ENVIRONMENT AGENCY AUSTRIA umweltbundesamt

Austria's National Air Emission Projections 2015 for 2015, 2020 & 2030

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

Scenarios: With Existing Measures (WEM) & With additional Measures (WAM)

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Andreas Zechmeister

Authors

Michael Anderl
Simone Haider
Thomas Krutzler
Christoph Lampert
Katja Pazdernik
Stephan Poupa
Maria Purzner
Wolfgang Schieder
Alexander Storch
Gudrun Stranner
Manuela Wieser
Andreas Zechmeister

Editor

Maria Deweis
Ulrike Lamb
Brigitte Read

Layout and typesetting

Elisabeth Riss

Title Photograph

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ZUSAMMENFASSUNG

Die österreichischen Emissionsprojektionen für die Luftschadstoffe Schwefeldioxid (SO_2), Stickstoffoxide (NO_x), flüchtige organische Verbindungen ohne Methan (NMVOC), Ammoniak (NH_3) und Feinstaub ($PM_{2,5}$) wurden für die Szenarien „mit bestehenden Maßnahmen" und „mit zusätzlichen Maßnahmen" zuletzt im Jahr 2014 publiziert (UMWELTBUNDESAMT 2014).

Der vorliegende Bericht aktualisiert die Emissionsprojektionen für beide Szenarien. Sie basieren auf den aktuellen energiewirtschaftlichen Grundlagendaten von WIFO, Österreichischer Energieagentur, TU Wien und TU Graz (UMWELTBUNDESAMT 2015a) und für den Sektor Landwirtschaft auf den Aktivitätsszenarien vom WIFO und der Universität für Bodenkultur (WIFO & BOKU 2015), die auch für die Projektionen der Treibhausgas-Emissionsentwicklung herangezogen wurden.

In der EU-Richtlinie 2001/81/EG[1] werden für die untersuchten Luftschadstoffe Emissionshöchstmengen ab dem Jahr 2010 festgelegt. Nach der englischen Bezeichnung dieser Obergrenzen (National Emission Ceilings, NEC) ist auch im Deutschen der Begriff „NEC-Richtlinie" und „NEC-Gase" üblich. Artikel 7 in Verbindung mit Annex III der NEC-Richtlinie legt fest, dass für diese Luftschadstoffe Emissionsprojektionen für das Jahr 2010 zu erstellen und jährlich zu aktualisieren sind. Dabei kommen die Verfahren zur Anwendung, die im Rahmen des UNECE-Übereinkommens über weiträumige grenzüberschreitende Luftverunreinigung (Convention on Long-Range Transboundary Air Pollution, LRTAP-Convention[2] 1979) vereinbart wurden.

Österreich berichtet die Emissionen im Rahmen des UNECE-Übereinkommens („Guidelines for Reporting Emission Data"[3]) anhand der verkauften Treibstoffmenge. Die Emissionsberichterstattung an die Europäische Kommission gemäß NEC-Richtlinie erfolgt auf Basis der verbrauchten Treibstoffmenge. In den folgenden Abschnitten werden die Ergebnisse deshalb in beiden Versionen dargestellt.

Die NEC-Richtlinie wird derzeit überarbeitet. Zusätzlich zu den vier bisher erfassten Luftschadstoffen SO_2, NO_x, NMVOC und NH_3 soll für die primären Emissionen von Feinstaub ($PM_{2,5}$) eine Emissionshöchstmenge festgelegt werden. Ziele für 2020 und 2030 sollen als Relativziele – bezogen auf die Emissionshöchstmenge 2005 – verankert werden.

Nationale Gesamtemissionen

Die folgenden Tabellen zeigen die nationalen Gesamtemissionen der Luftschadstoffe für die Jahre 1990, 2005 und 2013 aus der österreichischen Emissionsinventur (UMWELTBUNDESAMT 2015b) sowie die aktuellen Ergebnisse der Projektionen bis 2030.

[1] Richtlinie 2001/81/EG des Europäischen Parlaments und des Rates vom 23. Oktober 2001 über nationale Emissionshöchstmengen für bestimmte Luftschadstoffe

[2] http://www.unece.org/env/lrtap/full%20text/1979.CLRTAP.e.pdf

[3] http://www.ceip.at/fileadmin/inhalte/emep/reporting_2009/Rep_Guidelines_ECE_EB_AIR_97_e.pdf

Tabelle A umfasst die Emissionen auf Basis

a. der **verkauften** Treibstoffmenge gemäß dem UNECE-Übereinkommen über weiträumige grenzüberschreitende Luftverunreinigung. Dabei ist zu beachten, dass in Österreich in den letzten Jahren ein beachtlicher Teil der verkauften Treibstoffmenge im Inland getankt, jedoch im Ausland verfahren wurde (Kraftstoffexport im Fahrzeugtank).

b. der in Österreich **verbrauchten** Treibstoffmenge ohne Kraftstoffexport im Fahrzeugtank (gemäß Artikel 2 der NEC-Richtlinie). Diese Emissionsmengen (außer $PM_{2,5}$) sind Österreichs offizielle Werte gemäß Artikel 8 (1) der NEC-Richtlinie.

Tabelle A: Nationale Gesamtemissionen für 1990 bis 2013 und projizierte Emissionen für 2015, 2020, 2025 und 2030 auf Basis der ***verkauften Treibstoffmengen*** *(CLRTAP-Projektionen; „fuel sold") und* ***verbrauchten Treibstoffmengen*** *(NEC-Projektionen; „fuel used") mit den beiden Szenarien* ***„mit bestehenden Maßnahmen (WEM)"*** *und* ***„mit zusätzlichen Maßnahmen (WAM)"*** *(Quelle: Umweltbundesamt).*

Luftschadstoff	Luftschadstoff-Inventur			projizierte Emissionen				Szenarien	
[kt/a]	1990	2005	2013	2015	2020	2025	2030		
NO_x	215,47	234,95	162,32	150,17	114,64	94,90	87,53	WEM	fuel sold
				150,98	102,06	84,34	76,80	WAM	
	197,78	175,93	136,00	129,39	105,26	89,36	83,08	WEM	fuel used
				128,62	98,83	82,10	74,72	WAM	
SO_2	74,45	26,69	17,25	17,03	16,65	16,53	16,97	WEM	fuel sold
				16,93	16,33	16,14	16,34	WAM	
	73,54	26,63	17,21	16,99	16,61	16,49	16,92	WEM	fuel used
				16,89	16,31	16,12	16,31	WAM	
NMVOC	281,02	159,24	126,34	124,70	115,73	104,64	99,00	WEM	fuel sold
				124,66	114,23	102,92	97,42	WAM	
	277,72	155,08	125,49	123,88	115,16	104,13	98,52	WEM	fuel used
				123,78	114,09	102,76	97,24	WAM	
NH_3	66,47	66,10	66,25	68,29	73,44	73,47	73,51	WEM	fuel sold
				67,46	70,33	69,12	67,91	WAM	
	66,41	65,51	66,14	68,15	73,29	73,31	73,34	WEM	fuel used
				67,30	70,32	69,09	67,87	WAM	
$PM_{2,5}$	25,18	22,65	18,23	16,81	14,97	13,39	12,93	WEM	fuel sold
				16,79	14,52	12,75	12,13	WAM	
	24,61	21,02	17,73	16,44	14,81	13,30	12,86	WEM	fuel used
				16,39	14,47	12,72	12,10	WAM	

Gemäß Artikel 2 der NEC-Richtlinie gilt diese für die Emissionen von Schadstoffen im Gebiet der jeweiligen Mitgliedstaaten. Die folgende Tabelle gibt die Ziele gemäß der NEC-Richtlinie für das Jahr 2010 an. Abbildung B stellt die Emissionen den nationalen Emissionshöchstmengen der NEC-Richtlinie gegenüber. Einzig die NO_x-Emissionen lagen 2010 darüber. Diese Höchstmengen sind als Obergrenze auch in den Folgejahren nach 2010 einzuhalten.

[kt/a]	Emissionshöchstmenge 2010
NO_x	103
SO_2	39
NMVOC	159
NH_3	66

Tabelle B: Ziele für 2010 gemäß NEC-Richtlinie 2001/81/EG (NEC-Projektionen) (Quelle: Umweltbundesamt).

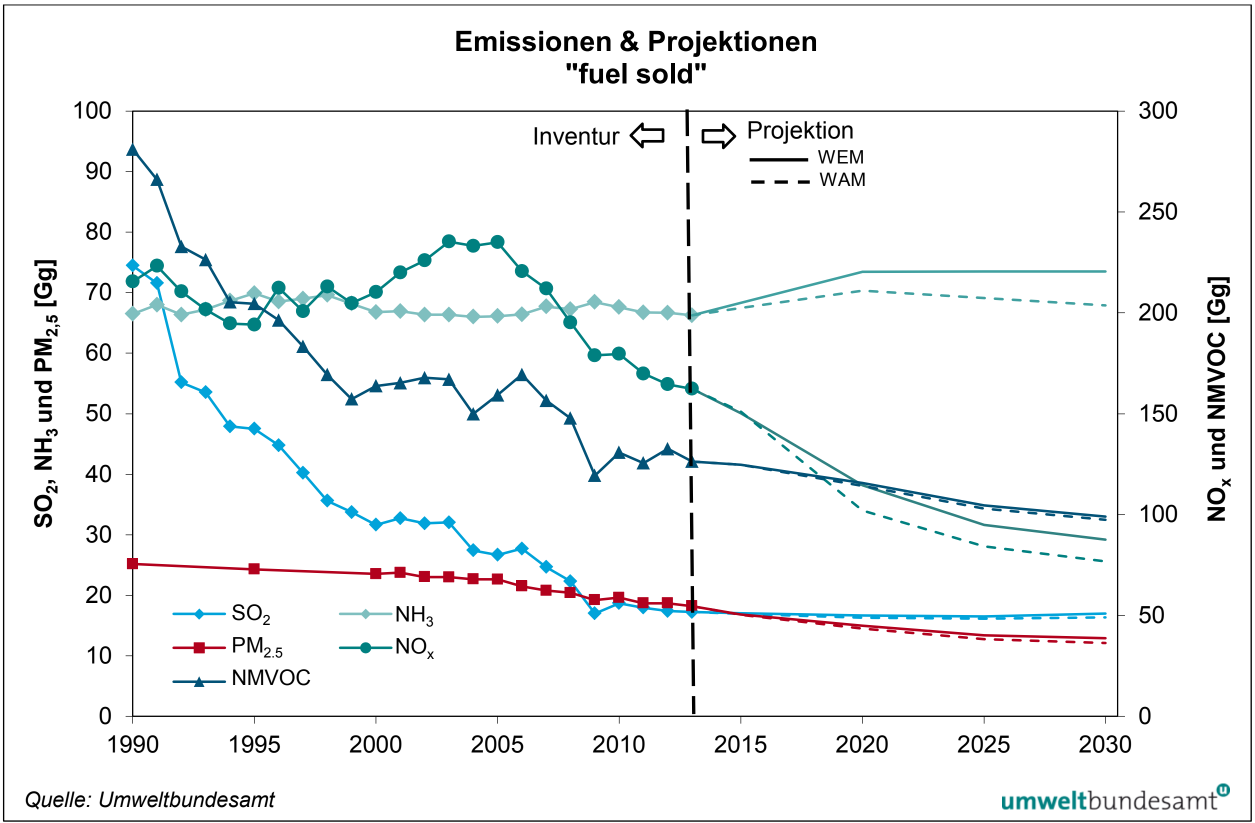

Abbildung A: *Historische (1990–2013) und projizierte Emissionen auf Basis der verkauften Treibstoffmengen (2015, 2020, 2025 und 2030) (CLRTAP-Projektionen) mit den zwei Szenarien „mit bestehenden Maßnahmen (WEM)" und „mit zusätzlichen Maßnahmen (WAM)".*

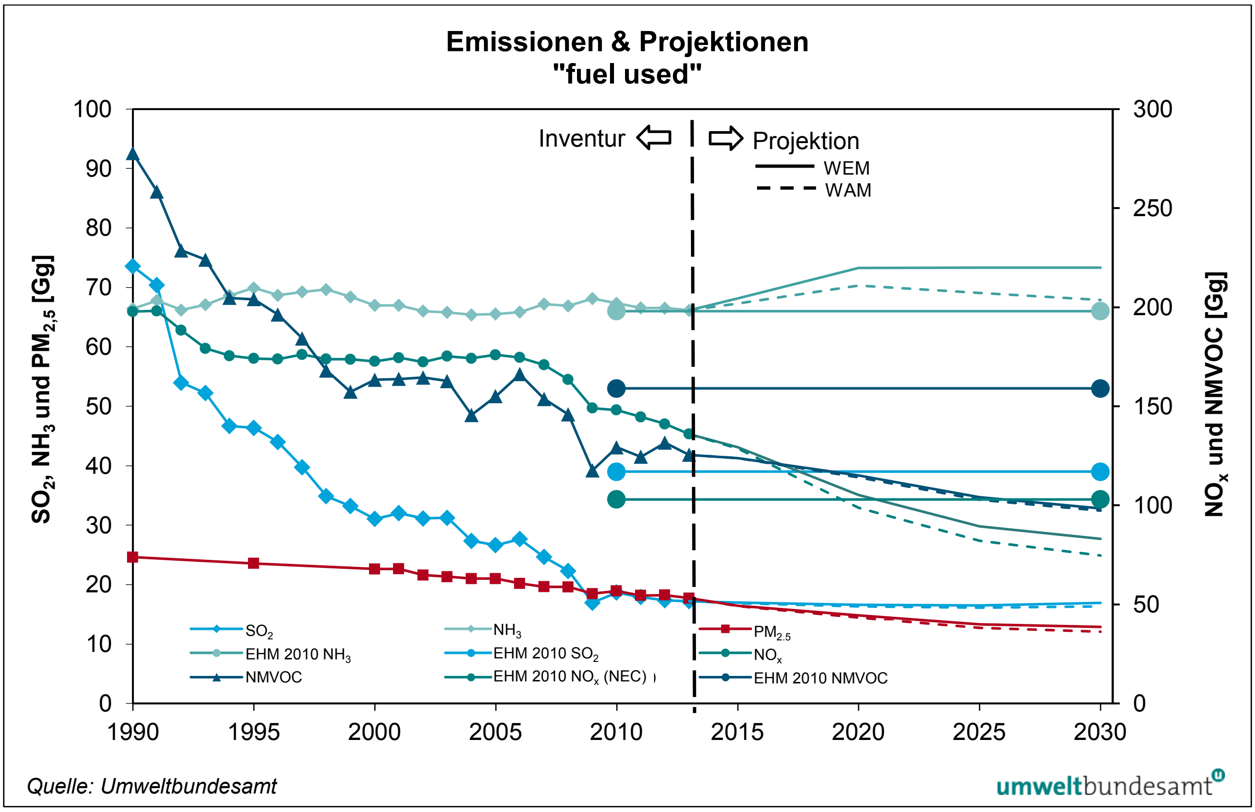

Abbildung B: Historische (1990–2013) und projizierte Emissionen auf Basis der verbrauchten Treibstoffmengen (2015, 2020, 2025 und 2030), mit den zwei Szenarien „mit bestehenden Maßnahmen (WEM)" und „mit zusätzlichen Maßnahmen (WAM)" sowie die Ziele (Emissionshöchstmengen, EHM) gemäß NEC-Richtlinie 2001/81/EG.

NO_x-Trend

NO_x-Emissionen entstehen vorwiegend bei hoher Temperatur als unerwünschtes Nebenprodukt bei der Verbrennung von Brenn- und Treibstoffen.

Die Hauptquelle der nationalen NO_x-Emissionen ist die Verbrennung von Brenn- und Kraftstoffen mit einem Anteil von mehr als 96 %, wobei der größte Anteil an den NO_x-Gesamtemissionen im Jahr 2013 auf den Straßenverkehr mit 53 % (inklusive Kraftstoffexport im Fahrzeugtank, d. h. auf Basis des verkauften Treibstoffs) bzw. 44 % (exklusive Kraftstoffexport im Fahrzeugtank) entfällt. Weitere bedeutende Emissionsquellen sind die Sektoren Industrie inkl. Prozessemissionen (20 %), Kleinverbrauch (12 %) und Energieversorgung (8 %).

In den letzten Jahren ist ein beachtlicher Teil der verkauften Treibstoffmenge im Inland getankt, jedoch im Ausland verfahren worden (Kraftstoffexport im Fahrzeugtank). Die nationalen NO_x-Emissionen betrugen 2013 inklusive Kraftstoffexport im Fahrzeugtank 162 kt und ohne Kraftstoffexport im Fahrzeugtank 136 kt. Österreich berichtet die Emissionen gemäß NEC-Richtlinie auf Basis des verbrauchten Kraftstoffs (ohne Kraftstoffexport im Fahrzeugtank), damit wird die Emissionshöchstmenge von 103 kt/a um rund 33 kt überschritten.

Die Szenarien zeigen eine Reduktion der NO_x-Emissionen um – 63 % im Szenario WEM bzw. – 67 % im Szenario WAM im Zeitraum 2005–2030.

Besonders im Straßenverkehr ist dieser Trend zu erkennen. Die wichtigsten Ursachen für diesen Rückgang liegen in der Modernisierung der Flotte sowie in verbesserten spezifischen NO_x-Emissionen des neu eingeführten Emissionsstandards EURO 6 (Pkw und LNF[4]) sowie EURO VI bei SNF. Die größten Reduktionen der NO_x-Emissionsfaktoren ergeben sich bei SNF von EURO V auf EURO VI sowie im Übergang zu Stage IV im Offroad-Sektor. Zusätzlich wurde ebenfalls eine pessimistische Option für EURO 6 und EURO 6c (geltende Schadstoffklasse ab ca. 2018) durchgeführt, wobei sich die nationalen Gesamtemissionen um – 57 % im WEM bzw. – 47 % im WAM reduzieren (2005 gegenüber 2030).

Im WAM-Szenario wirken zwei Annahmen besonders emissionsmindernd:

1. Auch künftig werden Erhöhungen der Mineralölsteuer vorgenommen.
2. In die Lkw-Maut werden externe Kosten für Luftverschmutzung im Rahmen einer Novellierung der EU-Wegekosten-Richtlinie eingerechnet. Somit könnte eine frühzeitige Umstellung auf die EURO VI-Technologie bei Lkw stattfinden.

Außerdem führen erwartete Maßnahmen wie beispielsweise eine Forcierung des Mobilitätsmanagements (klimaaktiv mobil Programm des BMLFUW) inkl. Masterplan Radverkehr & Masterplan Fußgänger sowie Anreize für verstärkte ÖV-Nutzung zu weiteren NO_x-Reduktionen.

Neben dem Straßenverkehr mit einer Reduktion von – 126 kt (WEM) bzw. – 130 kt (WAM) im Jahr 2030 gegenüber 2005, sind in den Sektoren Energieaufbringung (– 3 kt bis – 5 kt) und Industrie inkl. Prozesse (– 3 kt bis – 7 kt) absolute Reduktionen erzielbar, wenn auch in deutlich geringerem Ausmaß.

SO_2-Trend

SO_2-Emissionen entstehen vorwiegend beim Verbrennen von schwefelhaltigen Brenn- und Treibstoffen. Im Jahr 2013 war die Industrie (inkl. Prozesse) für nahezu drei Viertel der österreichischen SO_2-Emissionen verantwortlich, gefolgt von der Energieversorgung (1A1) und dem Sektor Kleinverbrauch (1A4).

Die starke Emissionsabnahme seit 1990 konnte durch die Absenkung des Schwefelanteils in Mineralölprodukten und Treibstoffen (gemäß Kraftstoffverordnung), den Einbau von Entschwefelungsanlagen in Kraftwerken (gemäß Luftreinhaltegesetz für Kesselanlagen) sowie die verstärkte Nutzung schwefelärmerer Brennstoffe, wie z. B. Erdgas, erreicht werden.

In den beiden Projektionsszenarien verringert sich die weitere Abnahme jedoch kontinuierlich, sodass gegen Ende 2030 sogar mit einem geringen Anstieg der SO_2-Emissionen zu rechnen ist. Der parallel zum erwarteten Wirtschaftswachstum steigende Trend in der Industrie (1A2) wird durch Reduktionen in der Energieversorgung (1A1) und dem Kleinverbrauch (1A4) durch den weiteren Wechsel zu schwefelärmeren Brennstoffen und erneuerbaren Energieträgern beinahe kompensiert.

