbundesamt (energy providers, manufacturing industries, residential and commercial sector, parts of the transport sector)<br>Graz University of Technology (transport sector) |
| Industry | Austrian Institute of Economic Research (macroeconomic model DYNK)<br>Solvents: Statistics Austria, expert judgements. VOC directive | Umweltbundesamt |
| Agriculture | Austrian Institute of Economic Research (agriculture model PASMA) (WIFO & BOKU 2015). | Umweltbundesamt |
| Waste | Landfill database, 'EDM' (national database on waste amounts, deposited and treated)<br>Federal Waste Management Plan<br>Expert judgement by Umweltbundesamt on waste amounts expected to be pre-treated in mechanical-biological treatment plants<br>population scenarios (STATISTIK AUSTRIA 2016a) | 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 (2017b, c).

*Table 3: Key input parameters for emission projections (UMWELTBUNDESAMT 2017a).*

| Year | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| GDP [billion € 2015] | 335 | 360 | 388 | 419 |
| GDP real growth rate [%] | 1.0% | ~ 1.5% | ~ 1.5% | ~ 1.5% |
| Population [1 000] | 8 621 | 8 939 | 9 156 | 9 314 |
| Number of households [1 000] | 4 197 | 4 438 | 4 624 | 4 776 |
| Heating degree days | 3 238 | 3 204 | 3 171 | 3 118 |
| Exchange rate [US$/€] | 1.12 | 1.16 | 1.20 | 1.20 |
| International coal price [US$15/t] | 57 | 74 | 92 | 110 |
| International oil price [US$15/bbl.] | 55 | 89 | 105 | 115 |
| International natural gas price [US$15/GJ] | 6.2 | 7.7 | 8.3 | 9.0 |
| $CO_2$ certificate price [€/t $CO_2$] | 7.5 | 15.0 | 20.0 | 26.5 |

# 2 MAIN RESULTS

The following table shows Austria´s national total emissions 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 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 66% for fuel sold and 56% 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.

Emission reductions for the other pollutants are in the range from 22% to 48%; $NH_3$ emissions, however, are projected to increase by 8–9% (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 | Emission inventory 2017 | | | | Emission scenario | | | Type of scenario |
|---|---|---|---|---|---|---|---|---|
| [kt] | 1990 | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 | |
| $NO_x$ | 220.89 | 238.06 | 181.08 | 149.12 | 113.69 | 92.82 | 82.04 | fuel sold |
| | | *0%* | *– 24%* | *– 37%* | *– 52%* | *– 61%* | *– 66%* | |
| | 203.12 | 178.94 | 149.42 | 131.74 | 106.67 | 89.03 | 79.23 | fuel used |
| | | *0%* | *– 16%* | *– 26%* | *– 40%* | *– 50%* | *– 56%* | |
| $SO_2$ | 74.57 | 25.95 | 16.70 | 14.90 | 13.98 | 13.70 | 13.55 | fuel sold |
| | | *0%* | *– 36%* | *– 43%* | *– 46%* | *– 47%* | *– 48%* | |
| | 73.66 | 25.89 | 16.66 | 14.87 | 13.94 | 13.67 | 13.52 | fuel used |
| | | *0%* | *– 36%* | *– 43%* | *– 46%* | *– 47%* | *– 48%* | |
| NMVOC | 280.63 | 136.62 | 118.73 | 112.89 | 108.69 | 105.08 | 103.28 | fuel sold |
| | | *0%* | *– 13%* | *– 17%* | *– 20%* | *– 23%* | *– 24%* | |
| | 277.27 | 132.43 | 117.19 | 112.36 | 108.35 | 104.80 | 103.04 | fuel used |
| | | *0%* | *– 12%* | *– 15%* | *– 18%* | *– 21%* | *– 22%* | |
| $NH_3$ | 66.15 | 65.30 | 66.80 | 66.87 | 70.29 | 70.31 | 70.37 | fuel sold |
| | | *0%* | *2%* | *2%* | *8%* | *8%* | *8%* | |
| | 66.09 | 64.70 | 66.53 | 66.80 | 70.23 | 70.25 | 70.31 | fuel used |
| | | *0%* | *3%* | *3%* | *9%* | *9%* | *9%* | |
| $PM_{2.5}$ | 25.25 | 22.11 | 19.02 | 16.62 | 14.57 | 13.64 | 12.99 | fuel sold |
| | | *0%* | *– 14%* | *– 25%* | *– 34%* | *– 38%* | *– 41%* | |
| | 24.67 | 20.48 | 18.33 | 16.33 | 14.46 | 13.58 | 12.95 | fuel used |
| | | *0%* | *– 11%* | *– 20%* | *– 29%* | *– 34%* | *– 37%* | |

## 2.1 Nitrogen Oxides $NO_x$

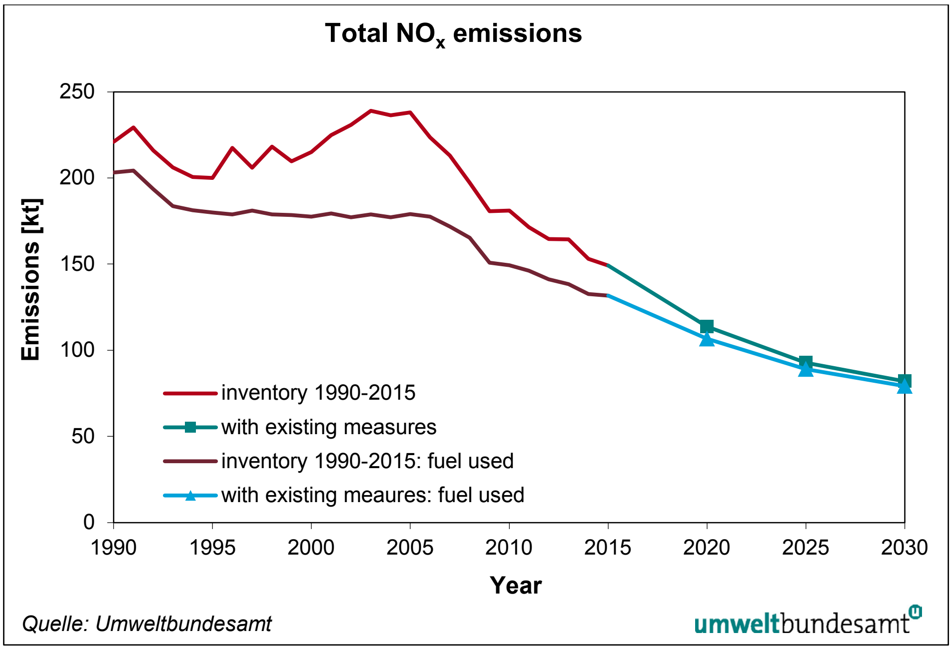
In 1990, national total $NO_x$ emissions amounted to 221 kt (including fuel exports in the vehicle tank, i.e. based on fuel sold). After an all-time high between 2003 and 2005, emissions have since been following a continuously decreasing trend. In 2015, $NO_x$ emissions amounted to 149 kt and were about 32.5% lower than in 1990.

Compared to 2005 levels, emissions in 2015 were about 37% lower. When considering inland fuel consumption without 'fuel exports in the vehicle tank', $NO_x$ emissions amounted to only 132 kt in 2015, corresponding to a 26% 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 for $NO_x$ emissions in Austria (with a share of 92% in 2015) is the sector *1.A Fuel Combustion Activities.* Within this sector, *Road transport* ('fuel sold') accounts for the highest share (51%) of the total $NO_x$ emissions. Further major sources were 1.A.2 *Industry* (20%), 1.A.4 Other Sectors (12%) and 1.A.1 *Energy Industry (7.9%).* Sector *3 Agriculture* contributes 7.3%.

In the scenario "with existing measures" (WEM) the national total emissions (including 'fuel export') are expected to decrease to 82.0 kt by 2030 (–66% compared to 2005). Without 'fuel export' they are expected to decrease to 79.2 kt (–56% compared to 2005).

*Figure 1: Historical (1990 to 2015) and projected emissions (2020–2030) of $NO_x$ based on (a)* ***fuel sold*** *and (b)* ***fuel used****.*




The main drivers of the $NO_x$ emissions trend until 2030 are expected to be road transport, households and energy industry.

$NO_x$ emissions from *Road Transport* (especially cars and heavy duty vehicles) are projected to decrease by 73% (i.e. 53 kt) from 2015 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% (i.e. 5.6 kt) from 2015 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 electrified propulsion in these categories. Mobile sources in households and agriculture (off-road) show a decrease by 46% (–3.1 kt) by 2030. Stationary sources decrease by 21% (–2.5 kt) by 2030 because of a decrease in the use of fuel oil, ongoing stock replacement with condensing boilers and the effects of 'Ecodesign' 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* (–34%, i.e. –4.1 kt) by 2030. Mobile sources in industry (off-road) show a decrease by 63% (–4.0 kt) by 2030.

*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 | 2015 | 2020 | 2025 | 2030 | |
| | **Total** | **220.89** | **238.06** | **181.08** | **149.12** | **113.69** | **92.82** | **82.04** | fuel sold |
| | | **203.12** | **178.94** | **149.42** | **131.74** | **106.67** | **89.03** | **79.23** | fuel used |
| **1 A 1** | **Energy Industries** | 17.73 | 14.30 | 13.01 | 11.85 | 9.02 | 8.42 | 7.79 | |
| **1 A 2** | **Manufacturing Industries and Construction** | 32.97 | 33.72 | 32.24 | 29.33 | 26.72 | 25.84 | 25.96 | |
| **1 A 3 a, c, d, e** | **Off-Road transport** | 3.46 | 4.90 | 4.11 | 3.48 | 3.35 | 3.20 | 3.09 | |
| **1 A 3 b** | **Road Transportation** | 122.15 | 146.89 | 98.38 | 73.16 | 45.53 | 28.50 | 20.11 | fuel sold |
| | | 104.38 | 87.78 | 66.73 | 55.78 | 38.51 | 24.71 | 17.30 | fuel used |
| **1 A 4** | **Other Sectors** | 27.72 | 26.37 | 21.72 | 18.59 | 16.45 | 14.53 | 13.02 | |
| **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** | 4.80 | 1.75 | 1.81 | 1.72 | 1.75 | 1.78 | 1.81 | |
| **2D, 2G** | **Solvent and other product use** | NA | NA | NA | NA | NA | NA | NA | |
| **3 B** | **Manure Management** | 0.48 | 0.37 | 0.37 | 0.37 | 0.30 | 0.29 | 0.29 | |
| **3 D** | **Agricultural Soils** | 11.38 | 9.60 | 9.32 | 10.53 | 10.47 | 10.17 | 9.88 | |
| **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 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | |

** Data source: Austrian Emission Inventory 2017 (UMWELTBUNDESAMT 2017b)*

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

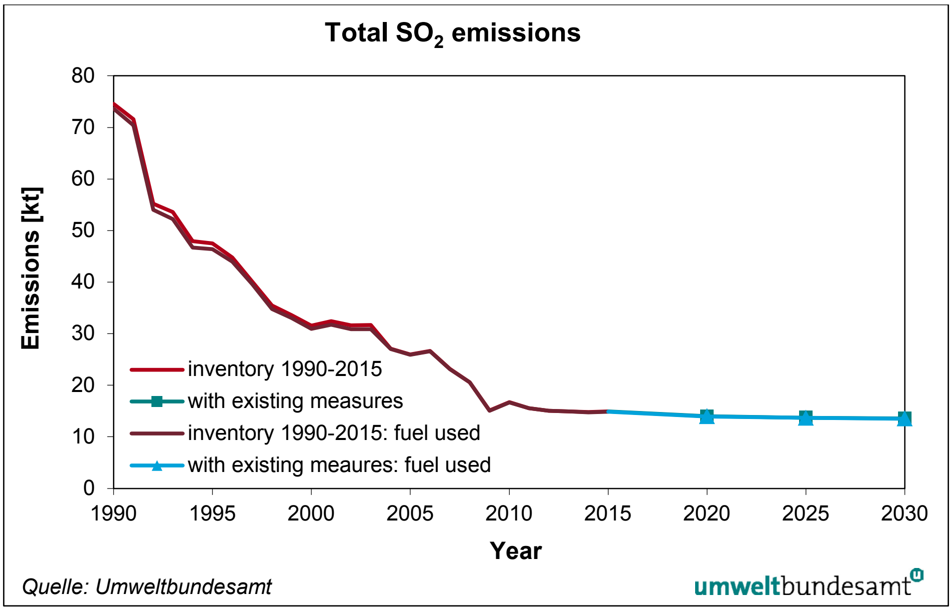
## 2.2 Sulphur Dioxide $SO_2$

In 1990, national total $SO_2$ emissions amounted to 75 kt. Since then emissions have decreased quite steadily. In the year 2015, emissions had decreased by 80% compared to 1990 (amounting to 15 kt), which was 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 of domestic heating oil. In 2015, emissions were about 43% lower than 2005.

