PERSPEKTIVEN FÜR UMWELT & GESELLSCHAFT umweltbundesamt

Austria's National Air Emission Projections 2013 For 2015, 2020 And 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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REPORT
REP-0456

Vienna 2014

Project management

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Acknowledgment

The authors of this report want to express their thanks to all experts involved in the preparation of this report.

For further information about the publications of the Umweltbundesamt please go to:
http://www.umweltbundesamt.at/

Imprint

Owner and Editor:Umweltbundesamt GmbH
Spittelauer Lände 5, 1090 Vienna/Austria

This publications is only available on: http://www.umweltbundesamt.at/

ISBN 978-3-99004-261-8

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ZUSAMMENFASSUNG

Die österreichischen Emissionsprojektionen für die Luftschadstoffe Schwefeldioxid (SO_2), Stickstoffoxide (NO_x), flüchtige organische Verbindungen ohne Methan (NMVOC) und Ammoniak (NH_3) wurden für das Szenario „mit bestehenden Maßnahmen" zuletzt im Jahr 2011 erstellt (UMWELTBUNDESAMT 2011a, b).

Seit dem Jahr 2012 sind diese Emissionsprojektionen um das Szenario „mit zusätzlichen Maßnahmen" und eine erstmalige Abschätzung für den Schadstoff Feinstaub ($PM_{2,5}$) erweitert worden (UMWELTBUNDESAMT 2012c). Dadurch wurden neben bereits implementierten Maßnahmen auch jene abgebildet, die sich im Planungsstadium befinden und nach Einschätzung der involvierten ExpertInnen eine realistische Chance auf Umsetzung haben sowie bis 2030 emissionswirksam werden.

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, die auch für die Projektionen der Treibhausgas-Emissionsentwicklung herangezogen wurden (UMWELTBUNDESAMT 2013a). Da die verwendeten Grundlagendaten auf der Energiestatistik 2011 (letztes Datenjahr 2010) basieren, sind seitdem erfolgte Aktualisierungen der Energiestatistik nicht berücksichtigt.

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 oder ein späteres Jahr sollen als Relativziele – bezogen auf die Emissionshöchstmenge 2005 – verankert werden.

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[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

Nationale Gesamtemissionen

Die folgenden Tabellen zeigen die nationalen Gesamtemissionen der Luftschadstoffe für die Jahre 1990, 2005 und 2010 aus der österreichischen Emissionsinventur (UMWELTBUNDESAMT 2012a) sowie die aktuellen Ergebnisse der Projektionen bis 2030.

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 (preisbedingter Kraftstoffexport im Fahrzeugtank).
b. der in Österreich verbrauchten Treibstoffmenge ohne preisbedingtem Kraftstoffexport (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 2010 und projizierte Emissionen für 2015, 2020, 2025 und 2030 auf Basis der (a) ***verkauften Treibstoffmengen*** *(CLRTAP-Projektionen; „fuel sold") und (b)* ***verbrauchten Treibstoffmengen*** *(NEC-Projektionen; „fuel used") mit den beiden Szenarien:* ***(I) „mit bestehenden Maßnahmen (WEM)"*** *und* ***(II) „mit zusätzlichen Maßnahmen (WAM)"****. (Quelle: Umweltbundesamt).*

Luftschadstoff	Emissions-Inventur 2012			Projizierte Emissionen				Szenarien	
[kt/a]	1990	2005	2010	2015	2020	2025	2030		
NO_x	195,47	237,52	193,16	165,76	130,57	116,56	112,08	WEM	fuel sold
				157,38	119,43	112,65	105,59	WAM	
	181,55	168,96	147,52	129,11	109,14	100,13	96,63	WEM	fuel used
				124,36	103,16	97,68	91,93	WAM	
SO_2	74,45	27,15	18,85	18,25	18,32	18,80	19,23	WEM	fuel sold
				18,16	18,16	18,28	18,72	WAM	
	73,72	27,09	18,81	18,20	18,27	18,74	19,17	WEM	fuel used
				18,11	18,11	18,22	18,66	WAM	
NMVOC	274,74	167,58	136,70	131,60	125,38	120,43	116,32	WEM	fuel sold
				131,09	123,91	118,75	113,86	WAM	
	273,43	159,23	131,76	127,93	122,03	117,02	112,74	WEM	fuel used
				127,49	120,86	115,38	110,55	WAM	
NH_3	65,39	62,72	63,19	63,75	65,79	66,34	66,95	WEM	fuel sold
				62,65	63,13	63,10	62,76	WAM	
	65,37	61,99	62,91	63,58	65,66	66,22	66,84	WEM	fuel used
				62,48	63,01	63,00	62,67	WAM	
$PM_{2,5}$	24,14	22,27	19,76	18,13	17,04	16,59	16,42	WEM	fuel sold
				17,92	16,76	16,35	15,97	WAM	
	23,64	20,56	18,92	17,64	16,73	16,31	16,15	WEM	fuel used
				17,46	16,48	16,08	15,71	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.

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

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

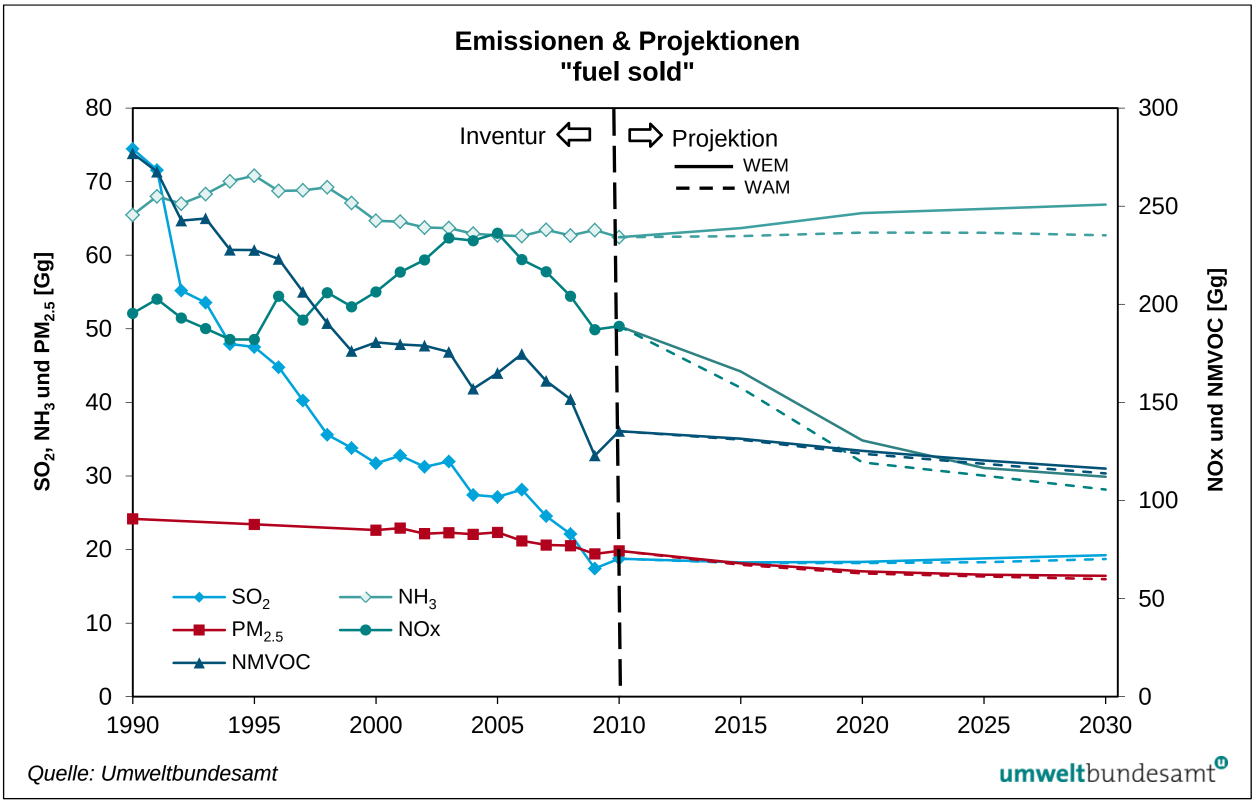

*Abbildung A: Historische (1990–2010) und projizierte Emissionen auf Basis der **verkauften Treibstoffmengen** (2015, 2020, 2025 und 2030) (CLRTAP-Projektionen) mit den zwei Szenarien: **(I) „mit bestehenden Maßnahmen (WEM)“** und **(II) „mit zusätzlichen Maßnahmen (WAM)“**.*

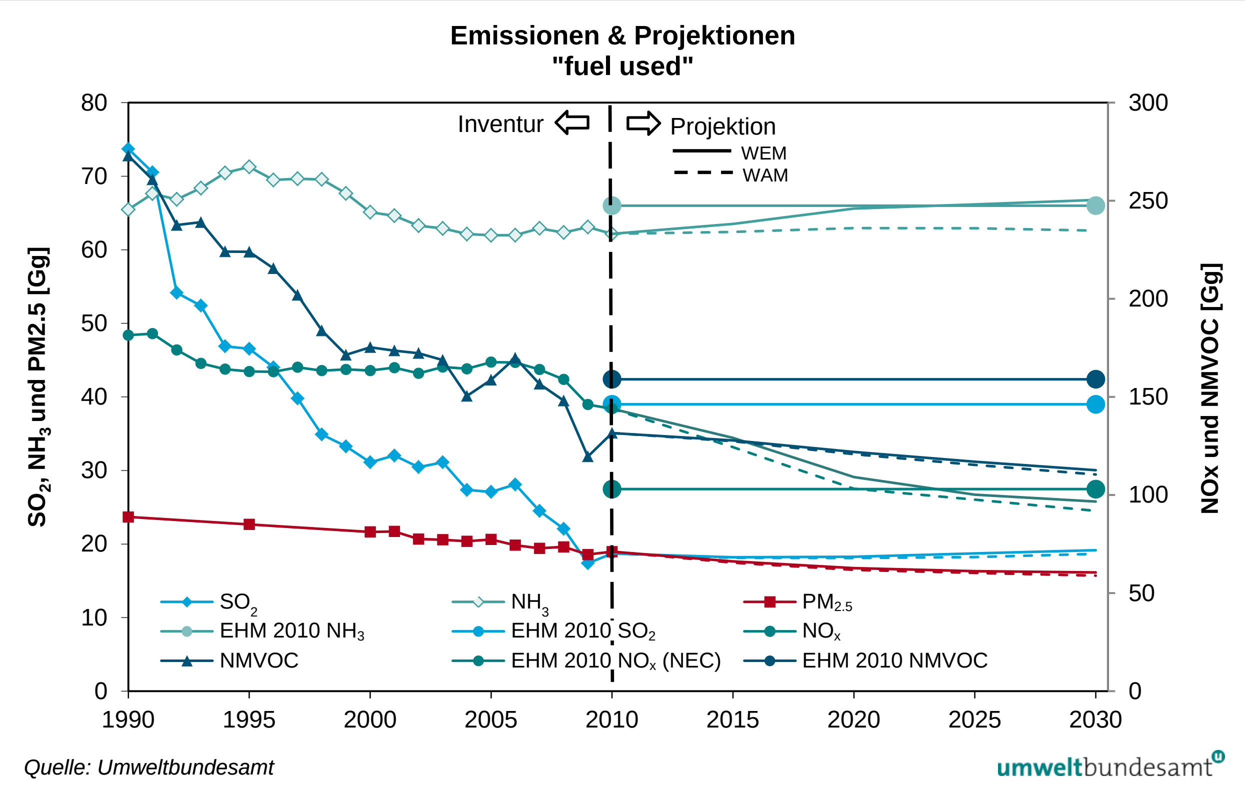

*Abbildung B: Historische (1990–2010) und projizierte Emissionen auf Basis der **verbrauchten Treibstoffmengen** (2015, 2020, 2025 und 2030), mit den zwei Szenarien: **(I) „mit bestehenden Maßnahmen (WEM)“** und **(II) „mit zusätzlichen Maßnahmen (WAM)“** sowie die Ziele (Emissionshöchstmengen, EHM) gemäß NEC-Richtlinie 2001/81/EC.*

NO_x-Trend

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 2010 auf den Straßenverkehr mit 58 % (inklusive Kraftstoffexport im Fahrzeugtank, d. h. auf Basis des verkauften Treibstoffs) bzw. 45 % (exklusive Kraftstoffexport im Fahrzeugtank) entfällt.

In den letzten Jahren ist ein beachtlicher Teil der verkauften Treibstoffmenge im Inland getankt, jedoch im Ausland verfahren worden (preisbedingter Kraftstoffexport im Fahrzeugtank). Dieser hat für die Zielerreichung der NO_X-Emissionen einen maßgeblichen Einfluss. Die nationalen NO_x-Emissionen betrugen 2010 inklusive Kraftstoffexport im Fahrzeugtank 193 kt und ohne Kraftstoffexport im Fahrzeugtank 148 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 45 kt überschritten.