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[4] Leichte Nutzfahrzeuge

NMVOC-Trend

Flüchtige Kohlenwasserstoffe entstehen beim Verdunsten von Lösemitteln und Treibstoffen sowie durch unvollständige Verbrennung von Brenn- und Treibstoffen. Die Hauptquellen der nationalen NMVOC-Emissionen sind der Sektor Lösemittel (2D), der im Jahr 2013 etwa 58 % der Gesamtemissionen verursachte, der Kleinverbrauch mit 25 % und der Straßenverkehr mit 6 %.

Seit 1990 kam es zu einer deutlichen Reduktion der NMVOC-Emissionen in den genannten Sektoren. Im Lösemittelsektor konnten die Reduktionen aufgrund diverser legislativer Instrumente (Lösungsmittelverordnung, HKW-Anlagen-Verordnung sowie VOC-Anlagen-Verordnung) erzielt werden.

Die aktuellen Projektionen gehen von weiter sinkenden NMVOC-Emissionen bis 2030 aus (– 38 % im Szenario WEM und – 39 % im Szenario WAM im Zeitraum 2005–2030). Dies ist hauptsächlich auf Emissionsminderungen in den Sektoren Kleinverbrauch (Trend zu Zentralheizungssystemen, Rückgang des Stückholzeinsatzes und niedrigere Emissionsfaktoren von Neuanlagen) und Verkehr (Verbesserung der Motorentechnik und Flottenerneuerung durch Fahrzeuge mit sukzessiv sinkenden Abgasgrenzwerten) zurückzuführen. Zusätzlich wird ebenfalls ein Rückgang bei der Verwendung von Lösemitteln erwartet.

NH_3-Trend

NH_3-Emissionen entstehen bei der Viehhaltung, der Lagerung von Gülle und Mist sowie beim Abbau von organischem und mineralischem Dünger. Die Landwirtschaft ist somit für den Großteil (rd. 94 %) der NH_3-Emissionen verantwortlich.

Von 1990 bis 2013 sind die NH_3-Emissionen in Summe annähernd konstant verlaufen (– 0,3%). Der reduzierte Viehbestand ist für die leichte Abnahme der NH_3-Emissionen Ende der 1990er-Jahre hauptverantwortlich. Die Stagnation der letzten Jahre kann mit dem leicht sinkenden Rinderbestand bei vermehrter Haltung in Laufställen, der Zunahme von leistungsstärkeren Milchkühen sowie dem verstärkten Einsatz von Harnstoff als Stickstoffdünger erklärt werden.

Bis 2030 wird im WEM-Szenario jedoch wieder mit steigenden NH_3-Emissionen gerechnet (+ 11 % gegenüber 2005). Die im WAM-Szenario implementierten zusätzlichen Minderungsmaßnahmen konnten die durch ansteigende Viehbestände und vermehrte Rinder-Laufstallhaltung verursachten Emissionen nur teilweise kompensieren (+ 3 % gegenüber 2005).

$PM_{2,5}$-Trend

Die primären $PM_{2,5}$-Emissionen stammen hauptsächlich aus Verbrennungsprozessen von Brenn- und Treibstoffen. Im Sektor Verkehr wird $PM_{2,5}$ auch zu einem großen Teil durch Brems- und Reifenabrieb sowie Aufwirbelung auf der Straße verursacht.

Mit 43 % nimmt der Sektor Kleinverbrauch (1A4) im Jahr 2013 den größten Anteil an den $PM_{2,5}$-Emissionen ein. Weitere bedeutende Emissionsquellen sind die Industrie (inkl. Prozessemissionen; 22 %), Verkehr (20 %), Energieversorgung (6 %) und Landwirtschaft (6 %).

Von 1990 bis 2013 kam es bei den $PM_{2,5}$-Emissionen zu einem Rückgang um 28 %. Im Sektor Kleinverbrauch sind insbesondere die Anbindung an das Erdgas- und Fernwärmenetz, der Ersatz alter Heizungsanlagen durch neue Technologien und der Wechsel zu emissionsärmeren Brennstoffen für den Rückgang verantwortlich. Im Sektor Verkehr kam es bis zum Jahr 2003 durch den Anstieg an Fahrleistung und Diesel-Pkw in der Flotte zu einer Zunahme der $PM_{2,5}$-Emissionen, wobei durch die Verbesserung der Antriebs- und der Abgasnachbehandlung (Partikelfilter) bis 2013 eine deutliche Trendumkehr erzielt wurde. Die $PM_{2,5}$-Emissionen im Sektor Industrie (inkl. Prozesse) sind gegenüber 1990 deutlich gefallen (– 24 %).

In den Szenarien bis 2030 erfolgt die Reduktion der $PM_{2,5}$-Emissionen im Sektor Kleinverbrauch vorwiegend durch die Steigerung der Gebäude- und Heizungseffizienz und durch die Abkehr von manuell beschickten Scheitholz-Kesseln. Der prognostizierte verminderte Einsatz von festen Brennstoffen (Scheitholz und Kohle) wird im WEM-Szenario in diesem Sektor von 2005 bis 2030 zu einer $PM_{2,5}$-Reduktion von – 58 % bzw. – 5,1 kt führen (WAM – 62 % bzw. – 5,5 kt u. a. aufgrund Berücksichtigung des Energieeffizienzgesetzes).

Im Straßenverkehr führen insbesondere die Flottenerneuerung und damit einhergehend der Anstieg von Diesel-Pkw mit Abgasnachbehandlungstechnologie (wie Partikelfilter) zu einer deutlichen Reduktion in beiden Szenarien (– 78 % bis – 79 % bzw. – 5,1 kt bis – 5,2 kt) gegenüber 2005, wobei bereits bis zum Jahr 2013 eine Reduktion von – 53 % bzw. – 3,5 kt beobachtbar ist.

1 INTRODUCTION

The Austrian emission projections for the pollutants sulphur dioxide (SO_2), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC), ammonia (NH_3) and particulate matter ($PM_{2.5}$) for the scenarios "with existing measures" und "with additional measures" were last published in 2014 in the report entitled "Austria's National Air Emission Projections 2013 for 2015, 2020 and 2030" (UMWELTBUNDESAMT 2014).

This year's report provides an update of the emission projections for both scenarios, which are based on the new energy scenarios (UMWELTBUNDESAMT 2015a) and the implementation of additional measures for air pollution.

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

The report further outlines relevant background information in order to enable a quantitative understanding of the key socioeconomic assumptions used in the preparation of the projections. For the purpose of comparison, emission data from the National Air Emission Inventory as of March 2015 (UMWELTBUNDESAMT 2015b) are included as well.

Austria´s emission projections were calculated based on both methods: fuel sold and fuel used. Table 1 shows Austria´s national total emissions and projections under the UNECE LRTAP Convention (Gothenburg Protocol; based on fuel sold) and Austria´s official projections under Article 8 (1) of the NEC Directive (based on fuel used). When referring to emissions based on 'fuel used', 'fuel exports in the vehicle tank' are not considered.

Legal Background

Upon signing the UNECE Gothenburg Protocol to the Convention on Long-Range Transboundary Air Pollution of 1 December 1999[5], the EU agreed on national emission ceilings for sulphur dioxide (SO_2), nitrogen oxides (NO_x), ammonia (NH_3) and non-methane volatile organic compounds (NMVOC) for the year 2010. Austria signed the Gothenburg Protocol but to date has not ratified it. For this reason the targets are not binding for Austria. However, Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants ("NEC Directive")[6] stipulates national emission ceilings for these air pollutants which are relevant for Austria. Pursuant to Article 7, Member States are obliged to prepare and annually update their national emission inventories and emission projections for 2010. Pursuant to Art. 8 (1), Member States have to report their emission inventories and pro-

[5] Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution to Abate Acidification, Eutrophication and Ground-level Ozone, http://www.unece.org/env/lrtap/full%20text/1999%20Multi.E.Amended.2005.pdf

[6] 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

jections to the Commission. These obligations have been transposed into national law by the Emission Ceilings Act – Air (*Emissionshöchstmengengesetz-Luft)*[7].

According to Article 15 of the Guidelines[8] for reporting emission data under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP) 2009 Parties shall report emissions from road transport on the basis of fuel sold to the final consumer and may additionally report emissions based on 'fuel used' in the geographic area of the Party. According to Article 2, the NEC Directive (2001/81/EC) covers "emissions in the territory of the Member States". In order to comply with this spatial requirement, Austria's reporting to the European Commission according to the NEC-Directive (NECD) is based on 'fuel used'.

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

Annex I of the NEC Directive determines national emission ceilings for certain atmospheric pollutants (see Table 1). By the year 2010, Member States had to limit their annual national emissions of these pollutants to an amount not exceeding the emission ceilings. These emission ceilings shall further not be exceeded at any time thereafter.

Table 1: Emission ceilings according to the NEC Directive 2001/81/EC for 2010 in 1,000 tonnes per year, i.e. [kt/a].

[kt/a]	Ceilings 2010
NO_x	103
SO_2	39
NMVOC	159
NH_3	66

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

[8] http://www.ceip.at/fileadmin/inhalte/emep/reporting_2009/Rep_Guidelines_ECE_EB_AIR_97_e.pdf

2 MAIN RESULTS

The following results show Austria´s national total emissions and projections under the UNECE LRTAP Convention (Gothenburg Protocol; based on fuel sold) and Austria´s projections under Article 8 (1) of the NEC Directive (based on fuel used). When referring to emissions based on 'fuel used', 'fuel exports in the vehicle tank' are not considered. According to the proposal for a new NEC Directive, new emission ceilings are likely to be established for the four substances regulated already, as well as for primary emissions of $PM_{2.5}$. Emissions of $PM_{2.5}$ are thus included in the following tables and emission projections were calculated for $PM_{2.5}$ as well.

The scenario "with existing measures" leads to significant reductions in emissions by 2030 for all pollutants but NH_3. The most substantial reduction with about 63% (fuel sold) or 53% (fuel used) from 2005 until 2030 is projected for the pollutant NO_x, provided that the latest and new emission standards for road vehicles meet their specifications. To examine a possible non-compliance with these standards under real world driving conditions, an additional scenario (WAM pessimistic) has been introduced, which results in a reduction that is 6 percentage points less (see Table 2 and Table 3).

Emission reductions for the other pollutants are in the range from 46% to 36%; NH_3 emissions, however, increase by 11–12%. The scenario with additional measures shows some percentage points more reduction for most of the pollutants and NH_3 emissions slightly higher than nowadays.

*Table 2: Austrian national total emissions in kt and trend in comparison with the base year 2005 in % for the scenario (I) **with existing measures (WEM)** and (II) **with additional measures (WAM)** based on (a) **fuel sold** and (b) **fuel used** (Source: Umweltbundesamt).*

Pollutant	Emission inventory 2015				Emission scenario				Type of scenario	
[kt/a]	1990	2005	2010	2013	2015	2020	2025	2030		
NO_x	215.47	234.95	179.63	162.32	150.17	114.64	94.90	87.53	WEM	fuel sold
		0%	*-24%*	*-31%*	*-36%*	*-51%*	*-60%*	*-63%*		
	215.47	234.95	179.63	162.32	150.98	102.06	84.34	76.80	WAM	
		0%	*-24%*	*-31%*	*-36%*	*-57%*	*-64%*	*-67%*		
	197.78	175.93	148.12	136.00	129.39	105.26	89.36	83.08	WEM	fuel used
		0%	*-16%*	*-23%*	*-26%*	*-40%*	*-49%*	*-53%*		
	197.78	175.93	148.12	136.00	128.62	98.83	82.10	74.72	WAM	
		0%	*-16%*	*-23%*	*-27%*	*-44%*	*-53%*	*-58%*		
SO_2	74.45	26.69	18.70	17.25	17.03	16.65	16.53	16.97	WEM	fuel sold
		0%	*-30%*	*-35%*	*-36%*	*-38%*	*-38%*	*-36%*		
	74.45	26.69	18.70	17.25	16.93	16.33	16.14	16.34	WAM	
		0%	*-30%*	*-35%*	*-37%*	*-39%*	*-40%*	*-39%*		
	73.54	26.63	18.66	17.21	16.99	16.61	16.49	16.92	WEM	fuel used
		0%	*-30%*	*-35%*	*-36%*	*-38%*	*-38%*	*-36%*		
	73.54	26.63	18.66	17.21	16.89	16.31	16.12	16.31	WAM	
		0%	*-30%*	*-35%*	*-37%*	*-39%*	*-39%*	*-39%*		

Pollutant [kt/a]	Emission inventory 2015 1990	2005	2010	2013	Emission scenario 2015	2020	2025	2030	Type of scenario	
NMVOC	281.02	159.24	130.79	126.34	124.70	115.73	104.64	99.00	WEM	fuel sold
		0%	*-18%*	*-21%*	*-22%*	*-27%*	*-34%*	*-38%*		
	281.02	159.24	130.79	126.34	124.66	114.23	102.92	97.42	WAM	
		0%	*-18%*	*-21%*	*-22%*	*-28%*	*-35%*	*-39%*		
	277.72	155.08	129.27	125.49	123.88	115.16	104.13	98.52	WEM	fuel used
		0%	*-17%*	*-19%*	*-20%*	*-26%*	*-33%*	*-36%*		
	277.72	155.08	129.27	125.49	123.78	114.09	102.76	97.24	WAM	
		0%	*-17%*	*-19%*	*-20%*	*-26%*	*-34%*	*-37%*		
NH_3	66.47	66.10	67.58	66.25	68.29	73.44	73.47	73.51	WEM	fuel sold
		0%	*2%*	*0%*	*3%*	*11%*	*11%*	*11%*		
	66.47	66.10	67.58	66.25	67.46	70.33	69.12	67.91	WAM	
		0%	*2%*	*0%*	*2%*	*6%*	*5%*	*3%*		
	66.41	65.51	67.32	66.14	68.15	73.29	73.31	73.34	WEM	fuel used
		0%	*3%*	*1%*	*4%*	*12%*	*12%*	*12%*		
	66.41	65.51	67.32	66.14	67.30	70.32	69.09	67.87	WAM	
		0%	*3%*	*1%*	*3%*	*7%*	*5%*	*4%*		
$PM_{2,5}$	25.18	22.65	19.63	18.23	16.81	14.97	13.39	12.93	WEM	fuel sold
		0%	*-13%*	*-20%*	*-26%*	*-34%*	*-41%*	*-43%*		
	25.18	22.65	19.63	18.23	16.79	14.52	12.75	12.13	WAM	
		0%	*-13%*	*-20%*	*-26%*	*-36%*	*-44%*	*-46%*		
	24.61	21.02	18.93	17.73	16.44	14.81	13.30	12.86	WEM	fuel used
		0%	*-10%*	*-16%*	*-22%*	*-30%*	*-37%*	*-39%*		
	24.61	21.02	18.93	17.73	16.39	14.47	12.72	12.10	WAM	
		0%	*-10%*	*-16%*	*-22%*	*-31%*	*-39%*	*-42%*		

Table 3: Austrian national total emissions in kt and trend in comparison with the base year 2005 in % for the scenario (I) ***with existing measures pessimistic (WEM pessimistic)*** *and (II)* ***with additional measures pessimistic (WAM pessimistic)*** *based on (a)* ***fuel sold*** *and (b)* ***fuel used*** *(Source: Umweltbundesamt).*

Pollutant [kt/a]	Emission inventory 2015 1990	2005	2010	2013	Emission scenario 2015	2020	2025	2030	Type of scenario	
NO_x	215.47	234.95	179.63	162.32	152.53	128.78	111.27	100.67	WEM pess.	fuel sold
		0%	-24%	-31%	-35%	-45%	-53%	-57%		
	215.47	234.95	179.63	162.32	153.34	116.20	100.71	89.94	WAM pess.	
		0%	-24%	-31%	-35%	-51%	-57%	-62%		
	197.78	175.93	148.12	136.00	131.09	116.95	102.69	93.17	WEM pess.	fuel used
		0%	-16%	-23%	-25%	-34%	-42%	-47%		
	197.78	175.93	148.12	136.00	130.27	111.78	96.98	86.25	WAM pess.	
		0%	-16%	-23%	-26%	-36%	-45%	-51%		

2.1 Nitrogen Oxides NO_x

In 2013, NO_x emissions amounted to 162 kt (including fuel exports in the vehicle tank, i.e. based on fuel sold). Compared to 2005 levels, emissions were about 30.9% lower in 2013. When considering inland fuel consumption without 'fuel exports in the vehicle tank', NO_x emissions amounted to only 136 kt in 2013, i.e. a 22.7% decrease since 2005. The gradual replacement of vehicles by new cars with lower fuel consumption and improved NO_x emissions have contributed to the decreasing trend in the last few years.

The main sources of NO_x emissions in 2013 were fuel combustion activities with a share of more than 96%. Road transport including 'fuel export' contributed the highest share (53%) of total NO_x emissions. Road transport without 'fuel export' accounted for 44% of the national total emissions. Further major sources were the manufacturing industries and the construction industry (19%), fuel combustion in power plants and households as well as off-road vehicles and other machinery in agriculture and forestry.

The scenarios "with existing measures" (WEM) and "with additional measures" (WAM) both show a reduction of NO_x emissions.

- WEM: National total emissions including 'fuel export' are expected to decrease to 87.5 kt by 2030 (–63% compared to 2005). Without 'fuel export' they are expected to reach 83.1 kt (–53% compared to 2005).
- WAM: National total emissions including 'fuel export' are expected to decrease to 76.8. kt by 2030 (–67% compared to 2005). Without 'fuel export' they are expected to reach 74.7 kt (–58% compared to 2005).

The pessimistic versions of WEM and WAM show a significantly less pronounced decrease in emissions.

- WEM pessimistic: National total emissions including 'fuel export' are expected to decrease to 100.7 kt by 2030 (–57% compared to 2005). Without 'fuel export' they are expected to reach 93.2 kt (–47% compared to 2005).
- WAM pessimistic: National total emissions including 'fuel export' are expected to decrease to 89.9 kt by 2030 (–62% compared to 2005). Without 'fuel export' they are expected to reach 86.2 kt (–51% compared to 2005).

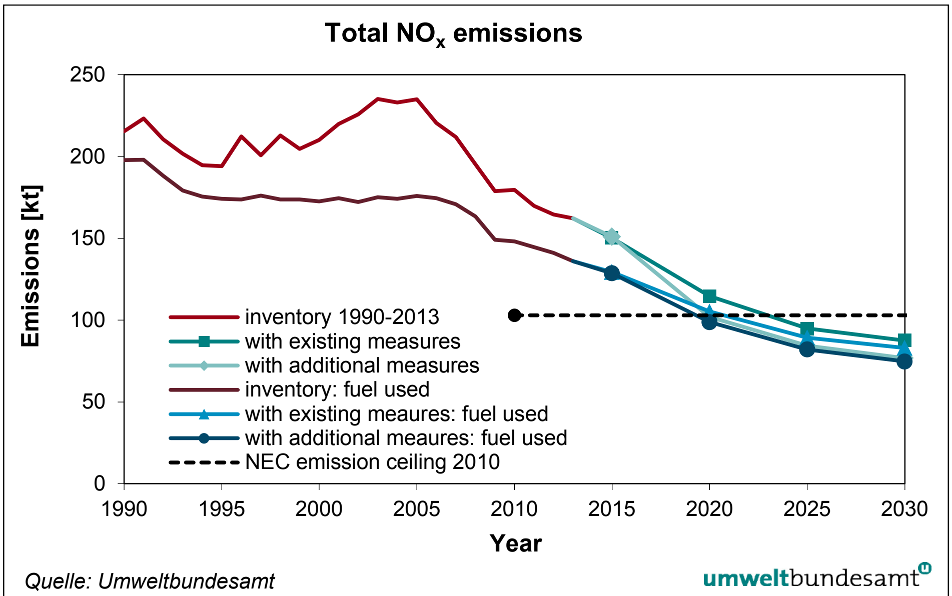

*Figure 1: Historical (1990 to 2013) and projected emissions (2015–2030) of NO_x based on (a) **fuel sold** and (b) **fuel used** in the scenarios **(I) with existing measures (WEM)** and **(II) with additional measures (WAM)**.*

The main driver of the NO_x emissions trend until 2030 is expected to be industry and road transport. NO_x emissions from heavy duty vehicles and cars are projected to decrease by more than 80% from 2005 to 2030. The main reasons for this decline are the modernisation of the vehicle fleet in combination with low specific emissions, especially through the introduction of the latest emission classes Euro VI (HDV) and Euro 6 (PC and LDV). Another cause of the decreasing NO_x emissions in road transport is a slight increase in the share of e-mobility which is expected to take place (and substitute conventionally fuelled cars) from now until 2030.