The main source of $SO_2$ emissions in Austria is the NFR sector *1.A Fuel Combustion Activities* with 94% in 2015). Within this sector, the main contributors to the total $SO_2$ emissions are *1.A.2 Manufacturing Industries* with 71% (about half of the emissions arise from iron and steel industry), *1.A.1 Energy Industries* with 10% and *1.A.4 Other Sectors* (residential heating) with 11% of the total share.

In the scenario "with existing measures" (WEM) the national total emissions including 'fuel export' are expected to decrease to 13.55 kt by 2030 (–48% compared to 2005). Without 'fuel export' they are expected to decrease to 13.52 kt (–48% compared to 2005).

*Figure 2: Historical (1990 to 2015) and projected emissions (2020–2030) of $SO_2$ based on (a) **fuel sold** and (b) **fuel used**.*




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

Minor effects can be seen on sectoral level: Emissions from *Energy Industries* (1.A.1) are expected to decrease due to less fuel input (–46%, i.e. 0.7 kt) and those from Other Sectors (1.A.4) are expected to decrease (–36%, i.e. 0.6 kt) by 2030 due to a shift from fossil fuels (oil, coal) to renewable fuels. Emissions from the manufacturing industries and construction (1.A.2) are expected to remain stable.

*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 | 2015 | 2020 | 2025 | 2030 | |
| | **Total** | 74.57 | 25.95 | 16.70 | 14.90 | 13.98 | 13.70 | 13.55 | fuel sold |
| | | 73.66 | 25.89 | 16.66 | 14.87 | 13.94 | 13.67 | 13.52 | fuel used |
| **1 A 1** | **Energy Industries** | 14.04 | 6.67 | 2.74 | 1.45 | 1.02 | 0.89 | 0.78 | |
| **1 A 2** | **Manufacturing Industries and Construction** | 17.96 | 10.06 | 9.88 | 10.61 | 10.36 | 10.46 | 10.56 | |
| **1 A 3 a, c, d, e** | **Off-Road transport** | 0.47 | 0.19 | 0.18 | 0.18 | 0.17 | 0.18 | 0.18 | |
| **1 A 3 b** | **Road Transportation** | 4.85 | 0.16 | 0.13 | 0.13 | 0.13 | 0.13 | 0.12 | fuel sold |
| | | 3.95 | 0.11 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | fuel used |
| **1 A 4** | **Other Sectors** | 32.94 | 7.73 | 2.75 | 1.66 | 1.42 | 1.18 | 1.06 | |
| **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** | 2.22 | 1.02 | 0.95 | 0.81 | 0.82 | 0.82 | 0.82 | |
| **2D, 2G** | **Solvent and other product use** | NA | NA | NA | NA | NA | NA | NA | |
| **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 2017 (UMWELTBUNDESAMT 2017b)*

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

## 2.3 Non-Methane Volatile Organic Compounds (NMVOCs)

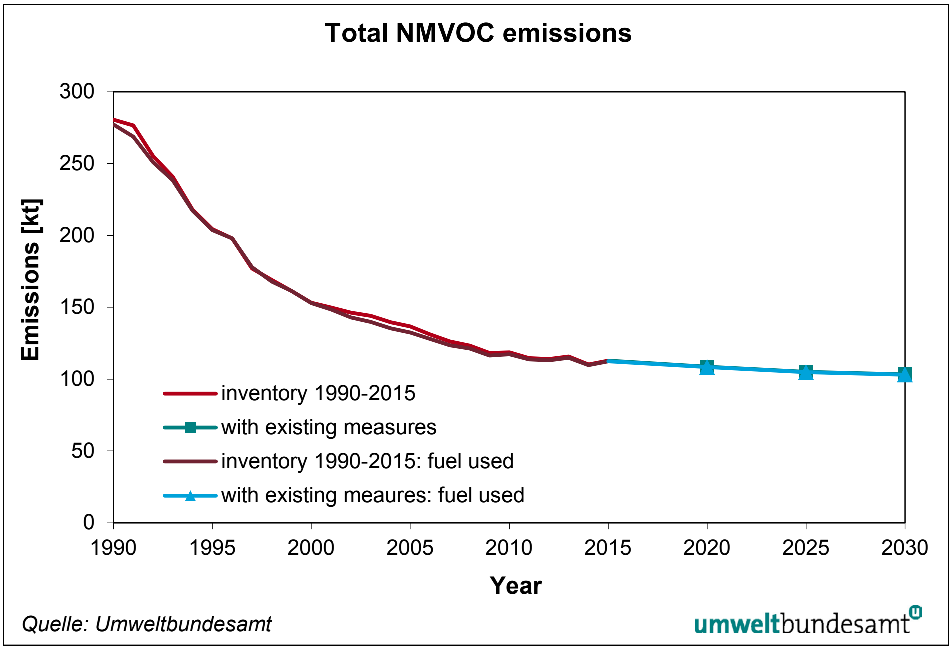
In 1990, Austria's total NMVOC emissions amounted to 281 kt. Emissions have decreased steadily since then and in the year 2015 emissions had decreased by 60% to 113 kt compared to 1990. In 2015 the emissions were about 17% lower than in 2005.

The main reasons for the reduction 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 more than 57% in 2015, 1.A.4 Other Sectors (26%) and 1.A.3 Transport (7%).

In the scenario 'with existing measures' (WEM) the national total emissions including 'fuel export' are expected to decrease to 103.3 kt by 2030 (–24% compared to 2005). Without 'fuel export' they are expected to decrease to 103.0 kt (–22% compared to 2005).

*Figure 3: Historical (1990 to 2015) and projected emissions (2020–2030) of NMVOC based on (a)* ***fuel sold*** *and (b)* ***fuel used****.*




Total NMVOC emissions are projected to decrease by 9% until 2030 (compared to 2015). The largest reduction is expected to be achieved in sector 1.A.4 (mainly households and commercial), with a decrease of 37% (i.e. 11 kt) from 2015 to 2030. This is mainly due to a trend towards central heating and the projected lower emission factors for new boilers in the residential sector (see also 'Ecodesign' requirements in chapter 3), as well as a decrease in the use of log wood as a source of energy.

Emissions in the sector *Road Transport* are projected to fall by 47% (i.e. 3.4 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 8% by 2030 (i.e.5.3 kt) due to an increase in the consumption of solvents. Emission regulations for the relevant sectors have been enacted at EU level (although some of the legal requirements in Austria are even stricter). The requirements for paints and varnishes have also been harmonised at EU level; existing regulations do not foresee a further tightening of emission standards. The model for calculating emissions from solvents is currently under revision, as it is not clear whether it potentially leads to overestimations.

*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** | 280.63 | 136.62 | 118.73 | 112.89 | 108.69 | 105.08 | 103.28 | fuel sold |
| | | 277.27 | 132.43 | 117.19 | 112.36 | 108.35 | 104.80 | 103.04 | 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** | 1.69 | 1.94 | 1.95 | 1.59 | 1.39 | 1.34 | 1.34 | |
| **1 A 3 a, c, d, e** | **Off-Road transport** | 1.21 | 1.28 | 1.08 | 0.92 | 0.97 | 0.91 | 0.90 | |
| **1 A 3 b** | **Road Transportation** | 73.59 | 18.20 | 9.93 | 7.23 | 5.72 | 4.74 | 3.86 | fuel sold |
| | | 70.22 | 14.01 | 8.39 | 6.70 | 5.38 | 4.47 | 3.62 | fuel used |
| **1 A 4** | **Other Sectors** | 61.36 | 35.84 | 32.04 | 29.47 | 25.65 | 21.58 | 18.67 | |
| **1 A 5** | **Other** | 0.01 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.02 | |
| **1 B** | **Fugitive Emissions** | 15.49 | 3.34 | 2.45 | 2.35 | 2.20 | 2.00 | 1.82 | |
| **2A,B, C,H,I, J,K,L** | **Industrial Processes** | 11.10 | 4.72 | 4.93 | 5.27 | 5.35 | 5.41 | 5.47 | |
| **2D, 2G** | **Solvent and other product use** | 114.43 | 69.72 | 64.74 | 64.50 | 65.94 | 67.66 | 69.81 | |
| **3 B** | **Manure Management** | NA | NA | NA | NA | NA | NA | NA | |
| **3 D** | **Agricultural Soils** | 1.15 | 1.11 | 1.06 | 1.03 | 0.96 | 0.93 | 0.90 | |
| **3 F, I** | **Field Burning and other agriculture** | 0.12 | 0.09 | 0.07 | 0.06 | 0.06 | 0.06 | 0.06 | |
| **5** | **Waste** | 0.16 | 0.11 | 0.09 | 0.07 | 0.05 | 0.04 | 0.04 | |

** Data source: Austrian Emission Inventory 2017 (UMWELTBUNDESAMT 2017b)*

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

## 2.4 Ammonia ($NH_3$)

In 1990, national total $NH_3$ emissions amounted to 66.1 kt; emissions have been quite stable over the period from 1990 to 2015. In 2015, emissions were 1.1% above 1990 levels, amounting to 66.9 kt.

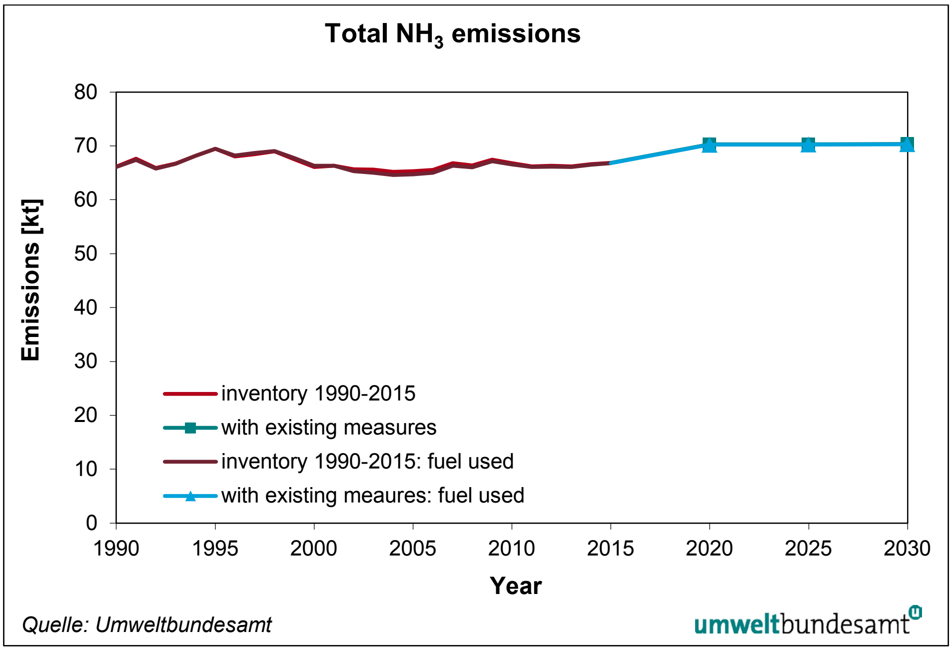
The main source of ammonia is the agricultural sector, contributing 94% of the total $NH_3$ emissions in 2015. Agricultural $NH_3$ emissions mainly result from animal husbandry and the application of organic and mineral N fertilisers.