Die Szenarien zeigen eine Reduktion der NO_x-Emissionen um –47 % im Szenario WEM bzw. –50 % im Szenario WAM im Zeitraum 1990–2030. Besonders bei schweren Nutzfahrzeugen (SNF) und Pkw ist dieser Trend deutlich. Erste Messungen deuten darauf hin, dass die wichtigsten Ursachen für diesen Rückgang in der Modernisierung des Fuhrparks in Kombination mit niedrigeren als bisher prognostizierten spezifischen NO_x-Emissionen der neuesten Schadstoffklasse Euro 6 (Pkw) bzw. VI (SNF) begründet sind.[4]

Euro 6 Pkw-Messungen zeigten deutlich geringere NO_x-Emissionswerte als Euro 5-Pkw und ein leicht niedrigeres Niveau als Euro 4-Pkw. Diese kamen aber immer noch über dem ursprünglich vorhergesagten Niveau zu liegen. Dieselben Emissionswerte wurden auch für leichte Nutzfahrzeuge angenommen. Euro VI SNF-Messungen zeigten ebenfalls niedrigere NO_x-Werte als ursprünglich prognostiziert.

Eine weitere Ursache für die Abnahme der NO_x-Emissionen im Straßenverkehr ist der projizierte steigende Anteil von elektrifizierten Fahrzeugen (rein elektrische und Plug-in-Hybrid-Pkw) bis 2030, von denen angenommen wird, dass sie konventionell betriebene Pkw ersetzen werden.

Im WAM-Szenario wirkt die Annahme, dass auch künftig Erhöhungen der Mineralölsteuer vorgenommen werden, am stärksten emissionsmindernd; außerdem führen erwartete Maßnahmen wie beispielsweise eine weitere Spreizung der Mautsätze bei der Lkw-Maut oder geänderte Tempolimits zu niedrigeren Emissionen.

Details zu den Prognosen der einzelnen Maßnahmen können im Bericht „GHG Projections and Assessment of Policies and Measures in Austria. Reporting under Decision 280/2004/EC" (UMWELTBUNDESAMT 2013b) und im Synthesebericht „Energiewirtschaftliche Inputdaten und Szenarien als Grundlage für den Monitoring Mechanisms 2013 und das Klimaschutzgesetz" (UMWELTBUNDESAMT 2013a) nachgelesen werden.

SO_2-Trend

Die in der NEC-Richtlinie festgesetzte Emissionshöchstmenge für SO_2 von 39 kt/a wird in Österreich bereits seit mehreren Jahren unterschritten. Die Reduktion der SO_2-Emissionen ergab sich in der Vergangenheit hauptsächlich durch die Einführung von Emissionsgrenzwerten in der Energieerzeugung und durch die Reduktion des Schwefelgehaltes in Mineralöl-Produkten. In den Projektionsszenarien verringert sich diese Abnahme jedoch kontinuierlich, sodass bis 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.

NMVOC-Trend

Die Hauptquellen der nationalen NMVOC-Emissionen sind der Sektor Lösemittel, der im Jahr 2010 etwa 54 % der Gesamtemissionen verursachte, der Kleinverbrauch mit 25 % und der Straßenverkehr mit 11 % (Datenstand 2013).

[4] Für Details zur aktuellen Projektion von Emissionsfaktoren der einzelnen Euro-Klassen siehe Kapitel 4.4.

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 (–15 % im Szenario WEM und –17 % im Szenario WAM im Zeitraum 2010–2030). 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. Ein leichter Anstieg der Emissionen aus der Verwendung von Lösemitteln bis 2015 ergibt sich aus einem Rebound-Effekt nach der Wirtschaftskrise 2009, der ab 2015 aber wieder abklingt.

NH_3-Trend

Die Hauptquelle der NH_3-Emissionen in Österreich ist der Sektor Landwirtschaft mit einem Anteil von rund 93 % an den Gesamt-NH_3-Emissionen, wobei der Großteil der NH_3-Emissionen beim Güllemanagement anfällt. Seit 1990 ist in diesem Sektor ein leichter Emissionsrückgang (–3 %) zu verzeichnen. Bis 2030 wird im WEM-Szenario mit leicht steigenden NH_3-Emissionen gerechnet.

$PM_{2,5}$-Trend

Die primären $PM_{2,5}$-Emissionen stammen hauptsächlich aus Verbrennungsprozessen von Brenn- und Kraftstoffen. Mit 42 % im Jahr 2010 nimmt der Sektor Kleinverbrauch (1A4) daran den größten Anteil. Hierzu zählen Emissionen aus Heizungsanlagen der Haushalte und Dienstleistungen, aus mobilen Geräten des Kleinverbrauchs (Rasenmäher, Traktoren) sowie von Brauchtumsfeuern und der Verwendung von Grillkohle. Die Reduktion der $PM_{2,5}$-Emissionen erfolgt im Szenario „mit zusätzlichen Maßnahmen" 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 WAM-Szenario in diesem Sektor von 2010 bis 2030 zu einer $PM_{2,5}$-Reduktion um 22 % führen.

Im Sektor Verkehr wird $PM_{2,5}$ aus Motoren, vor allem Dieselmotoren, emittiert; ein großer Teil wird auch durch Brems- und Reifenabrieb und durch Aufwirbelung auf der Straße verursacht. Die Maßnahme, die die Emissionsreduktion im Szenario WAM am stärksten beeinflusst, ist die sukzessive Erhöhung der Mineralölsteuer von Diesel.

Veränderungen im Vergleich zu älteren Projektionen

Der wesentliche Unterschied zu den Projektionen von 2011/2012 ist die unterschiedliche Annahme des Bruttoinlandsprodukts. Für die aktuellen Projektionen wurde ein BIP-Wachstum von 1,5 % anstatt von 2 % angenommen. Dies rührt daher, dass die erwartete Erholung der Wirtschaft seit der Krise im Jahr 2009 langsamer voranschreitet als vermutet. Aus diesem Grund liegen die aktuellen Emissionsprojektionen generell niedriger als 2011/2012. Im Sektor Energieerzeugung sind die Emissionen in der vorliegenden Projektion höher, da die 2012 erwartete Abnahme der Brennstoffe Öl und Kohle nicht eingetroffen ist. Im Verkehrssektor wurde der Euro 5 NO_x-Emissionsfaktor aufgrund neuer Messungen im Jahr 2012 (Update der Emissionsfaktoren des HBEFA 3.1[5]) bei Pkw Diesel, Leichten und Schweren Nutzfahrzeugen nach oben revidiert, was zu höheren NO_x-Emissionen in den aktuellen Projektionen führt.

5 Handbuch Emissionsfaktoren des Straßenverkehrs Version 3.1

1 INTRODUCTION

The last Austrian emission projections for the pollutants sulphur dioxide (SO_2), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC) and ammonia (NH_3) for the scenario "with existing measures" (WEM) were published in 2011 (UMWELTBUNDESAMT 2011a, b). In the year 2012 this existing scenario was extended with the addition of the scenario "with additional measures" (WAM) and for the first time also a projection for $PM_{2.5}$ was made (UMWELTBUNDESAMT 2012C). Planned policies and measures with a realistic chance of being adopted and implemented in time to influence the emissions by 2030 are thus included in the WAM scenario.

This report provides now an update of the emission projections for both scenarios, which are based on the new energy projection (UMWELTBUNDESAMT 2013a).

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 2012 (UMWELTBUNDESAMT 2012c) are included as well.

Legal Background

Upon signing the UNECE Gothenburg Protocol to the Convention on Long-Range Transboundary Air Pollution of 1 December 1999[6], 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 in 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") stipulates national emission ceilings for these air pollutants[7] 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 projections to the Commission. These obligations have been transposed into national law by the Emission Ceilings Act – Air (*Emissionshöchstmengengesetz-Luft)*[8].

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[6] 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

[7] 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

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

2 EMISSIONS

According to Article 15 of the Guidelines[9] 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 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 the NO_X emissions only.

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.

With the planned revision of the NEC Directive for 2013, 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.

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

The following table shows emission ceilings for air pollutants according to the NEC Directive.

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

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

Table 2: Austrian national total emissions for 1990, 2005, 2010 and projected emissions for 2015, 2020, 2025 and 2030 based on (a) ***fuel sold*** *(including fuel export in vehicle tanks) and (b)* ***fuel used*** *(excluding fuel export in vehicle tanks)* ***after implementation of (I) existing policies (with existing measures, WEM)*** *and* ***(II) planned policies for Austria (with additional measures, WAM)*** *(Source: Umweltbundesamt).*

Pollutant	Emission inventory 2012			Projected emissions				Scenarios	
[kt/a]	1990	2005	2010	2015	2020	2025	2030		
NO_x	195.47	237.52	193.16	165.76	130.57	116.56	112.08	WEM	fuel sold
				157.38	119.43	112.65	105.59	WAM	
	181.55	168.96	147.52	129.11	109.14	100.13	96.63	WEM	fuel used
				124.36	103.16	97.68	91.93	WAM	
SO_2	74.45	27.15	18.85	18.25	18.32	18.80	19.23	WEM	fuel sold
				18.16	18.16	18.28	18.72	WAM	
	73.72	27.09	18.81	18.20	18.27	18.74	19.17	WEM	fuel used
				18.11	18.11	18.22	18.66	WAM	
NMVOC	274.74	167.58	136.70	131.60	125.38	120.43	116.32	WEM	fuel sold
				131.09	123.91	118.75	113.86	WAM	
	273.43	159.23	131.76	127.93	122.03	117.02	112.74	WEM	fuel used
				127.49	120.86	115.38	110.55	WAM	
NH_3	65.39	62.72	63.19	63.75	65.79	66.34	66.95	WEM	fuel sold
				62.65	63.13	63.10	62.76	WAM	
	65.37	61.99	62.91	63.58	65.66	66.22	66.84	WEM	fuel used
				62.48	63.01	63.00	62.67	WAM	
$PM_{2,5}$	24.14	22.27	19.76	18.13	17.04	16.59	16.42	WEM	fuel sold
				17.92	16.76	16.35	15.97	WAM	
	23.64	20.56	18.92	17.64	16.73	16.31	16.15	WEM	fuel used
				17.46	16.48	16.08	15.71	WAM	

2.1 Nitrogen Oxides NO_x

In 2010, NO_x emissions amounted to 193 kt, after a significant decrease between 2008 and 2009, caused by the economic crisis. Emissions showed a slight increase from 2009 to 2010 (+ 2.3%). Compared to 1990 levels, NO_x emissions (including fuel export, i.e. based on fuel sold) were about 1.2 % lower in 2010.

When considering inland fuel consumption without 'fuel exports', NO_x emissions amounted to only 148 kt in 2010, i.e. a 19% decrease since 1990.

The main sources of Austrian NO_x emissions in 2010 were fuel combustion activities with a share of more than 96%. Road transport including 'fuel export' contributed the highest share (58%) of total NO_x emissions. Road transport without 'fuel export' accounted for 45% of the national total emissions.

Further sources were the manufacturing industries and the construction industry (17%), fuel combustion in 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 112.1 kt by 2030 (–42%). Without 'fuel export' they are expected to reach 96.6 kt (–35%).
- WAM: National total emissions including 'fuel export' are expected to decrease to 105.6. kt by 2030 (–45%). Without 'fuel export' they are expected to reach 91.9 kt (–38%).

The main driving force of NO_x emissions until 2030 is expected to be road transport. NO_x emissions from heavy duty vehicles and cars are projected to decrease. The main reasons for this decline are the modernisation of the vehicle fleet in combination with low specific emissions from cars and heavy duty vehicles of the latest emission class Euro VI as first measurements were suggesting, which were used in the 2013 scenarios. Euro 6 passenger car measurements showed a significantly lower emission level than Euro V and slightly lower levels than EURO IV, but still above the level originally predicted. These emission levels were also used for light duty vehicles. Heavy duty vehicle measurements of NO_x emissions with the Euro VI standard showed lower values than previously expected. 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) until 2030.

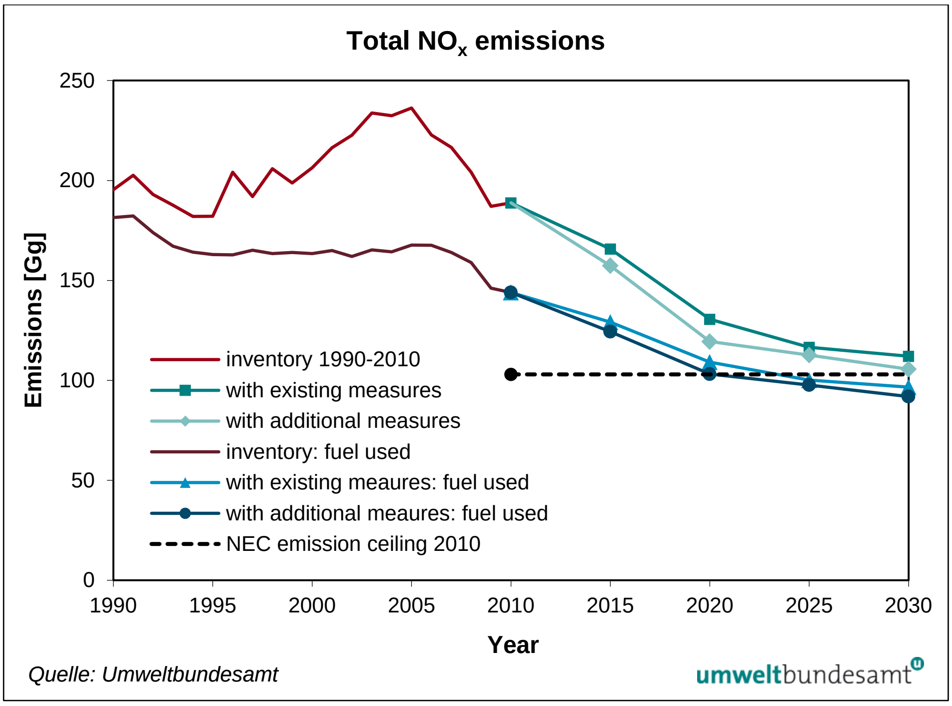


Figure 1: Historical (1990 to 2010) and projected emissions (2015, 2020, 2025 and 2030) of NO_x based on (a) ***fuel sold*** *(including fuel export in vehicle tanks) and (b)* ***fuel used*** *(excluding fuel export in vehicle tanks)* ***after implementation of (I) existing policies (with existing measures, WEM)*** *and* ***(II) planned policies for Austria (with additional measures, WAM)****.*

The calculations of transport emissions in the WAM scenario are based on the same general key factors (GDP, population and economic export data) as in the WEM (with existing measures) scenario. Road transport is the main source of NO_x emissions. A detailed description of the underlying assumptions is provided in a report titled "GHG Projections and Assessment of Policies and Measures in Austria", submitted to the European Commission and the European Environment Agency in 2013 (UMWELTBUNDESAMT 2013b).