Emissions from manufacturing industries and construction (without mobile sources) are projected to increase in WEM scenario due to an average GDP growth of 1.5% per year resulting in more production needing more energy input. However, total industrial emissions (including off-road) are projected to decrease by 7% (2.5 kt) in 2030 compared to 2005.

Significant increases are projected for other stationary industries (3.5 kt), the chemical industry (1.0 kt) and the pulp and paper industry (0.5 kt). In contrast, emissions from the iron and steel industry are projected to decrease by 1.0 kt in 2030 compared to 2005, due to the installation of an SCR in a sinter plant. Mobile sources in industry (off-road) show a decrease by 72% (–6.0 kt).

Due to appropriate energy efficiency measures, energy use in industry is projected to be lower in the WAM scenario than in WEM. Apart from that, emissions are expected to be reduced by primary and secondary measures in combustion. By 2030, total industrial emissions in the WAM scenario are projected to decrease by 6.6 kt compared to 2005. Increases are projected for the chemical industry (0.8 kt) while significant decreases are projected for the pulp and paper industry (1.2 kt), non-metallic minerals (2.3 kt), the iron and steel industry (1.0 kt) and off-road (6.0 kt).

Emissions from fuel combustion in stationary sources and off-road machines in commercial and institutional buildings, households, forestry and agriculture ("other sectors") are projected to decrease by more than 50% from 2005 to 2030.

Table 4: Austrian national NO_x emissions in kt and trend for the scenario (I) with existing measures (WEM) and (II) with additional measures (WAM) based on (a) fuel sold and (b) fuel used (Source: Umweltbundesamt).

NFR	Description	Emission inventory* [kt]				Emission scenario [kt]				Type of scenario	
		1990	2005	2010	2013	2015	2020	2025	2030		
	Total	**215.47**	**234.95**	**179.63**	**162.32**	**150.17**	**114.64**	**94.90**	**87.53**	WEM	fuel sold
		215.47	**234.95**	**179.63**	**162.32**	**150.98**	**102.06**	**84.34**	**76.80**	WAM	
		197.78	**175.93**	**148.12**	**136.00**	**129.39**	**105.26**	**89.36**	**83.08**	WEM	fuel used
		197.78	**175.93**	**148.12**	**136.00**	**128.62**	**98.83**	**82.10**	**74.72**	WAM	
1 A 1	**Energy Industries**	17.74	15.08	14.89	13.07	12.62	13.42	12.73	12.44	WEM	
		17.74	15.08	14.89	13.07	12.62	13.45	11.30	10.54	WAM	
1 A 2	**Manufacturing Industries and Construction**	32.97	33.72	32.35	31.41	31.44	29.68	29.92	31.22	WEM	
		32.97	33.72	32.35	31.41	30.95	27.85	26.89	27.14	WAM	
1 A 3 a, c, d, e	**Off-Road transport**	3.42	4.90	4.46	4.23	4.24	4.16	4.27	4.41	WEM	
		3.42	4.90	4.46	4.23	4.32	4.31	4.38	4.20	WAM	

NFR	Description	Emission inventory* [kt]				Emission scenario [kt]				Type of scenario	
1 A 3 b	Road Transportation	122.07	146.76	97.90	86.23	74.61	42.96	26.72	19.95	WEM	fuel sold
		122.07	146.76	97.90	86.23	75.94	32.71	21.48	16.65	WAM	
		104.38	87.74	66.39	59.92	53.83	33.58	21.18	15.50	WEM	fuel used
		104.38	87.74	66.39	59.92	53.58	29.49	19.25	14.57	WAM	
1 A 4	Other Sectors	27.73	26.79	22.61	20.16	19.99	17.09	13.87	12.07	WEM	
		27.73	26.79	22.61	20.16	19.90	16.42	12.93	10.89	WAM	
1 A 5	Other	0.07	0.09	0.08	0.08	0.09	0.10	0.11	0.12	WEM	
		0.07	0.09	0.08	0.08	0.09	0.10	0.11	0.12	WAM	
1 B	Fugitive Emissions	IE	IE	IE	IE	IE	IE	IE	IE	WEM	
		IE	IE	IE	IE	IE	IE	IE	IE	WAM	
2A,B, C,H,I, J,K,L	Industrial Processes	4.80	1.75	1.50	1.27	1.28	1.31	1.36	1.41	WEM	
		4.80	1.75	1.50	1.27	1.28	1.31	1.36	1.41	WAM	
2D, 2G	Solvent and other product use	NA	NA	NA	NA	NA	NA	NA	NA	WEM	
		NA	NA	NA	NA	NA	NA	NA	NA	WAM	
3 B	Manure Management	0.34	0.26	0.25	0.25	0.23	0.21	0.20	0.19	WEM	
		0.34	0.26	0.25	0.25	0.23	0.21	0.20	0.19	WAM	
3 D	Agricultural Soils	6.20	5.53	5.56	5.60	5.63	5.71	5.70	5.68	WEM	
		6.20	5.53	5.56	5.60	5.62	5.68	5.66	5.63	WAM	
3 F, I	Field Burning and other agriculture	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	WEM	
		0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	WAM	
5	Waste	0.10	0.05	0.01	0.01	0.01	0.01	0.01	0.01	WEM	
		0.10	0.05	0.01	0.01	0.01	0.01	0.01	0.01	WAM	

** Data source: Austrian Emission Inventory 2015 (Umweltbundesamt 2015b)*

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

*Table 5: Austrian national NO_x emissions in kt and trend for the scenario (I) **with existing measures pessimistic (WEM pessimistic)** and (II) **with additional measures pessimistic (WAM pessimistic)** based on (a) fuel sold and (b) fuel used (Source: Umweltbundesamt).*

NFR	Description	Emission inventory* [kt]				Emission scenario [kt]**				Type of scenario**	
		1990	2005	2010	2013	2015	2020	2025	2030		
	Total	215.47	234.95	179.63	162.32	152.53	128.78	111.27	100.7	WEM	fuel sold
		215.47	234.95	179.63	162.32	153.34	116.20	100.71	89.9	WAM	
		197.78	175.93	148.12	136.00	131.09	116.95	102.69	93.2	WEM	fuel used
		197.78	175.93	148.12	136.00	130.27	111.78	96.98	86.2	WAM	
1 A 3 b	Road Transportation	122.07	146.76	97.90	86.23	76.98	57.10	43.09	33.1	WEM	fuel sold
		122.07	146.76	97.90	86.23	78.34	45.78	36.16	28.1	WAM	
		104.38	87.74	66.39	59.92	55.53	45.27	34.51	25.6	WEM	fuel used
		104.38	87.74	66.39	59.92	53.91	52.68	39.36	29.4	WAM	

** Data source: Austrian Emission Inventory 2015 (Umweltbundesamt 2015b)*

*** pessimistic assumptions for road transport*

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

2.2 Sulphur Dioxide SO_2

SO_2 emissions have decreased quite steadily since 1990, with a 77% reduction by the year 2013, which was mainly due to lower emissions from residential heating and from combustion in the energy sector and the manufacturing industries. The main reasons for this development are the implementation of emission limits in the power generation sector, a reduction of the sulphur content in mineral oil products and the usage of fuels with less sulphur content (e.g. natural gas). In 2013, emissions were about 35% lower than 2005.

The economic crisis caused a significant emission reduction in 2009, which was partly counterbalanced by a rebound in economic activity in 2010.

The main sources of SO_2 emissions in Austria are fuel combustion activities (accounting for a share of 93% in 2013). Within this category, the manufacturing industries and construction contribute most of the total SO_2 emissions (65.8%). Energy industries and Other Sectors have a share of 14% (and 11%, respectively) of the national total emissions.

The scenarios "with existing measures" (WEM) and "with additional measures" (WAM) both show a reduction of SO_2 emissions compared to 2005 and a stabilisation at the current level.

- WEM: National total emissions including 'fuel export' are expected to decrease to 16.97 kt by 2030 (–36% compared to 2005). Without 'fuel export' they are expected to reach 16.92 kt (–36% compared to 2005).
- WAM: National total emissions including 'fuel export' are expected to decrease to 16.34 kt by 2030 (–39% compared to 2005). Without 'fuel export' they are expected to reach 16.31 kt (–39% compared to 2005).

Emissions from the manufacturing industries and construction are expected to increase (WEM: +22%; WAM: +18% – in absolute terms, an increase of about 2 kt), mainly due to increasing GDP projections. By contrast, emissions from the energy industries are expected to decrease (WEM: –72%; WAM: –73%) and those from Other Sectors are expected to decrease (WEM: –88%; WAM: –89%) by 2030 due to a shift from fossil fuels to renewable fuels in both categories.

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.

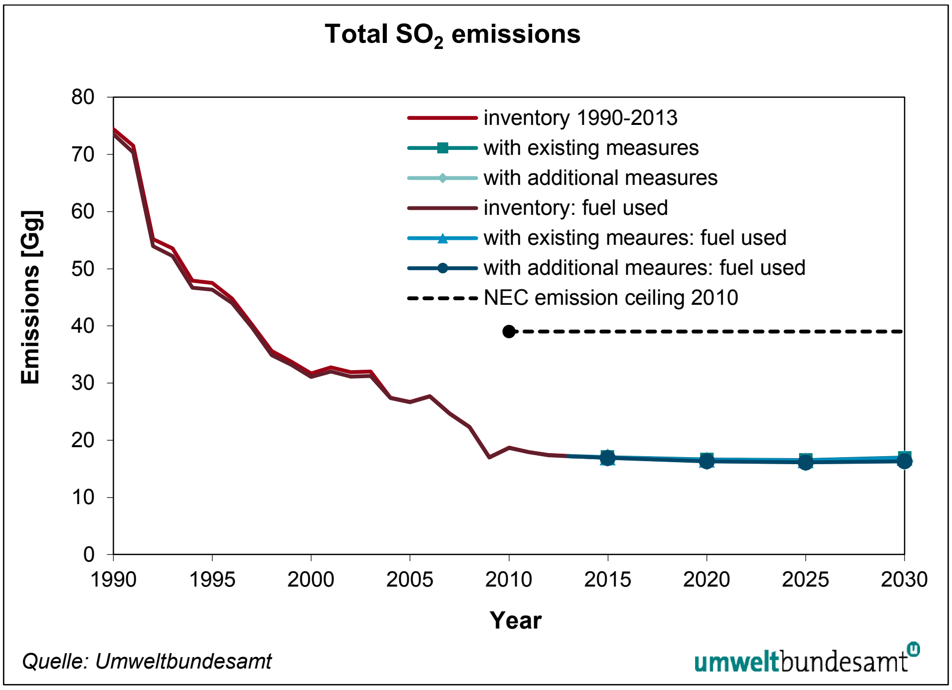

Figure 2: Historical (1990 to 2013) and projected emissions (2015–2030) of SO_2 based on (a) ***fuel sold*** *and (b)* ***fuel used*** *in the scenarios* ***(I) with existing measures (WEM)*** *and* ***(II) with additional measures (WAM)****.*

Table 6: Austrian national SO_2 emissions in kt and trend for the scenario (I) with existing measures (WEM) and (II) with additional measures (WAM) based on (a) fuel sold and (b) fuel used (Source: Umweltbundesamt).

NFR	Description	Emission inventory* [kt]				Emission scenario [kt]				Type of scenario	
		1990	2005	2010	2013	2015	2020	2025	2030		
	Total	**74.45**	**26.69**	**18.70**	**17.25**	**17.03**	**16.65**	**16.53**	**16.97**	WEM	fuel sold
		74.45	**26.69**	**18.70**	**17.25**	**16.93**	**16.33**	**16.14**	**16.34**	WAM	
		73.54	**26.63**	**18.66**	**17.21**	**16.99**	**16.61**	**16.49**	**16.92**	WEM	fuel used
		73.54	**26.63**	**18.66**	**17.21**	**16.89**	**16.31**	**16.12**	**16.31**	WAM	
1 A 1	**Energy Industries**	14.04	6.88	3.89	2.40	2.06	2.14	1.91	1.92	WEM	
		14.04	6.88	3.89	2.40	2.10	2.15	1.95	1.86	WAM	
1 A 2	**Manufacturing Industries and Construction**	17.97	10.30	10.48	11.34	11.12	11.55	12.05	12.61	WEM	
		17.97	10.30	10.48	11.34	10.99	11.34	11.76	12.20	WAM	
1 A 3 a, c, d, e	**Off-Road transport**	0.34	0.18	0.17	0.17	0.19	0.21	0.22	0.24	WEM	
		0.34	0.18	0.17	0.17	0.19	0.21	0.23	0.25	WAM	
1 A 3 b	**Road Transportation**	4.85	0.16	0.13	0.13	0.13	0.14	0.14	0.14	WEM	fuel sold
		4.85	0.16	0.13	0.13	0.13	0.11	0.11	0.11	WAM	
		3.95	0.11	0.09	0.09	0.09	0.09	0.09	0.09	WEM	fuel used
		3.95	0.11	0.09	0.09	0.09	0.09	0.09	0.08	WAM	
1 A 4	**Other Sectors**	32.94	7.84	2.74	1.92	2.46	1.54	1.13	0.96	WEM	
		32.94	7.84	2.74	1.92	2.45	1.44	1.01	0.83	WAM	
1 A 5	**Other**	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	WEM	
		0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	WAM	
1 B	**Fugitive Emissions**	2.00	0.04	0.05	0.04	0.05	0.05	0.05	0.05	WEM	
		2.00	0.04	0.05	0.04	0.05	0.05	0.05	0.05	WAM	
2A,B, C,H,I, J,K,L	**Industrial Processes**	2.22	1.22	1.21	1.22	1.00	1.00	1.00	1.00	WEM	
		2.22	1.22	1.21	1.22	1.00	1.00	1.00	1.00	WAM	

NFR	Description	Emission inventory* [kt]				Emission scenario [kt]				Type of scenario
		1990	2005	2010	2013	2015	2020	2025	2030	
2D, 2G	Solvent and other product use	NA	NA	NA	NA	NA	NA	NA	NA	WEM
		NA	NA	NA	NA	NA	NA	NA	NA	WAM
3 B	Manure Management	NA	NA	NA	NA	NA	NA	NA	NA	WEM
		NA	NA	NA	NA	NA	NA	NA	NA	WAM
3 D	Agricultural Soils	NA	NA	NA	NA	NA	NA	NA	NA	WEM
		NA	NA	NA	NA	NA	NA	NA	NA	WAM
3 F, I	Field Burning and other agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	WEM
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	WAM
5	Waste	0.07	0.06	0.01	0.01	0.01	0.01	0.01	0.01	WEM
		0.07	0.06	0.01	0.01	0.01	0.01	0.01	0.01	WAM

** Data source: Austrian Emission Inventory 2015 (Umweltbundesamt 2015b)*

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

2.3 Non-Methane Volatile Organic Compounds (NMVOCs)

There has been a considerable reduction in emissions of non-methane volatile organic compounds from 1990 to 2013 (–55%). In 2013 the emissions were about 21% lower than in 2005. The main reasons for the reduction is the implementation of EU Directives on 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.

The main sources of NMVOC emissions in Austria are Solvent and Other product use (NFR 2 D, 2 G) with a share of more than 58% in 2013, and fuel combustion activities with a share of 34%.

The scenarios "with existing measures" (WEM) and "with additional measures" (WAM) both show a reduction in NMVOC emissions.

- WEM: National total emissions including 'fuel export' are expected to decrease to 99 kt by 2030 (–38% compared to 2005). Without 'fuel export' they are expected to reach 99 kt (–36% compared to 2005).
- WAM: National total emissions including 'fuel export' are expected to decrease to 97 kt by 2030 (–39% compared to 2005). Without 'fuel export' they are expected to reach 97 kt (–37% compared to 2005).

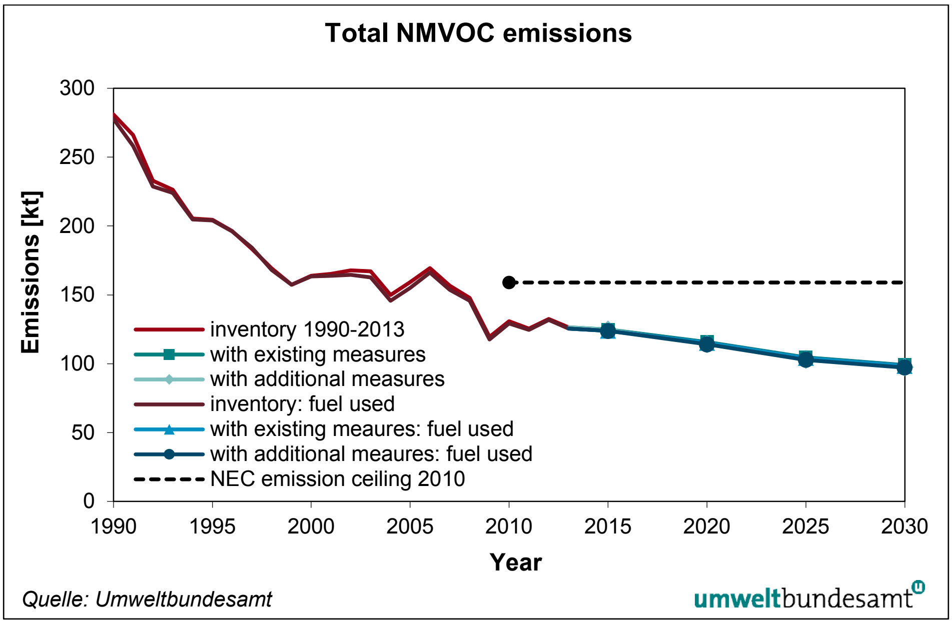

Figure 3: Historical (1990 to 2013) and projected emissions (2015–2030) of NMVOC based on (a) ***fuel sold*** *and (b)* ***fuel used*** *in the scenarios* ***(I) with existing measures (WEM)*** *and* ***(II) with additional measures (WAM)****.*

NMVOC emissions are projected to decrease until 2030. Improvements of engine technologies for mobile sources, along with a trend towards central heating and lower emission factors for new boilers in the residential sector as well as a decrease in the use of log wood as energy source are expected to lead to further significant emission reductions from road transport and space heating.

In the category "Solvent and Other product use" emissions are expected to decrease slightly due to a reduced 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). Requirements for paints and varnishes have also been harmonised at EU level; no additional measures are planned for solvents.

Table 7: Austrian national NMVOC emissions in kt and trend for the scenario (I) with existing measures (WEM) and (II) with additional measures (WAM) based on (a) fuel sold and (b) fuel used (Source: Umweltbundesamt).