The sub-sector 3.B *Manure Management* has a share of 43.2% in Austria's total $NH_3$ emissions in 2015. The emissions result from animal husbandry and the storage of manure. Within this source category cattle manure management has the highest share with 58%. Emissions are linked 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 this sub sector have increased by 4.8%, mainly due to higher emissions from cattle.

The sub-sector 3.D *Agricultural Soils* (with a share of 50.7%) has the highest share in the national total $NH_3$ emissions in 2015. These emissions result from fertilisation with mineral N fertilisers as well as organic fertilisers (including the application of 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 70.4 kt by 2030 (+8% compared to 2005). Without 'fuel export' they are expected to increase to 70.3 kt (+9% compared to 2005).

*Figure 4: Historical (1990 to 2015) 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 is expected to closely follow the development of livestock in Austria (+5% compared to 2015). Based on national forecasts for agricultural production in Austria (WIFO & BOKU 2015), animal numbers of dairy cattle and swine 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 8% increase in emissions (i.e. 2.2 kt) in the sub-sector 3.B *Manure Management.* Furthermore, emissions in sub-sector 3.D *Agricultural Soils* are projected to increase by 5% (i.e. 1.6 kt) by 2030, due to an increase in the quantity of animal manure applied as organic fertiliser.

*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 | 2015 | 2020 | 2025 | 2030 | |
| | Total | 66.15 | 65.30 | 66.80 | 66.87 | 70.29 | 70.31 | 70.37 | fuel sold |
| | | 66.09 | 64.70 | 66.53 | 66.80 | 70.23 | 70.25 | 70.31 | fuel used |
| 1 A 1 | Energy Industries | 0.19 | 0.32 | 0.47 | 0.42 | 0.42 | 0.42 | 0.42 | |
| 1 A 2 | Manufacturing Industries and Construction | 0.33 | 0.41 | 0.42 | 0.44 | 0.44 | 0.44 | 0.44 | |
| 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 | 1.13 | 2.57 | 1.69 | 1.33 | 1.31 | 1.24 | 1.14 | fuel sold |
| | | 1.07 | 1.98 | 1.43 | 1.27 | 1.25 | 1.18 | 1.08 | fuel used |
| 1 A 4 | Other Sectors | 0.63 | 0.69 | 0.64 | 0.59 | 0.56 | 0.52 | 0.48 | |
| 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 | 0.08 | 0.08 | 0.08 | 0.08 | |
| 2D, 2G | Solvent and other product use | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| 3 B | Manure Management | 27.55 | 28.09 | 29.22 | 28.88 | 30.64 | 30.84 | 31.05 | |
| 3 D | Agricultural Soils | 35.64 | 31.90 | 33.01 | 33.89 | 35.58 | 35.53 | 35.50 | |
| 3 F, I | Field Burning and other agriculture | 0.04 | 0.03 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | |
| 5 | Waste | 0.36 | 1.21 | 1.22 | 1.22 | 1.24 | 1.22 | 1.24 | |

** Data source: Austrian Emission Inventory 2017 (UMWELTBUNDESAMT 2017b)*

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

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

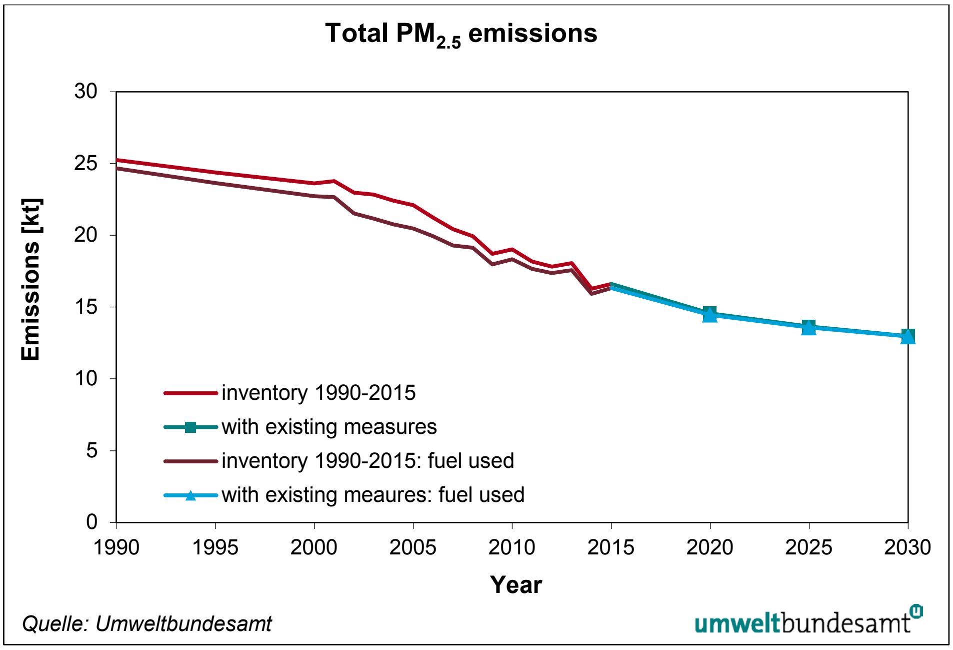
National total $PM_{2.5}$ emissions amounted to 25.2 kt in 1990 and have decreased steadily ever since: from 1990 to 2015, emissions (with 'fuel export') decreased by 25% to 16.6 kt. Emissions from fuel used amounted to 24.7 kt in 1990 and decreased to 16.3 kt in 2015 (–20%).

$PM_{2.5}$ emissions in Austria in 2015 mainly arose from combustion activities in the energy sector, which accounted for 81% of the national total emissions. Within this sector, *1.A.4 Other Sectors* (43%), *1.A.3 Transport* (18%), *1.A.2 Industry* (14%) are the main contributors to $PM_{2.5}$ emissions. Sector *3 Agriculture* is responsible for 7%.

In sector 1.A.4 (mainly households and commercial), substantial emission reductions have been achieved as a result of the substitution of old installations with modern technology, a reduction of biomass use in ovens and stoves, the installation of energy-saving combustion plants, by connecting buildings to district heating networks or other public energy and heating networks and by replacing high-emission fuels with low-emission (low-ash) fuels. The reduction in the *Transport* sector since 2005 is due to improvements in drive and exhaust gas after-treatment technologies and reductions in the Austrian fuel consumption based tax for diesel passenger cars with particulate filter systems (NOVA control).

In the scenario "with existing measures" (WEM) the national total emissions including 'fuel export' are expected to decrease to 13.0 kt by 2030 (–41% compared to 2005). Without 'fuel export' they are expected to decrease to 12.9 kt (–37% compared to 2005).

*Figure 5: Historical (1990 to 2015) 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 24% (i.e. 1.7 kt) by 2030 compared to 2015. $PM_{2.5}$ emission reductions are mainly due to an increased efficiency of buildings and heating systems and a trend away from manually fed log wood boilers. A decreasing energy demand for solid fuel (log wood, coal) is also responsible for $PM_{2.5}$ reductions.

Total $PM_{2.5}$ emissions of the sector *Road Transport* (including 'fuel export') are expected to decrease by about 43% (i.e. 1.1 kt) compared to 2015. Without 'fuel export' they are expected to decrease by about 37% (i.e. 0.9 kt) compared to 2015. Whereas exhaust emission from cars and trucks are expected to decrease by 2030 (due to the penetration of vehicles fitted with filters), emissions from automobile road abrasion increase slightly because of an increased in the total vehicle km driven.

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

Mobile sources in industry (off-road) show a decrease by 51% (i.e. 0.2 kt) by 2030, mainly due to the 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 | 2015 | 2020 | 2025 | 2030 | |
| | **Total** | 25.25 | 22.11 | 19.02 | 16.62 | 14.57 | 13.64 | 12.99 | fuel sold |
| | | 24.67 | 20.48 | 18.33 | 16.33 | 14.46 | 13.58 | 12.95 | fuel used |
| **1 A 1** | **Energy Industries** | 0.83 | 0.79 | 1.16 | 1.03 | 0.93 | 0.89 | 0.80 | |
| **1 A 2** | **Manufacturing Industries and Construction** | 2.06 | 2.17 | 2.52 | 2.35 | 2.00 | 2.02 | 2.08 | |
| **1 A 3 a, c, d, e** | **Off-Road transport** | 0.80 | 0.72 | 0.52 | 0.39 | 0.38 | 0.37 | 0.37 | |
| **1 A 3 b** | **Road Transportation** | 4.83 | 6.57 | 4.06 | 2.59 | 1.85 | 1.59 | 1.48 | fuel sold |
| | | 4.25 | 4.94 | 3.36 | 2.30 | 1.74 | 1.54 | 1.44 | fuel used |
| **1 A 4** | **Other Sectors** | 11.65 | 8.20 | 7.63 | 7.15 | 6.55 | 5.94 | 5.46 | |
| **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 | 0.07 | 0.05 | 0.05 | 0.05 | |
| **2A,B, C,H,I, J,K,L** | **Industrial Processes** | 3.24 | 1.83 | 1.37 | 1.35 | 1.17 | 1.17 | 1.18 | |
| **2D, 2G** | **Solvent and other product use** | 0.41 | 0.44 | 0.44 | 0.46 | 0.47 | 0.49 | 0.49 | |
| **3 B** | **Manure Management** | 0.12 | 0.10 | 0.11 | 0.11 | 0.10 | 0.10 | 0.10 | |
| **3 D** | **Agricultural Soils** | 1.02 | 1.04 | 1.00 | 0.98 | 0.91 | 0.87 | 0.84 | |
| **3 F, I** | **Field Burning and other agriculture** | 0.14 | 0.12 | 0.10 | 0.06 | 0.06 | 0.06 | 0.06 | |
| **5** | **Waste** | 0.02 | 0.03 | 0.03 | 0.07 | 0.07 | 0.07 | 0.08 | |

** Data source: Austrian Emission Inventory 2017 (UMWELTBUNDESAMT 2017b)*

*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 2015, the reporting of 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 the current GHG emissions projections under the EU Monitoring Regulation (UMWELTBUNDESAMT 2017c).

## 3.1 GHG PAMs

A detailed description of 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 2017 (UMWELTBUNDESAMT 2017c).

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

**Cross-cutting measures**

- EU Emission Trading Scheme (WEM): The system covers $CO_2$ emissions from large emitters from the industry sectors, energy and heat supply and aircraft operators, as well as $N_2O$ emissions from the chemical industry, and also has positive side-effects on $SO_2$ and $NO_x$ by inducing upgrades to facilities so as to reduce emission and increase efficiency.
- Domestic Environmental Support Scheme (WEM): The objective of this funding scheme is to protect the environment and to reduce pressures such as air pollution, greenhouse gases, noise and waste.
- Austrian Climate and Energy Fund (WEM): Although the main objective of this fund is to provide subsidies for research in – and the implementation of – climate friendly technology, positive side effects on air pollution are also expected.