*Table 3: Historical (1990, 2005, 2010) and projected emissions (2015, 2020, 2025 and 2030) of NO_x based on **fuel sold** (including fuel export in vehicle tanks) and **fuel used** (excluding fuel export in vehicle tanks) after implementation of **(I) existing policies (with existing measures, WEM)** and **(II) planned policies for Austria (with additional measures, WAM)**.*

NFR	Description	Emission inventory* [kt]			Projections [kt]				Scenarios	
		1990	2005	2010	2015	2020	2025	2030		
	Total	**195.47**	**237.52**	**193.16**	**165.76**	**130.57**	**116.56**	**112.08**	WEM	fuel sold
					157.38	**119.43**	**112.65**	**105.59**	WAM	
		181.55	**168.96**	**147.52**	**129.11**	**109.14**	**100.13**	**96.63**	WEM	fuel used
					124.36	**103.16**	**97.68**	**91.93**	WAM	
1 A	**Fuel Combustion Activities**	184.06	230.07	186.07	158.49	123.28	109.32	104.89	WEM	fuel sold
					150.18	112.22	105.47	98.42	WAM	
		170.14	161.51	140.43	121.84	101.85	92.89	89.44	WEM	fuel used
					117.15	95.95	90.50	84.76	WAM	
1 A 1	**Energy Industries**	17.74	15.39	13.93	14.08	14.10	13.64	12.70	WEM	fuel sold
					14.02	14.43	14.60	13.52	WAM	
1 A 2	**Manufacturing Industries and Construction**	32.97	34.13	32.16	30.86	29.35	29.86	31.51	WEM	fuel sold
					30.64	28.78	28.85	29.60	WAM	
1 A 3 a, c, d, e	**Non-Road transport**	3.30	4.70	4.33	4.49	4.55	4.65	4.78	WEM	fuel sold
					4.52	4.56	4.67	4.79	WAM	
1 A 3 b	**Road Transportation**	102.25	148.94	112.53	88.94	57.41	44.82	40.61	WEM	fuel sold
					81.07	47.00	41.50	35.94	WAM	
		88.33	80.38	66.89	52.30	35.98	28.40	25.17	WEM	fuel used
					48.05	30.73	26.53	22.27	WAM	
1 A 4	**Other Sectors**	27.73	26.82	23.03	20.12	17.87	16.35	15.28	WEM	
					19.92	17.46	15.85	14.58	WAM	
1 A 5	**Other**	0.07	0.09	0.08	0.07	0.08	0.09	0.11	WEM	
					0.07	0.08	0.09	0.11	WAM	
1 B	**Fugitive Emissions from Fuels**	IE	IE	IE	IE	IE	IE	IE	WEM	
					IE	IE	IE	IE	WAM	
2	**Industrial Processes**	4.80	1.75	1.50	1.52	1.53	1.55	1.57	WEM	
					1.52	1.53	1.55	1.57	WAM	
3	**Solvent and Other Product Use**	NA	NA	NA	NA	NA	NA	NA	WEM	
					NA	NA	NA	NA	WAM	
4	**Agriculture**	6.51	5.64	5.59	5.66	5.66	5.58	5.50	WEM	
					5.61	5.58	5.52	5.48	WAM	
4 B	**Manure Manage-Ment**	5.10	4.59	4.64	4.61	4.63	4.64	4.65	WEM	
					4.60	4.62	4.65	4.67	WAM	
4 D	**Agri-Cultural Soils**	1.35	0.99	0.87	1.00	0.97	0.88	0.80	WEM	
					0.95	0.90	0.82	0.76	WAM	
4 F, G	**Field Burning and Other Agriculture**	0.07	0.07	0.07	0.06	0.06	0.05	0.05	WEM	
					0.06	0.06	0.05	0.05	WAM	
6	**Waste**	0.10	0.05	0.01	0.01	0.01	0.01	0.01	WEM	
					0.01	0.01	0.01	0.01	WAM	

** Data source: Austrian Emission Inventory 2012 (Umweltbundesamt 2012a)*

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

Table 4 shows the results of the sensitivity scenarios sens1 and sens2 for NO_x based on the assumptions described in chapter 4.2.1.

*Table 4: Sensitivity analysis with scenarios WEMsens1 and WEMsens2 for projected emissions (2015, 2020, 2025 and 2030) of NO_X based on **fuel sold** (including fuel export in vehicle tanks) and **fuel used** (excluding fuel export in vehicle tanks)*

NFR	Description	Emission inventory* [kt]			Projections [kt]				Scenarios	
		1990	2005	2010	2015	2020	2025	2030		
	Total	**195.47**	**237.52**	**193.16**	**167.99**	**136.07**	**124.65**	**122.16**	WEMsens1	fuel sold
					164.65	**128.21**	**113.70**	**108.10**	WEMsens2	
		181.55	**168.96**	**147.52**	**131.11**	**114.24**	**107.75**	**106.13**	WEMsens1	fuel used
					128.13	**107.04**	**97.59**	**93.04**	WEMsens2	
1 A	**Fuel Combustion Activities**	184.06	230.07	186.07	160.67	128.64	117.18	114.66	WEMsens1	fuel sold
					157.40	120.99	106.57	101.07	WEMsens2	
		170.14	161.51	140.43	123.79	106.81	100.29	98.63	WEMsens1	fuel used
					120.89	99.82	90.45	86.00	WEMsens2	
1 A 1	**Energy Industries**	17.74	15.39	13.93	14.25	15.57	16.01	15.29	WEMsens1	fuel sold
					13.96	13.81	13.70	12.62	WEMsens2	
1 A 2	**Manufacturing Industries and Construction**	32.97	34.13	32.16	31.61	30.97	32.44	35.19	WEMsens1	fuel sold
					30.52	28.65	28.75	29.83	WEMsens2	
1 A 3 a, c, d, e	**Non-Road transport**	3.30	4.70	4.33	4.53	4.68	4.90	5.16	WEMsens1	fuel sold
					4.47	4.48	4.52	4.58	WEMsens2	
1 A 3 b	**Road Transportation**	102.25	148.94	112.53	90.03	59.35	47.20	43.42	WEMsens1	fuel sold
					88.32	56.19	43.30	38.81	WEMsens2	
		88.33	80.38	66.89	53.15	37.53	30.31	27.39	WEMsens1	fuel used
					51.80	35.02	27.18	23.74	WEMsens2	
1 A 4	**Other Sectors**	27.73	26.82	23.03	20.25	18.07	16.63	15.60	WEMsens1	
					20.14	17.87	16.30	15.23	WEMsens2	
1 A 5	**Other**	0.07	0.09	0.08	0.07	0.09	0.11	0.13	WEMsens1	
					0.07	0.08	0.09	0.10	WEMsens2	
1 B	**Fugitive Emissions from Fuels**	IE	IE	IE	IE	IE	IE	IE	WEMsens1	
					IE	IE	IE	IE	WEMsens2	
2	**Industrial Processes**	4.80	1.75	1.50	1.57	1.66	1.76	1.86	WEMsens1	
					1.49	1.47	1.45	1.42	WEMsens2	

2.2 Sulphur Dioxide SO_2

SO_2 emissions have decreased quite steadily since 1990, with a 75% reduction by the year 2010, 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 and the reduction of the sulphur content in mineral oil products.

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

The main sources of SO_2 emissions in Austria are fuel combustion activities (accounting for a share of 92% in 2010). Within this category, the manufacturing industries and construction contribute most of the total SO_2 emissions (56%). Energy industries and Other Sectors have a share of 19% (and 15%, respectively) of the national total emissions.

The scenario "with **existing** measures" (WEM) shows a slight increase in SO_2 emissions, whereas the "with additional measures" (WAM) shows a slight reduction of SO_2 emissions.

- WEM: National total emissions including 'fuel export' are expected to increase to 19.23 kt by 2030 (+2.0%). Without 'fuel export' they are expected to reach 19.17 kt (+1.9).
- WAM: National total emissions including 'fuel export' are expected to decrease to 18.72 kt by 2030 (–0.7%). Without 'fuel export' they are expected to reach 18.66 kt (–0.8%).

Emissions from the manufacturing industries and construction are expected to increase (WEM: +24.6%; WAM: +19.9%), mainly due to increasing GDP projections. By contrast, emissions from the energy industries are expected to decrease (WEM: –18.8%; WAM: –15.7%) and those from Other Sectors are expected to decrease (WEM: –49.2%; WAM: –52.8%) by 2030 due to a shift from fossil fuels to renewable fuels in both categories.

A large part of mitigation measures (e.g. reduction of sulphur content in liquid fuels, waste gas treatment) have already been implemented. Therefore the remaining reduction potential remains small.

*Figure 2: Historical (1990 to 2010) and projected emissions (2015, 2020, 2025 and 2030) of SO_2 based on (a) **fuel sold** (including fuel export in vehicle tanks) and (b) **fuel used** (excluding fuel export in vehicle tanks) **after implementation of (I) existing policies (with existing measures, WEM)** and **(II) planned policies for Austria (with additional measures, WAM)**.*

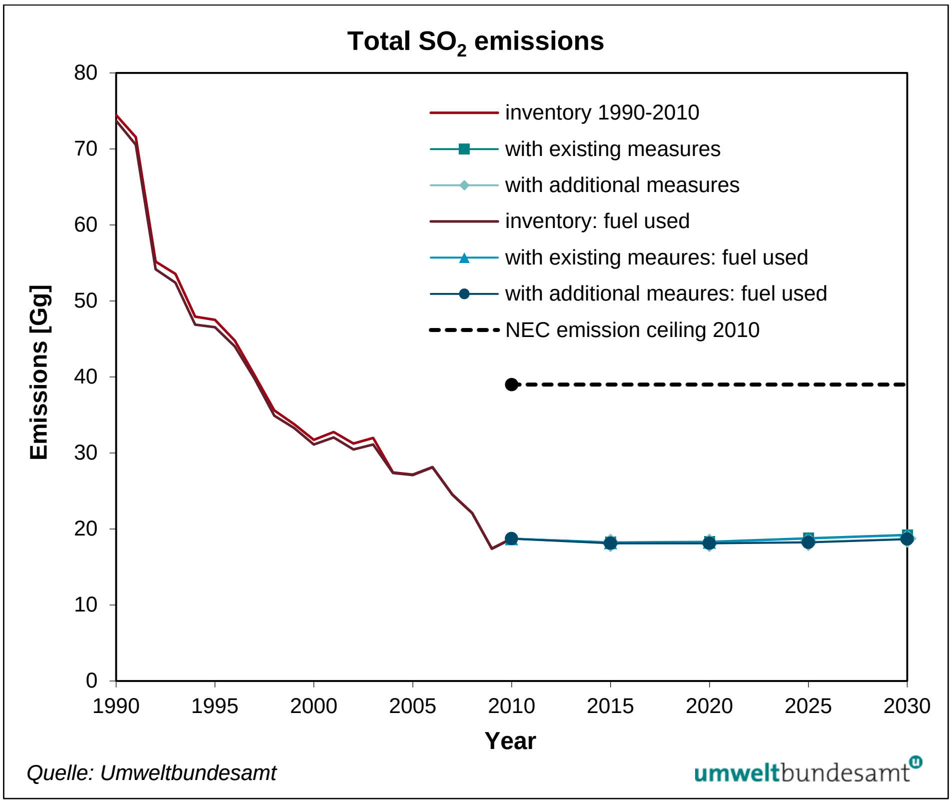


*Table 5: Historical (1990, 2005, 2010) and projected emissions (2015, 2020, 2025 and 2030) of SO_2 based on **fuel sold** (including fuel export in vehicle tanks) and **fuel used** (excluding fuel export in vehicle tanks) after implementation of **(I) existing policies (with existing measures, WEM)** and **(II) planned policies for Austria (with additional measures, WAM)***