NFR	Description	Emission inventory* [kt]				Emission scenario [kt]				Type of scenario	
		1990	2005	2010	2013	2015	2020	2025	2030		
	Total	**281.02**	**159.24**	**130.79**	**126.34**	**124.70**	**115.73**	**104.64**	**99.00**	WEM	fuel sold
		281.02	**159.24**	**130.79**	**126.34**	**124.66**	**114.23**	**102.92**	**97.42**	WAM	
		277.72	**155.08**	**129.27**	**125.49**	**123.88**	**115.16**	**104.13**	**98.52**	WEM	fuel used
		277.72	**155.08**	**129.27**	**125.49**	**123.78**	**114.09**	**102.76**	**97.24**	WAM	
1 A 1	**Energy Industries**	0.42	0.57	0.82	0.85	0.85	0.85	0.85	0.85	WEM	
		0.42	0.57	0.82	0.85	0.85	0.85	0.85	0.85	WAM	
1 A 2	**Manufacturing Industries and Construction**	1.76	2.13	2.31	2.04	1.89	1.70	1.65	1.65	WEM	
		1.76	2.13	2.31	2.04	1.89	1.70	1.65	1.65	WAM	
1 A 3 a, c, d, e	**Off-Road transport**	1.09	1.14	1.02	0.93	0.92	0.93	0.97	1.04	WEM	
		1.09	1.14	1.02	0.93	0.92	0.94	0.98	1.04	WAM	
1 A 3 b	**Road Transportation**	73.55	18.10	9.75	7.92	7.29	5.67	4.89	4.34	WEM	fuel sold
		73.55	18.10	9.75	7.92	7.30	5.06	4.40	3.89	WAM	
		70.25	13.94	8.23	7.06	6.47	5.10	4.39	3.86	WEM	fuel used
		70.25	13.94	8.23	7.06	6.43	4.93	4.24	3.71	WAM	

NFR	Description	Emission inventory* [kt]				Emission scenario [kt]				Type of scenario
1 A 4	Other Sectors	61.27	38.13	33.87	31.72	28.99	23.92	15.75	12.74	WEM
		61.27	38.13	33.87	31.72	28.94	23.13	14.63	11.75	WAM
1 A 5	Other	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	WEM
		0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	WAM
1 B	Fugitive Emissions	15.49	3.34	2.45	2.30	2.41	2.41	2.38	2.33	WEM
		15.49	3.34	2.45	2.30	2.40	2.31	2.26	2.19	WAM
2A,B, C,H,I, J,K,L	Industrial Processes	11.10	4.72	4.70	4.96	4.99	5.05	5.11	5.17	WEM
		11.10	4.72	4.70	4.96	4.99	5.05	5.11	5.17	WAM
2D, 2G	Solvent and other product use	114.43	89.20	74.09	73.90	75.66	73.57	71.48	69.39	WEM
		114.43	89.20	74.09	73.90	75.66	73.57	71.48	69.39	WAM
3 B	Manure Management	NA	NA	NA	NA	NA	NA	NA	NA	WEM
		NA	NA	NA	NA	NA	NA	NA	NA	WAM
3 D	Agricultural Soils	1.61	1.69	1.61	1.60	1.57	1.49	1.43	1.37	WEM
		1.61	1.69	1.61	1.60	1.57	1.49	1.43	1.38	WAM
3 F, I	Field Burning and other agriculture	0.14	0.11	0.10	0.06	0.06	0.07	0.07	0.07	WEM
		0.14	0.11	0.10	0.06	0.06	0.07	0.07	0.07	WAM
5	Waste	0.16	0.09	0.06	0.05	0.04	0.03	0.02	0.02	WEM
		0.16	0.09	0.06	0.05	0.04	0.03	0.02	0.02	WAM

** Data source: Austrian Emission Inventory 2015 (Umweltbundesamt 2015b)*

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

2.4 Ammonia (NH_3)

Emissions of NH_3 have remained stable since 1990 (–0.3%). The main source of ammonia is the agricultural sector, contributing 94% of the total NH_3 emissions in 2013.

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

From now until 2030, the emission trend for NH_3 is expected to closely follow the development of livestock in Austria (+11% compared to 2005). Based on national forecasts for agricultural production in Austria (WIFO & BOKU 2015), animal numbers of dairy cattle and swine are expected to increase in both scenarios. The increase in the number of cattle in loose housing systems (to comply with animal welfare regulations) counterbalances the reduction effects of additional abatement measures in the WAM scenario.

The scenarios "with existing measures" (WEM) and "with additional measures" (WAM) both show an increase of NH_3 emissions.

- WEM: National total emissions including 'fuel export' are expected to increase to 73.5 kt by 2030 (+11% compared to 2005). Without 'fuel export' they are expected to reach 73.3 kt (+12% compared to 2005).
- WAM: National total emissions including 'fuel export' are expected to increase to 67.9 kt by 2030 (+3% compared to 2005). Without 'fuel export' they are expected to reach 67.9 kt (+4% compared to 2005).

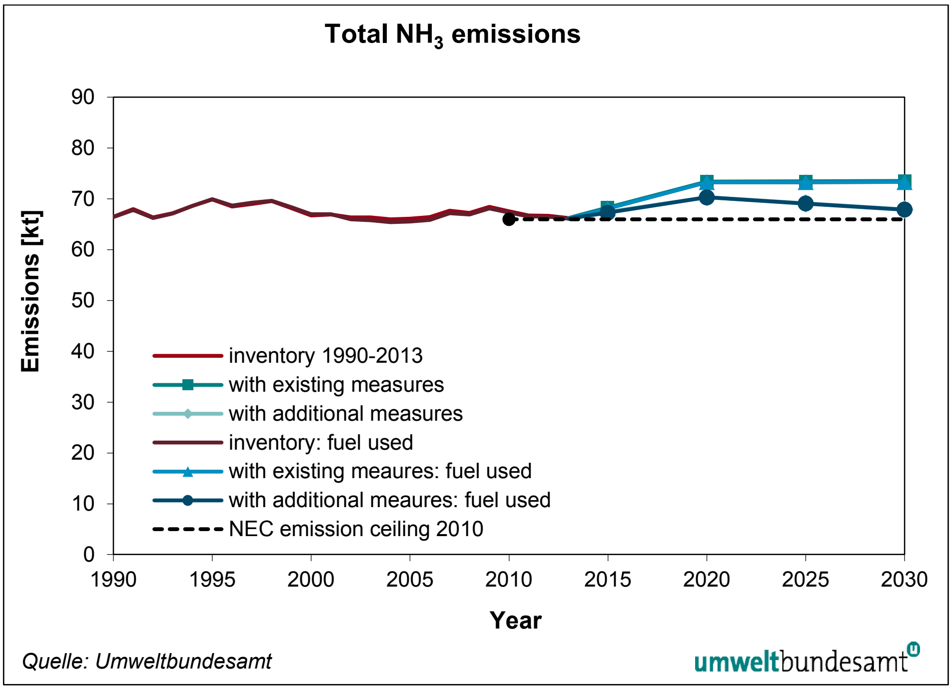

Figure 4: Historical (1990 to 2013) and projected emissions (2015–2030) of NH_3 based on (a) ***fuel sold*** *and (b)* ***fuel used*** *in the scenarios* ***(I) with existing measures (WEM)*** *and* ***(II) with additional measures (WAM)****.*

Table 8: Austrian national NH_3 emissions in kt and trend for the scenario (I) with existing measures (WEM) and (II) with additional measures (WAM) based on (a) fuel sold and (b) fuel used (Source: Umweltbundesamt).

NFR	Description	Emission inventory* [kt]				Emission scenario [kt]				Type of scenario	
		1990	2005	2010	2013	2015	2020	2025	2030		
	Total	**66.47**	**66.10**	**67.58**	**66.25**	**68.29**	**73.44**	**73.47**	**73.51**	WEM	fuel sold
		66.47	**66.10**	**67.58**	**66.25**	**67.46**	**70.33**	**69.12**	**67.91**	WAM	
		66.41	**65.51**	**67.32**	**66.14**	**68.15**	**73.29**	**73.31**	**73.34**	WEM	fuel used
		66.41	**65.51**	**67.32**	**66.14**	**67.30**	**70.32**	**69.09**	**67.87**	WAM	
1 A 1	**Energy Industries**	0.19	0.32	0.47	0.40	0.40	0.40	0.40	0.40	WEM	
		0.19	0.32	0.47	0.40	0.40	0.40	0.40	0.40	WAM	
1 A 2	**Manufacturing Industries and Construction**	0.33	0.41	0.43	0.42	0.42	0.42	0.42	0.42	WEM	
		0.33	0.41	0.43	0.42	0.42	0.42	0.42	0.42	WAM	
1 A 3 a, c, d, e	**Off-Road transport**	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	WEM	
		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	WAM	
1 A 3 b	**Road Transportation**	1.13	2.57	1.67	1.41	1.40	1.39	1.39	1.39	WEM	fuel sold
		1.13	2.57	1.67	1.41	1.40	1.22	1.21	1.19	WAM	
		1.07	1.98	1.40	1.30	1.26	1.24	1.23	1.23	WEM	fuel used
		1.07	1.98	1.40	1.30	1.24	1.21	1.18	1.14	WAM	
1 A 4	**Other Sectors**	0.63	0.71	0.68	0.63	0.61	0.60	0.56	0.52	WEM	
		0.63	0.71	0.68	0.63	0.61	0.57	0.50	0.45	WAM	
1 A 5	**Other**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	WEM	
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	WAM	
1 B	**Fugitive Emissions**	IE	IE	IE	IE	IE	IE	IE	IE	WEM	
		IE	IE	IE	IE	IE	IE	IE	IE	WAM	
2A,B, C,H,I, J,K,L	**Industrial Processes**	0.27	0.07	0.09	0.09	0.09	0.09	0.09	0.09	WEM	
		0.27	0.07	0.09	0.09	0.09	0.09	0.09	0.09	WAM	

NFR	Description	Emission inventory* [kt]				Emission scenario [kt]				Type of scenario
2D, 2G	**Solvent and other product use**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	WEM
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	WAM
3 B	**Manure Management**	27.55	27.99	28.88	28.11	29.04	31.37	31.56	31.75	WEM
		27.55	27.99	28.88	28.11	28.75	30.35	30.40	30.44	WAM
3 D	**Agricultural Soils**	35.96	32.71	33.97	33.87	35.01	37.87	37.75	37.62	WEM
		35.96	32.71	33.97	33.87	34.47	35.99	34.80	33.62	WAM
3 F, I	**Field Burning and other agriculture**	0.04	0.03	0.02	0.01	0.01	0.01	0.01	0.01	WEM
		0.04	0.03	0.02	0.01	0.01	0.01	0.01	0.01	WAM
5	**Waste**	0.36	1.29	1.36	1.29	1.29	1.26	1.27	1.29	WEM
		0.36	1.29	1.36	1.29	1.29	1.26	1.27	1.29	WAM

** Data source: Austrian Emission Inventory 2015 (Umweltbundesamt 2015b)*

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 2013, emissions (with 'fuel export') decreased by 28% to 18.2 kt. Emissions from fuel used amounted to 24.6 kt in 1990 and decreased to 17.7 kt in 2013 (–28%). $PM_{2.5}$ emissions in Austria in 2013 mainly arose from combustion activities in the energy sector, which accounted for 83% of the national total emissions.

The reductions in emissions from transport since 2005 have been achieved due to improvements in engine design and exhaust gas after-treatment technologies and continuous fleet renewal, along with the inclusion of particulate filter systems and the standard consumption tax (NoVA) (fuel-consumption based tax to be paid for passenger cars in Austria). In 2014 the NoVA tax was changed and has since then been based on CO_2 only. There is, however, a tax bonus for alternative, environmentally friendly engine designs, such as hybrid engines, natural gas and biogas engines, LPG engines, which are operated using E85 fuel blends, methane in the form of natural gas / biogas, LPG or hydrogen. In the sector 1 A 4 (households and commercial) substantial emission reductions have been achieved through substitution of old installations with modern technology, the installation of energy-saving combustion plants, by connecting buildings to district heating networks or other public energy and heating networks and replacing high-emission fuels by low-emission (low-ash) fuels.

The scenarios "with existing measures" (WEM) and "with additional measures" (WAM) both show a reduction in $PM_{2.5}$ emissions.

- WEM: National total emissions including 'fuel export' are expected to decrease to 12.9 kt by 2030 (–43% compared to 2005). Without 'fuel export' they are expected to reach 12.9 kt (–39% compared to 2005).
- WAM: National total emissions including 'fuel export' are expected to decrease to 12.1 kt by 2030 (–46% compared to 2005). Without 'fuel export' they are expected to reach 12.1 kt (–42% compared to 2005).

The sub-category 1A4 Other Sectors is the largest source of $PM_{2.5}$, accounting for a share of 43% of the national total emissions.

- In the WEM scenario, the $PM_{2.5}$ emissions in this sub category are expected to decrease by 58% by 2030 compared to 2005.
- In the WAM scenario, the $PM_{2.5}$ emissions in this sub category are expected to decrease by 62% by 2030 compared to 2005.

The sub-category Other Sectors includes fuel combustion in commercial and institutional buildings and in households as well as off-road vehicles and other machinery in the area of agriculture and forestry. $PM_{2.5}$ emission reductions are mainly due to an increased efficiency of buildings and heating systems and to a trend away from manually fed log wood boilers. A decreasing energy demand for solid fuel (log wood, coal) is also responsible for the $PM_{2.5}$ reduction in the Other Sectors sub-category. The main assumptions in the WAM scenario include an increased rate of renovation and a reduced demand for energy in the sub-sectors 'residential and commercial'.

The sub-category Road Transport has a share of 17% in 2013. The largest source within this category is automobile road abrasion, which is expected to increase slightly until 2030.

- WEM: Total $PM_{2.5}$ emissions of the sub-category Road Transport (including 'fuel export') are expected to decrease by about 78% compared to 2005. Without 'fuel export' they are expected to decrease by about 72% compared to 2005.
- WAM: Total $PM_{2.5}$ emissions of the sub-category Road Transport are expected to decrease by about 79% compared to 2005. Without 'fuel exports' they are expected to decrease by about 72% compared to 2005. The main reason for the further decrease in emissions in the WAM scenario is the inclusion of external costs for air pollution in the truck toll and an early transfer to EURO VI technology in the HDV segment.

In the sector Energy Industries the increase in $PM_{2.5}$ emissions is generally due to an increased use of biomass for electricity and heat generation. Furthermore there is also a rise expected in the industrial sector due to an increase in the GDP.

Figure 5: Historical (1990 to 2013) and projected emissions (2015–2030) of $PM_{2.5}$ based on (a) ***fuel sold*** *and (b)* ***fuel used*** *in the scenarios* ***(I) with existing measures (WEM)*** *and* ***(II) with additional measures (WAM)****.*

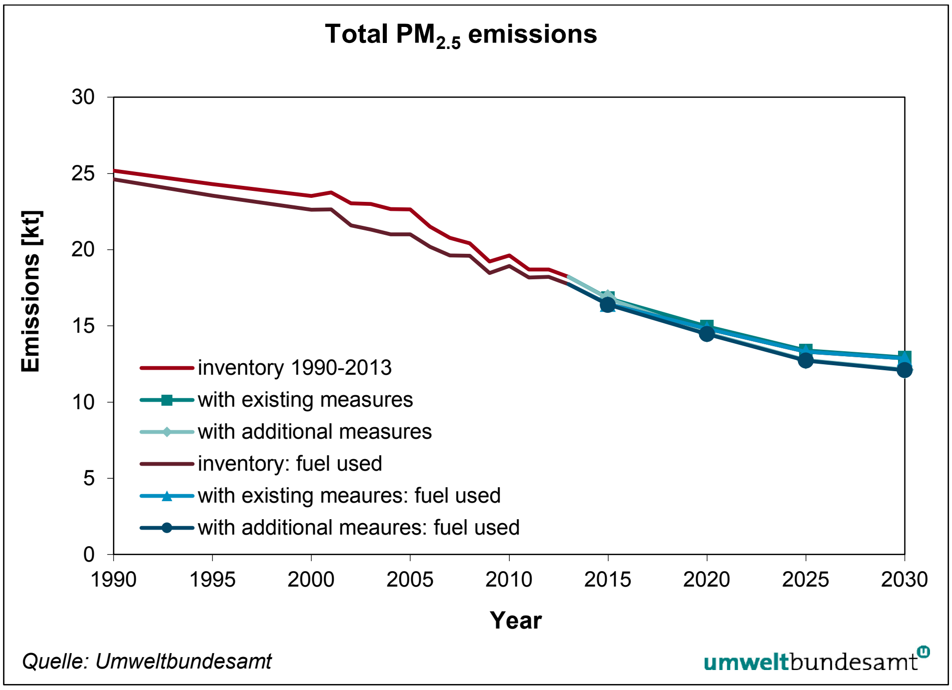

Table 9: Austrian national NH_3 emissions in kt and trend for the scenario (I) with existing measures (WEM) and (II) with additional measures (WAM) based on (a) fuel sold and (b) fuel used (Source: Umweltbundesamt).

NFR	Description	Emission inventory* [kt]				Emission scenario [kt]				Type of scenario	
		1990	2005	2010	2013	2015	2020	2025	2030		
	Total	**25.18**	**22.65**	**19.63**	**18.23**	**16.81**	**14.97**	**13.39**	**12.93**	WEM	fuel sold
		25.18	**22.65**	**19.63**	**18.23**	**16.79**	**14.52**	**12.75**	**12.13**	WAM	
		24.61	**21.02**	**18.93**	**17.73**	**16.44**	**14.81**	**13.30**	**12.86**	WEM	fuel used
		24.61	**21.02**	**18.93**	**17.73**	**16.39**	**14.47**	**12.72**	**12.10**	WAM	
1 A 1	Energy Industries	0.83	0.79	1.23	1.11	1.18	1.31	1.33	1.35	WEM	
		0.83	0.79	1.23	1.11	1.19	1.32	1.14	1.05	WAM	
1 A 2	Manufacturing Industries and Construction	2.07	2.17	2.56	2.67	2.65	2.67	2.84	3.06	WEM	
		2.07	2.17	2.56	2.67	2.62	2.62	2.75	2.94	WAM	
1 A 3 a, c, d, e	Off-Road transport	0.76	0.59	0.48	0.44	0.43	0.41	0.41	0.41	WEM	
		0.76	0.59	0.48	0.44	0.44	0.42	0.42	0.42	WAM	
1 A 3 b	Road Transportation	4.83	6.57	4.02	3.11	2.57	1.78	1.54	1.47	WEM	fuel sold
		4.83	6.57	4.02	3.11	2.59	1.58	1.43	1.39	WAM	
		4.25	4.94	3.32	2.61	2.20	1.63	1.46	1.40	WEM	fuel used
		4.25	4.94	3.32	2.61	2.18	1.54	1.40	1.36	WAM	
1 A 4	Other Sectors	11.64	8.87	8.21	7.83	6.98	5.84	4.34	3.72	WEM	
		11.64	8.87	8.21	7.83	6.96	5.61	4.07	3.41	WAM	
1 A 5	Other	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	WEM	
		0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	WAM	
1 B	Fugitive Emissions	0.09	0.09	0.07	0.07	0.06	0.06	0.05	0.05	WEM	
		0.09	0.09	0.07	0.07	0.06	0.06	0.05	0.05	WAM	
2A,B, C,H,I, J,K,L	Industrial Processes	3.24	1.83	1.37	1.35	1.30	1.29	1.31	1.33	WEM	
		3.24	1.83	1.37	1.35	1.30	1.29	1.31	1.33	WAM	

NFR	Description	Emission inventory* [kt]				Emission scenario [kt]				Type of scenario
2D, 2G	Solvent and other product use	0.41	0.44	0.44	0.45	0.45	0.46	0.47	0.48	WEM
		0.41	0.44	0.44	0.45	0.45	0.46	0.47	0.48	WAM
3 B	Manure Management	IE	IE	IE	IE	IE	IE	IE	IE	WEM
		IE	IE	IE	IE	IE	IE	IE	IE	WAM
3 D	Agricultural Soils	1.02	1.04	1.00	0.98	0.96	0.91	0.87	0.84	WEM
		1.02	1.04	1.00	0.98	0.96	0.91	0.87	0.84	WAM
3 F, I	Field Burning and other agriculture	0.26	0.21	0.20	0.17	0.17	0.17	0.17	0.16	WEM
		0.26	0.21	0.20	0.17	0.17	0.17	0.17	0.16	WAM
5	Waste	0.02	0.03	0.03	0.04	0.04	0.04	0.04	0.04	WEM
		0.02	0.03	0.03	0.04	0.04	0.04	0.04	0.04	WAM

** Data source: Austrian Emission Inventory 2015 (Umweltbundesamt 2015b)*

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

3 POLICIES AND MEASURES (PAMS) AND ADDITIONAL INSTRUMENTS FOR AIR POLLUTION

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

3.1 GHG PAMs

A detailed description of individual measures included in the WEM and the WAM scenario for GHGs is provided in a report entitled "GHG Projections and Assessment of Policies and Measures in Austria", submitted to the European Commission and the European Environment Agency in 2015 (UMWELTBUNDESAMT 2015c[9]).

For the GHG scenarios 24 measures have been identified and considered in the WEM and WAM scenario. These measures are either of a crosscutting nature or target specific sectors and represent the basis for the air pollutant projections.

Crosscutting measures

- EU Emission Trading Scheme (WEM): The system covers CO_2 emissions from large emitters from the industry sectors and energy supply, but also has side-effects on air pollutants especially SO_2 and NO_x by inducing an upgrade to lower emission facilities or higher efficiency.
- Domestic Environmental Support Scheme (WEM): The objective of this funding scheme is environmental protection and a reduction of pressures such as air pollution, greenhouse gases, noise and waste.
- Austrian Climate and Energy Fund (WEM): Although the objective of this fund is to provide research subsidies for the implementation of climate friendly technology, positive side effects on air pollution are 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 energy and manufacturing industries (WEM): This includes the implementation of the National Energy Efficiency Action Plan 2011 and the promotion of combined heat and power.

[9] http://www.umweltbundesamt.at/fileadmin/site/publikationen/REP0527.pdf

- Further enhancement of renewable energy in energy supply (WAM): this can be achieved by supporting green electricity beyond 2020 (currently there are only targets for 2020).
- Further enhancement of energy efficiency in energy and manufacturing industries: this measure foresees the full implementation of the Austrian Energy Efficiency Act.