### 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.
- 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 2011 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 Directive (2009/28/EC) on the promotion of the use of energy from renewable sources and the Implementation of the Austrian Plan for Electric Mobility are considered.
- 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 air quality induced speed limits.
- 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 buildings' standards according to the 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 the 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 and through the implementation of the District Heating and Cooling Act and subsidies for wood heating systems and solar heating systems.
- Increased energy efficiency in residential electricity demand (WEM): This measure includes the 'Ecodesign' requirements for energy using products, the effects of the implementation of the Energy Efficiency Directive, and the energy labelling of 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 is also part of this sector, but not relevant for air pollution.

In this 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 largely small-structured agricultural holdings. The Austrian Agri-Environmental Programme allocated funding for actions like reduced use of mineral fertilisers, organic farming, low-loss application of manure etc. for the period 2007–2013. The reform of the Common Agricultural Policy at EU level in 2013 brought about some changes regarding direct payments and the requirement to maintain land in good agricultural and ecological condition. The Austrian Agri-Environmental Programme will be continued for the period 2014–2020 with some modifications and additions.

  The implementation of this policy includes:

  - Improved feeding of pigs and poultry

  Feeding efficiency is increased by 2.5% in 2020.

  - Covering of manure storages

  75% of cattle slurry and 85% of pig slurry is covered in 2020.

  - Low-loss application of manure and biogas slurry

  30% of cattle slurry and 40% of pig slurry is applied through band spreading techniques in 2020. 10% of cattle, 40% of pig and 60% of poultry solid manure is applied within 12 hours in 2020.

  - Promotion of organic farming

  The current share of organic farming is maintained.

  - Promotion of grazing

  The current share of grazing is maintained.

  - Reduced usage of mineral fertilisers

  Mineral fertiliser amounts are continuously declining due to improved management practices.

### Waste (5)

- Reduce emissions from waste treatment (WEM) through further implementation of the Landfill Directive, by considering the requirements of the latest BREF document for mechanical biological treatment plants and by avoiding emissions from the anaerobic treatment of biogenic waste through covered storage facilities.

## 3.2 PAMs specifically designed to address air pollutants

In addition to the policies and measures (PAMs) to combat climate change, assumptions on the instruments and the concrete implementation of the PAMs to address air pollution are explained in this chapter. Besides existing emissions regulations for various kinds of plants in the energy and manufacturing industries and in the waste sector, which partly go beyond EU requirements but are not mentioned further in this report, the main issues are updated emission factors for transport and Ecodesign requirements for heating appliances in buildings.

### Transport (1.A.3)

No PAMs 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 respect to air pollutants in the transport sector have already been implemented through EU legislation. The scenario is based on the unmodified activity data from the scenario of the Monitoring Mechanism 2015 (MM17, UMWELTBUNDESAMT 2017c).

WEM includes the latest assumptions for emission factors for all relevant pollutants taken from 'HBEFA Version 3.3_draft'[5] (January 2017). The draft version of 'HBEFA V3.3' does not include the effects of changing ambient temperature on emission factors.

Emission factors for PM (exhaust), CO and HC from road transport are also based on the 'HBEFA V3.3_draft', but have not been updated with recent measurement results. They may differ slightly from those used in the last (2015) submission due to a slight change in the specific fuel consumption values. Although they correspond to the current state of knowledge for present and future vehicle technologies available on the market, some uncertainty is associated with these 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[6], water heaters and hot water storage tanks[7], solid fuel local space heaters[8], local space heaters[9] and solid fuel boilers[10] 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.

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[5] HBEFA…Handbook Emission Factors for Road Transport

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

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

[8] Commission Regulation (EU) 2015/1185

[9] Commission Regulation (EU) 2015/1188

[10] Commission Regulation (EU) 2015/1189

*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 | 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 11: Water heaters standard emission thresholds for $NO_x$ (according to Reg 814/2013), (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 12: Solid fuel local space heaters standard emission thresholds for PM, OGC, CO and $NO_x$ (according to Reg 2015/1185), (Source: Umweltbundesamt).*

| in $mg/m^3$ 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 13: Local space heaters standard emission thresholds for $NO_x$ (according to Reg 2015/1188), (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 14: Solid fuel boilers standard emission thresholds for PM, OGC, CO and $NO_x$ (according to Reg 2015/1189), (Source: Umweltbundesamt).*

| in $mg/m^3$ 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 |

For the period until the implementation of the Ecodesign regulations, the corresponding existing national emission standards apply, which are regulated in the Austrian Constitution Article 15a (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 under 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 in the EU legislation. Therefore the Ecodesign regulations will, once the deadline for transposition expires, overrule the partly more stringent national 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 and the Institute for Internal Combustion Engines and Thermodynamics at the Graz University of Technology (UMWELTBUNDESAMT 2017a). 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) and
- 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 2017).

For projecting the production of electricity and district heating 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 in combination with energy prices and the demand for electricity and district heating (taken from the model INVERT/EE-Lab). Subsidies (e.g. granted under the Green Electricity Act) and fees (like emission allowances) are also important input parameters (AEA 2017).

For modelling the energy consumption for domestic heating and domestic hot water supply, the software package INVERT/EE-Lab (TU WIEN 2017) was applied. This model 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 model INVERT. It allows the calculation of the energy demand for heating (space heating and hot water) in apartment buildings and buildings of the public or private service sector by 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 obtained with the different models were exchanged and adjusted ithin a few cycles. Umweltbundesamt experts combined the data obtained with 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 2017b). The data on energy demand have been split between 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 the 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. Emission factors for unspecified fuels (e.g. for refinery fuel gas, refinery coke) or waste (e.g. municipal solid waste, hazardous waste) were derived from plant-specific data.

**$SO_2$, $NO_x$ and $PM_{2.5}$**

Projected emissions of $SO_2$, $NO_x$ and $PM_{2.5}$ were calculated by multiplying projected energy data (UMWELTBUNDESAMT 2017a) 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 down 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 the current emission levels.

For $PM_{2.5}$, plant-specific emission factors for TSP have been converted to $PM_{2.5}$ applying the ratio used in the Austrian Air Emission Inventory.

A detailed description of the methodologies used for 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 closed down by 2030. For gas plants it has been assumed in the scenario WEM that new facilities with improved emission reduction systems will gradually substitute existing facilities. Therefore, the emission factor for gas plants will have decreased by 16 % by the year 2030 (compared to the year 2010).

For installations using solid biomass, emission factors have been reported in the literature for various plant sizes (UMWELTBUNDESAMT 2010). For the WEM scenario the emission factors have not been changed for the time period considered.

It is 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 2017b). 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 2007 and UMWELTBUNDESAMT 2009). The following industrial activities have been identified as the major emission sources:

- production in the cement, glass, magnesia, lime and other mineral industry,
- 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.

The projected emissions were calculated on the basis of the trends observed in energy scenarios (UMWELTBUNDESAMT 2017a) and by incorporating recent data from environmental impact statements on facility expansions and the opening and closing down 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 2015 levels (UMWELTBUNDESAMT 2017b). This simple approach was chosen because the share of these emissions in the total emissions is less than 1% for each source.

**$PM_{2.5}$**

The projected emissions were calculated on the basis of the trends observed in energy scenarios (UMWELTBUNDESAMT 2017a) and by incorporating recent data from environmental impact statements on facility expansions and the opening and closing down of facilities.

For process emissions from quarries, construction and the wood industry, historical trends of 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) is used to calculate the energy consumption of stationary sources separately for the sub-sectors residential and commercial (TU WIEN 2017). The input for mobile sources for agriculture comes from the macro-economic model DYNK. A detailed description of these models can be found in UMWELTBUNDESAMT 2017a, TU WIEN 2017 and WIFO 2017.

**Emissions**

$SO_2$, $NO_x$, NMVOC, $NH_3$ and $PM_{2.5}$ emissions were calculated based on the energy demand for stationary sources in the 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 2017b).

Separate emission factors have been used for:

- fuel type (e.g. coal, natural gas, heating and other oil, residual fuel oil, LPG, wood log & wood briquettes, wood chips and wood pellets).
- heating type (central heating, heating systems for apartments and stoves).
- different technologies (e.g. new biomass boilers – wood gasification, condensing gas and heating oil boilers).

Additionally, for future years, $NO_x$, NMVOC and $PM_{2.5}$ emission factors have been recalculated based on Ecodesign standard emission requirements for new installations of space heaters and combination heaters[11], water heaters and hot water storage tanks[12], solid fuel local space heaters[13], local space heaters[14] and

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

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

[13] Commission Regulation (EU) 2015/1185

solid fuel boilers[15]. 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 current national emission requirements (Article 15a Agreement).

The recalculation of the emission factors for new installations is based on a comparison of the ambition levels between national and EU-wide regulations. The rate of change was related to the national emission factor for new installations in the year 2015 (UMWELTBUNDESAMT 2017b) in order to provide conversion factors that reflect Ecodesign policy impact on new heating systems. Until the Ecodesign provisions enter into force, the recalculated emission factors are assumed to linearly approach the full effect of a phased introduction of the Ecodesign provisions on manufactures, distributers 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 in the transitional period.

National energy projections inter alia display the final energy demand for space heaters and combination heaters, water heaters, solid fuel local space heaters, local space heaters and solid fuel boilers by year of installation. It is assumed that new installations with lower emission factors substitute stock with average 2015 emission characteristics or increases the overall stock.

### Emission factors

$NO_x$ emission factors are assumed to decrease for natural gas and heating oil in central heating and apartment heating systems (due to an increased use of condensing boiler technology). Solid biomass emission factors are assumed to drop slightly due to minor differences in the ambition level between Ecodesign provisions and intermediate national regulations. There is no significant change in thermally produced $NO_x$ for average small scale biomass burning combustion technology. Additionally, a minor increase in the natural gas and heating oil emission factors for stoves and a noticeable increase in solid fossil fuel emission factors are expected because of a weakening of existing national regulations.

In Table 15 the $NO_x$ emission factors used in the projections are listed for central heating, apartment heating and stoves.