NFR	Description	Emission inventory [kt]			Projections [kt]				Scenarios	
		1990	2005	2010	2015	2020	2025	2030		
	Total	**74.45**	**27.15**	**18.85**	**18.25**	**18.32**	**18.80**	**19.23**	WEM	fuel sold
					18.16	**18.16**	**18.28**	**18.72**	WAM	
		73.72	**27.09**	**18.81**	**18.20**	**18.27**	**18.74**	**19.17**	WEM	fuel used
					18.11	**18.11**	**18.22**	**18.66**	WAM	
1 A	**Fuel Combustion Activities**	70.16	25.74	17.40	17.03	17.09	17.56	17.99	WEM	fuel sold
					16.93	16.93	17.04	17.47	WAM	
		69.42	25.68	17.36	16.98	17.03	17.50	17.92	WEM	fuel used
					16.89	16.88	16.99	17.41	WAM	
1 A 1	**Energy Industries**	14.04	6.91	3.55	3.46	3.12	3.02	2.88	WEM	fuel sold
					3.45	3.16	3.12	2.99	WAM	
1 A 2	**Manufacturing Industries and Construction**	17.97	10.65	10.65	10.90	11.62	12.48	13.27	WEM	fuel sold
					10.85	11.47	12.18	12.77	WAM	
1 A 3 a, c, d, e	**Non-Road transport**	0.33	0.17	0.17	0.18	0.19	0.21	0.23	WEM	fuel sold
					0.18	0.19	0.21	0.23	WAM	
1 A 3 b	**Road Transportation**	4.86	0.16	0.13	0.14	0.14	0.14	0.14	WEM	fuel sold
					0.12	0.13	0.13	0.12	WAM	
		4.12	0.10	0.09	0.09	0.08	0.08	0.08	WEM	fuel used
					0.08	0.08	0.07	0.06	WAM	
1 A 4	**Other Sectors**	32.94	7.83	2.88	2.35	2.02	1.71	1.46	WEM	
					2.33	1.98	1.41	1.36	WAM	
1 A 5	**Other**	0.01	0.01	0.01	0.02	0.02	0.02	0.02	WEM	
					0.02	0.02	0.02	0.02	WAM	
1 B	**Fugitive Emissions from Fuels**	2.00	0.13	0.23	0.20	0.21	0.21	0.22	WEM	
					0.20	0.21	0.21	0.22	WAM	
2	**Industrial Processes**	2.22	1.22	1.21	1.00	1.00	1.00	1.00	WEM	
					1.00	1.00	1.00	1.00	WAM	
3	**Solvent and Other Product Use**	NA	NA	NA	NA	NA	NA	NA	WEM	
					NA	NA	NA	NA	WAM	
4	**Agriculture**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	WEM	
					0.00	0.00	0.00	0.00	WAM	
4 B	**Manure Management**	NA	NA	NA	NA	NA	NA	NA	WEM	
					NA	NA	NA	NA	WAM	
4 D	**Agricultural Soils**	NA	NA	NA	NA	NA	NA	NA	WEM	
					NA	NA	NA	NA	WAM	
4 F, G	**Field Burning and Other Agriculture**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	WEM	
					0.00	0.00	0.00	0.00	WAM	
6	**Waste**	0.07	0.06	0.01	0.01	0.01	0.01	0.01	WEM	
					0.01	0.01	0.01	0.01	WAM	

* *Data source: Austrian Emission Inventory 2012 (UMWELTBUNDESAMT 2012a);*

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

2.3 Non-Methane Volatile Organic Compounds (NMVOCs)

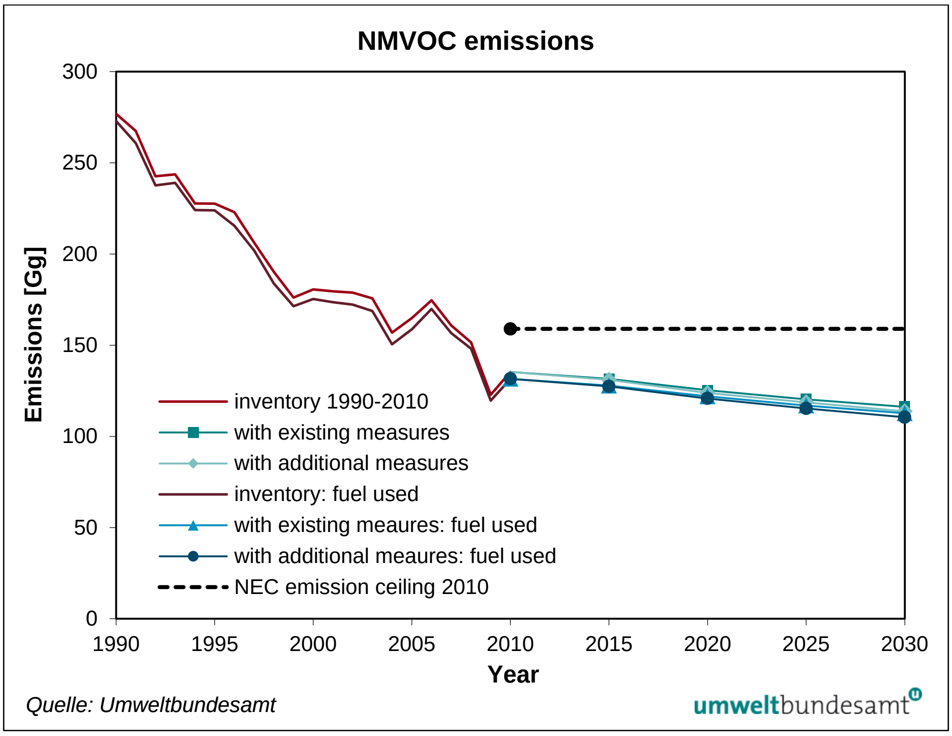
There has been a considerable reduction in emissions of non-methane volatile organic compounds from 1990 to 2010 (– 52%).

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 116 kt by 2030 (–15%). Without 'fuel export' they are expected to reach 113 kt (–14%).
- WAM: National total emissions including 'fuel export' are expected to decrease to 114 kt by 2030 (–17%). Without 'fuel export' they are expected to reach 111 kt (–16%).

The main sources of NMVOC emissions in Austria are Solvent and Other product use with a share of more than 54%, and fuel combustion activities with a share of 37%.

Figure 3: Historical (1990 to 2010) and projected emissions (2015, 2020, 2025 and 2030) of NMVOC based on (a) ***fuel sold*** *(including fuel export in vehicle tanks) and (b)* ***fuel used*** *(excluding fuel export in vehicle tanks)* ***after implementation of (I) existing policies (with existing measures, WEM)*** *and* ***(II) planned policies for Austria (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 emission reductions. In the category Solvent and Other product use emissions are expected to increase until 2015 due to a rebound effect after the 2009 economic crisis. Thereafter, the scenario shows a slight decrease caused by 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 6: *Historical (1990, 2005, 2010) and projected emissions (2015, 2020, 2025 and 2030) of NMVOC based on **fuel sold** (including fuel export in vehicle tanks) and **fuel used** (excluding fuel export in vehicle tanks) **after implementation of (I) existing policies (with existing measures, WEM)** and **(II) planned policies for Austria (with additional measures, WAM)***

NFR	Description	Emission inventory [kt]			Projections [kt]				Scenarios	
		1990	2005	2010	2015	2020	2025	2030		
	Total	**274.74**	**167.58**	**136.70**	**131.60**	**125.38**	**120.43**	**116.32**	WEM	fuel sold
					131.09	**123.91**	**118.75**	**113.86**	WAM	
		273.43	**159.23**	**131.76**	**127.93**	**122.03**	**117.02**	**112.74**	WEM	fuel used
					127.49	**120.86**	**115.38**	**110.55**	WAM	
1 A	**Fuel Combustion Activities**	134.58	68.85	54.08	44.30	40.13	37.34	35.38	WEM	fuel sold
					43.79	38.67	35.65	32.92	WAM	
		133.27	60.51	49.13	40.63	36.78	33.92	31.80	WEM	fuel used
					40.19	35.61	32.29	29.61	WAM	
1 A 1	**Energy Industries**	0.42	0.58	0.89	0.89	0.89	0.89	0.89	WEM	fuel sold
					0.89	0.89	0.89	0.89	WAM	
1 A 2	**Manufacturing Industries and Construction**	1.74	2.19	2.40	2.14	1.94	1.89	1.89	WEM	fuel sold
					2.13	1.94	1.89	1.89	WAM	
1 A 3 a, c, d, e	**Non-Road transport**	1.09	1.14	1.03	1.08	1.08	1.12	1.18	WEM	fuel sold
					1.08	1.08	1.13	1.18	WAM	
1 A 3 b	**Road Transportation**	70.05	26.81	16.03	11.95	10.36	9.77	9.52	WEM	fuel sold
					11.75	9.51	8.99	8.09	WAM	
		68.74	18.47	11.08	8.27	7.02	6.35	5.93	WEM	fuel used
					8.15	6.46	5.62	4.78	WAM	
1 A 4	**Other Sectors**	61.28	38.12	33.72	28.25	25.85	23.66	21.90	WEM	
					27.94	25.25	22.75	20.87	WAM	
1 A 5	**Other**	0.01	0.02	0.02	0.02	0.02	0.02	0.02	WEM	
					0.02	0.02	0.02	0.02	WAM	
1 B	**Fugitive Emissions from Fuels**	12.62	2.86	2.00	2.15	2.22	2.22	2.21	WEM	
					2.15	2.22	2.22	2.21	WAM	
2	**Industrial Processes**	11.10	4.71	4.69	4.69	4.69	4.69	4.69	WEM	
					4.69	4.69	4.69	4.69	WAM	
3	**Solvent and Other Product Use**	114.43	89.20	74.09	78.66	76.57	74.48	72.39	WEM	
					78.66	76.57	74.48	72.39	WAM	
4	**Agriculture**	1.85	1.86	1.78	1.73	1.72	1.66	1.60	WEM	
					1.73	1.72	1.66	1.60	WAM	
4 B	**Manure Management**	NA	NA	NA	NA	NA	NA	NA	WEM	
					NA	NA	NA	NA	WAM	
4 D	**Agricultural Soils**	NA	NA	NA	NA	NA	NA	NA	WEM	
					NA	NA	NA	NA	WAM	
4 F, G	**Field Burning and Other Agriculture**	1.85	1.86	1.78	1.73	1.72	1.66	1.60	WEM	
					1.73	1.72	1.66	1.60	WAM	
6	**Waste**	0.16	0.09	0.06	0.04	0.03	0.02	0.02	WEM	
					0.04	0.03	0.02	0.02	WAM	

* *Data source: Austrian Emission Inventory 2012 (UMWELTBUNDESAMT 2012a);*

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

2.4 Ammonia (NH_3)

Emissions of NH_3 have slightly decreased since 1990 (–3.4%). The main source of ammonia is the agricultural sector, contributing 93% of the total NH_3 emissions in 2010.

The scenario "with **existing** measures" (WEM) shows a slight increase, whereas the scenario "with additional measures" (WAM) shows a slight reduction in NH_3 emissions.

- WEM: National total emissions including 'fuel export' are expected to increase to 67 kt by 2030 (+5.9%). Without 'fuel export' they are expected to reach 66.8 kt (+6.2%).
- WAM: National total emissions including 'fuel export' are expected to decrease to 62.8 kt by 2030 (–0.7%). Without 'fuel export' they are expected to reach 62.7 kt –0.4%).

Agricultural NH_3 emissions result from animal husbandry, the storage of manure as well as the application of organic manure. The emission trend closely follows the development of livestock in Austria, so NH_3 emissions from agriculture are expected to show a stable trend in line with the stable livestock numbers. The increased number of cattle in loose housing systems (to comply with animal welfare regulations) partly counterbalances the reduction effects of additional abatement measures (such as the increased use of covered slurry tanks or compulsory use of highly efficient fertiliser application techniques).