Transport (1.A.3)

- Increase the share of clean energy sources for road transport (WEM): Here, the implementation of Renewables Directive (2009/28/EC) on the promotion of the use of energy from renewable sources and the Austrian Implementation 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): This measure has the objective to shift the modal split towards environmentally friendly transport modes by the following instruments: Mobility management and awareness – klimaaktiv mobil initiative and the Promotion of corporate rail connections for freight transport.
- Further enhancement of clean energy sources for transport (WAM): includes the promotion of alternative and biofuels and the promotion of electric vehicles.
- Further enhancement of fuel efficiency in road transport (WAM): The instruments to achieve this are a fuel tax increase in 2016 and 2019, implementation of the Energy Efficiency Directive and the Implementation of the Directive on the charging of heavy goods vehicles for the use of certain infrastructures.
- Further shift to environmentally friendly transport modes (WAM) by promoting mobility management including a Bicycle Masterplan and a Walking Masterplan, by providing incentives for an increased use of public transport and by implementing the National Action Plan Danube Navigation.

Other Sectors (1.A.4)

- Increased energy efficiency in buildings (WEM) by improving buildings' standards according to OIB (Austrian Institute of Construction Engineering) guideline 6 on energy saving and thermal insulation, by national and funding programmes, by providing building renovation initiatives for private, commercial and industrial buildings, and by a recast of the Energy Performance of Buildings Directive.
- Increased share of renewable energy for space heating (WEM) foresees stepping up the replacement of heating systems, the implementation of the district heating and cooling Act, and the funding 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 requirements of Directive 2006/32/EC on energy end-use efficiency and energy services and the energy labelling of household appliances.

- Further enhancement of energy efficiency in buildings (WAM): This measure consists of three instruments: adaptation of existing funding programmes, the Energy Efficiency Directive (2012/27/EU) and the amendment to the National Plan for non-residential buildings.

Industrial Processes and Product Use (CRF source category 2)

- Decrease emissions of F-gases and other product use (WEM) to be achieved by prohibition and restriction of the use of (partly) fluorinated hydrocarbons and SF_6, by implementation of the EU F-Gas Regulation, by reducing HFC emissions from air conditioning in motor vehicles, by implementation of the Solvents Ordinance to reduce VOC emissions from paints and varnishes and by limitation of VOC emissions from the use of organic solvents in industrial installations.
- Further minimisation of F-gas emissions (WAM) considers the introduction of a quota system for the production and import of F-gases.

Agriculture (CRF source category 3)

- Implementation of EU agricultural policies (WEM), which includes the Programme for rural development 2007–2013 and of the Common Agricultural Policy.
- Emission reduction through livestock and feeding management (WAM), whereby the lactation performance of dairy cows shall be increased, as well as the efficiency of other livestock. Feeding measures for cattle and pigs and the promotion of grazing shall further lead to lower GHG emissions.
- Sustainable N-management (WAM) comprises a multitude of individual submeasures (e.g. covering of slurry tanks) but also the promotion of anaerobic fermentation of animal manure and promotion of organic farming practises.

Waste (CRF source category 5)

- Reduce emissions from waste treatment (WEM) by further implementation of the Landfill Directive and by considering the requirements of the latest BREF document for mechanical biological treatment plants.
- Enhanced reduction of emissions from waste treatment (WAM) shall be achieved by higher N-removal rates in waste water treatment plants.

3.2 NEC PAMs

Furthermore additional policies and measures (PAMs) or instruments for air pollutants have been implemented in these projections in comparison with the GHG projections (see Table 10).

Table 10: Overview of additional measures.

Sector	measure
Energy Industry	• WAM: Additional abatement technology for NO_x and PM in biomass and gas plants
Manufacturing Industry	• WAM: Implementation of more stringent BAT-values for NO_x, SO_2 and PM
Transport	• WEM/WAM: Road transport is fully consistent with GHG projections • WAM: NO_x-abatement for new pipeline compressors
Other sectors (buildings)	• WEM/WAM: Ecodesign Directive – Implementation of Lot 15 and Lot 20 (emission requirements)
Solvents	• WEM/WAM: Full implementation of Deco-Paint-Directive
Agriculture	• WEM/WAM: Fully consistent with GHG projections

Energy Industry

For power and heat plants it has been assumed that additional technologies for abatement of NO_x and dust will be installed in biomass and gas plants in the WAM scenario only.

Manufacturing Industry & Industrial Processes

For NO_x emissions of the cement industry the implementation of the SCR technology was assumed by 2020 and for the pulp and paper industry the new lower BAT values have been applied as of 2025 in the WAM scenario only.

Transport

No additional PAMs – besides those included in the GHG projections – were added for road transport. Measures related to transport activities and modal split affect both GHG emissions and air pollution; technical requirements with respect to air pollutants in the transport sector have already been implemented by EU legislation. For transport in pipelines it was assumed that old installations are replaced by new installations with better primary measures for NO_x-abatement. Both scenarios are based on the unmodified activity data from the scenarios of the Monitoring Mechanism 2015 (MM15, UMWELTBUNDESAMT 2015c).

For *1.A.3.b Road Transport* two separate options were created – "WEM/WAM" and "WEM/WAM pessimistic":

- **WEM/WAM:** includes the latest assumptions for emission factors for all relevant pollutants taken from HBEFA V.3.2, which can be understood as a "realistic, but cautiously optimistic" forecast.
- **WEM/WAM pessimistic:** is the "pronounced pessimistic" estimate for NO_x emission levels of diesel passenger car and diesel light duty vehicle emission classes EURO 6 and EURO 6c and of diesel heavy duty vehicle emission class EURO VI. The remaining regulated pollutant components (PM motor driven, CO and HC) have not been changed in the pessimistic scenario. For further details please see chapter 4.2.2.

Emission factors for NO_x, PM (motor driven), CO and HC of road transport are based on HBEFA Version 3.2 (officially released in July 2014). Although these emission factors correspond to the current state of knowledge for present and future vehicle technologies available on the market (EURO 6 / EURO VI), they hold some uncertainties especially with regard to **NO_x from diesel vehicles**. In diesel engines low NO_x emissions come with trade-offs concerning low fuel consumption, system cost and drivability.

Other sectors (buildings)

Ecodesign standardized emission requirements for the placing on the market and putting into service of solid fuel boilers (Lot 15[10]) and solid fuel local space heaters (Lot 20[11]) were assumed to enter into force by 1st January 2020, respectively by 1st January 2022 (Lot 20). OGC (organic gaseous compounds), NO_x and particulate matter emission thresholds refer to the final draft Commission regulations from April 2015.

Table 11: Solid fuel boilers standardized emission thresholds for PM, OGC, CO and NO_X in the WAM scenario (equals Lot 15 final regulation).

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

10 Lot 15: S037501/01 (Summary record) in dossier CMTD(2014)1188
http://ec.europa.eu/transparency/regcomitology/index.cfm?do=Search.getPDF&N6yaoXolsDrtTlpUdLCZeFqBB7fl4EnisQ1BdEUO8vC5SVAw47eF02NzJJLXFBE7MymAolL+DBgWkUQAUSR0vEUBA1Uxa7mJl1GidS+HNzw=

11 Commission Regulation (EU) 2015/1185
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R1185&qid=1447149842438&from=DE

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

Table 12: Solid fuel local space heaters standardized emission thresholds for PM, OGC, CO and NO_X in the WAM scenario (equals Lot 20 final regulation).

Until the implementation of the Ecodesign Lot 15 and Lot 20 regulations, the corresponding existing national standardized emission requirements apply, which are regulated in the Austrian Constitution, Article 15a Agreement between the federal government and the federal provinces concerning the placing on the market of small scale combustion equipment respectively the inspection of heating appliance and block heat and power plants.

Member States are not allowed to keep more stringent national requirements. Since Ecodesign regulations fall under Article 114 of the Treaty on the Functioning of the European Union this cannot be done in principle. Therefore Ecodesign Lot 15 and Lot 20 regulations will overrule the partially more stringent national requirements of the Article 15a Agreement.

Solvents

In this scenario the Deco-Paint-Directive (**Directive 2004/42/EC**) will be 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

The following policies and measures have been considered for both scenarios:

- **Implementation of EU agricultural policies (WEM)**

  The NEC-WEM scenario includes existing measures implemented in the context of the Austrian Agri-Environmental Programme 2007–2013 as they will continue to be effective in the following programming period. Penetration rates of measures (e.g. feeding measures, covering of slurry tanks, improved manure application techniques,…) remain the same for the entire scenario.

- **Emission reduction through feeding management and sustainable N-management (WAM)**

  The WAM scenario considers the following NEC measures:

  - **Phase feeding of pigs**

    Improved feeding in line with the protein demand depending on the growth stages of pigs results in reduced nitrogen excretions.

    Assumptions: N excretions of pigs are decreased by 2.5% by 2020 and by 5.0% by 2030.

  - **Promotion of grazing**

    Grazing causes lower air emissions than indoor husbandry.

    Assumptions: The share of grazed suckling cows is increased by 5% from 2020 onwards.

  - **Covering of slurry tanks**

    The most proven method to reduce emissions from slurry stored in tanks is to cover the storage tank with a tight lid. Abatement efficiency of natural crusts depends on the nature and duration of the crust (no mixing of manure for spreading).

    - Cattle: share of solid covered slurry is 75% by 2020, 80% by 2030. Rest: natural crust.
    - Pigs: share of solid covered slurry is 85% by 2020 and 90% by 2030. Rest: uncovered.

  - **Band-spreading of slurry**

    Band-spreading of manures decreases the exposed surface area of soil resulting in lower emissions of NH_3.

    In Austria cattle husbandry is mainly practised on sloping terrain. The technical feasibility of band-spreading techniques is limited by sloping terrain and small parcels < 1 ha.

    - Cattle: the share of band-spreading of slurry is 30% by 2020 and 50% by 2030.

    Pig slurry is only applied on arable land; farms are predominantly not on steep terrain, resulting in higher technically feasible application rates.

    - Pigs: share of band-spreading of slurry is 40% by 2020 and 80% by 2030.

  - **Incorporation of farm yard manure (FYM) by plough**

    In cattle husbandry the technical potential of this measure is limited. Farms are predominantly situated in grassland areas; incorporation of FYM is not applicable on grassland.

    - Cattle: from 2020 onwards a share of 10% of FYM is incorporated within 12 h.
    - Pigs: a share of 40% is incorporated by 2020, 80% by 2030 within 12 h.
    - Poultry: a share of 60% is incorporated within 12 h by 2020. By 2030 onwards a share of 50% is incorporated within 12 h and another 50% are incorporated immediately.

  - **Urea application**

    - Reduced urea application: -50% by 2030 compared to the value of 2020.

Underlying activity data are consistent with the data presented in (UMWELTBUNDESAMT 2015c) and (WIFO & BOKU 2015). The following assumptions have been made (WIFO & BOKU 2015):

- Reduced losses of organic and mineral fertilizer (increased efficiency)
- More efficient livestock production in dairy (increased lactation of milk cows)
- More efficient feed usage in fattening pigs (adjusted to phases of maturity)
- Increased quality of grassland and maize forage production
- Further stimulation of organic farming and other measures aimed at reducing chemical inputs by granting higher subsidies.

4 METHODOLOGY

General Approach

Where reasonable and applicable, emissions were calculated and projected on the basis of the methodology used in the Austrian Inventory. 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 were thus also 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 2015 (UMWELTBUNDESAMT 2015a).

The projections for greenhouse gas developments described in this report include a scenario "with existing measures" (WEM) and a scenario "with additional measures" (WAM).The latter includes planned policies and measures with a realistic chance of being adopted and implemented in time to influence emissions. All these additional measures have been defined at expert level in consultation with the Federal Ministry of Agriculture, Forestry, Environment and Water Management. The projection for air pollutants is consistent with the current projections for GHG emissions under the EU Monitoring Regulation (UMWELTBUNDESAMT 2015c).

Sources of Data

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 a macro-economic model (DEIO) of the Austrian Institute of Economic Research (WIFO 2013), supported by calculations carried out with the bottom-up models TIMES (Austrian Energy Agency, AEA 2015), INVERT/EE-Lab (Energy Economics Group of the Technical University of Vienna, TU WIEN 2015) and NEMO & GEORG (Technical University of Graz, TU GRAZ 2013).

Projections for agriculture were 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 to the European Commission and the European Environment Agency in (UMWELTBUNDESAMT 2015c).

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 13: 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 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) Graz University of Technology (transport sector)
Industry	Austrian Institute of Economic Research (macroeconomic model DEIO)	Umweltbundesamt
Solvents	Statistics Austria, expert judgements	Umweltbundesamt
Agriculture	Austrian Institute of Economic Research (agriculture model PASMA) (WIFO & BOKU 2015).	Umweltbundesamt
Waste	Landfill database, Electronic Data Management (EDM) Federal Waste Management Plan Expert judgement by Umweltbundesamt on waste amounts expected to be pre-treated in mechanical-biological treatment plants ÖROK 2010 (population scenarios)	Umweltbundesamt

General Socio-economic Assumptions

Data used for general socio-economic assumptions, which form the basis of the Austrian emission projections, can be found in Table 14. Further assumptions about key input parameters can be found in UMWELTBUNDESAMT (2015b, c).

Table 14: Key input parameters for emission projections (UMWELTBUNDESAMT 2015b).

Year	2010	2015	2020	2025	2030
GDP [billion € 2010]	285	306	330	355	383
Population [1 000]	8 382	8 555	8 733	8 889	9 034
Stock of dwellings [1 000]	3 638	3 818	3 957	4 069	4 166
Heating degree days	3 252	3 228	3 204	3 161	3 118
Exchange rate [US$/€]	1.33	1.30	1.30	1.30	1.30
International coal price [US$10/t]	99.2	105	109	113	116
International oil price [US$10/bbl]	78.1	106	118	127	135
International natural gas price [US$10/GJ]	7.1	9.3	10.4	11.3	11.9
CO_2 certificate price [€/t CO_2]	13	15	20	25	30

Other underlying assumptions are included in the following chapter and in the Annexes.

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 2015a). The scenarios were developed with the help of several models:

- macroeconomic input-output data (DEIO),
- domestic heating and domestic hot water supply (INVERT/EE-Lab),
- electricity demand and 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 macroeconomic model DEIO combines a private consumption module with an energy and environment module. Important input parameters are energy prices, population and household income (WIFO 2013).

For evaluating the electricity demand, a model based on TIMES has been used. The model has been especially adapted for Austria. For the calculation of the electricity demand it combines a bottom-up (used devices and the characteristics thereof in several sub-sectors) approach for households with a top-down (development of energy intensity and gross-value added) approach for industry, the service sector and agriculture. For transport and heating the results of different models have been used (AEA 2015).

For projecting the production of electricity and district heating the same model (i.e. TIMES Austria) has been used. 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 (such as emission allowances) are also important input parameters (AEA 2015).

For modelling the energy consumption for domestic heating and domestic hot water supply, the software package INVERT/EE-Lab[12] (TU WIEN 2015) 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 was developed by Schriefl (EEG 2007). It 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.

[12] http://eeg.tuwien.ac.at

The results obtained with the different models were exchanged and balanced within 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 2015b). The data on energy demand have been split up into 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 2015a) 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 operated in Austria, an SNOX plant, installed in November 2007, significantly reduced its emissions of SO_2 and NO_x. As no other changes are expected for the next few years, emission projections have been based on current emission levels.

For $PM_{2.5}$, plant-specific emission factors for TSP have been converted to $PM_{2.5}$ by 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).

It has been assumed for all scenarios that the coal and oil plants will have been closed down by 2030.

For gas plants in the scenario WEM it has been assumed that new facilities with better reduction systems will subsequently substitute existing facilities and therefore the emission factor for gas plants decreases by 16 % by the year 2030 compared to the year 2010.

For the WAM scenario the application of more stringent emission limit values by the year 2025 has been assumed. Therefore the emission factor for gas plants decreases by 41 % by the year 2030 compared to the year 2010.

For installations using solid biomass emission factors have been reported in literature for various plant sizes (UMWELTBUNDESAMT 2010). For the WEM scenario the emission factors were not changed over the time period considered, for the WAM scenario lower emission factors were used from the year 2025 onwards (see Table 15). For biogas an emission factor of 125 kg/TJ instead of 150 kg/TJ was used from the year 2025 onwards, since it was assumed that the share of biomass used in gas turbines would increase.

Table 15: Calculation parameters for plants using solid biomass. Quelle: UMWELTBUNDESAMT 2010.

Rated thermal input	Emission factor		Abated emission factor	
	(kg NO_x/TJ)	(kg TSP/TJ)	(kg NO_x/TJ)	(kg TSP/TJ)
0,2–1 MW	131	54	125	38
1–2 MW	119	38	119	31
2–5 MW	106	25	100	13
5–10 MW	94	16	94	13
> 10 MW	81	13	50	13

The emission factors for waste incineration plants, oil and gas exploration and refineries have neither been changed over time nor for the various scenarios.

NMVOC and NH_3

NMVOC and NH_3 emissions are assumed to remain constant at 2013 levels (UMWELTBUNDESAMT 2015a). 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, both sectors NFR 1 A 2 and 2 have been assessed together (UMWELTBUNDESAMT 2003a, c, UMWELTBUNDESAMT 2007 and UMWELTBUNDESAMT 2009). The following industrial sectors 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 trend in energy consumption (UMWELTBUNDESAMT 2015a) and by incorporating recent data from environmental impact statements on facility expansions and the opening and closing down of facilities.

In the WEM scenario the only changes in emission factors have been applied for the iron and steel industry, since there will be further improvements of the SCR plant following the sinter plant compared to the current state reflected in the national inventory.

For the WAM scenario it has been assumed that the SCR technology will be applied by 2020 in all Austrian cement plants that are covered by the ordinance on waste incineration (BGBl. II Nr. 389/2002). These plants will have yearly average emission values of 200 mg NO_x/Nm^3.
For the pulp and paper industry it has been assumed that by 2025 the boilers will meet the yearly average values given in Table 16.

Table 16: Emission values (YAV) for boilers in the pulp and paper industry.

	O_2 content	mg NO_x/ Nm^3
Sulfite recovery boilers	5%	200
Sulfate recovery boilers	6%	180
Fluidised bed boilers	6%	150
Gas turbines	15%	20–35
Gas boilers	3%	100
Lime kilns	10%	160–260

NMVOC and NH_3

The NMVOC and NH_3 emissions from stationary sources are assumed to remain constant at 2013 levels (UMWELTBUNDESAMT 2015b). This simple approach was chosen because their share in total emissions is less than 2%.

$PM_{2.5}$

The projected emissions were calculated on the basis of the trend in energy consumption (UMWELTBUNDESAMT 2015a) 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.

For all scenarios an improvement in the capture of diffuse emissions in the iron and steel industry has been assumed. Otherwise there have been no changes of the emission factors.

NFR 1 A 2 g 7 Mobile Sources in Industry – Soil Abrasion

This category includes emissions from soil abrasion of industrial off-road mobile machinery, mainly from the construction sector.

Projected $PM_{2.5}$ emissions have been estimated by means of correlating historical $PM_{2.5}$ emissions from soil abrasion and fuel consumption (UMWELTBUNDESAMT 2015a) with projected fuel consumption.

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 2015). The input for mobile sources for agriculture comes from the macro-economic model DEIO. A detailed description of these models can be found in UMWELTBUNDESAMT 2015a, TU WIEN 2015 and WIFO 2013.

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 subsectors 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 2015b).

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 were recalculated based on Ecodesign standardized emission requirements for new installations of solid fuel boilers (Lot 15) from 2020 onwards and for solid fuel local space heaters (Lot 20) from 2022 onwards. For former years of installation the corresponding national standardized emission requirements were assumed, if applicable (Article 15a Agreement). Trends in standardized emission requirements were used to modify the emission factor by year of installation starting from 2008.

Assumptions regarding final energy distribution by year of installation based upon energy statistics, annually market share data and expert judgement were made to compute the average standardized emission threshold of the heating appliance stock at base year 2008, which was related to the national emission factor in the year 2008 (UMWELTBUNDESAMT 2015b) in order to provide conversion factors.

National energy projections inter alia display the final energy demand of solid fuel boilers (Lot 15) and solid fuel local space heaters (Lot 20) by year of installation. It is assumed that new installations with lower emission factors substitute stock with average 2008 emission characteristics or increase the overall stock.