[14] Commission Regulation (EU) 2015/1188

[15] Commission Regulation (EU) 2015/1189

| in kg/TJ | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| **Central heating** | | | | |
| *Natural gas* | 26.2 | 24.0 | 21.0 | 17.9 |
| *Heating oil* | 33.5 | 30.9 | 28.2 | 25.3 |
| *Solid biomass* | 106.8 | 106.7 | 106.5 | 106.3 |
| *Solid fossil fuels* | 78.0 | 79.6 | 83.6 | 87.8 |
| **Apartment heating** | | | | |
| *Natural gas* | 23.7 | 21.8 | 19.7 | 17.6 |
| *Heating oil* | 34.2 | 32.4 | 30.3 | 27.7 |
| *Solid biomass* | 107.0 | 106.9 | 106.7 | 106.5 |
| *Solid fossil fuels* | 78.0 | 79.4 | 83.0 | 87.7 |
| **Stoves** | | | | |
| *Natural gas* | 51.0 | 52.0 | 53.3 | 54.6 |
| *Heating oil* | 19.0 | 19.1 | 19.2 | 19.4 |
| *Solid biomass* | 103.3 | 102.8 | 102.4 | 102.1 |
| *Solid fossil fuels* | 132.0 | 134.6 | 143.4 | 154.7 |

*Table 15: $NO_x$ emission factors for natural gas, heating oil, solid biomass and solid fossil fuels in central heating, apartment heating and stoves, (Source: Umweltbundesamt).*

NMVOC emission factors are assumed to decrease for solid biomass and solid fossil fuels from 2015 onwards due to existing national regulations imposing standard 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 NMVOC emission factors for natural gas and heating oil. In Table 16 the NMVOC emission factors used in the projections are listed for central heating, apartment heating and stoves.

| in kg/TJ | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| **Central heating** | | | | |
| *Natural gas* | 0.2 | 0.2 | 0.2 | 0.2 |
| *Heating oil* | 0.8 | 0.8 | 0.8 | 0.8 |
| *Solid biomass* | 319 | 271 | 222 | 190 |
| *Solid fossil fuels* | 284 | 274 | 249 | 221 |
| **Apartment heating** | | | | |
| *Natural gas* | 0.2 | 0.2 | 0.2 | 0.2 |
| *Heating oil* | 0.8 | 0.8 | 0.8 | 0.8 |
| *Solid biomass* | 329 | 275 | 223 | 185 |
| *Solid fossil fuels* | 284 | 276 | 252 | 222 |
| **Stoves** | | | | |
| *Natural gas* | 0.2 | 0.2 | 0.2 | 0.2 |
| *Heating oil* | 1.5 | 1.5 | 1.5 | 1.5 |
| *Solid biomass* | 557 | 542 | 531 | 522 |
| *Solid fossil fuels* | 333 | 336 | 343 | 353 |

*Table 16: NMVOC emission factors for natural gas, heating oil, solid biomass and solid fossil fuels in central heating, apartment heating and stoves, (Source: Umweltbundesamt).*

$PM_{2.5}$ emission factors are assumed to decrease for solid biomass and solid fossil fuels due to the Ecodesign requirements which in general outreach existing national regulations for standard $PM_{2.5}$ emission thresholds. In Table 17 the $PM_{2.5}$ emission factors used in the projections are listed for central heating in the WEM scenario.

*Table 17: $PM_{2.5}$ emission factors for fuel wood, wood waste and other, pellets and solid fossil fuels in central heating, apartment heating and stoves, (Source: Umweltbundesamt).*

| in kg/TJ | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| **Central heating** | | | | |
| *Fuel wood* | 71.6 | 71.6 | 71.5 | 71.4 |
| *Wood waste and other* | 66.0 | 60.0 | 54.3 | 51.9 |
| *Pellets* | 24.3 | 24.1 | 24.0 | 23.9 |
| *Solid fossil fuels* | 72.5 | 69.8 | 63.7 | 56.9 |
| **Apartment heating** | | | | |
| *Fuel wood* | 72.0 | 71.9 | 71.8 | 71.7 |
| *Pellets* | 24.3 | 24.1 | 24.0 | 23.9 |
| *Solid fossil fuels* | 75.2 | 74.0 | 70.9 | 67.0 |
| **Stoves** | | | | |
| *Fuel wood* | 118.4 | 117.8 | 116.4 | 114.9 |
| *Pellets* | 24.3 | 23.4 | 22.2 | 21.2 |
| *Solid fossil fuels* | 122.4 | 121.4 | 118.2 | 113.9 |

**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 2015 emissions with projected population statistics (STATISTIK AUSTRIA 2016a).

## 4.2 Mobile Fuel Combustion Activities (NFR 1 A)

This chapter describes the methodology used for estimating emissions from the sector NFR *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 using the econometric input-output model DYNK of the Austrian Institute of Economic Research (WIFO 2017). 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.

### 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 for the time series up to 2035 have been based on the NEMO model – Network Emission Model (DIPPOLD et al. 2012, HAUSBERGER et al. 2015a, 2015b). NEMO has been set up according to the same methodology as the former model (GLOBEMI) and 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 as to be 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 based on a categorisation of traffic activities into 'urban', 'rural' and 'motorway' has been applied with the NEMO model.

- **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 the quantities of fuel exported in motor vehicles abroad in the future. The KEX tool was developed for estimating the change in domestic fuel demand and the export of fuels in motor vehicles [MOLITOR et al. 2004; MOLITOR et al. 2009)]. As independent variables, the KEX tool uses the development of GDP, population, export quotas and domestic and foreign gasoline and diesel prices. Whereas the model NEMO 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 features predefined technologies for new vehicle registrations, their market penetration and the effects on consumption and emissions.

- **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) (HAUSBERGER 2000). The GEORG model has a fleet model part which simulates the actual age and size distribution of the non-road mobile machinery (NRMM) stock via 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 their propulsion systems (gasoline 4-stroke, gasoline 2-stroke, diesel > 80 kW, diesel < 80 kW).

**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 the Air Emission Inventory (UMWELTBUNDESAMT 2017b). Projected passenger car and heavy duty vehicle kilometres (HAUSBERGER & SCHWINGSHACKL 2016) are multiplied by emission factors.

- **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 2015 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 2015 emissions and projected fuel consumption.
  **Aviation operations:** $PM_{2.5}$ emissions from military aviation operations have been extrapolated by means of 2015 emissions.
  **Soil abrasion:** Projected $PM_{2.5}$ emissions have been estimated by correlating historical $PM_{2.5}$ emissions from soil abrasion and fuel consumption (UMWELTBUNDESAMT 2017a) with projected fuel consumption.

- **NFR 1 A 2 g 7 Mobile Sources in Industry – Soil Abrasion &**
  **NFR 1 A 4 c ii Off-road Vehicles and Other Machinery – Soil Abrasion**
  These categories include emissions from soil abrasion of industrial off-road mobile machinery, mainly from the construction sector and emissions from soil abrasion of agricultural off-road mobile machinery such as tractors and mowers.

  Projected $PM_{2.5}$ emissions have been estimated by correlating historical $PM_{2.5}$ emissions from soil abrasion and fuel consumption (Umweltbundesamt 2017a) with projected fuel consumption.

### *$NO_x$ – Emission factors*

As $NO_x$ is the most important air pollutant in the transport sector, it is worth showing the underlying emission factors for $NO_x$ which have been used for the projections across the different EURO classifications. Real-world driving conditions are always considered for the underlying test cycles of HBEFA (Handbook of Emission Factors in Road Transport).

All emission factors ('HBEFA Version 3.3_draft') are presented in Table 27 to Table 29 in chapter 5.1.2.

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

According to the latest amendments in European legislation[16] 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.

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[16] Regulation (EC) Nr. 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.

#### EURO6a/b

Actual measurement data (real-world driving conditions plus chassis dynamometer) on 25 EURO 6 vehicles was analysed. The emission behaviour of all the single vehicles was assessed by taking into account the shares of the produced vehicle models in the European registration statistics. In the actually implemented 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 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 in 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 real world emission factors for LDV 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 (SCHWINGSHACKL & REXEIS 2017).

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

*Table 18: 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 19: 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 |

### 4.2.3 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 from 2011 to 2015, as well as on projected activity data such as natural gas exploration, natural gas consumption and gasoline consumption according to the energy scenario (WIFO 2017). The pipeline length has been extrapolated by the average yearly growth rate between 2011 and 2015.

Emission reduction measures such as the introduction of vapour recovery units at fuel depots and service stations were already implemented in 2003, and 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 for emission estimates can be found in the Austrian Informative Inventory Report (UMWELTBUNDESAMT 2017b).

**$NO_x$ 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 projected coal consumption (WIFO 2017) and emission factors as used in the 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 production sector has been based on macro-economic data for the sub-sectors (UMWELTBUNDESAMT 2017a), 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. $NO_x$ emissions from fibreboard production are expected to increase in line with the economic development. $PM_{2.5}$ emissions from wood processing are assumed to remain constant at the level specified in the national inventory.

**NMVOC and $NH_3$**

NMVOC and $NH_3$ emissions are assumed to remain constant at the levels of 2015 (UMWELTBUNDESAMT 2017b) for most sub-sectors. This simple approach has been chosen because their share in the total emissions is very small.

For NMVOC emissions in the sub-sector 2.H 'Other Processes' a detailed approach has been developed for the projections. Whereas the emissions from sources such as wine, beer and spirits were kept constant, emissions from the category bread were extrapolated according to the population scenario. NMVOC emissions from 2.H.1 chipboard were extrapolated with the energy consumption data for the specific industrial sector.

### 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, or in some cases a constant development (e.g. where technological achievements offset an increase in use – see below for more details).

The basic data for the Austrian Air Emission Inventory were provided by surveys (WINDSPERGER et al. 2002a, 2002b, 2004; WINDSPERGER & SCHMID-STEJSKAL 2008) as well as import-export statistics (foreign trade balance) and production statistics provided by Statistik Austria, as well as 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 amount of solvents used in different applications and the solvent emission factors were calculated on the basis of the bottom-up approach. Also, the emissions reported under the VOC Directive were taken for all those sectors where this was possible (emissions were extrapolated taking into account the number of employees in the relevant sector, to include those installations that did not pass the threshold for reporting). By linking together 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.

*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 assumed to remain constant after 2015. Additionally, data from reports under the VOC Installation Ordinance were taken into consideration for 2012. The model is currently being evaluated, as there is some evidence that the amount of substances used as solvents is overestimated (i.e. some non-solvent applications not yet taken into account).

The emission factors used for the scenarios were the same as in 2010, as the positive impact of the laws and regulations implemented in Austria is expected to be only minimal in the next few years. Emission factors are calculated by solvent use per substance category at NACE-level 4 for all industrial sectors, and are based on information from surveys in households and industry as well as structural business statistics.

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 paint 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.

For the emission scenarios until 2030 it is assumed that emissions from Car manufacturing, Domestic Use, Coil coating, Other industrial cleaning, Rubber processing, Pharmaceuticals, Paint Manufacturing, Inks manufacturing, Glues manufacturing, Asphalt Blowing, Adhesive, Films and photographs, and the Printing industry, will remain constant, as the increased use of induced by the economic projections will be offset by products containing less solvents, or by technological advances.

For Car repairing, Construction and buildings, Wood coating, and Fat, edible and non-edible oil, emissions were correlated with the expected economic growth, and for Dry cleaning, Electronic components, Application of glues and adhesives, Treatment of vehicles, and Other, the trend of the last few years was assumed to continue until 2030. Domestic solvent use, as well as Domestic use of pharmaceuticals were correlated with population growth. For Textile finishing as well as Preservation of wood, a downward trend is expected due to technological achievements.

**$NO_x$, $SO_2$ and $NH_3$**

According to the Austrian inventory, $NO_x$. $SO_2$ and $NH_3$ emissions from solvent use do not occur in Austria.

**$PM_{2.5}$**

$PM_{2.5}$ emission from product use (i.e. tabaco smoke and fireworks) were calculated by multiplying the emission factor of the latest inventory year (2015; submission 2017) by the projected number of inhabitants (population) in Austria until 2030 (STATISTIK AUSTRIA 2016a).

## 4.5 Agriculture (NFR 3)

Agricultural activities and emissions are 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

Activity data are based on the results of the Positive Agricultural Sector Model Austria (PASMA), developed by the Austrian Institute of Economic Research (WIFO) (WIFO & BOKU 2015). For the current submission, the projected activity data were adjusted to the values of 2015.

The PASMA model maximises sectoral farm welfare and is calibrated on the basis of historical crops, forestry, livestock, and farm tourism activities, using the method of Positive Mathematical Programming (PMP). 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, derived from OECD-FAO outlooks on agricultural markets (OECD-FAO 2014). For Austria lower milk prices are assumed than in the OECD-FAO scenarios for the EU. The reason behind this is 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 (see SINABELL et al. 2011 for more details). Other exogenous economic assumptions for Austria (like GDP or population size) are not necessarily essential for the model used in this analysis because the partial equilibrium model of the agricultural sector mainly depends on the prices for outputs and inputs. Since the Austrian agricultural sector is an integral part of the common market, carry-over effects from European demand patterns are noticeable and affect the results.