Figure 4: Historical (1990 to 2010) and projected emissions (2015, 2020, 2025 and 2030) of NH_3 based on (a) ***fuel sold*** *(including fuel export in vehicle tanks) and (b)* ***fuel used*** *(excluding fuel export in vehicle tanks)* ***after implementation of (I) existing policies (with existing measures, WEM)*** *and* ***(II) planned policies for Austria (with additional measures, WAM)****.*

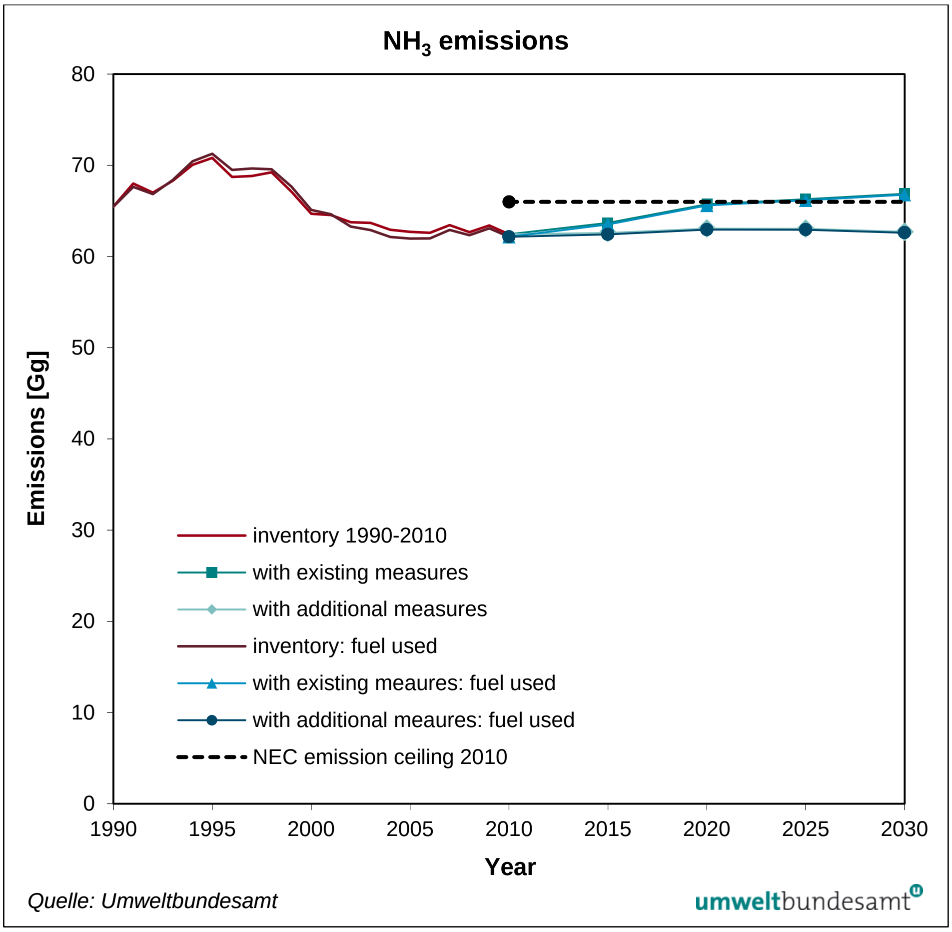


*Table 7: Historical (1990, 2005, 2010) and projected emissions (2015, 2020, 2025 and 2030) of NH_3 based on **fuel sold** (including fuel export in vehicle tanks) and **fuel used** (excluding fuel export in vehicle tanks) **after implementation of (I) existing policies (with existing measures, WEM)** and **(II) planned policies for Austria (with additional measures, WAM)***

NFR	Description	Emission inventory [kt]			Projections [kt]				Scenarios	
		1990	2005	2010	2015	2020	2025	2030		
	Total	**65.39**	**62.72**	**63.19**	**63.75**	**65.79**	**66.34**	**66.95**	WEM	fuel sold
					62.65	**63.13**	**63.10**	**62.76**	WAM	
		65.37	**61.99**	**62.91**	**63.58**	**65.66**	**66.22**	**66.84**	WEM	fuel used
					62.48	**63.01**	**63.00**	**62.67**	WAM	
1 A	**Fuel Combustion Activities**	4.05	4.50	2.88	2.35	2.14	2.02	1.94	WEM	fuel sold
					2.32	2.07	1.95	1.84	WAM	
		4.04	3.77	2.60	2.18	2.00	1.90	1.83	WEM	fuel used
					2.16	1.95	1.85	1.74	WAM	
1 A 1	**Energy Industries**	0.20	0.33	0.50	0.50	0.50	0.50	0.50	WEM	fuel sold
					0.50	0.50	0.50	0.50	WAM	
1 A 2	**Manufacturing Industries and Construction**	0.35	0.44	0.43	0.43	0.43	0.43	0.43	WEM	fuel sold
					0.43	0.43	0.43	0.43	WAM	
1 A 3 a, c, d, e	**Non-Road transport**	0.01	0.01	0.01	0.01	0.01	0.01	0.01	WEM	fuel sold
					0.01	0.01	0.01	0.01	WAM	
1 A 3 b	**Road Transportation**	2.87	3.02	1.24	0.77	0.58	0.49	0.43	WEM	fuel sold
					0.75	0.53	0.44	0.36	WAM	
		2.86	2.28	0.96	0.60	0.44	0.37	0.32	WEM	fuel used
					0.59	0.41	0.33	0.26	WAM	
1 A 4	**Other Sectors**	0.63	0.71	0.69	0.64	0.62	0.59	0.57	WEM	
					0.63	0.60	0.57	0.54	WAM	
1 A 5	**Other**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	WEM	
					0.00	0.00	0.00	0.00	WAM	
1 B	**Fugitive Emissions from Fuels**	IE	IE	IE	IE	IE	IE	IE	WEM	
					IE	IE	IE	IE	WAM	
2	**Industrial Processes**	0.27	0.07	0.09	0.09	0.09	0.09	0.09	WEM	
					0.09	0.09	0.09	0.09	WAM	
3	**Solvent and Other Product Use**	NA	NA	NA	NA	NA	NA	NA	WEM	
					NA	NA	NA	NA	WAM	
4	**Agriculture**	60.70	56.86	58.83	59.99	62.28	62.97	63.68	WEM	
					58.91	59.68	59.80	59.60	WAM	
4 B	**Manure Management**	55.12	51.63	53.08	54.63	57.05	58.09	59.15	WEM	
					53.71	55.12	55.53	55.92	WAM	
4 D	**Agricultural Soils**	5.12	4.68	5.13	4.85	4.73	4.40	4.08	WEM	
					4.69	4.07	3.80	3.23	WAM	
4 F, G	**Field Burning and Other Agriculture**	0.47	0.54	0.62	0.51	0.50	0.48	0.45	WEM	
					0.51	0.50	0.48	0.45	WAM	
6	**Waste**	0.36	1.29	1.39	1.32	1.28	1.26	1.24	WEM	
					1.32	1.28	1.26	1.24	WAM	

** Data source: Austrian Emission Inventory 2012 (UMWELTBUNDESAMT 2012a);*
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 24.1 kt in 1990 and have decreased steadily ever since: From 1990 to 2010, emissions (with 'fuel export') decreased by 18% to 19.8 kt. Emissions from fuel used amounted to 23.6 kt in 1990 and decreased to 18.9 kt in 2010 (–20%). $PM_{2.5}$ emissions in Austria in 2010 mainly arose from combustion activities in the energy sector, account for a share of 83% of the national total emissions.

The scenarios "with **existing** measures" (WEM) and "with additional measures" (WAM) show reductions in NH_3 emissions.

- WEM: National total emissions including 'fuel export' are expected to decrease to 16.4 kt by 2030 (–16.9%). Without 'fuel export' they are expected to reach 16.2 kt (–14.7%).
- WAM: National total emissions including 'fuel export' are expected to decrease to 16.0 kt by 2030 (–19.2%). Without 'fuel export' they are expected to reach 15.7 kt (–17.0%).

Emissions of fine particulate matter result to a large extent from power plants with flue gas cleaning systems, which use filters to capture the larger particles. The reduction of $PM_{2.5}$ emissions is generally due to the installation of flue gas collection and modern flue gas cleaning technologies in several sectors.

The sub-category 1A4 Other Sectors is the largest source of $PM_{2.5}$, accounting for a share of 42% of the national total emissions.

- In the WEM scenario, the $PM_{2.5}$ emissions in this sub category are expected to decrease by 18.3% by 2030.
- In the WAM scenario, the $PM_{2.5}$ emissions in this sub category are expected to decrease by 21.5% by 2030.

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 the increased efficiency of buildings and heating systems and to a trend away from manually fed log boilers. A decreasing energy demand for solid fuel (log wood, coal) is also responsible for the PM2.5 reduction in the Other Sectors sub-category. The main assumptions in the WAM scenario include a faster speed of renovation and a reduced demand for energy in the sub-sectors 'residential and commercial'

The sub-category Road Transport has a share of 20%. The largest source within this category is automobile road abrasion, which is expected to increase slightly by 2030.

- WEM: Total $PM_{2.5}$ emissions of the sub-category Road Transport (including 'fuel export') are expected to decrease by about 54%. Without 'fuel export' they are expected to decrease by about 50%.
- WAM: Total $PM_{2.5}$ emissions of the sub-category Road Transport are expected to decrease by about 56%. Without 'fuel exports' they are expected to decrease by about 53%.The main reason for the further decrease in emissions in the WAM scenario is the slightly reduced transport demand due to an expected increase in the Austrian fuel tax.

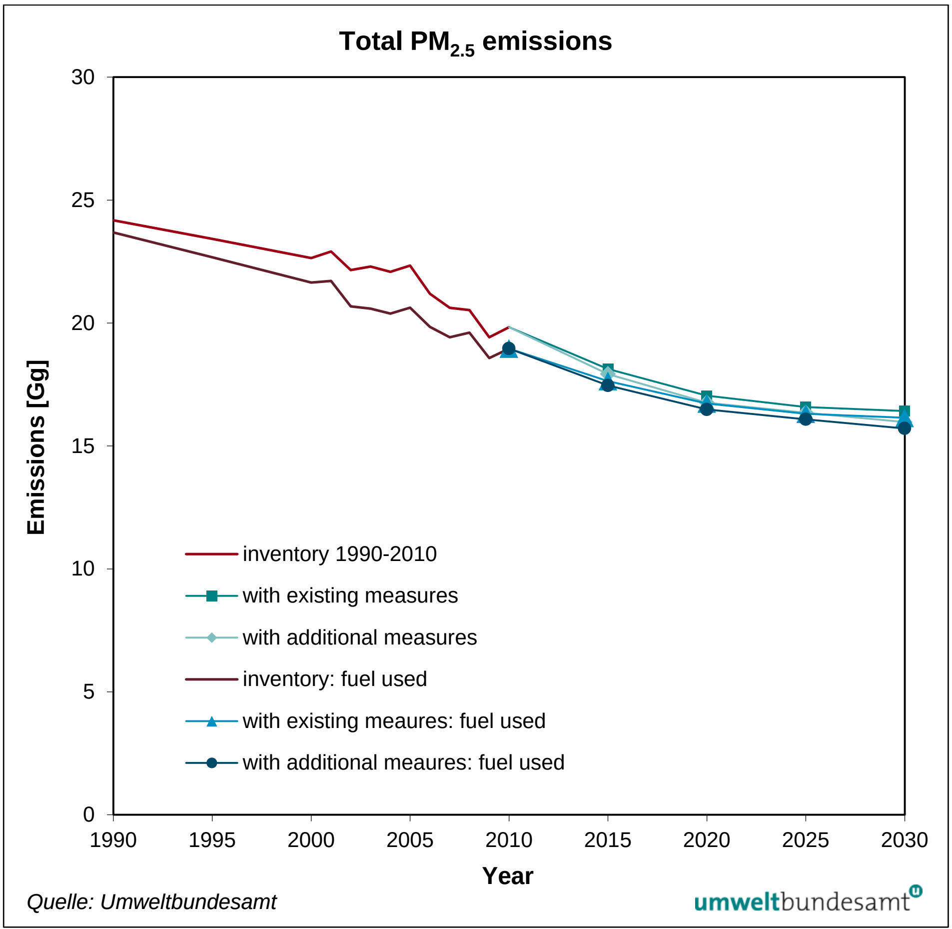


Figure 5: Historical (1990 to 2010) and projected emissions (2015, 2020, 2025 and 2030) of $PM_{2.5}$ based on (a) ***fuel sold*** *(including fuel export in vehicle tanks) and (b)* ***fuel used*** *(excluding fuel export in vehicle tanks) after implementation of* ***(I) existing policies (with existing measures, WEM)*** *and* ***(II) planned policies for Austria (with additional measures, WAM)****.*

*Table 8: Historical (1990, 2005, 2010) and projected emissions (2015, 2020, 2025 and 2030) of $PM_{2.5}$ based on **fuel sold** (including fuel export in vehicle tanks) and **fuel used** (excluding fuel export in vehicle tanks) after implementation of **(I) existing policies (with existing measures, WEM)** and **(II) planned policies for Austria (with additional measures, WAM)**.*