Emission factors

NO_x emission factors are assumed to decrease for natural gas and heating oil in all heating systems (due to an increased use of condensing boiler technology) and existing national legislation. Solid biomass emission factors are assumed to drop overall due to Ecodesign and intermediate national regulations; however, the energy carrier shift from fuel wood to pellets with less stringent Ecodesign emission thresholds than in the overruled Article 15a Agreement will stop the declining trend in apartment heating and stoves around 2025. Additionally, a slight increase in many solid fossil fuel emission factors is expected because of a weakening of existing national regulations.

In Table 17 the NO_x emission factors used in the projections are listed as examples for central heating in the WEM and WAM scenarios.

Table 17: NO_x emission factors for natural gas, heating oil, solid biomass and solid fossil fuels in central heating.

in kg/TJ		2010	2015	2020	2025	2030
Central heating						
Natural gas						
	WEM	33.5	33.2	32.6	31.8	31.3
	WAM	33.5	33.2	32.6	31.8	31.3
Heating oil						
	WEM	42.8	40.4	38.7	36.4	34.5
	WAM	42.8	40.4	38.7	36.5	34.7
Solid biomass						
	WEM	106.9	105.3	93.9	77.5	70.8
	WAM	106.9	105.4	93.7	77.9	71.0
Solid fossil fuels						
	WEM	78.0	77.9	77.9	79.8	84.2
	WAM	78.0	77.9	78.0	79.9	85.2

In Table 18 the NO_x emission factors used in the projections are listed as examples for apartment heating in the WEM and WAM scenarios.

Table 18: NO_x emission factors for natural gas, heating oil, solid biomass and solid fossil fuels in apartment heating.

in kg/TJ		2010	2015	2020	2025	2030
Apartment heating						
Natural gas						
	WEM	32.6	32.2	31.4	30.7	30.2
	WAM	32.6	32.2	31.4	30.7	30.2
Heating oil						
	WEM	39.8	39.5	38.6	34.9	34.1
	WAM	39.8	39.5	38.7	35.6	34.1
Solid biomass						
	WEM	107.0	105.6	91.1	63.1	79.6
	WAM	107.0	105.8	92.8	63.7	81.1
Solid fossil fuels						
	WEM	78.0	77.9	77.9	79.6	82.4
	WAM	78.0	77.9	78.0	79.0	81.8

In Table 19 the NO_x emission factors used in the projections are listed as examples for stoves in the WEM and WAM scenarios.

Table 19: NO_x emission factors for natural gas, heating oil, solid biomass and solid fossil fuels in stoves.

in kg/TJ		2010	2015	2020	2025	2030
Stoves						
Natural gas						
	WEM	50.8	50.0	47.9	46.8	NO
	WAM	50.8	50.1	48.2	46.8	NO
Heating oil						
	WEM	19.0	18.8	18.4	16.7	16.3
	WAM	19.0	18.9	18.5	17.0	16.3
Solid biomass						
	WEM	106.0	104.8	95.1	83.7	84.0
	WAM	106.0	104.9	95.0	83.7	84.4
Solid fossil fuels						
	WEM	132.0	131.9	130.5	127.5	124.4
	WAM	132.0	131.9	131.4	129.8	125.0

$PM_{2.5}$ emission factors are assumed to decrease for solid biomass and solid fossil fuels both due to Ecodesign requirements, which in general outreach existing national regulations for standardized $PM_{2.5}$ emission thresholds.

In Table 20 the $PM_{2.5}$ emission factors used in the projections are listed as examples for central heating in the WEM and WAM scenarios.

in kg/TJ		2010	2015	2020	2025	2030
Central heating						
Fuel wood						
	WEM	71.4	70.3	62.5	45.1	37.1
	WAM	71,5	70,4	62,9	45,2	37,5
Wood waste and other						
	WEM	55.2	55.2	43.9	35.8	33.8
	WAM	55,3	52,5	43,7	36,7	34,0
Pellets						
	WEM	24.0	21.0	16.4	14.3	12.8
	WAM	24.0	20.8	15.4	14.6	12.8
Solid fossil fuels						
	WEM	71.5	71.2	69.1	56.0	29.0
	WAM	71,5	71,2	70,3	56,5	27,7

Table 20: $PM_{2.5}$ emission factors for fuel wood, wood waste and other, pellets and solid fossil fuels in central heating.

In Table 21 the $PM_{2.5}$ emission factors used in the projections are listed as examples for apartment heating in the WEM and WAM scenarios.

in kg/TJ		2010	2015	2020	2025	2030
Apartment heating						
Fuel wood						
	WEM	72.0	70.8	59.9	34.7	NO
	WAM	72.0	70.9	61.4	34.9	NO
Pellets						
	WEM	24.0	20.8	15.5	13.3	13.1
	WAM	24.0	20.6	14.5	13.7	13.4
Solid fossil fuels						
	WEM	75.2	75.1	73.4	59.0	35.2
	WAM	75.2	75.1	74.5	64.5	36.5

Table 21: $PM_{2.5}$ emission factors for fuel wood, wood waste and other, pellets and solid fossil fuels in apartment heating.

In Table 22 the $PM_{2.5}$ emission factors used in the projections are listed as examples for stoves in the WEM and WAM scenarios.

in kg/TJ		2010	2015	2020	2025	2030
Stoves						
Fuel wood						
	WEM	118.3	116.5	98.7	57.4	NO
	WAM	118.4	116.7	101.1	57.7	NO
Pellets						
	WEM	24.0	22.3	18.0	15.2	12.9
	WAM	24.0	22.0	16.8	15.2	13.3
Solid fossil fuels						
	WEM	122.4	122.2	119.6	95.9	56.7
	WAM	122.4	122.2	121.3	104.8	58.8

Table 22: $PM_{2.5}$ emission factors for fuel wood, wood waste and other, pellets and solid fossil fuels in stoves.

NMVOC emission factors are assumed to decrease for solid biomass and solid fossil fuels both starting from 2015 due to existing national regulations for standardized OGC emission thresholds and the follow-up by the Ecodesign requirements, which are less stringent for solid fuel local space heaters.

In Table 23 the NMVOC emission factors used in the projections are listed as examples for central heating in the WEM and WAM scenarios.

Table 23: NMVOC emission factors for natural gas, heating oil, solid biomass and solid fossil fuels in central heating.

in kg/TJ		2010	2015	2020	2025	2030
Central heating						
Natural gas						
	WEM	0.2	0.2	0.2	0.2	0.2
	WAM	0.2	0.2	0.2	0.2	0.2
Heating oil						
	WEM	0.8	0.8	0.8	0.8	0.7
	WAM	0.8	0.8	0.8	0.8	0.7
Solid biomass						
	WEM	317	291	228	134	100
	WAM	317	293	231	132	100
Solid fossil fuels						
	WEM	284	284	277	229	121
	WAM	284	284	282	235	108

In Table 24 the NMVOC emission factors used in the projections are listed as examples for apartment heating in the WEM and WAM scenarios.

Table 24: NMVOC emission factors for natural gas, heating oil, solid biomass and solid fossil fuels in apartment heating.

in kg/TJ		2010	2015	2020	2025	2030
Apartment heating						
Natural gas						
	WEM	0.2	0.2	0.2	0.2	0.2
	WAM	0.2	0.2	0.2	0.2	0.2
Heating oil						
	WEM	0.8	0.8	0.8	0.7	0.7
	WAM	0.8	0.8	0.8	0.7	0.7
Solid biomass						
	WEM	402	389	305	132	20
	WAM	402	391	315	133	21
Solid fossil fuels						
	WEM	284	284	278	217	117
	WAM	284	284	282	239	120

In Table 25 the NMVOC emission factors used in the projections are listed as examples for stoves in the WEM and WAM scenarios.

Table 25: NMVOC emission factors for natural gas, heating oil, solid biomass and solid fossil fuels in stoves.

in kg/TJ		2010	2015	2020	2025	2030
Stoves						
Natural gas						
	WEM	0.2	0.2	0.2	0.2	NO
	WAM	0.2	0.2	0.2	0.2	NO
Heating oil						
	WEM	1.5	1.5	1.5	1.3	1.3
	WAM	1.5	1.5	1.5	1.3	1.3
Solid biomass						
	WEM	529	483	332	150	29
	WAM	530	486	342	148	29
Solid fossil fuels						
	WEM	333	333	328	290	228
	WAM	333	333	331	305	231

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 barbecuing. Projected $PM_{2.5}$ emissions have been estimated by extrapolating 2013 emissions with projected population statistics.

NFR 1 A 4 c ii Off-road Vehicles and Other Machinery – Soil Abrasion

This category includes emissions from soil abrasion of agricultural off-road mobile machinery such as tractors and mowers.

Projected $PM_{2.5}$ emissions have been estimated by means of correlating historical $PM_{2.5}$ emissions from soil abrasion and fuel consumption (UMWELTBUNDESAMT 2015a) with projected fuel consumption.

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)

The projected energy consumption in the aviation sector up to 2030 is based on an original forecast by the Austrian Institute of Economic Research (WIFO) for jet fuel, a forecast which was obtained as a result within a larger project framework for forecasting energy demand in the different NFR sectors in Austria for the Monitoring Mechanism 2013 (WIFO 2013). For the Monitoring Mechanism 2015 the base year was updated and the annual growth rates applied.

$PM_{2.5}$ emissions have been calculated on the basis of emission factors from (UMWELTBUNDESAMT 2015a) and projected fuel consumption. To separate LTO and cruise emissions, the average split into LTO and cruise emissions of 2010–2013 has been used.

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. The following input parameters are used for road/off-road emission projections:

- **NEMO – Emission model road (NFR Source Category 1 A 3 b)**

Emissions from Mobile Combustion have been calculated with the GLOBEMI model (HAUSBERGER 1998; HAUSBERGER & SCHWINGSHACKL 2012) so far. The calculations are based on a detailed depiction of fleet composition, driving behaviour, related energy consumption and emission factors.

From the 2015 submission onwards projections for the time series up to 2030 are based on the NEMO (Network Emission Model) model (DIPPOLD et al. 2012; HAUSBERGER et al. 2015a, 2015b). NEMO is based on the same methodology as the former GLOBEMI model 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 upcoming varieties 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 to be suitable for all main fields of application of simulation of energy consumption and emission output on a road-section based model approach. As there is no complete road network for Austria on a highly resolved spatial level available yet, the old methodology based on a categorisation of the traffic activity into "urban", "rural" and "motorway" has been applied in NEMO for the moment.

Furthermore, the model delivers an assumption for the fuel export effect.

- **GEORG – Emission model off-road (NFR Source Category 1 A 2 g, 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 with the GEORG (**G**razer **E**missionsmodel für **O**ff **R**oad **G**eräte) model (PISCHINGER 2000). The GEORG model has a fleet model part, which simulates the actual age and size distribution of the vehicle stock via age- and size-dependent drop-out rates (i.e. the probability that a vehicle will be scrapped by the following year). With this approach the number of vehicles in each category of mobile sources is calculated according to the year of their first registration and the vehicles' 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 consistent with the Air Emission Inventory (UMWELTBUNDESAMT 2015b). Projected passenger car and heavy duty vehicle kilometres (HAUSBERGER & SCHWINGSHACKL 2012) 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 with 2013 emissions.
- **NFR 1 A 5 b Military mobile machinery**
  Ground operations: $PM_{2.5}$ emissions from ground operations of military vehicles have been extrapolated by means of 2013 emissions and projected fuel consumption.
  Aviation operations: $PM_{2.5}$ emissions from military aviation operations have been extrapolated by means of 2013 emissions.
  Soil abrasion: Projected $PM_{2.5}$ emissions have been estimated by means of correlating historical $PM_{2.5}$ emissions from soil abrasion and fuel consumption (UMWELTBUNDESAMT 2015a) 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 in the projections across the different EURO classifications. Moreover, the assumptions used in the pessimistic scenario are explained for each vehicle group. Real Driving Emissions (RDE) are always considered for the underlying test cycles used in HBEFA (Handbook of Emission FActors in Road Transport).

Passenger cars (PC) and Light duty vehicles (LDV)

EURO 6

Very few EURO 6 vehicles could be measured in the field monitoring measurements for HBEFA V.3.2. Thus, the representativeness of the emission factors is uncertain. Those vehicles – available at the time of emission measurements – are mainly located in the premium car segment. It could therefore be the case that the later appearing EURO 6 diesel vehicles in the low-price car segment will show more cost-effective NO_x abatement technologies and thus higher NO_x emissions under real driving conditions.

Recent field monitoring measurements tend to indicate that NOx emissions have been underestimated for EURO 6 diesel cars in HBEFA V.3.2. Within the next national inventory it should be checked, whether an early update (earlier than the upcoming HBEFA V.4) of NO_x emission factors is necessary in the emissions simulation model NEMO.

Assumptions for the pessimistic scenarios:

- Recent field monitoring measurements and PEMS (on board) measurements used for the development of the RDE (real drive emissions) legislation are confirmed.
- Diesel passenger cars from the first EURO 6 generation emit significantly higher NO_x emissions than in the HBEFA V.3.2 forecast with average NO_x emissions of approximately 600 mg/km.

EURO 6c

For the purpose of forecasting the emission factor of EURO 6c diesel passenger cars it was assumed that in HBEFA3.2 all cars from about 2018 onwards will have to pass an on-road emissions test ("RDE" Real Driving Emission) besides the type test at the dynamometer. In the on-road emissions test cars are not allowed to exceed the limit value by more than a “conformity factor” (CF) (assuming CF = 2).

Assumptions for the pessimistic scenario:

- It is assumed that the RDE legislation is not very effective and thus 50% of real driving conditions (engine load, engine speed, ambient conditions) are not covered. For those not covered driving conditions a conformity factor (CF) of 4 is assumed. The second half of the driving conditions is assumed to have a CF of 2 which means in average a CF of 3 in all driving conditions (corresponds to average NO_x emissions of 240 mg/km). In addition, it is assumed that the rules for RDE are delayed by 4 years and thus do not come into force in the years 2018/2019 as adopted in HBEFA V.3.2.

In the following table the emission factors of the pessimistic scenario are compared with the corresponding values of the base scenario (HBEFA Version 3.2) for diesel passenger cars and diesel light duty vehicles.

Table 26: Comparison of emission factors of diesel passenger cars (PC) in g/km.

legislation	NO_x urban		NO_x rural		NO_x motorway	
	HBEFA V.3.2	pess.	HBEFA V.3.2	pess.	HBEFA V.3.2	pess.
EURO 4	0.588	-	0.485	-	0.640	-
EURO 5	0.684	-	0.585	-	0.825	-
EURO 6	0.246	0.551	0.217	0.467	0.356	0.766
EURO 6c	0.122	0.206	0.116	0.195	0.193	0.320

Table 27: Comparison of emission factors of diesel light duty vehicles in g/km.

legislation	NO_x urban		NO_x rural		NO_x motorway	
	HBEFA V.3.2	pess.	HBEFA V.3.2	pess.	HBEFA V.3.2	pess.
EURO 4	0.666	-	0.754	-	1.294	-
EURO 5	0.626	-	0.695	-	1.202	-
EURO 6	0.222	0.490	0.245	0.528	0.417	0.898
EURO 6c	0.113	0.189	0.130	0.219	0.221	0.372

Heavy duty vehicles (HDV)

EURO VI

So far, seven HDV models were measured on roller or engine test stands for HBEFA V.3.2. Under test conditions, the NO_x emissions were at very low levels, in some cases even well below the very strict EURO VI limit. Whether this NO_x level will really occur in all real driving conditions (ambient temperatures, aging effect etc.) must be checked in detail (in this respect also road measurements with PEMS measurement systems are planned for the next HBEFA update of version 4). Recent emission measurements tend to confirm the low NOx emissions of HDV given in HBEFA V.3.2.

Assumptions for the pessimistic scenario:

- It is assumed that under real driving conditions all HDV exploit the full scope which is provided by the EUROVI emissions legislation for the on-road emissions level (limit value multiplied by a CF of 1.5). Even in this pessimistic scenario EUROVI HDV are still significantly cleaner than all previous generations of HDV.

In the following table the emission factors of the pessimistic scenario are compared with the corresponding values of the base scenario (HBEFA Version 3.2) for heavy duty vehicles.

Table 28: Comparison of emission factors of heavy duty vehicles in g/kWh.

legislation	NO_x calibration factor	
	HBEFA V.3.2	pess.
EURO IV	5.50	-
EURO V	4.19	-
EURO VI	0.51	1.02

A detailed description of all underlying assumptions can be found in the according technical study by TU Graz (SCHWINGSHACKL & REXEIS 2015).

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

Table 29: Introduction periods of EURO-classes in new registrations (passenger cars and light duty vehicles).

PC	WEM/WAM		pess.	
	from	until	from	until
EURO 4	2005	2008	2005	2008
EURO 5	2009	2013	2009	2013
EURO 6	2014	2018	2014	**2022**
EURO 6c	2019		**2022**	

Table 30: Introduction periods of EURO-classes in new registrations (heavy duty vehicles).

PC	WAM/WEM/pess.	
	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 in the WEM scenario no changes have been assumed. For the WAM scenario it was assumed that after 2017 new installations are equipped with better primary measures for NO_x-abatement and meet yearly average values of 35 mg NO_x/Nm^3 (> 50 MW) respectively 50 mg NO_x/Nm^3 (< 50 MW) by 2030.

4.3 Fugitive Emissions (NFR 1 B)

SO_2 and NMVOC

SO_2 and NMVOC emission projections for fugitive emissions are based on emission/activity data ratios of 2009–2013, as well as on projected activity data such as natural gas and crude oil exploration, and natural gas and gasoline consumption according to the projected energy consumption (WIFO 2013). The pipeline length has been extrapolated by the average yearly growth rate between 2009 and 2013.

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 2015 (UMWELTBUNDESAMT 2015b).

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.

$PM_{2.5}$

1 B 1 a coal handling: $PM_{2.5}$ emissions from coal handling and storage have been calculated on the basis of projected coal consumption (WIFO 2013) and emission factors as used in the national air emissions inventory.

4.4 Industrial Processes (NFR 2 without 2 D)

The forecast for developments in industrial production has been based on macro-economic data from the sub-sectors (UMWELTBUNDESAMT 2015a), taking into account known predictions about expansions, opening 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 national inventory and are assumed to remain constant over time. There are no differences between the WEM and WAM scenarios. Emissions from the chemical industry are based on the development of sulphuric acid production (SO_2), nitric acid and ammonia production (NO_x) and fertiliser production (NO_x and $PM_{2.5}$). There are no differences between the WEM and WAM scenarios. Emissions from metal production are based on the national inventory and environmental reports of Austrian enterprises. Emissions are expected to remain constant in the WEM and WAM scenarios. NO_x emissions from fibreboard production are expected to decrease due to the decommissioning of the plant located in Hallein in 2014 and to increase afterwards in relation to the economic development $PM_{2.5}$ emissions from wood processing are assumed to remain constant at the level of the national inventory.

NMVOC and NH_3

NMVOC and NH_3 emissions are assumed to remain constant at the levels of 2013 (UMWELTBUNDESAMT 2015b). This simple approach has been chosen because their share in the total emissions is relatively small.

4.5 Solvent and Other Product Use (NFR 2 D)

NMVOCs

Recalculation Information

The implementation of the Deco Paint Directive was not fully accounted for in the previous projection, as the last update of emission factors was made in 2008, whereas the Directive sets lower limits for VOC contents again from 2010 onwards.

Methodology of the Austrian Air Emission Inventory

The basis for NMVOC emission projections up to 2030 is the Austrian Air Emission Inventory, which is supported by several 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 Statistics Austria.

In order to determine the quantity of solvents used for the various applications in Austria, a bottom-up approach was combined with a top-down approach. The top-down approach provided the total quantities of solvents used in Austria, whereas the proportion of solvents used for different applications and the solvent emission factors were calculated on the basis of the bottom-up approach. Emission factors are calculated on the basis of solvent use per substance category at NACE-level-4 for all industrial sectors, and they are based on information from surveys in households and industry as well as structural business statistics. By linking together the results of the bottom-up and the top-down approach, the quantities of solvents used per year and the solvent emissions from the different applications were obtained.

Methodology of the Projection

The quantity (balance) of the solvents (substances) and solvent containing products which were imported and exported was calculated in the Austrian Air Emission Inventory for the period up to 2012. The trend between 2000 and 2012 was used as a basis to calculate further trends in the development of the quantity of solvents and solvent containing products which are imported and exported (linear trend extrapolation).