**Other assumptions**

- Increase in milk yield per cow from +7% (2020) to +22% (2035) relative to 2015
- loss of agricultural land following the long-term trend

**Main results**

The number of dairy cows is expected to increase. The reason for this increase is that milk production is likely to expand after the abolition of the milk quota in 2015. Additionally, the Rural Development programme promotes farming in mountain regions where milk production is the most profitable activity if sufficient workers are available.

Slightly increasing prices for pork lead to an increasing number of pigs. The expansion in production is consistent with the overall outlook at European level (EC 2014), but not consistent with the currently observed trend which shows a declining numbers of pigs. An expansion of pork production is not unrealistic if the sector makes the same adjustments as the milk sector which gained significant market shares beyond the domestic market.

According to the model results, poultry production will decrease. This result is not consistent with the observed trend which shows increasing numbers of heads. Following international projections (EC 2014) one would expect more poultry as well. The model result is the consequence of relative prices. 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. This result is consistent with the long term trend but not consistent with observations of more recent sales data. Given the relative increase in energy costs which determines the fertiliser costs, along with the fact that agricultural land will decline and production of manure increase due to increasing livestock numbers, the result seems to be plausible.

**Emission Calculation**

Emissions are calculated on the basis of the methodology used in Austria's Annual Air Emission Inventory. A comprehensive description can be found in Austria's Informative Inventory Report (IIR) 2017 (UMWELTBUNDESAMT 2017b).

Feed intake and N excretion

The feed intake parameters and N excretion values applied here are the same as those applied in Austria's Annual Air Emission Inventory (UMWELTBUNDESAMT 2017b). Data for dairy cows were calculated on the basis of projected milk yields. N excretion of poultry and pigs was adjusted downwards by 2.5% in 2020 due to improved animal feed (see chapter 3).

Animal Waste Management Systems (AWMS)

Data on AWMS distribution are based on a comprehensive analysis of Austria's agricultural practices in 2005 (AMON et al. 2007).

For 2020 the share of cattle kept in tie stall housing systems was adjusted downwards by 50% (provisions on animal welfare). The share varies by cattle sub-category; overall, it is in the range of 30% (expert judgement; OFNER-SCHRÖCK & PÖLLINGER 2013). The shares of liquid and solid waste within the tie stall housing system 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 2020 has been increased by 50%.

Particle Emissions from Field Operations

Emissions of particulate matter from field operations are linked to the use of machines on agricultural soils. They are considered together with the farmed areas. For the projections, the same emission factors have been applied as those in Austria's Air Emission Inventory (UMWELTBUNDESAMT 2017b).

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 2015).

Particle Emissions from Bulk Material Handling

Because this source is of minor importance, $PM_{2.5}$ emissions have been extrapolated with the inventory values from 2015 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 excrements 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.

The estimates of the particle emissions from animal husbandry are related to the Austrian livestock projections. The emission factors are the same as those used in Austria's Air Emission Inventory (UMWELTBUNDESAMT 2017b).

## 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 vol.% and for $NH_3$ a concentration of 10 vol.% 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[17] Tier 2 (First Order Decay) method is applied, taking into account also 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 2017b).

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 (Landfill Ordinance; BREF Document for waste treatment industries affecting trends in the mechanical biological treatment (MBT) of waste, which is currently in preparation). 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 decrease in accordance with the assumptions made for the 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 20: 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 | 135 | 135 |
| 2025 | 0.0 | 119 | 119 |
| 2030 | 0.0 | 119 | 119 |

A detailed description of the methodology used for the calculation of landfill gas emissions can be found in Austria's National Inventory Report (UMWELTBUNDESAMT 2017b).

[17] Intergovernmental Panel on Climate Change

### $PM_{2.5}$ 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 95% (2015) 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 2017b).

*Table 21: 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 | 25 964 | 27 030 | 28 062 |

For projections of activity data, different assumptions are made: Mineral waste and construction waste are assumed to increase in line with the gross value added of the construction industry (NACE 41). Residues from the iron and steel production are expected to develop in line with the projected gross value added of the metal production and processing industries (NACE 24). For the projection of residues from thermal waste treatment and combustion plants, projected energy data (on waste used as fuel) have been used as an indicator (UMWELTBUNDESAMT 2017a).

### $NH_3$ 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 2017b).

### Composting plants, home composting

Home-composted waste amounts are assumed to increase in accordance with the population growth. Amounts of waste treated in composting plants are partly expected to remain constant at 2015 level (loppings and wood as structure material in the composting process), partly to increase with the population growth (organic waste collected from households).

**Mechanical-biological treatment plants**

As regards the amount of waste undergoing mechanical-biological treatment (MBT) in Austria, it is assumed that these activities will decline due to closures and reconstructions of MBT plants triggered among others by future requirements stipulated in the BREF Document for waste treatment industries (which is currently under revision).

Activity data projections are based on a detailed analysis of existing MBT plants and expected plant-specific developments and trends in input amounts, assuming that the planned BREF update will be completed by the end of 2017 and contain transition and adjustment periods until the end of 2021. Projections for input amounts have been made for the years 2020, 2025 and 2030 (see Table 22); the values in between have been interpolated.

It is assumed that some plants will close down in response to stricter regulations on waste air purification. At the same time, other treatment options such as thermal treatment and dry stabilisation methods are expected to gain importance.

*Table 22: 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 | 2 783 | 2 832 | 2 868 |
| Mechanically-biologically treated waste | 345 | 254 | 623 | 551 | 439 | 439 | 385 | 385 |

**$NO_x$, $SO_2$, 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 this forecast. A detailed description of the methodology used for emission estimates can be found in the Austrian Informative Inventory Report 2017 (UMWELTBUNDESAMT 2017b).

**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'[18]).

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

*Table 23: Past trend (1990–2015) and scenarios (2020–2030) of wastewater volumes.*

| [Mio. m$^3$ 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 | 1 095 | 1 122 | 1 141 |

[18] 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)

# 5 RECALCULATIONS: CHANGES WITH RESPECT TO THE SUBMISSION 2015

The changes made to the projections since the previous emission projections of air pollutants in 2015 (UMWELTBUNDESAMT 2015) are presented in this chapter. In general, there are five main factors influencing these changes:

1. Changes in the 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 emission projections, as the methods have to be applied consistently for the calculation of past trends and emission scenarios.
3. Changes in the assumptions for activity scenarios. These changes can be triggered by revised economic or technical scenarios, consideration of additional policies and measures, and revisions of policies or measures which become necessary due to amendments to legal texts.
4. Update of 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 24: Comparison of projections 2015 and 2016 in the scenarios based on fuel sold – national totals (in kt), (Source: Umweltbundesamt).*

| Total | 2005 | 2010 | 2015 | 2020 | 2015 | 2030 |
|---|---|---|---|---|---|---|
| **Projections 2015** | | | | | | |
| $NO_x$ | 235 | 180 | 150 | 115 | 95 | 88 |
| $SO_2$ | 27 | 19 | 17 | 17 | 17 | 17 |
| NMVOC | 159 | 131 | 125 | 116 | 105 | 99 |
| $NH_3$ | 66 | 68 | 68 | 73 | 73 | 74 |
| $PM_{2.5}$ | 23 | 20 | 17 | 15 | 13 | 13 |
| **Projections 2017** | | | | | | |
| $NO_x$ | 238 | 181 | 149 | 114 | 93 | 82 |
| $SO_2$ | 26 | 17 | 15 | 14 | 14 | 14 |
| NMVOC | 137 | 119 | 113 | 109 | 105 | 103 |
| $NH_3$ | 65 | 67 | 67 | 70 | 70 | 70 |
| $PM_{2.5}$ | 22 | 19 | 17 | 15 | 14 | 13 |
| **Difference 2017/2015** | | | | | | |
| $NO_x$ | 3 | 1 | – 1 | – 1 | – 2 | – 5 |
| $SO_2$ | – 1 | – 2 | – 2 | – 3 | – 3 | – 3 |
| NMVOC | – 23 | – 12 | – 12 | – 7 | 0 | 4 |
| $NH_3$ | – 1 | – 1 | – 1 | – 3 | – 3 | – 3 |
| $PM_{2.5}$ | – 1 | – 1 | 0 | 0 | 0 | 0 |

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 25: Major changes between the projections 2015 and 2017 for the 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 | – 0.8 | – 1.9 | – 0.8 | – 4.4 | – 4.3 | – 4.7 |
| | 1 A 2 – Manufacturing Industries and Construction | 0.0 | – 0.1 | – 2.1 | – 3.0 | – 4.1 | – 5.3 |
| | 2 – Industrial Processes | 0.0 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 |
| $SO_2$ | 1 A 1 – Energy industries | – 0.2 | – 1.2 | – 0.6 | – 1.1 | – 1.0 | – 1.1 |
| | 1 A 2 – Manufacturing Industries and Construction | – 0.2 | – 0.6 | – 0.5 | – 1.2 | – 1.6 | – 2.1 |
| | 2 – Industrial Processes | – 0.2 | – 0.3 | – 0.2 | – 0.2 | – 0.2 | – 0.2 |
| $PM_{2.5}$ | 1 A 1 – Energy industries | 0.0 | – 0.1 | – 0.2 | – 0.4 | – 0.4 | – 0.5 |
| | 1 A 2 – Manufacturing Industries and Construction | 0.0 | 0.0 | – 0.3 | – 0.7 | – 0.8 | – 1.0 |
| | 2 – Industrial Processes | 0.0 | 0.0 | 0.1 | – 0.1 | – 0.1 | – 0.1 |
| NMVOC | 1 A 1 – Energy industries | – 0.3 | – 0.4 | – 0.5 | – 0.5 | – 0.5 | – 0.5 |
| | 1 A 2 – Manufacturing Industries and Construction | – 0.2 | – 0.4 | – 0.3 | – 0.3 | – 0.3 | – 0.3 |
| | 2 – Industrial Processes | – 19.5 | – 9.1 | – 10.9 | – 7.3 | – 3.5 | 0.7 |
| | 2 D – Solvents | – 19.5 | – 9.4 | – 11.2 | – 7.6 | – 3.8 | 0.4 |

Revisions up to the year 2015 are mainly due to updates of the national energy balance. For the projections in 2015 the energy balance with data up to 2012 was used, whereas for the projections in 2017 the energy balance with data up to 2015 is used. Hence, energy demand and thus emissions are different in the current projections. The year 2015 has changed from a scenario year to an accounting year.

Revisions thereafter are due to recent developments on the European electricity markets, i.e. a reduced profitability of gas and coal power plants and a drastic change in the profitability of photovoltaic installations in the last couple of years.

The differences in the process emissions are mainly due to updated assumptions for production based on the new energy data.

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

*2 D – Solvents and other product use*

On the one hand, new data and methods were applied for the years from 2003 onwards, and mainly data available from reports under Directive 1999/13/EC (VOC Solvents Directive)[19] were implemented in the model. On the other hand, the statistical data used for estimating overall solvent use in Austria was revised for the years from 2000 onwards: import-export/production statistics were screened for items that had not been considered (although they should have

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

been) as well as for items that had been considered although they included non-solvent uses. In addition, fluctuations in the timeline (i.e. significant differences between the years) were checked and evaluated. Several changes were made as a result of this revision of the top-down data. The main changes were:

- non-methylated (un-denatured) ethanol is no longer considered (as it is normally used for human consumption and because this category also included bioethanol used as a fuel which is denatured after being exported; the category showed a strong negative balance for the last few years),
- non-solvent use of methanol in biodiesel production is now considered and thus subtracted from total consumption.