NFR	Description	Emission inventory* [kt] 1990	2005	2010	Projections [kt] 2015	2020	2025	2030	Scenarios	
	Total	**24.14**	**22.27**	**19.76**	**18.13**	**17.04**	**16.59**	**16.42**	WEM	fuel sold
					17.92	**16.76**	**16.35**	**15.97**	WAM	
		23.64	**20.56**	**18.92**	**17.64**	**16.73**	**16.31**	**16.15**	WEM	fuel used
					17.46	**16.48**	**16.08**	**15.71**	WAM	
1 A	**Fuel Combustion Activities**	18.97	18.56	16.55	14.89	13.75	13.27	13.04	WEM	fuel sold
					14.68	13.48	13.05	12.61	WAM	
		18.48	16.85	15.70	14.39	13.44	12.99	12.76	WEM	fuel used
					14.22	13.20	12.78	12.35	WAM	
1 A 1	**Energy Industries**	0.83	0.85	1.26	1.32	1.34	1.26	1.11	WEM	fuel sold
					1.32	1.40	1.41	1.27	WAM	
1 A 2	**Manufacturing Industries and Construction**	2.06	2.27	2.60	2.44	2.47	2.64	2.90	WEM	fuel sold
					2.42	2.40	2.50	2.65	WAM	
1 A 3 a, c, d, e	**Non-Road transport**	0.72	0.55	0.45	0.58	0.54	0.51	0.49	WEM	fuel sold
					0.59	0.54	0.52	0.49	WAM	
1 A 3 b	**Road Transportation**	3.69	6.01	4.00	2.68	2.05	1.87	1.84	WEM	fuel sold
					2.57	1.92	1.83	1.75	WAM	
		3.19	4.29	3.16	2.19	1.74	1.60	1.56	WEM	fuel used
					2.11	1.64	1.56	1.49	WAM	
1 A 4	**Other Sectors**	11.65	8.87	8.21	7.86	7.35	6.98	6.71	WEM	
					7.78	7.21	6.79	6.45	WAM	
1 A 5	**Other**	0.02	0.02	0.02	0.02	0.02	0.02	0.02	WEM	
					0.02	0.02	0.02	0.02	WAM	
1 B	**Fugitive Emissions from Fuels**	0.10	0.09	0.07	0.07	0.06	0.07	0.07	WEM	
					0.07	0.06	0.06	0.07	WAM	
2	**Industrial Processes**	3.24	1.83	1.38	1.49	1.55	1.61	1.72	WEM	
					1.49	1.54	1.60	1.70	WAM	
3	**Solvent and Other Product Use**	0.41	0.44	0.44	0.45	0.46	0.47	0.48	WEM	
					0.45	0.46	0.47	0.48	WAM	
4	**Agriculture**	1.40	1.32	1.29	1.19	1.17	1.13	1.08	WEM	
					1.19	1.17	1.13	1.08	WAM	
4 B	**Manure Management**	IE	IE	IE	IE	IE	IE	IE	WEM	
					IE	IE	IE	IE	WAM	
4 D	**Agricultural Soils**	1.14	1.11	1.09	0.99	0.98	0.93	0.88	WEM	
					0.99	0.98	0.93	0.88	WAM	
4 F, G	**Field Burning and Other Agriculture**	0.26	0.21	0.20	0.20	0.20	0.20	0.19	WEM	
					0.19	0.19	0.19	0.19	WAM	
6	**Waste**	0.02	0.03	0.03	0.03	0.03	0.03	0.03	WEM	
					0.03	0.03	0.03	0.03	WAM	

** Data source: Austrian Emission Inventory 2012 (Umweltbundesamt 2012a);*
IE … included elsewhere; NA … not applicable; NO … not occurring

Table 9 shows the results of the sensitivity scenarios 1 and 2 for $PM_{2.5}$ based on the assumptions described in chapter 4.2.1.

*Table 9: Sensitivity analysis with scenarios WEMsens1 and WEMsens2 for projected emissions (2015, 2020, 2025 and 2030) of $PM_{2.5}$ based on **fuel sold** (including fuel export in vehicle tanks) and **fuel used** (excluding fuel export in vehicle tanks)*

NFR	Description	Emission inventory* [kt]			Projections [kt]				Scenarios	
		1990	2005	2010	2015	2020	2025	2030		
	Total	**24.14**	**22.27**	**19.76**	**18.34**	**17.44**	**17.20**	**17.34**	WEMsens1	fuel sold
					18.09	**16.91**	**16.34**	**15.94**	WEMsens2	
		23.64	**20.56**	**18.92**	**17.84**	**17.13**	**16.92**	**17.06**	WEMsens1	fuel used
					17.60	**16.60**	**16.07**	**15.67**	WEMsens2	
1 A	**Fuel Combustion Activities**	18.97	18.56	16.55	15.06	14.11	13.82	13.79	WEMsens1	fuel sold
					14.86	13.63	13.05	12.67	WEMsens2	
		18.48	16.85	15.70	14.56	13.79	13.54	13.51	WEMsens1	fuel used
					14.36	13.33	12.78	12.40	WEMsens2	
1 A 1	**Energy Industries**	0.83	0.85	1.26	1.32	1.34	1.27	1.11	WEMsens1	fuel sold
					1.32	1.34	1.26	1.11	WEMsens2	
1 A 2	**Manufacturing Industries and Construction**	2.06	2.27	2.60	2.51	2.64	2.92	3.33	WEMsens1	fuel sold
					2.42	2.39	2.50	2.67	WEMsens2	
1 A 3 a, c, d, e	**Non-Road transport**	0.72	0.55	0.45	0.59	0.56	0.53	0.52	WEMsens1	fuel sold
					0.58	0.53	0.50	0.47	WEMsens2	
1 A 3 b	**Road Transportation**	3.69	6.01	4.00	2.72	2.13	1.98	1.98	WEMsens1	fuel sold
					2.66	2.00	1.80	1.74	WEMsens2	
		3.19	4.29	3.16	2.22	1.81	1.70	1.70	WEMsens1	fuel used
					2.16	1.69	1.53	1.48	WEMsens2	
1 A 4	**Other Sectors**	11.65	8.87	8.21	7.92	7.44	7.11	6.85	WEMsens1	
					7.88	7.37	6.99	6.68	WEMsens2	
1 A 5	**Other**	0.02	0.02	0.02	0.02	0.02	0.02	0.02	WEMsens1	
					0.02	0.02	0.02	0.02	WEMsens2	
1 B	**Fugitive Emissions from Fuels**	0.10	0.09	0.07	0.07	0.07	0.07	0.07	WEMsens1	
					0.06	0.06	0.06	0.06	WEMsens2	
2	**Industrial Processes**	3.24	1.83	1.38	1.52	1.59	1.67	1.87	WEMsens1	
					1.48	1.53	1.59	1.61	WEMsens2	

3 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 (AEA 2013), ERNSTL (TU WIEN 2013) and GLOBEMI & GEORG (TU GRAZ 2013).

Projections for agriculture were calculated by the Austrian Institute of Economic Research (SINABELL ET AL. 2011a) in cooperation with Umweltbundesamt. Projections for solvents und waste were modelled by Umweltbundesamt.

A detailed description of the models is provided in a report titled "GHG Projections and Assessment of Policies and Measures in Austria", submitted to the European Commission and the European Environment Agency in (UMWELTBUNDESAMT 2013b).

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 10: Main data sources for activity data and emission values (Source: Umweltbundesamt).

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), ERNSTL (Vienna University of Technology) as well as GLOBEMI & 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	Umweltbundesamt
Agriculture	Austrian Institute of Economic Research (agriculture model PASMA) (SINABELL et al. 2011a). Expert judgement by (ALFRED PÖLLINGER 2013).	Umweltbundesamt
Waste	Historical values: Landfill database, EDM (solid waste deposited) Projected values: expert judgement on future amounts of solid waste expected to be disposed of at landfills (based on recent and expected developments)	Umweltbundesamt

4 METHODOLOGY

4.1 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 transformed 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 transformed into the NFR format.

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 meetings of experts where overlaps and possible gaps were discussed.

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.

Emissions from energy-related sectors (NFR 1.A) are calculated on the basis of energy scenarios 2013 (UMWELTBUNDESAMT 2013a).

4.2 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 11. Further assumptions about key input parameters can be found in UMWELTBUNDESAMT (2013b).

Table 11: Key input parameters for emission projections (Umweltbundesamt, 2013b).

Parameters/Year	2010	2015	2020	2025	2030
GDP [billion € 2010]	286	312	340	372	410
Population [1 000]	8 382	8 555	8 733	8 889	9 034
Stock of dwellings [1 000]	3 683	3 820	3 957	4 069	4 166
Heating degree days	3 241	3 166	3 100	3 053	3 006
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

4.2.1 Sensitivity of Underlying Assumptions

The sensitivity assessment analyses the increasing and decreasing levels of key factors, or of a combination of key factors. It is based on the influence of economic growth on GHG emissions from Transport, the Energy Industries and the Manufacturing Industries and Construction, as well as on the influence of changes in fuel prices and subsidies on GHG emissions in the Residential and Commercial sector.

All these assessments are based on model results, obtained by calculating the effects on the Energy sector. It is important to mention that the emission results in general are not linearly dependent on the changes of an input factor. This is the reason why the presented sensitivity data cannot be seen as a functional dependency with varying parameters. The emission effect can only be seen for the specific values of the given parameters.

For the Energy sector two complete scenarios were calculated with different assumptions about economic growth and energy prices:

- WEMsens1 and
- WEMsens2.

The input main variables are summarised in Table 12. Average economic growth was assumed to be 2.5 % per year in WEMsens 1 and 0.8 % per year in WEMsens2.

Table 12: Basic parameters for sensitivity analysis modelling (UMWELTBUNDESAMT, 2013b)

Parameter WEMsens1	**2010**	**2015**	**2020**	**2025**	**2030**
GDP [bn. € 2010]	286	329	379	438	510
International coal prices [US$10/t]	99.2	105	112	121	131
International oil price [US$/bbl]	78.1	124	163	215	284
International oil price [US$10/bbl]	78.1	111	130	153	180
International natural gas price [US$10/GJ]	7.1	9.6	11.5	13.6	16.1
CO_2 certificate price [€/t CO_2]	13	17	30	35	40
Parameter WEMsens2	**2010**	**2015**	**2020**	**2025**	**2030**
GDP [bn € 2010]	286	302	318	336	356
International coal prices [US$10/t]	99.2	104	107	109	110
International oil price [US$/bbl]	78.1	112	136	159	184
International oil price [US$10/bbl]	78.1	100	108	113	117
International natural gas price [US$10/GJ]	7.1	9.0	9.9	10.1	10.2
CO_2 certificate price [€/t CO_2]	13	13	15	17	20

The following figures show the sensitivity scenarios sens1 and sens2 of the WEM scenarios, on the basis of fuel sold and fuel used, for the air pollutants NO_x and $PM_{2.5}$. The data tables for the sensitivity scenarios are presented separately in sections 2.1 and 2.5

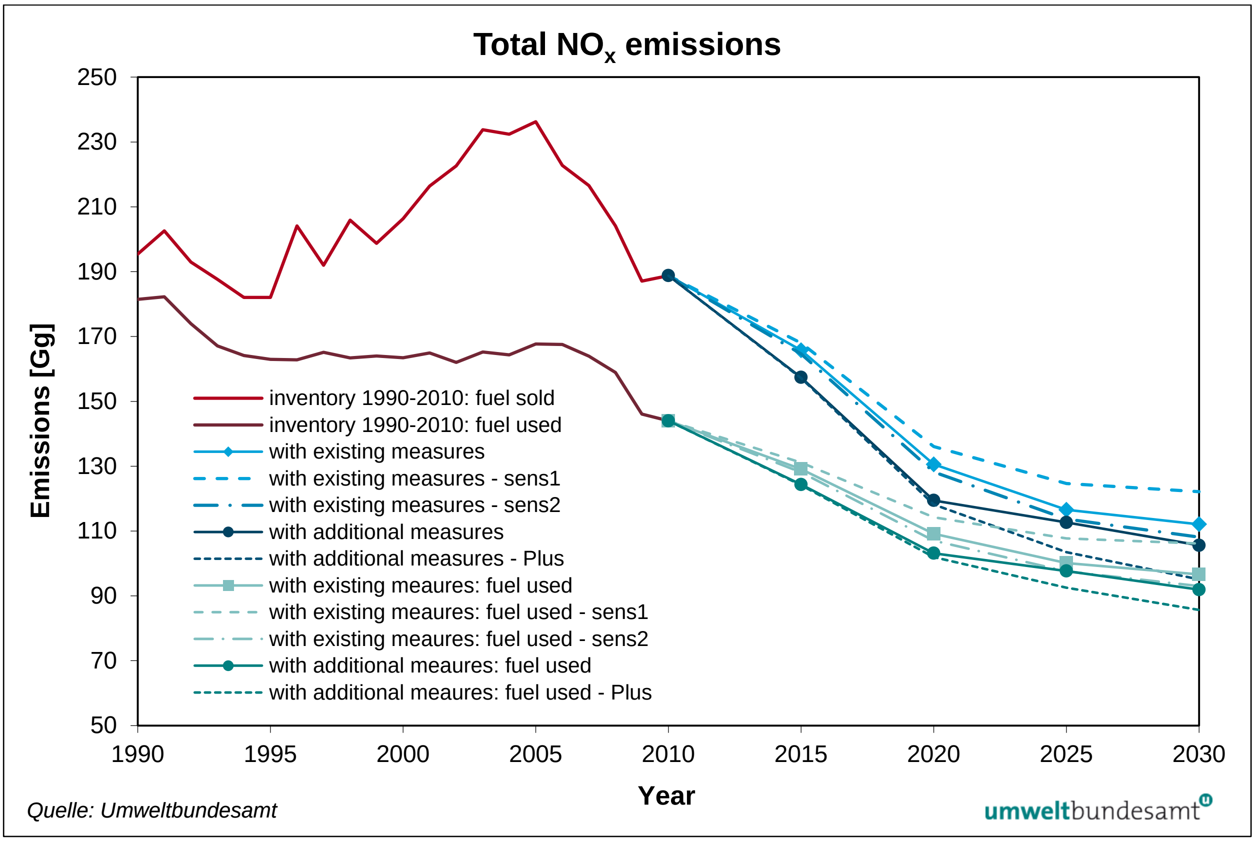


Figure 6: Sensitivity analysis for NO_x for scenarios WEM 'fuel sold' and WEM 'fuel used'