Production was assumed to remain constant at 2010 levels as the drastic reduction that occurred in the years before 2010 due to the economic crisis impairs an overall downward trend for the trend extrapolation which is not plausible. The quantity (balance) of solvents (substances) and solvent containing products and production were summed up to yield the total Solvent Activity in Austria. The total Solvent Activity in Austria was split up into the specific SNAP categories taking the results from the bottum up approach as explained above; also the emission factors from the Austrian Air Emissions inventory were applied, as further positive impact of law enforcement in Austria is expected to be only minimal in the coming years. However, the extrapolated activity data already includes techological development such as further substitution as this results in decreasing solvent activity.

The solvents sector of the Austrian Air Emissions Inventory is currently under revision. The new model will allow a more detailed projection (on a sector basis instead of on basis of overall solvent activity); results for the projection are expected for 2017 at the latest.

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.

$PM_{2.5}$

Emission projections for $PM_{2.5}$ are calculated by multiplying the emission factor of the latest inventory year (2013; submission 2015) by the projected number of inhabitants (population) in Austria until 2030 (provided by Statistics Austria).

The basis for the emission factor (data 2013, Austrian Air Emission Inventory 2015) comes from a survey (WINIWARTER et. al. 2007).

4.6 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

Projected activity data of both scenarios are the result of calculations carried out with the Positive Agricultural Sector Model Austria (PASMA), developed by the Austrian Institute of Economic Research (WIFO) (WIFO & BOKU 2015). The model maximises sectorial 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 for 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 scenarios projected by OECD-FAO for the EU. The reasoning behind the deviation is that for countries which are likely to expand milk production, lower prices may prevail over a long period until a new equilibrium establishes itself (see Schmid et al. 2011 for more elaborations on this expectation). Other exogenous economic assumptions for Austria (like the 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 prices of outputs and inputs. Since Austrian agriculture is an integrated part of the common market, carry-over effects from European demand patterns are noticeable and determine the results.

Other assumptions

- Increase of milk yield per cow from 15% (2020) to 30% (2030) relative to reference period in both scenarios
- loss of agricultural land following the long term trend in both scenarios

Results

The number of dairy cows is expected to be larger in each of the scenarios analysed. The reason is that milk production is likely to expand after the abolition of the milk quota (2015). Additionally, the Programme of Rural Development promotes farming in mountain regions where milk production is the most profitable activity, if sufficient labour is available.

Slightly increasing prices for pork lead to an increasing number of pigs. The expansion of production is consistent with the overall outlook at European level (EC 2014) but it is not consistent with the currently observed trend of declining numbers of pigs. An expansion of pork production is not unrealistic if the sector makes the same adjustment 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 of increasing numbers of heads. Following international projections (EC 2014) one would expect more poultry as well. The model result is the consequence of prices, poultry and egg production in Austria has to cope with considerably higher costs than producers in other countries.

The sales of mineral nutrients are 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 increasing energy costs which determine fertilizer costs, the fact that agricultural land will decline, and the increasing production of manure from increasing livestock numbers, this result seems 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) 2015 (UMWELTBUNDESAMT 2015b).

Feed intake and N-excretion

Feed intake parameters and N excretion values applied here are the same as those applied in Austria's Annual Air Emission Inventory (UMWELTBUNDESAMT 2015b). Data for dairy cows were calculated on the basis of projected milk yields.

Animal Waste Management Systems (AWMS)

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

For 2020 the share of cattle kept in tie stall housing systems was reduced by 50% (provisions on animal welfare). Shares vary by cattle sub-category; overall they are in the range of the expert judgement of 30% provided by (OFNER-SCHRÖCK & PÖLLINGER 2013). Shares of liquid and solid within the tie housing system have not been changed – they are the same as in the national inventory.

Taking into account the trend to liquid systems the share of loose housing systems/liquid has been increased by 50% in 2020.

For the years after 2020 a further reduced use of solid systems is projected. A linear decrease of 50% between 2020 and 2050 was assumed for solid systems.

The same assumptions on AWMS have been used for both scenarios.

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 treated areas. For the projections, the same emission factors have been applied as those in Austria's Air Emission Inventory (UMWELTBUNDESAMT 2015b).

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 2013 inventory values 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 vegetation 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 particle emissions from animal husbandry are related to the Austrian livestock projections. Emission factors are the same as those used in Austria's Air Emission Inventory (UMWELTBUNDESAMT 2015b).

4.7 Waste (NFR 5)

NMVOCs and NH_3 from Waste Disposal on Land

NMVOC and NH_3 emissions 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 emissions arising from solid waste disposal on land, the IPCC (Intergovernmental Panel on Climate Change) Tier 2/First Order Decay method is applied, consisting of two equations: firstly, calculating the amount of methane accumulated up to the inventory year; secondly, calculating the emitted methane after subtracting the recovered and oxidised amounts of methane. Country-specific parameters are used (e.g. the recovered landfill gas), if available. More detailed information as well as the parameters themselves can be found in Austria's Informative Inventory Report (UMWELTBUNDESAMT 2015b).

Projections for landfill gas emissions are calculated on the basis of predictable future trends in waste management as a result of the implementation of legal provisions at federal government level (Landfill Ordinance, Ordinance on 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 from the mechanical biological treatment of waste; this fraction is expected to decrease (in accordance with the assumptions for projected emissions from MBT plants).
2. The landfill fraction from the mechanical treatment and biological pre-treatment of waste.

A detailed description of the methodology used for the calculation of projections for CH_4 emissions can be found in Austria's greenhouse gas projections, submitted to the European Commission under the EU Monitoring Mechanism (UMWELTBUNDESAMT 2015c).

NO_x, SO_2, NMVOC and NH_3 from Waste Incineration

Because of the small contribution of these pollutants to the national total emissions (less than 1%), the 2013 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 2015 (UMWELTBUNDESAMT 2015b).

NH_3 Emissions from Composting

Emissions are calculated separately for

- waste treated in mechanical-biological treatment (MBT) plants and
- composted waste

by multiplying the respective emission factors by the waste amounts. The emission factors used for the projections are the same as those used in the annual inventory (UMWELTBUNDESAMT 2015b).

Amounts of bio-waste collected separately as well as home composted waste are expected to increase in accordance with population growth. Amounts of municipal garden and park waste are expected to stay constant.

Amounts of waste undergoing a mechanical-biological treatment (MBT) in Austria are assumed to decline due to closures and reconstructions of MBT plants triggered amongst 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 2015 and contain transition and adjustment periods until the end of 2019. Projections for input amounts have been made for the years 2015, 2020, 2025 and 2030 (see Table 31).

Table 31: Forecast (2015–2030) activity data for composting.

Activity [kt]	2015	2020	2025	2030
Bio waste and green waste	3 055	3 103	3 146	3 186
Mechanical biological treatment (MBT)	360	284	284	284

$PM_{2.5}$ from waste disposal on land (handling of dusty waste)

For the calculation of $PM_{2.5}$ emissions, only specific waste types are considered such as residues from iron and steel production (slags, dusts), clinker, dust and ashes from thermal waste treatment and combustion plants, as well as some mineral and construction waste.

Emissions are calculated by multiplying the waste amount by an emission factor (the same as used for the Austrian Air Emission Inventory, see UMWELTBUNDESAMT 2015b). For the projection of activity data, differentiated assumptions have been made: Mineral waste (dominated by excavated soil) increases in line with the growing population. Metallurgic waste (clinker, dusts, etc.) is assumed to develop in accordance with the projected gross value added (ÖNACE 27 Manufacture of basic metals). For the projection of residues from thermal waste treatment and combustion plants, projected energy data (waste as fuel) have been used as indicator (UMWELTBUNDESAMT 2015a). For all other wastes historical values have been used (for extrapolation).

5 RECALCULATIONS: CHANGES WITH RESPECT TO THE SUBMISSION 2013

Changes with respect to the last emission projections of air pollutants of 2013 (UMWELTBUNDESAMT 2014) are presented in this chapter. In general, there are four main factors influencing these changes:

1. The implementation of additional policies and measures (PAMs) for air pollution (in the scenario from 2013 only PAMs for GHGs were applied).
2. The switch to the new EMEP/EEA Guidebook 2013 (in addition to the IPCC Guidelines 2006 for the GHG inventory), which implied methodical changes, also led to partly considerable sectorial recalculations (e.g. for the sector agriculture) of inventory and emission projections, as the methods have to be applied consistently for the calculation of past trends and emission scenarios.
3. Assumptions for activity scenarios have changed. These changes can be triggered by revised economic or technical scenarios, the consideration of additional policies and measures, and by revisions of policies or measures due to amendments to legal texts.
4. Changes of the models used for activity or emission scenarios.
5. Update of new emission factors (e.g. in the transport sector)

The following tables show a comparison of past trends and scenarios for national emission totals.

*Table 32: Comparison of projections 2013 and 2015 in the scenarios **with existing measures (WEM)** based on **fuel sold** – national totals (in kt).*

Total – WEM	2005	2010	2015	2020	2015	2030
Projections 2013						
NO_x	238	193	166	131	117	112
SO_2	27	19	18	18	19	19
NMVOC	168	137	132	125	120	116
NH_3	63	63	64	66	66	67
$PM_{2.5}$	22	20	18	17	17	16
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
Difference 2015/13						
NO_x	–3	–14	–16	–16	–22	–25
SO_2	0	0	–1	–2	–2	–2
NMVOC	–8	–6	–7	–10	–16	–17
NH_3	3	4	5	8	7	7
$PM_{2.5}$	0	0	–1	–2	–3	–3

*Table 33: Comparison of projections 2013 and 2015 in the scenarios **with additional measures (WAM)** based on **fuel sold** – national totals (in kt).*

Total – WAM	2005	2010	2015	2020	2015	2030
Projections 2013						
NO_x	238	193	157	119	113	106
SO_2	27	19	18	18	18	19
NMVOC	168	137	131	124	119	114
NH_3	63	63	63	63	63	63
$PM_{2.5}$	22	20	18	17	16	16
Projections 2015						
NO_x	235	180	151	102	84	77
SO_2	27	19	17	16	16	16
NMVOC	159	131	125	114	103	97
NH_3	66	68	67	70	69	68
$PM_{2.5}$	23	20	17	15	13	12
Difference 2015/13						
NO_x	–3	–14	–6	–17	–28	–29
SO_2	0	0	–1	–2	–2	–2
NMVOC	–8	–6	–6	–10	–16	–16
NH_3	3	4	5	7	6	5
$PM_{2.5}$	0	0	–1	–2	–4	–4

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 34: Major changes in projections 2013 and 2015 for the WEM and WAM scenarios for the sectors 1A1, 1A2 and 2 in kt.

Pollutant	Sector (CRF)	2005	2010	2015	2020	2025	2030
WEM							
NO_x	1 A 1 – Energy industries	–0.3	1.0	–1.5	–0.7	–0.9	–0.3
	1 A 2 – Manufacturing Industries and Construction	–0.4	0.2	0.6	0.3	0.1	–0.3
	2 – Industrial Processes	0.0	0.0	–0.2	–0.2	–0.2	–0.2
SO_2	1 A 1 – Energy industries	0.0	0.3	–1.4	–1.0	–1.1	–1.0
	1 A 2 – Manufacturing Industries and Construction	–0.4	–0.2	0.2	–0.1	–0.4	–0.7
	2 – Industrial Processes	0.0	0.0	0.0	0.0	0.0	0.0
$PM_{2.5}$	1 A 1 – Energy industries	–0.1	0.0	–0.1	0.0	0.1	0.2
	1 A 2 – Manufacturing Industries and Construction	–0.1	0.0	0.2	0.2	0.2	0.2
	2 – Industrial Processes	0.4	0.4	0.3	0.2	0.2	0.1
WAM							
NO_x	1 A 1 – Energy industries	–0.3	1.0	–1.4	–1.0	–3.3	–3.0
	1 A 2 – Manufacturing Industries and Construction	–0.4	0.2	0.3	–0.9	–2.0	–2.5
	2 – Industrial Processes	0.0	0.0	–0.2	–0.2	–0.2	–0.2

Pollutant	Sector (CRF)	2005	2010	2015	2020	2025	2030
SO_2	1 A 1 – Energy industries	0.0	0.3	–1.4	–1.0	–1.2	–1.1
	1 A 2 – Manufacturing Industries and Construction	–0.4	–0.2	0.1	–0.1	–0.4	–0.6
	2 – Industrial Processes	0.0	0.0	0.0	0.0	0.0	0.0
$PM_{2.5}$	1 A 1 – Energy industries	–0.1	0.0	–0.1	–0.1	–0.3	–0.2
	1 A 2 – Manufacturing Industries and Construction	–0.1		0.2	0.2	0.3	0.3
	2 – Industrial Processes	0.4	0.4	0.3	0.2	0.2	0.1

Revisions up to the year 2010 are mainly due to updates of the national energy balance. For the projections in 2013 the energy balance with data up to 2010 was used, whereas for the projections in 2015 the energy balance with data up to 2012 was drawn upon. Hence, the energy demand and thus the emissions are different in the current projections.

Revisions thereafter are due to recent developments on the European electricity markets leading to a reduced profitability of gas and coal power plants and to 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.

For the WAM scenario the new version of the national Energy Efficiency Law has been taken into account. This law entered into force late in 2014 and was significantly different from the draft used for the 2013 projections.

Emission factors have been adapted mainly as an effect of measures but partly also to incorporate recalculations of the latest inventory. The revised emissions factors for biomass plants in the WAM scenario are given in Table 15. These have not been applied in the projections made in 2013. The same is valid for measures in the industrial sector described in chapter 4.1.2 and Table 16.

5.1.2 Transport (1 A 3)

Table 35: Major changes in projections 2013 and 2015 for the WEM and WAM scenarios for the sector 1A3 in kt (fuel sold).

Pollutant	Sector (CRF)	2005	2010	2015	2020	2025	2030
WEM							
NO_x	**1 A 3 – Transport**	**–2.0**	**–14.5**	**–14.6**	**–14.8**	**–18.5**	**–21.0**
	1 A 3 b 1 – Passenger cars	6.3	–0.5	–0.1	–2.7	–5.9	–7.4
	1 A 3 b 2 – Light duty vehicles	1.4	1.4	1.3	0.2	–1.1	–1.8
	1 A 3 b 3 – Heavy duty vehicles	–9.8	–15.5	–15.6	–12.0	–11.1	–11.5
	1 A 3 e – Pipeline compressors	0.0	0.0	–0.3	–0.5	–0.5	–0.6
NMVOC	**1 A 3 – Transport**	**–8.7**	**–6.3**	**–4.8**	**–4.8**	**–5.0**	**–5.3**
	1 A 3 b 1 – Passenger cars	–5.2	–2.0	0.4	0.2	0.1	–0.1
	1 A 3 b 2 – Light duty vehicles	–0.1	0.0	–0.1	–0.2	–0.4	–0.5
	1 A 3 b 3 – Heavy duty vehicles	–1.5	–2.7	–3.9	–4.0	–4.2	–4.4

Pollutant	Sector (CRF)	2005	2010	2015	2020	2025	2030
WAM							
NO_x	**1 A 3 – Transport**	**–2.0**	**–14.5**	**–5.3**	**–14.5**	**–20.3**	**–19.9**
	1 A 3 b 1 – Passenger cars	6.3	–0.5	2.9	–2.8	–6.3	–6.6
	1 A 3 b 2 – Light duty vehicles	1.4	1.4	1.7	0.5	–1.0	–1.6
	1 A 3 b 3 – Heavy duty vehicles	–9.8	–15.5	–9.8	–12.1	–12.8	–11.2
	1 A 3 e – Pipeline compressors	0.0	0.0	–0.3	–0.5	–0.6	–1.0
NMVOC	**1 A 3 – Transport**	**–8.7**	**–6.3**	**–4.6**	**–4.6**	**–4.7**	**–4.3**
	1 A 3 b 1 – Passenger cars	–5.2	–2.0	0.6	0.4	0.5	0.7
	1 A 3 b 2 – Light duty vehicles	–0.1	0.0	–0.1	–0.2	–0.3	–0.4
	1 A 3 b 3 – Heavy duty vehicles	–1.5	–2.7	–3.8	–3.8	–4.2	–4.2

Emissions from Mobile Combustion have so far been calculated with the GLOBEMI model (HAUSBERGER 1998; HAUSBERGER & SCHWINGSHACKL 2012) – which was also used for the 2013 projections. From the submission in 2015 onwards projections for the time series up to 2030 are based on the NEMO (Network Emission Model) model (DIPPOLD et al. 2012; HAUSBERGER et al. 2015a, 2015b). For details see chapter 4.2.2.

It can be seen that the NO_x emissions for both scenarios (WEM and WAM) of the 2015 submission are lower than the 2013 submission, for several reasons:

- The implementation of NEMO resulted in a more precise estimate of fuel consumption. This model change showed that the last WEM scenario which was calculated with the GLOBEMI model was a lot overestimated.
- Combined with a whole updated set of emission factors taken from HBEFA V3.2[13] the current scenarios are lower than before (details and a comparison of specific emissions factors per vehicle category are shown below).
- Especially for the latest NO_x emission factors of HDV first measurements show that they have much lower specific emissions than thought so far.
- Fuel prices in Austria and its neighboring countries, as well as assumptions concerning their development, have been adapted with the consumer price index.
- In the 2015 WAM scenario the second fuel tax increase which is expected to take place in 2019 is more ambitious than was assumed in the 2013 projections. The second fuel tax increase means that the export of fuel may be maintained at a roughly constant level. Unlike other countries, the diesel price delta is then almost completely eliminated. The remaining fuel export is thus mainly structural and no longer price driven.
- Additionally, the 2015 WAM scenario is very optimistic. New measures were implemented in the WAM scenario, particularly the implementation of the Energy Efficiency Directive (2012/27/EU), with the aim to decrease energy consumption in transport by 16 PJ by 2020 and by 32 PJ by 2030.

[13] Handbook of emission factors for Road Transport (INFRAS 2014)

Recalculation of the past time series

Emission levels for the whole past time series have been revised downwards which has had an emission reducing effect on the whole future trend. The values for the years 2005 and 2010 in the 2013 projections stem from the inventory for the year 2011, which was calculated with GLOBEMI back then. The effect of the downwards revised NO_x emissions from 2005 downward for road transport incl. fuel export (fuel used) can be explained by 1) the downward revision of annual energy inputs in fuel export and 2) by the downward revision of NO_x emission factors for HDV (lorries and semitrailers) which are mainly traveling in the fuel export segment (see Table 38), which enhances the first revision of energy inputs. This is why we see this high downward revision in the HDV segment compared to the 2013 projections in the years 2005 and 2010.

Absolute NO_x figures of passenger cars (PC) were revised upwards. This can be explained by the fact that the latest specific fuel consumptions of PC have been revised upwards in HBEFA V3.2 from 2000 onwards. In addition NO_x emission factors have also been revised upwards for PC up to EURO 4 compared to the old HBEFA version, which was used in GLOBEMI (see Table 36).

Absolute NOx figures of light duty vehicles (LDV) were slightly revised upwards. NO_x emission factors have strongly been revised upwards for LDV up to EURO 4 compared to the old HBEFA version which was used in GLOBEMI (see Table 37). This effect is reduced by a reduction of specific fuel consumption of LDV over the whole times series according to HBEFA V.2.

Recalculation of future time series

For PC and LDV, HBEFA V.3.2 shows lower NO_x emission factors for EURO 6 and much lower values for the future emission class EURO 6c. For HDV, HBEFA V.3.2 shows much lower NO_x emissions for EURO VI and an assumed future emissions class EURO VI 2050.

Details on NO_x emission factors

The tables below show a comparison between the emission factors between the projections 2013 (GLOBEMI) and 2015 (NEMO) per vehicle category. In NEMO the latest HBEFA Version 3.2 has been integrated. In GLOBEMI, which was used for the 2013 projections, an older version was used.

Table 36: Comparison of NO_x emission factors for diesel passenger cars (PC).

NO_x	NEMO HBEFA V.3.2	GLOBEMI
PRE ECE	1.016	-
ECE15/01	1.016	-
ECE15/02	1.016	-
ECE15/03	1.016	-
ECE15/04	1.016	0.740
US 83	0.750	0.660
Gesetz A	0.772	0.660
EURO 2	0.817	0.776

NO_x	NEMO HBEFA V.3.2	GLOBEMI
EURO 3	0.859	0.718
EURO 4	0.569	0.561
EU4+DPF	0.569	0.562
EURO 5	0.697	0.707
EURO 6	0.274	0.285
EURO 6c	0.144	0.201

Table 37: Comparison of NO_x emission factors for diesel light duty vehicles (LDV).