Both changes (combined with other minor methodological changes as explained above) resulted in a decrease of the top-down value for overall solvent consumption with the most significant changes for the years 2003-2008. As the overall top-down data shows fluctuations that reflect market effects rather than actual changes in overall consumption, interpolated top-down data is now used, also for previous years (see further explanations under "methodology").

### 5.1.2 Transport (1 A 3)

*Table 26: Major changes between the projections 2015 and 2017 for the sector 1A3, in kt (fuel sold), (Source: Umweltbundesamt).*

| Pollutant | Sector (CRF) | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|---|
| $NO_x$ | **1 A 3 – Transport** | 0.1 | 0.1 | – 2.2 | 1.8 | 0.7 | – 1.2 |
| | 1 A 3 a – Civil Aviation | 0.0 | 0.0 | 0.0 | – 0.3 | – 0.5 | – 0.6 |
| | 1 A 3 b 1 – Passenger cars | 0.0 | 0.2 | 0.0 | 3.8 | 2.8 | 1.4 |
| | 1 A 3 b 2 – Light duty vehicles | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | – 0.2 |
| | 1 A 3 b 3 – Heavy duty vehicles | 0.1 | 0.3 | – 1.6 | – 1.3 | – 1.1 | – 1.1 |
| | 1 A 3 b 4 – Mopeds & Motorcycles | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 |
| | 1 A 3 c – Railways | 0.0 | – 0.1 | – 0.2 | – 0.3 | – 0.3 | – 0.4 |
| | 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 | – 0.3 | – 0.3 | – 0.2 | – 0.3 | – 0.2 |
| **NMVOC** | **1 A 3 – Transport** | 0.2 | 0.2 | – 0.1 | 0.1 | – 0.2 | – 0.6 |
| | 1 A 3 a – Civil Aviation | 0.0 | 0.0 | 0.0 | – 0.1 | – 0.2 | – 0.3 |
| | 1 A 3 b 1 – Passenger cars | 0.1 | 0.2 | 0.0 | 0.1 | – 0.1 | – 0.3 |
| | 1 A 3 b 2 – Light duty vehicles | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| | 1 A 3 b 3 – Heavy duty vehicles | 0.0 | 0.0 | – 0.1 | – 0.1 | – 0.1 | – 0.1 |
| | 1 A 3 b 4 – Mopeds & Motorcycles | 0.0 | 0.0 | – 0.1 | 0.0 | – 0.1 | – 0.1 |
| | 1 A 3 c – Railways | 0.0 | – 0.1 | – 0.1 | – 0.1 | – 0.1 | – 0.1 |
| | 1 A 3 d – Navigation | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 |
| | 1 A 3 e – Pipeline compressors | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

$NO_x$ emissions for WEM in the 2017 submission are lower than in the 2015 submission, for several reasons:

- The methodology for estimating fuel consumption in aviation has changed. In the previous model from the Austrian Institute of Economic Research, fuel consumption was strongly linked to economic growth. Now, using the econometric input-output model DYNK, fuel consumption in aviation is coupled with the oil price (WIFO 2017). This results in decreased emissions for the time series between 2020 and 2030.

- Fuel prices in Austria and its neighbouring countries, as well as assumptions concerning their development, have been adapted in accordance with the consumer price index.
- Assumptions about the development of fuel prices in Austria and its neighbouring countries have been adapted resulting in lower fuel consumption in fuel export. Based on the historical trend which shows a slight reduction in the difference between diesel fuel prices in Austria and its neighbouring countries over the past few years, it is assumed that this difference will become smaller in the future. This results in a decrease in fuel consumption in fuel export in absolute numbers. As fuel export occurs especially in truck transport (HDVs) this results – amongst other aspects (e.g. a decrease in emission factors caused by an improved performance of exhaust after-treatment systems – see next point) in a decrease in emissions from 1.A.3.b.iii.
- Combined with a whole updated set of emission factors from the 'HBEFA V3.3_draft'[20] the current emission scenario is lower than before (for details and a comparison of specific emissions factors per vehicle category see below).

**Recalculation of time series**

Absolute $NO_x$ figures for diesel passenger cars (PC) were revised upwards. This can be explained by the fact that the latest specific fuel consumption data were revised upwards. $NO_x$ emission factors derived from measurements of real driving emissions (which showed disastrous results) were updated in the 'HBEFA V3.3_draft' for all PC with emission classes newer than EURO 5 (see Table 27).

Absolute $NO_x$ figures for light duty vehicles (LDV) have not been updated in 'HBEFA V3.3_draft' so far.

For heavy duty vehicles (HDV), 'HBEFA V.3.3_draft' shows lower $NO_x$ emissions for all emission classes due to updated specific fuel consumption factors.

**Details on $NO_x$ emission factors**

The tables below show a comparison between the emission factors of the projections 2015 and 2017 per vehicle category. In the 2017 submission the latest 'HBEFA Version 3.3_draft' has been integrated.

[20] Handbook of Emission Factors for Road Transport (INFRAS 2017)

*Table 27: Comparison of $NO_x$ emission factors for diesel passenger cars (PC), (Source: Umweltbundesamt).*

| $NO_x$ | NEMO HBEFA V.3.3_draft[21] | NEMO HBEFA V.3.2 |
|---|---|---|
| PRE ECE | 1.014 | 1.016 |
| ECE15/01 | 1.014 | 1.016 |
| ECE15/02 | 1.014 | 1.016 |
| ECE15/03 | 1.014 | 1.016 |
| ECE15/04 | 1.014 | 1.016 |
| US 83 | 0.748 | 0.750 |
| Legal Act A | 0.770 | 0.772 |
| EURO 2 | 0.815 | 0.817 |
| EURO 3 | 0.857 | 0.859 |
| EURO 4 | 0.567 | 0.569 |
| EU4+DPF | 0.567 | 0.569 |
| EURO 5 | 0.695 | 0.697 |
| EURO 6a/b | 0.421 | EURO 6 (0.247)[22] EURO 6c (0.144) |
| EURO 6d_temp | 0.197 | |
| EURO 6d | 0.127 | |

*Table 28: Comparison of $NO_x$ emission factors for diesel light duty vehicles (LDV), (Source: Umweltbundesamt).*

| $NO_x$ | NEMO HBEFA V.3.3_draft | NEMO HBEFA V.3.2* |
|---|---|---|
| | | |
| 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.*

[21] HBEFA 3.3_draft incl. the latest measurement results for updating $NO_x$ 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 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 HBEFA.

[22] Euro 6 = Euro 6a/b; Euro 6c = Euro 6d temp [HBEFA 6d1] ($NO_x$ Update); Euro 6d is new [HBEFA Euro 6d2]

| $NO_x$ | NEMO HBEFA V.3.3_draft | NEMO HBEFA V.3.2 |
|---|---|---|
| 1980s | 14.11 | 14.15 |
| Euro-I | 9.67 | 9.71 |
| Euro-II | 9.84 | 9.89 |
| Euro-III | 7.73 | 7.82 |
| Euro-IV EGR | 5.40 | 5.56 |
| Euro-IV SCR | 3.11 | 3.25 |
| Euro-V EGR | 3.97 | 4.17 |
| Euro-V SCR | 2.02 | 2.15 |
| Euro-VI 2014–2015 | 0.30 | 0.34 |
| Euro-VI 2050 | 0.19 | 0.23 |

*Table 29: Comparison of $NO_x$ emission factors for heavy duty vehicles (HDV), (Source: Umweltbundesamt).*

### 5.1.3 Other Sectors (NFR 1 A 4)

*Table 30: Major changes between the projections 2015 and 2017 for the sector 1A4 in kt (Source: Umweltbundesamt).*

| Pollutant | Sector (CRF) | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|---|
| **$NO_x$** | **1 A 4 – Other Sectors** | – 0.4 | – 0.9 | – 1.4 | – 0.6 | 0.7 | 1.0 |
| | 1 A 4 a 1– Commercial/Institutional: Stationary | 0.5 | 0.3 | – 0.7 | – 0.7 | – 0.4 | – 0.2 |
| | 1 A 4 b 1 – Residential: stationary | – 0.9 | – 0.9 | – 0.4 | 0.0 | 1.0 | 1.1 |
| | 1 A 4 c 1 – Agriculture/Forestry/Fishing: Stationary | 0.0 | – 0.2 | – 0.2 | – 0.2 | – 0.1 | 0.0 |
| **NMVOC** | **1 A 4 – Other Sectors** | – 2.3 | – 1.8 | 0.5 | 1.7 | 5.8 | 5.9 |
| | 1 A 4 a 1– Commercial/Institutional: Stationary | 0.3 | 0.3 | 0.2 | 0.2 | 0.4 | 0.5 |
| | 1 A 4 b 1 – Residential: stationary | – 2.4 | – 1.1 | 1.9 | 3.0 | 6.7 | 6.6 |
| | 1 A 4 c 1 – Agriculture/Forestry/Fishing: Stationary | 0.0 | – 0.2 | – 0.1 | 0.0 | 0.3 | 0.6 |
| **PM2.5** | **1 A 4 – Other Sectors** | – 0.7 | – 0.6 | 0.2 | 0.7 | 1.6 | 1.7 |
| | 1 A 4 a 1– Commercial/Institutional: Stationary | 0.0 | 0.0 | – 0.1 | 0.0 | 0.1 | 0.1 |
| | 1 A 4 b 1 – Residential: stationary | – 0.7 | – 0.5 | 0.4 | 0.8 | 1.5 | 1.6 |
| | 1 A 4 c 1 – Agriculture/Forestry/Fishing: Stationary | 0.0 | – 0.1 | – 0.1 | – 0.1 | 0.0 | 0.1 |

The underlying INVERT/EE-Lab model has been updated with recent statistical data on building stock and thermal building quality (UMWELTBUNDESAMT 2017a). Emerging trends in activity data (energy consumption) over the recent inventory data years (in particular a decline in fossil fuel use), which form the basis for the projections (and the model calibration), partly account for the difference to the previous projections (2015).

The major change to the pollutants $NO_x$, NMVOC and $PM_{2.5}$ is due to a remodelling of the effect of existing national legislation (Article 15a Agreement) on emission factors for new installations and of Ecodesign standard emission requirements for the placing on the market and putting into service of space heaters and combination heaters[23], water heaters and hot water storage tanks[24], solid fuel local space heaters[25], local space heaters[26] and solid fuel boilers[27], which will gradually replace the partly more stringent national requirements. Previous assumptions on Ecodesign policy have been revised, strongly reduced in impact and extended in scope, and now include gaseous and liquid fuels. Furthermore, all the dates of the entry into force of the final Ecodesign provisions are now available. The recalculation of emission factors for new installations is based on a comparison of ambition levels between national and EU-wide regulations. A phased introduction of the Ecodesign emission thresholds for manufacturers, distributers and sellers of heating products is assumed, as Member States will not be allowed to keep their more stringent national requirements in the transitional period.

The boiler exchange model (based on the final energy demand for new boilers in the year of their installation) which was first implemented in WEM 2015. was updated with new activity data at higher level of detail (TU WIEN 2017).

$NO_x$, NMVOC and $PM_{2.5}$ emissions were recalculated based on new installations with lower emission factors from 2016 onwards, which substitute boiler stock with average 2015 emission characteristics or increases in the overall boilder stock.

Both cause major shifts in the resulting overall stock emission factors, especially within sub-sector 1 A 4 b because of its high share in biomass heating systems. Further details on standard emission requirements and emissions factors are provided in chapter 3.1 and chapter 4.1.3.