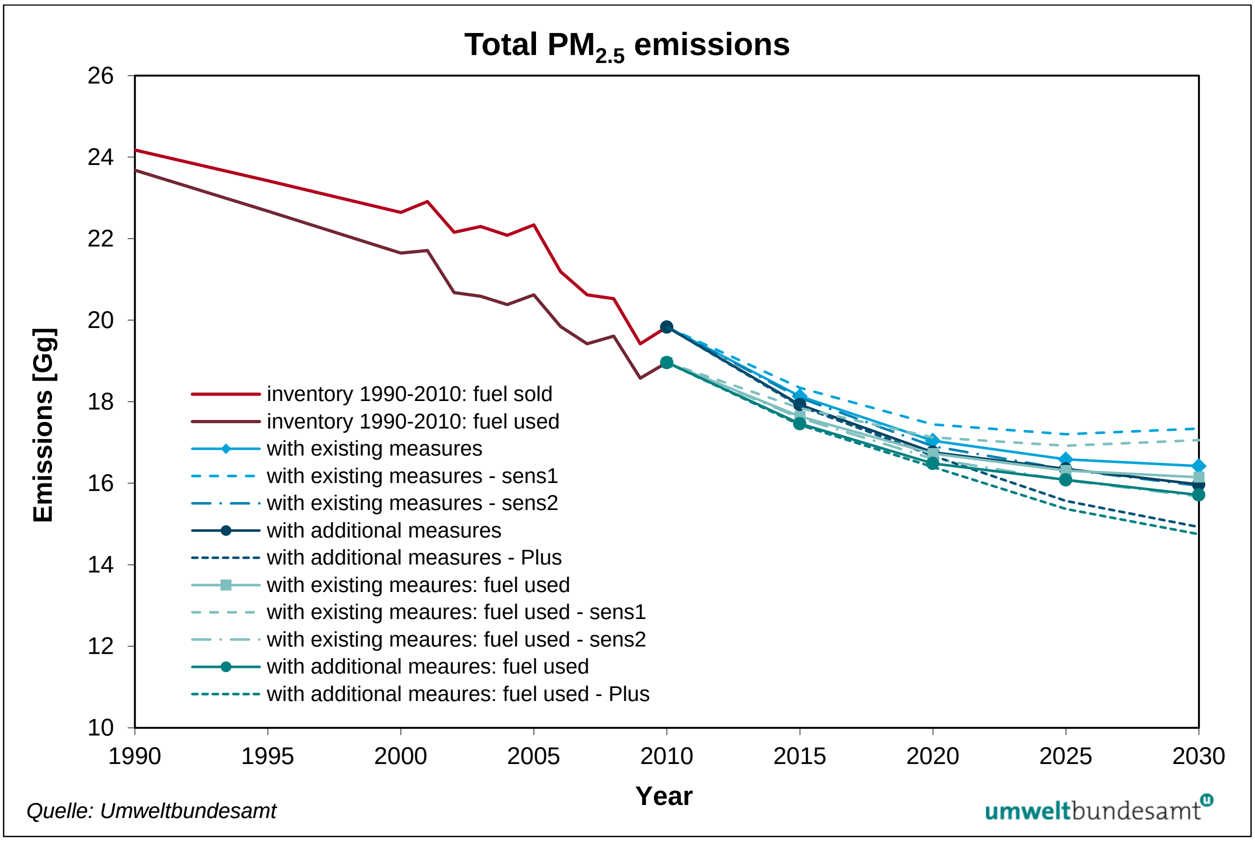


Figure 7: Sensitivity analysis for $PM_{2.5}$ for scenarios WEM 'fuel sold' and WEM 'fuel used'

4.3 Stationary Fuel Combustion Activities (NFR 1 A)

Total energy demand and production were 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 2013a). 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, public power and district heating supply (TIMES Austria) and
- energy demand and emissions of transport (GLOBEMI & GEORG).

In addition, several parameters were calculated endogenously, e.g. pipeline compressors and industrial auto-producers.

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 adapted especially for Austria. For the calculation of the electricity demand it combines a bottom-up approach (which includes the used devices and the characteristics thereof in several sub-sectors) for households with a top-down approach (development and trend in energy intensity and gross value added) for industry, the service sector and agriculture. For transport and heating the results of different models have been used (AEA 2013).

For projecting the production of electricity and district heating the same model (TIMES Austria) has been used. It is based on the available capacities for all types of power plants which it combines with energy prices and the demand for electricity and district heating (taken from the model INVERT/EE-Lab). Subsidies (e.g. granted under the Green Electricity Act) and fees (like emission allowances) are also important input parameters (AEA 2013).

For modelling the energy consumed for domestic heating and domestic hot water supply, the software package INVERT/EE-Lab[10] (TU WIEN 2013) 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.

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 2012a). The data on energy demand have been split up into the sub-sectors of the Austrian air emission inventory.

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

4.3.1 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 2013a) 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.

As regards the only refinery operated in Austria, an SNOX plant, installed in November 2007, has significantly reduced 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).

NMVOC and NH_3

NMVOC and NH_3 emissions are assumed to remain constant at 2010 levels (UMWELTBUNDESAMT 2012a). This simple approach has been chosen because their share in the total emissions is less than 1%.

4.3.2 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 4.4.1.

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 2013a) and by incorporating recent data from environmental impact statements on facility expansions and the opening and closing down of facilities.

NMVOC and NH_3

The NMVOC and NH_3 emissions from stationary sources are assumed to remain constant at 2010 levels (UMWELTBUNDESAMT 2012a). This simple approach has been 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 2013a) 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, the historical trends of the past have been extrapolated.

NFR 1 A 2 f i Other Mobile 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 2012a) with projected fuel consumption.

4.3.3 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 4.4.

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 2013). The input for the sector agriculture comes from the macro-economic model DEIO. A detailed description of these models can be found in UMWELTBUNDESAMT 2013a, TU WIEN 2013 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 comprehensive description of the methods and emission factors used for these calculations can be found in the Austrian Informative Inventory Report (UMWELTBUNDESAMT 2012a).

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).

In Table 13 the NO_x and $PM_{2.5}$ emission factors used in the projections are listed as examples. NO_x emission factors are assumed to be decreasing for natural gas and heating oil in central and apartment heating systems (due to an increased use of condensing boiler technology), whereas solid biomass emission factors remain constant. Likewise, emission factors for stoves are assumed to remain constant over the whole projected period. $PM_{2.5}$ emission factors are supposed to remain constant as well.

Table 13: NO_x emission factors for natural gas, heating oil and solid biomass in central heating, apartment heating and stoves

in kg/TJ	2010	2015	2020	2025	2030
Central heating					
Natural gas	31.4	29.9	28.3	26.7	25.1
Heating oil	32.7	31.3	29.9	28.4	27.0
Solid biomass	107	107	107	107	107
Apartment heating					
Natural gas	30.1	28.6	27.1	25.6	24.1
Heating oil	35.3	34.1	32.9	31.7	30.5
Solid biomass	107	107	107	107	107
Stoves					
Natural gas	51	51	51	51	51
Heating oil	55	55	55	55	55
Solid biomass	106	106	106	106	106

Table 14: $PM_{2.5}$ emission factors for 'wood waste and other' and pellets in central heating, apartment heating and stoves

in kg/TJ	2010	2015	2020	2025	2030
Central heating					
Wood waste and other	50	50	50	50	50
Pellets	24	24	24	24	24
Apartment heating					
Wood waste and other	81	81	81	81	81
Pellets	24	24	24	24	24
Stoves					
Wood waste and other	133	133	133	133	133
Pellets	24	24	24	24	24

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 2010 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 2012a) with projected fuel consumption.

4.4 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 f, 1 A 4 and 1 A 5.

A detailed description of individual measures included in the WEM and the WAM scenario is provided in a report titled "GHG Projections and Assessment of Policies and Measures in Austria", submitted to the European Commission and the European Environment Agency in 2013 (UMWELTBUNDESAMT 2013b).

4.4.1 Road and Off-road Transport (1A3b-d, 1A2f, 1A4b-c, 1A5)

The calculation of transport emissions is based on different models. The following input parameters are used for road/off-road emission projections:

- **GLOBEMI – Emission model road (NFR *1 A 3 b*)**
  For the calculation of road emissions the GLOBEMI model is used (HAUSBERGER 1998, HAUSBERGER & SCHWINGSHACKL 2012). GLOBEMI has been developed for the calculation of emission inventories in larger areas. Input parameters are, amongst others, the vehicle stock of each category (cars, light duty vehicles, …) split into layers according to the propulsion system (SI, CI, …), engine volume or vehicle mass, the emission factors for the vehicles according to the year of their first registration, and the number of passengers per vehicle and tonnes of payload per vehicle. The model also delivers an assumption regarding the fuel export effect.
- **GEORG – Emission model off-road (NFR 1 A 2 f, 1 A 3 c, 1 A 3 d, 1 A 4 b, 1 A 4 c, 1 A 5)**
  The energy consumption and off-road emissions in Austria are calculated with the GEORG model (**G**razer **E**missionsmodell für **O**ff **R**oad **G**eräte) (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 next year). With this approach, the stock of each category of mobile sources is calculated

based on the year of the vehicle's first registration and the propulsion system (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 2012a). 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 2010 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 2010 emissions and projected fuel consumption.
  Aviation operations: $PM_{2.5}$ emissions from military aviation operations have been extrapolated by means of 2010 emissions.
  Soil abrasion: This category includes emissions from soil abrasion of military mobile machinery. Projected $PM_{2.5}$ emissions have been estimated by means of correlating historical $PM_{2.5}$ emissions from soil abrasion and fuel consumption (UMWELTBUNDESAMT 2012a) with projected fuel consumption.

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 for the two most important vehicle types across the different EURO classifications. The following table includes the NO_x emission factors for Diesel Heavy Duty Vehicles and Diesel Passenger Cars with regard to their **motor performance (in g/kWh)**. The Real Driving Provisions have been considered for all emission factors for the underlying test cycles.

Table 15: NO_x emission factors for diesel HDVs (heavy duty vehicles)

in g/kWh	EURO 0	EURO I	EURO II	EURO III	EURO IV	EURO V	EURO VI
2011	12.78	9.99	10.84	8.39	6.43	4.16	NO
2015	12.65	9.90	10.76	8.33	6.39	4.15	0.64
2020	13.64	10.47	10.72	8.31	6.38	4.15	0.64
2025	13.30	10.66	11.09	8.28	6.37	4.13	0.64
2030	13.22	11.52	11.18	8.48	6.34	4.12	0.64

Table 16: NO_x emission factors for diesel passenger cars

in g/kWh	EURO 0	EURO 1	EURO 2	EURO 3	EURO 4	EURO 4 DPF[11]	EURO 5	EURO 6
2011	3.66	3.45	4.29	4.12	3.15	3.10	4.00	NO
2015	3.64	3.42	4.26	4.08	3.10	3.05	4.09	1.90
2020	3.63	3.44	4.26	4.10	3.11	3.07	4.12	2.03
2025	3.70	3.45	4.27	4.10	3.12	3.08	4.15	2.18
2030	3.72	3.45	4.28	4.11	3.13	3.08	4.15	2.33

[11] Diesel particulate filter

4.4.2 Aviation (NFR 1 A 3 a)

The projected energy consumption in the aviation sector up to 2030 is based on a 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 CRF sectors in Austria (WIFO 2013).

$PM_{2.5}$ emissions have been extrapolated on the basis of 2010 emissions and projected fuel consumption. To separate LTO and cruise emissions, the split into LTO and cruise emissions of 2010 has been used.

4.4.3 Other Transportation – Pipeline Compressors (NFR 1 A 3 e)

The projected energy demand for pipeline transport up to 2030 is based on expert judgments and historical trends.

4.5 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 2006–2010, as well as on projected activity data such as natural gas and crude oil exploration, and natural gas and gasoline consumption according to (WIFO 2013). The pipeline length has been extrapolated by the average yearly growth rate between 2000 and 2010.

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 2012 (UMWELTBUNDESAMT 2012a).

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 extrapolated on the basis of 2010 emissions and projected coal consumption (WIFO 2013).

4.6 Industrial Processes (NFR 2)

The forecast for developments in industrial production has been based on macro-economic data from the sub-sectors (UMWELTBUNDESAMT2013C), taking into account known predictions about expansions in iron and steel production, the opening of new installations and the decommissioning of old facilities for sulphuric acid production.

NO_x emissions from 2 D 1 Pulp and Paper are reported together with energy-related emissions under 1 A 2 f Other.

SO_2, NO_x and $PM_{2.5}$

The methodology used for calculating SO_2, NO_x and $PM_{2.5}$ is described in Chapter 4.3.2.

NMVOC and NH_3

NMVOC and NH_3 emissions are assumed to remain constant at the levels of 2008 (UMWELTBUNDESAMT 2012a). This simple approach has been chosen because their share in the total emissions is less than 3%.

4.7 Solvent and Other Product Use (NFR 3)

NMVOCs

The basis for NMVOC emission projections for 2011 to 2030 is the Austrian Air Emission Inventory submitted in 2012 which covers emissions up to 2010. The basis for the data of the Austrian Air Emission Inventory has been provided by surveys (Windsperger et al. 2002a, 2002b, 2004; Windsperger & Schmid-Stejskal 2008) as well as import-export statistics (foreign trade balance) and production statistics provided by 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. 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.