NO_x	NEMO HBEFA V.3.2	GLOBEMI
PRE ECE	1.78	-
ECE15/01	1.78	-
ECE15/02	1.78	-
ECE15/03	1.78	-
ECE15/04	1.78	1.14
US 83	1.56	1.14
Gesetz A	1.59	1.12
EURO 2	1.41	1.00
EURO 3	1.14	0.86
EURO 4	0.93	0.70
EURO 5	0.86	0.95
EURO 6	0.30	0.33
EURO 6c	0.16	0.33

Table 38: Comparison of NO_x emission factors for heavy duty vehicles (HDV).

NO_x	NEMO HBEFA V.3.2	GLOBEMI
80erJahre	14.15	11.69
Euro-I	9.71	8.36
Euro-II	9.89	8.52
Euro-III	7.82	6.90
Euro-IV EGR	5.56	5.67
Euro-IV SCR	3.25	5.67
Euro-V EGR	4.17	3.13
Euro-V SCR	2.15	3.13
Euro-VI 2014-2015	0.34	0.43
Euro-VI 2050	0.23	0.43

5.1.3 Other Sectors (NFR 1 A 4)

Table 39: Major changes in projections 2013 and 2015 for the WEM and WAM scenarios for the sector 1A4 in kt.

Pollutant	Sector (CRF)	2005	2010	2015	2020	2025	2030
WEM							
NO_x	**1 A 4 – Other Sectors**	**0.0**	**–0.4**	**–0.1**	**–0.8**	**–2.5**	**–3.2**
	1 A 4 a 1– Commercial/Institutional: Stationary	0.0	–0.2	–0.1	–0.1	–0.3	–0.4
	1 A 4 b 1 – Residential: stationary	0.0	–0.2	0.3	–0.2	–1.4	–1.7
	1 A 4 c 1 – Agriculture/Forestry/Fishing: Stationary	0.0	–0.1	–0.2	–0.4	–0.8	–1.1
NMVOC	**1 A 4 – Other Sectors**	**0.0**	**0.1**	**0.7**	**–1.9**	**–7.9**	**–9.2**
	1 A 4 a 1– Commercial/Institutional: Stationary	0.0	0.0	–0.2	–0.2	–0.3	–0.4
	1 A 4 b 1 – Residential: stationary	0.0	0.0	0.7	–2.0	–7.6	–8.6
	1 A 4 c 1 – Agriculture/Forestry/Fishing: Stationary	0.0	0.0	0.0	–0.2	–0.6	–0.8
PM2.5	**1 A 4 – Other Sectors**	**0.0**	**0.0**	**–0.9**	**–1.5**	**–2.6**	**–3.0**
	1 A 4 a 1– Commercial/Institutional: Stationary	0.0	0.0	–0.1	–0.1	–0.2	–0.2
	1 A 4 b 1 – Residential: stationary	0.0	0.0	–0.7	–1.1	–2.0	–2.2
	1 A 4 c 1 – Agriculture/Forestry/Fishing: Stationary	0.0	0.0	–0.1	–0.2	–0.4	–0.6
WAM							
NO_x	**1 A 4 – Other Sectors**	**0.0**	**–0.4**	**0.1**	**–0.4**	**–2.0**	**–2.5**
	1 A 4 a 1– Commercial/Institutional: Stationary	0.0	–0.2	–0.1	0.0	–0.1	–0.2
	1 A 4 b 1 – Residential: stationary	0.0	–0.2	0.4	0.1	–1.0	–1.2
	1 A 4 c 1 – Agriculture/Forestry/Fishing: Stationary	0.0	–0.1	–0.2	–0.4	–0.8	–1.1
NMVOC	**1 A 4 – Other Sectors**	**0.0**	**0.1**	**1.1**	**–1.3**	**–7.0**	**–8.1**
	1 A 4 a 1– Commercial/Institutional: Stationary	0.0	0.0	–0.2	–0.2	–0.2	–0.4
	1 A 4 b 1 – Residential: stationary	0.0	0.0	1.0	–1.4	–6.8	–7.7
	1 A 4 c 1 – Agriculture/Forestry/Fishing: Stationary	0.0	0.0	0.0	–0.2	–0.6	–0.8
PM2.5	**1 A 4 – Other Sectors**	**0.0**	**0.0**	**–0.9**	**–1.5**	**–2.6**	**–3.0**
	1 A 4 a 1– Commercial/Institutional: Stationary	0.0	0.0	–0.1	–0.1	–0.2	–0.2
	1 A 4 b 1 – Residential: stationary	0.0	0.0	–0.7	–1.1	–2.0	–2.2
	1 A 4 c 1 – Agriculture/Forestry/Fishing: Stationary	0.0	0.0	–0.1	–0.2	–0.4	–0.6

Emerging trends in activity data (energy consumption) for the recent inventory data years, in particular decline of fossil fuel use, which form the basis for the projections (and the model calibration), partly account for the difference to the last projections (2013). With regard to the WAM scenario, the implementation of the Federal Energy Efficiency Law (Federal Law Gazette I No. 72/2014) results in a higher estimate of the possible emission reduction potential, which surpasses the measures assumed for the WAM scenario 2013.

A major change with the pollutants NO_x, NMVOC and $PM_{2.5}$ is due to a remodelling of existing national legislation (Article 15a Agreement) and implementing the Ecodesign standardized emission requirements for the placing on the market and putting into service solid fuel boilers (Lot 15) and local space heaters (Lot 20), which will overrule the partially more stringent national requirements.

Previous fixed assumptions of shares in stock of condensing gas and heating oil boilers (NO_x) and of new solid biomass boilers (NMVOC) by the year 2030 no longer apply because of a new boiler exchange model based on final energy demand for new boilers by year of installation which may cause a minor deviation in early model years. NO_x, NMVOC and $PM_{2.5}$ emission factors were recalculated based on new installations from 2008 onwards, which substitute the heating system stock with average 2008's emission characteristics or increase the overall stock. The legislation in force by the year of installation defines the specific emissions of the new installation which contributes to the stock's total emission factor.

Both cause major shifts in resulting overall stock emission factors, especially within subsector 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 3.2 and chapter 4.1.3.

Emission factors

Solid biomass NO_x emission factors significantly decrease when compared to the 2013 projections. In apartment heating and stoves a reversal of this trend will occur by about 2025, because of the energy carrier shift from fuel wood to pellets with less stringent Ecodesign emission thresholds than in the overruled Article 15a Agreement.

Slightly lower specific emissions are expected for solid fossil fuels until about 2025, when a weakening of existing national regulations becomes evident.

Due to less optimistic assumptions for the future use of condensing boiler technology for natural gas and heating oil for central and apartment heating the correspondent NO_x emission factors are slightly higher than in the last projections (2013); however, the overall trend shows constantly declining emissions factors from 2010 onwards (see chapter 4.1.3.).

In Table 40 the changes in NO_x emission factors used in the projections are listed as examples for central heating in the WEM and WAM scenarios.

Table 40: Changes in NO_x emission factors from 2013 to 2015 projections for natural gas, heating oil, solid biomass and solid fossil fuels in central heating.

in kg/TJ		2010	2015	2020	2025	2030
Central heating						
Natural gas						
	WEM	2.0	3.4	4.4	5.1	6.3
	WAM	2.0	3.4	4.4	5.1	6.3
Heating oil						
	WEM	4.7	5.3	5.8	5.5	5.0
	WAM	4.7	5.3	5.8	5.4	4.9
Solid biomass						
	WEM	–0.1	–1.7	–13.1	–29.5	–36.2
	WAM	–0.1	–1.7	–13.1	–29.5	–36.2
Solid fossil fuels						
	WEM	0.0	–0.1	–0.1	1.8	6.2
	WAM	0.0	–0.1	–0.1	1.8	6.2

In Table 41 the changes in NO_x emission factors used in the projections are listed as examples for apartment heating in the WEM and WAM scenario.

Table 41: Changes in NO_x emission factors from 2013 to 2015 projections for natural gas, heating oil, solid biomass and solid fossil fuels in apartment heating.

in kg/TJ		2010	2015	2020	2025	2030
Apartment heating						
Natural gas						
	WEM	2.5	3.6	4.3	5.1	6.1
	WAM	2.5	3.6	4.3	5.1	6.1
Heating oil						
	WEM	4.5	5.4	5.7	3.2	3.6
	WAM	4.5	5.4	5.7	3.2	3.6
Solid biomass						
	WEM	0.0	–1.4	–15.9	–43.9	–27.4
	WAM	0.0	–1.4	–15.9	–43.9	–27.4
Solid fossil fuels						
	WEM	0.0	–0.1	–0.1	1.6	4.4
	WAM	0.0	–0.1	–0.1	1.6	4.4

In Table 42 the changes in NO_x emission factors used in the projections are listed as examples for stoves in the WEM and WAM scenarios.

Table 42: Changes in NO_x emission factors from 2013 to 2015 projections for natural gas, heating oil, solid biomass and solid fossil fuels in stoves.

in kg/TJ		2010	2015	2020	2025	2030
Stoves						
Natural gas						
	WEM	–0.2	–1.0	–3.1	–4.2	NO
	WAM	–0.2	–1.0	–3.1	–4.2	NO
Heating oil						
	WEM	0.0	–0.2	–0.6	–2.3	–2.7
	WAM	0.0	–0.2	–0.6	–2.3	–2.7
Solid biomass						
	WEM	0.0	–1.2	–10.9	–22.3	–22.0
	WAM	0.0	–1.2	–10.9	–22.3	–22.0
Solid fossil fuels						
	WEM	0.0	–0.1	–1.5	–4.5	–7.6
	WAM	0.0	–0.1	–1.5	–4.5	–7.6

$PM_{2.5}$ emission factors for solid biomass and solid fossil fuels decrease when compared to the 2013 projections both due to Ecodesign requirements, which in general outreach existing national regulations for standardized $PM_{2.5}$ emission thresholds.

Slightly higher specific emissions are expected for solid fossil fuels and wood waste and other in central heating until about 2020 respectively 2025, when ecodesign requirements become evident.

In Table 43 the changes in $PM_{2.5}$ emission factors used in the projections are listed as examples for central heating in the WEM and WAM scenario.

Table 43: Changes in $PM_{2.5}$ emission factors from 2013 to 2015 projections for natural gas, heating oil, solid biomass and solid fossil fuels in central heating.

in kg/TJ		2010	2015	2020	2025	2030
Central heating						
Fuel wood						
	WEM	0.1	–1.1	–9.0	–26.5	–34.5
	WAM	0.1	–1.1	–9.0	–26.5	–34.5
Wood waste and other						
	WEM	2.6	1.3	–5.6	–12.7	–14.1
	WAM	2.6	1.4	–5.6	–12.6	–14.0
Pellets						
	WEM	0.0	–3.0	–7.6	–9.7	–11.2
	WAM	0.0	–3.0	–7.6	–9.7	–11.2
Solid fossil fuels						
	WEM	2.9	3.3	2.0	–10.0	–35.2
	WAM	2.9	3.5	2.1	–9.6	–34.1

In Table 44 the changes in $PM_{2.5}$ emission factors used in the projections are listed as examples for apartment heating in the WEM and WAM scenarios.

Table 44: Changes in $PM_{2.5}$ emission factors from 2013 to 2015 projections for natural gas, heating oil, solid biomass and solid fossil fuels in apartment heating.

in kg/TJ		2010	2015	2020	2025	2030
Apartment heating						
Fuel wood						
	WEM	0.0	–1.2	–12.1	–37.3	NO
	WAM	0.0	–1.2	–12.1	–37.3	NO
Pellets						
	WEM	0.0	–3.2	–8.5	–10.7	–10.9
	WAM	0.0	–3.2	–8.5	–10.7	–10.9
Solid fossil fuels						
	WEM	0.0	–0.1	–1.8	–16.2	–40.0
	WAM	0.0	–0.1	–1.8	–16.2	–40.0

In Table 45 the changes in $PM_{2.5}$ emission factors used in the projections are listed as examples for stoves in the WEM and WAM scenarios.

Table 45: Changes in $PM_{2.5}$ emission factors from 2013 to 2015 projections for natural gas, heating oil, solid biomass and solid fossil fuels in stoves.

in kg/TJ		2010	2015	2020	2025	2030
Stoves						
Fuel wood						
	WEM	–0.1	–1.9	–19.7	–61.0	NO
	WAM	–0.1	–1.9	–19.7	–61.0	NO
Pellets						
	WEM	0.0	–1.7	–6.0	–8.8	–11.1
	WAM	0.0	–1.7	–6.0	–8.8	–11.1
Solid fossil fuels						
	WEM	d	–0.2	–2.8	–26.5	–65.7
	WAM	0.0	–0.2	–2.8	–26.5	–65.7

NMVOC emission factors are assumed to decrease for solid fossil fuels when compared to the 2013 projections due to the Ecodesign requirements. Slightly higher NMVOC emission factors are expected for solid biomass until about 2020 because of a remodeling of existing national legislation; thereafter ecodesign requirements will become evident. Only minor changes are expected for natural gas and heating oil.

In Table 46 the changes in NMVOC emission factors used in the projections are listed as examples for central heating in the WEM and WAM scenario.

Table 46: Changes in NMVOC emission factors from 2013 to 2015 projections for natural gas, heating oil, solid biomass and solid fossil fuels in central heating.

in kg/TJ		2010	2015	2020	2025	2030
Central heating						
Natural gas						
	WEM	0.0	0.0	0.0	0.0	0.0
	WAM	0.0	0.0	0.0	0.0	0.0
Heating oil						
	WEM	0.0	0.0	0.0	0.0	–0.1
	WAM	0.0	0.0	0.0	0.0	–0.1
Solid biomass						
	WEM	11.1	18.1	–17.1	–85.8	–100.0
	WAM	10.8	18.2	–15.6	–83.5	–96.8
Solid fossil fuels						
	WEM	0.0	–0.4	–7.0	–55.9	–163.9
	WAM	0.0	–0.4	–7.0	–55.9	–163.9

In Table 47 the changes in NMVOC emission factors used in the projections are listed as examples for apartment heating in the WEM and WAM scenarios.

Table 47: Changes in NMVOC emission factors from 2013 to 2015 projections for natural gas, heating oil, solid biomass and solid fossil fuels in apartment heating.

in kg/TJ		2010	2015	2020	2025	2030
Apartment heating						
Natural gas						
	WEM	0.0	0.0	0.0	0.0	0.0
	WAM	0.0	0.0	0.0	0.0	0.0
Heating oil						
	WEM	0.0	0.0	0.0	–0.1	–0.1
	WAM	0.0	0.0	0.0	–0.1	–0.1
Solid biomass						
	WEM	15.3	15.2	–56.1	–216.8	–320.2
	WAM	15.3	15.3	–55.9	–216.3	–319.6
Solid fossil fuels						
	WEM	0.0	–0.3	–6.4	–67.0	–167.1
	WAM	0.0	–0.3	–6.4	–67.0	–167.1

In Table 48 the changes in NMVOC emission factors used in the projections are listed as examples for stoves in the WEM and WAM scenario.

Table 48: Changes in NMVOC emission factors from 2013 to 2015 projections for natural gas, heating oil, solid biomass and solid fossil fuels in stoves.

in kg/TJ		2010	2015	2020	2025	2030
Stoves						
Natural gas						
	WEM	0.0	0.0	0.0	0.0	NO
	WAM	0.0	0.0	0.0	0.0	NO
Heating oil						
	WEM	0.0	0.0	0.0	–0.2	–0.2
	WAM	0.0	0.0	0.0	–0.2	–0.2
Solid biomass						
	WEM	40.4	34.3	–74.9	–205.6	–270.0
	WAM	40.3	34.6	–73.7	–202.6	–265.8
Solid fossil fuels						
	WEM	0.0	–0.5	–5.4	–43.4	–105.1
	WAM	0.0	–0.5	–5.4	–43.4	–105.1

5.1.4 Solvent and Other Product Use (NFR 2 D)

The previous implementation of the Deco Paint Directive was not fully taken into account in the projection. The last update of emission factors was made in 2008, whereas the Directive sets lower limits for VOC contents again from 2010 onwards.

Based on the old projection the potential for the full implementation was estimated in an expert judgement (3 kt VOC from 2010 onwards) and subtracted from the sub category 3 A Paint Application.

Table 49: Major changes in projections 2013 and 2015 for the WEM and WAM scenarios for the sector 2 D in kt.

Pollutant	Sector (CRF)	2005	2010	2015	2020	2025	2030
WEM							
NMVOC	2 D – Solvents and other product use	0.0	0.0	–3.0	–3.0	–3.0	–3.0
WAM							
NMVOC	2 D – Solvents and other product use	0.0	0.0	–3.0	–3.0	–3.0	–3.0

5.1.5 Agriculture (NFR 4)

Table 50: Major changes in projections 2013 and 2015 for the WEM and WAM scenarios for the sector 3 in kt.

Pollutant	Sector (CRF)	2005	2010	2015	2020	2025	2030
WEM							
NH_3	3 – Agriculture	3.9	4.0	4.3	6.7	5.4	4.5
WAM							
NH_3	3 – Agriculture	3.9	4.0	4.1	7.0	6.3	5.7

Methodological improvements of the Austrian Air Emission Inventory

In the 2015 submission NH_3 emissions from the non-key animal categories sheep, goats, poultry, horses and other animals have been estimated for the first time, using the detailed Tier 2 method following the current version of the EMEP/EEA Guidebook 2013. The Tier 2 method follows a mass flow analysis, which is more detailed and thus better reflects Austrian conditions.

Default Tier 1 values used in previous inventories considered higher amounts of time spent on pasture than is typical for Austria. The smaller amounts of pasturing time of sheep, goats, horses and other animals led to increased NH_3 emissions from manure management.

In addition to N from digested manure, which has already been accounted for in previous submissions, the revised 2015 inventory implements additional N inputs from energy crops that are digested in biogas plants, and applied to soils as fertilizer after the digestion process (biogas slurry). This update resulted in additional NH_3 and NO_x emissions of 1 241 t for NH_3 and 224 t for NO_x in 2013, reported under *3.D.a.2.c Other organic fertilisers applied to soils*.

Revisions of the sectoral projection model

Activity data projections

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

The results of the new study are in many aspects in line with the results of (WIFO & BOKU 2011) used for the previous submission:

- an increase of milk production and an increase in the number of dairy cows
- a decline of suckling cows;

- a decrease of crop output mainly due to the loss of farm land for other uses;
- organic farming will not significantly expand production, even if the market and policy environment is favorable.

The first major difference between the results from 2011 and those of the present analysis is that it now seems likely that milk production will expand more than expected in 2011. This implies that the number of cows is likely to be significantly larger. This result is driven by the better prospects for milk production in the coming years.

The second major difference of the results of the scenario analysis in 2011 is that according to the recent outlook pork production will increase while poultry production will decline. The difference can be explained by the different price assumptions. The price development for livestock products is generally very favorable for livestock production and the model adjusts production accordingly.

Projections for the use of commercial fertilizer are very similar.

Emission projection model

Based on expert judgement (OFNER-SCHRÖCK & PÖLLINGER 2013) the share of tied systems of cattle was reduced by 50% from 2020 onwards (provisions on animal welfare). On the other hand the share of loose housing systems/liquid was increased by 50%. Revised housing systems resulted in significantly higher amounts of NH_3 emissions from the sector manure management/cattle.

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ENVIRONMENT AGENCY AUSTRIA umweltbundesamt

Umweltbundesamt GmbH
Spittelauer Lände 5
1090 Vienna/Austria

Tel.: +43-(0)1-313 04
Fax: +43-(0)1-313 04/5400

office@umweltbundesamt.at
www.umweltbundesamt.at

This report covers the results of projections for the pollutants sulphur dioxide (SO_2), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC), ammonia (NH_3) and particulate matter ($PM_{2.5}$) for two scenarios: "with existing measures" (WEM) and "with additional measures" (WAM). It updates previous projections for air pollutants published in 2014 (REP-0456).
The WEM scenario leads to significant reductions in emissions by 2030 for all pollutants but NH_3. The most substantial reduction with about 63% from 2005 until 2030 is projected for the pollutant NO_x. Emission reductions for the other pollutants are in the range from 36% to 46%; NH_3 emissions, however, increase by 11–12%.
The WAM scenario shows some percentage points more reduction for most of the pollutants and NH_3 emissions slightly higher than nowadays.

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