**Emission factors**

Natural gas and heating oil $NO_x$ emission factors in central heating and apartment heating systems are significantly lower than in the 2015 projections, since the Ecodesign provisions for gaseous and liquid are now taken into account. A minor increase in the natural gas and heating oil emission factors in stoves is also due to Ecodesign requirements.

Due to less optimistic assumptions for future impacts of the Ecodesign requirements, $NO_x$ emission factors for solid biomass and solid fossil fuels are noticeably higher than in the previous projections (2015).

In Table 31 the changes in the $NO_x$ emission factors used in the projections are listed for central heating, apartment heating and stoves in the WEM scenario.

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

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

[25] Commission Regulation (EU) 2015/1185

[26] Commission Regulation (EU) 2015/1188

[27] Commission Regulation (EU) 2015/1189

*Table 31: Changes in $NO_x$ emission factors between 2015 and 2017 projections for natural gas, heating oil, solid biomass and solid fossil fuels in central heating, apartment heating and stoves (Source: Umweltbundesamt).*

| in kg/TJ | | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| **Central heating** | | | | |
| Natural gas | WEM | –8.7 | –10.8 | –13.4 |
| Heating oil | WEM | –7.7 | –8.2 | –9.2 |
| Solid biomass | WEM | 12.8 | 29.0 | 35.5 |
| Solid fossil fuels | WEM | 1.7 | 3.7 | 3.6 |
| **Apartment heating** | | | | |
| Natural gas | WEM | –9.6 | –10.9 | –12.6 |
| Heating oil | WEM | –6.2 | –4.6 | –6.4 |
| Solid biomass | WEM | 15.8 | 43.5 | 26.9 |
| Solid fossil fuels | WEM | 1.5 | 3.5 | 5.2 |
| **Stoves** | | | | |
| Natural gas | WEM | 4.0 | 6.5 | NO |
| Heating oil | WEM | 0.7 | 2.6 | 3.1 |
| Solid biomass | WEM | 7.6 | 18.6 | 18.1 |
| Solid fossil fuels | WEM | 4.0 | 15.8 | 30.3 |

$PM_{2.5}$ emission factors for solid biomass and solid fossil fuels are higher than in the 2015 projections due to revised assumptions about the impact of Ecodesign provisions; in general, they surpass existing national regulations for standard $PM_{2.5}$ emission thresholds. Higher specific $PM_{2.5}$ emissions are expected especially for solid fossil fuels and fuel wood in stoves after 2022, when the impact of Ecodesign requirements becomes evident.

In Table 32 the changes in the $PM_{2.5}$ emission factors used in the projections are listed for central heating, apartment heating and stoves in the WEM scenario.

*Table 32: Changes in $PM_{2.5}$ emission factors between 2015 and 2017 projections for fuel wood, wood waste and other, pellets and solid fossil fuels in central heating, apartment heating and stoves (Source: Umweltbundesamt).*

| in kg/TJ | | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| **Central heating** | | | | |
| Fuel wood | WEM | 9.1 | 26.4 | 34.3 |
| Wood waste and other | WEM | 16.1 | 18.5 | 18.1 |
| Pellets | WEM | 7.7 | 9.7 | 11.1 |
| Solid fossil fuels | WEM | 0.7 | 7.7 | 27.9 |
| **Apartment heating** | | | | |
| Fuel wood | WEM | 12.0 | 37.1 | NO |
| Wood waste and other | WEM | NO | NO | NO |
| Pellets | WEM | 8.6 | 10.7 | 10.8 |
| Solid fossil fuels | WEM | 0.6 | 11.9 | 31.8 |
| **Stoves** | | | | |
| Fuel wood | WEM | 19.1 | 58.9 | NO |
| Wood waste and other | WEM | NO | NO | NO |
| Pellets | WEM | 5.5 | 7.0 | 8.4 |
| Solid fossil fuels | WEM | 1.9 | 22.3 | 57.3 |

NMVOC emission factors are assumed to stay almost unchanged for natural gas and heating oil when compared to the 2015 projections. Significantly higher NMVOC emission factors are expected for solid biomass because of a remodelled impact of the Ecodesign requirements for standard OGC emission thresholds, which is assumed to be far less pronounced than in the previous projections (2015), especially for solid biomass stoves. In addition, higher specific NMVOC emissions are expected for solid fossil fuels in stoves after 2022, when the impact of the Ecodesign requirements becomes evident.

In Table 33 the changes in the NMVOC emission factors used in the projections are listed for central heating, apartment heating and stoves in the WEM scenario.

*Table 33: Changes in NMVOC emission factors between 2015 and 2017 projections for natural gas, heating oil, solid biomass and solid fossil fuels in central heating, apartment heating and stoves.*

| in kg/TJ | | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| **Central heating** | | | | |
| Natural gas | WEM | 0.0 | 0.0 | –0.0 |
| Heating oil | WEM | 0.0 | 0.0 | 0.1 |
| Solid biomass | WEM | 42.9 | 88.6 | 90.9 |
| Solid fossil fuels | WEM | –3.2 | 20.0 | 100.9 |
| **Apartment heating** | | | | |
| Natural gas | WEM | –0.0 | 0.0 | 0.0 |
| Heating oil | WEM | 0.0 | 0.1 | 0.1 |
| Solid biomass | WEM | –30.3 | 91.1 | 165.3 |
| Solid fossil fuels | WEM | –2.3 | 34.6 | 104.9 |
| **Stoves** | | | | |
| Natural gas | WEM | 0.0 | –0.0 | 0.0 |
| Heating oil | WEM | 0.0 | 0.2 | 0.2 |
| Solid biomass | WEM | 211.1 | 381.6 | 493.1 |
| Solid fossil fuels | WEM | 7.7 | 53.4 | 125.1 |

### 5.1.4 Agriculture (NFR 3)

*Table 34: Major changes between the projections 2015 and 2017 for the sector 3 (in kt), (Source: Umweltbundesamt).*

| Pollutant | Sector (CRF) | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|---|
| **$NH_3$** | **3 – Agriculture** | – 0.7 | – 0.6 | – 1.3 | – 3.0 | – 2.9 | – 2.8 |
| | 3 B 1 a | 0.0 | 0.0 | – 0.4 | – 0.2 | – 0.3 | – 0.3 |
| | 3 B 1 b | 0.0 | 0.0 | – 0.3 | – 0.6 | – 0.6 | – 0.6 |
| | 3 B 4 e | 0.1 | 0.3 | 0.5 | 0.5 | 0.6 | 0.6 |
| | 3 B 3 | 0.0 | 0.0 | – 0.3 | – 0.7 | – 0.8 | – 0.8 |
| | 3 B 4 g | 0.0 | 0.0 | 0.4 | 0.3 | 0.3 | 0.3 |
| | 3 D | – 0.8 | – 1.0 | – 1.1 | – 2.3 | – 2.2 | – 2.1 |

**Main improvements of the Austrian Air Emission Inventory**

*Update of activity data*

Updated horse numbers provided by the Ministry of Agriculture have been implemented. The revision resulted in significantly increased animal numbers from 2004 onwards.

*Manure Management (3.B)*

The inventory was updated by using the default Tier 1 EFs for NO emissions from stored manure according to the new EMEP/EEA emission inventory guidebook 2016. The revision resulted in a slight decrease in $NO_2$ emissions from the sector manure management.

*Inorganic N fertilisers including urea application (3.D.a.1)*

The ammonia inventory was updated by using the default Tier 2 $NH_3$ EF for urea fertiliser according to the new EMEP/EEA emission inventory guidebook 2016, resulting in decreased $NH_3$ emissions. For $NO_x$ emission calculations the default Tier 1 EF for NO emissions from N applied in fertilisers according to the new EMEP/EEA emission inventory guidebook 2016 was used which resulted in significantly increased emissions.

*Animal manure applied to soils (3.D.a.2.a)*

The inventory was updated by using the default Tier 1 EF for NO emissions from N applied in fertilisers according to the new EMEP/EEA emission inventory guidebook 2016. The revision resulted in significantly increased emissions.

*Sewage sludge applied to soils (3.D.a.2.b)*

The inventory was updated by using the default Tier 1 $NH_3$ EF for sewage sludge application according to the new EMEP/EEA emission inventory guidebook 2016, resulting in a decrease in $NH_3$ emissions. For $NO_x$ emission calculations the default Tier 1 EF for NO emissions from sewage sludge according to the new EMEP/EEA emission inventory guidebook 2016 was used. The revision resulted in increased emissions.

*Other organic fertilisers applied to soils including digestate and compost (3.D.a.2.c)*

In addition to digested energy crops already considered in previous submissions, compost application was introduced as a new activity. For both activities (digestate and compost) the default Tier 1 $NH_3$ EF for other organic fertilisers according to the new EMEP/EEA emission inventory guidebook 2016 has been used. resulting in a considerable decrease in emissions from the source category "other organic fertilisers applied to soils". For $NO_x$ emission calculations the default Tier 1 EF for NO according to the new EMEP/EEA emission inventory guidebook 2016 was used. The revision resulted in a considerable increase in emissions from the source category "other organic fertilisers applied to soils".

*Cultivated Crops (3.D.e)*

When updating the inventory using the new EMEP/EEA guidebook 2016, Austria removed $NH_3$ estimates for biological N fixation based on the outdated default methodology. The EMEP/EEA guidebook 2016 (and the 2006 IPCC guidelines) no longer consider biological N fixation as a source of emissions. In the 2016 submission Austria reported emissions amounting to 284 t $NH_3$ from legume cropland for 2014. In the 2017 submission Austria reports 'NA' under the source category "cultivated crops" for all years.

For more details see Austria's Informative Inventory Report (IIR) 2017 (UMWELTBUNDESAMT 2017b).

**Revisions of the sectoral projection model**

Activity data projections

Projected activity data are based on the results of calculations carried out with the Positive Agricultural Sector Model Austria (PASMA), developed by the Austrian Institute of Economic Research (WIFO) (WIFO & BOKU 2015).

In the 2017 submission, activity levels of animal livestock and mineral fertiliser application have been adjusted to the respective 2015 inventory data. However, the projected activity data trends remain unchanged.

Compared to the 2015 submission this adjustment led to

- Slightly increased numbers of dairy cattle
- Slightly decreased numbers of non-dairy cattle
- Decreased numbers of swine
- Slightly decreased numbers of sheep
- Slightly increased numbers of goats
- Significantly increased numbers of poultry
- Significantly increased numbers of horses
- Decreased numbers of other animals (deer)
- Significantly increased amounts of mineral fertilisers

### 5.1.5 Waste (NFR 5)

*Table 35:Major changes between projections 2015 and 2017 for the sector 5 (in kt), (Source: Umweltbundesamt).*

| Pollutant | Sector (CRF) | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|---|
| **$NH_3$** | **5 – Waste** | – 0.1 | – 0.1 | – 0.1 | 0.0 | 0.0 | – 0.1 |

Austria has adapted its DOC of residual waste for the historical years 1950–1989 in response to the recommendation by the Technical Expert Review Team (TERT) in the course of the ESD[28] comprehensive review on greenhouse gases in 2016. Furthermore a small correction was made to the amounts of deposited construction waste and tar paper for the year 2010, resulting in a slight increasing in the emissions from 2011 onwards.

This has affected the amount of landfill gas generated and thus also the emission value for $NH_3$ (revised downwards by 0.03 t $NH_3$ in 2014).

[28] Effort-Sharing Decision

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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 66%) is projected for the pollutant $NO_x$. Emission reductions for the other pollutants range from 24% to 48 %; $NH_3$ emissions, however, are projected to increase by 8%.**

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