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 2010. The trend between 2000 and 2010 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 it cannot be assumed that the drastic reduction that occurred in the years before 2010 continues. It is further assumed that the error/deviation introduced by keeping the values constant is comparatively small to the total associated uncertainty. 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 spilt up into the specific SNAP categories.

The share of each SNAP category in the total Solvent Activity was taken from the Austrian Air Emission Inventory. For the years 2011 to 2030 it was assumed that these shares would remain constant and thus the SNAP category shares for 2005 (the last year for which data from studies were available, Windsperger et al. 2002b, Windsperger et al. 2004) were applied for these years. Then the Solvent Activity per category was multiplied by the respective emission factors to obtain the NMVOC emissions per SNAP category. Again, it was assumed that the emission factors would stay constant for the years 2011 to 2030 and the emission factors for 2005 (the last year for which data from studies were available, Windsperger et al. 2002b, Windsperger et al. 2004, Windsperger et al. 2008) were applied for these years. The positive impact of law enforcement in Austria is expected to be only minimal in subsequent years. 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. The SNAP categories were summed up within the sectors presented in this report.

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 (2010; submission 2012) by the projected number of inhabitants (population) in Austria in 2030 (provided by Statistics Austria).

The basis for the emission factor (data 2010, Austrian Air Emission Inventory 2012) comes from a survey (WINIWARTER, W. et. al. 2007).

4.8 Agriculture (NFR 4)

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 ($PM_{2.5}$).

4.8.1 Methodology

Emissions are calculated on the basis of the methodology used for the Austrian Air Emission Inventory. A comprehensive description can be found in Austria's Informative Inventory Report 2013 (UMWELTBUNDESAMT 2012a).

Activity data

The projected activity data included in the WEM scenario are a result of calculations carried out within the Positive Agricultural Sector Model Austria (PASMA), developed by the Austrian Institute of Economic Research (WIFO) (SINABELL et al. 2011a). The model maximises sectoral farm welfare and is calibrated on the basis of historical crop, forestry, livestock, and farm tourism activities by 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.

In the WAM scenario several policy measures have been considered endogenously, e.g. increased efficiency of mineral fertiliser application, specific treatment options for manure storage and application etc. The measures are consistent with those considered in the 2013 WAM scenario for greenhouse gases.

Economic assumptions

Several assumptions (basically about input prices) were made to run the model outlined above. Prices were derived from OECD-FAO outlooks on agricultural markets (OECD-FAO 2010). Other exogenous economic assumptions about Austria (like the GDP or population size) are not explicitly essential for the model used in this analysis because the partial equilibrium model of the agricultural sector mainly depends on the prices of outputs and inputs. Since the Austrian agriculture is an integral part of the common market, carry-over effects from European demand patterns are noticeable and determine the results.

Technological progress

Assumptions about technical progress in plant and animal production are based on (SINABELL & SCHMID 2005). However, estimates of increasing milk yields per dairy cow have been somewhat lowered according to the estimates discussed during an expert panel meeting in January 2011.

The use of mineral fertilisers is calculated in two ways: First the consumption of urea is given, exogenously based on a linear trend of past observations. Then the level of input of all other nutrients is determined by a model based on nutrient balances.

4.8.2 Policy Measures

A large number of different policies and measures have been considered for both scenarios for the projections of the agriculture sector. More detailed descriptions can be found in ANNEX 2: Agriculture Policies and measures of this report.

WEM Agricultural measures:

- Common Agricultural Policy (CAP)
- Fulfilling cross compliance requirements
- Programme for rural development 2007-2013
  (followed by the Programme for rural development 2014-2020)
- Modulation of direct payments

WAM Agricultural measures:

- Promotion of grazing for cows
- Decoupling of premiums for suckling cows
- Adapted feeding (in phases) for pigs
- Covers for slurry stores
- Band spreading of liquid manure
- ÖPUL (Austrian Agri-environmental Programme) measures that lead to a reduction in the use of mineral fertilisers
- Short-rotation areas
- Sustainable N management
- Organic farming

4.8.3 Emission Calculation

Emissions are calculated on the basis of the methodology used for the Austrian Air Emission Inventory. A comprehensive description can be found in Austria's Informative Inventory Report 2012 (UMWELTBUNDESAMT 2012a).

N Excretion Values

The feed intake parameters applied here are the same as those applied in the National Air Emission Inventory (UMWELTBUNDESAMT 2012a). Austria-specific N excretion values for dairy cows have been calculated on the basis of projected milk yields.

Animal Waste Management Systems

The projected animal waste management system (AWMS) distribution corresponds to the AWMS data used in the 2011 inventory. The data is based on a comprehensive investigation of Austria's agricultural practices in 2005 (AMON et al. 2007).

A comprehensive description of the methodologies used for emission calculations can be found in 'Austria's Informative Inventory Report 2012' (UMWELTBUNDESAMT 2012a).

Tie Stall Housing Systems (cattle)

It is assumed that, in order to comply with provisions on animal welfare, the share of cattle kept in tie stall housing systems will be reduced to 30% in 2020, 25% in 2025 and 20% in 2030 (exceptions based on expert judgement by OFNER-SCHRÖCK & PÖLLINGER 2013). The same assumption has been used for both scenarios. The steadily rising share of loose housing systems results in an increase in emissions of ammonia.

$PM_{2.5}$ Emissions from Field Operations

Emissions of particulate matter from field operations are linked to the usage of machines on agricultural soils. They are considered together with the treated areas. For the projections, the same emission factors have been used as those in the Austria's Air Emission Inventory (UMWELTBUNDESAMT 2013).

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) (SINABELL et al. 2011a).

PM Emissions from Bulk Material Handling

Because this source is of minor importance, $PM_{2.5}$ emissions have been extrapolated from 2011 inventory values.

Particle Emissions from Animal Husbandry

Particle emissions from this source are primarily associated with the manipulation of forage, and a smaller part arises from dispersed excrements and litter. Wet vegetation and mineral particles of soil are assumed to be negligible, so 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 2012a).

4.9 Waste (NFR 6)

NMVOCs and NH_3 from Waste Disposal

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 methane amounts. 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 National Inventory Report (UMWELTBUNDESAMT 2012b).

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 of waste, which is currently in preparation). As provided for 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 2013b).

NO_x, SO_2, NMVOC and NH_3 from Waste Incineration

Because of the small contribution of these pollutants to the national total emissions (below 1%), the 2010 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 2012 (UMWELTBUNDESAMT 2012a).

NH_3 Emissions from Mechanical-biological Treatment and Composting of Waste

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 in the annual inventory (UMWELTBUNDESAMT 2012a, UMWELTBUNDESAMT 2012b).

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.

With regard to the amount of waste undergoing mechanical-biological treatment (MBT) in Austria it is assumed that activities will decline due to the closing down and reconstruction of MBT plants triggered by a planned MBT Ordinance. Activity data projections have been made after a detailed analysis of existing MBT plants and expected plant-specific ranges of input amounts, based on the assumption that the MBT ordinance will enter into force in 2014 with a transitional period until the end of 2019.

Table 17: forecast (2015– 2030) activity data for compost production.

[kt]	2015	2020	2025	2030
Biowaste and green waste	2 987	3 035	3 077	3 117
Mechanical biological treatment (MBT)	451	361	301	241

$PM_{2.5}$

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 the one used for the Austrian Air Emission Inventory). For the projection of waste amounts, differentiated assumptions have been made about single fractions: Metallurgic waste (clinker, dusts, etc.) and mineral waste are assumed to increase/decrease in accordance with the respective projected gross value added in the respective economic sector (ÖNACE 27 Manufacture of basic metals, ÖNACE 45 Construction). For the projection of residues from thermal treatment and combustion plants, projected energy data (waste as fuel) have been used as indicator (UMWELTBUNDESAMT 2013a). For all other wastes historical values have been used (for extrapolation).

5 RELATION AND CHANGES TO PREVIOUSLY REPORTED DATA

This chapter describes changes to Austria's National Air Emission Projections submitted to the European Commission under Directive 2001/81/EC (NEC Directive) in 2011 for the WEM scenario (UMWELTBUNDESAMT 2011a, b) and in the 2012 submission for the WAM scenario (UMWELTBUNDESAMT 2012c). The figures presented in this report replace data reported previously by Austria under the NEC Directive of the European Union.

Emission projections of some sources have been recalculated on the basis of updated projections of activity data and emission factors. Methodological changes such as recalculations in the Austrian inventory are described on a sectoral basis in the sections below. These changes have also led to recalculations of the emission projections, as the methods are applied consistently for the calculation of historical and forecast emissions. Projections of activity data are in line with the "with existing measures" and "with additional measures" scenarios of Austria's updated GHG projections reported under Decision 280/2004/EC (UMWELTBUNDESAMT 2013b).

For some small sources, where emissions are considered to remain constant until 2030 (see chapter 4), projected emissions have been updated on the basis of emissions for the year 2010 (UMWELTBUNDESAMT 2012a).

As can be seen in Table 18, projections for the national total have considerably changed in the case of NO_x, NMVOC, SO_2 and NH_3 show minor changes in the national total. Especially the NO_x emissions of sector 1 A 2 have been revised downwards due to the slower economic recovery. Changes to assumptions for the transport sector 1 A 3 have led to projected NO_x emissions which are lower as well. An increasing trend towards fuel switching in sector 1 A 4 (from heating oil to renewables, mainly biomass) has also led to projected NO_x emission reductions.

Table 18: Changes in the National Total of NO_x, NMVOC, SO_2, NH_3 in the WEM scenario compared to the previous submission

National Total			
in kt	2015	2020	2030
NO_x	5,61	1.00	–9.81
NMVOC	0.90	1.31	0.31
SO_2	0.41	0.13	–0.58
NH_3	1.90	3.79	5.47

5.1 Energy – Stationary fuel combustion

The calculation of emission projections for the energy sectors is based on the energy scenarios described in Austria's submission to the Monitoring Mechanism (UMWELTBUNDESAMT 2013b).

The main difference in the basic assumptions is that the average GDP growth used in the 2011 projections was 2 % per year. For the 2013 projections the average GDP growth has been estimated at 1.5 % per year. Higher international energy prices lead to less energy demand and thus emissions are significantly lower in the current projections. Furthermore, the trend towards fuel mix with low-emission fuels has become more widespread.

1 A 1 – Energy Industries

For the calculations for the WEM scenario 2011 an immediate reduction of coal and oil inputs in power plants had been assumed, which could not be supported by data in the previous emissions inventory. Thus, the 2010 emissions levels in the current scenario (13.9 kt to 12.0 kt) are significantly higher and this trend is apparent over the whole projected period.

The current scenario takes the provisions of the Green Electricity Act and its targets until 2020 into account. This leads to an increase in biomass capacities by 200 MW. Hence, the decline in NO_x emissions is less pronounced (and happening later) than in the 2011 scenario.

As regards refineries, emissions rise and fall depending on the performance of the SNOX plant. In the 2011 scenario performance was based on operator estimates, whereas for the current scenario it is based on activity data, resulting in slightly higher emissions.

Therefore, the projected NO_x and SO_2 emissions in sector 1 A 1 tend to be higher compared to the 2011 projections (Table 19).

Table 19: Major changes in the WEM scenario compared to the previous submission for sector 1 A 1 Energy Industries

1 A 1 – Energy industries			
in kt	**2015**	**2020**	**2030**
NO_x	2.82	4.18	3.21
SO_2	1.39	1.25	1.21

1 A 2 – Manufacturing Industries and Construction & 2 – Industrial Processes

The economic recovery after the crisis in 2009 was overestimated in the 2011 scenario. The latest emissions inventory shows much lower emissions for the year 2010 than estimated in the 2011 scenario (e.g. a change from 3.8 kt to 2.8 kt for the cement industry). In the magnesia industry, emission projections are based on data from 2004 in the 2011 scenario. They have been updated using the latest figures of the inventory. These updates, together with lower economic growth assumptions, result in new projections for NO_x emissions which are remarkably lower.

The average emission factor for natural gas of industrial sector was applied to the food industry in the 2011 scenario, whereas the specific inventory factor was used for the 2013 scenario.

Table 20: Major changes in the WEM scenario compared to the previous submission for sector 1 A 2 Manufacturing Industries and Construction

1 A 2 – Manufacturing Industries and Construction			
in kt	**2015**	**2020**	**2030**
NO_x	–4.10	–7.79	–12.44
NMVOC	–1.12	–1.38	–1.62
SO_2	–0.66	–0.87	–1.59

1 A 4 – Other Sectors

Compared to other sectors, the changes due to recalculations are relatively small in this sector. Especially the activity data (energy consumption) for the most recent inventory years (serving as a basis for the projections and model calibration) show a declining trend for heating oil in comparison to the last submission, which results in slightly lower emission projections for NO_x.

Furthermore, higher international oil prices have triggered a more distinctive trend towards renewables (in particular biomass) consumption, which has slightly increased NMVOC and $PM_{2.5}$ emission projections in comparison to the last projection.

The method used for emission calculations and the emission factors have both remained unchanged.

Table 21: Major changes in the WEM scenario compared to the previous submission for sector 1 A 4 Other Sectors

1 A 4 – Other Sectors			
in kt	**2015**	**2020**	**2030**
NO_x	–0.26	–0.99	–2.36
NMVOC	2.77	2.79	1.61

5.2 Energy – Mobile fuel combustion

1A3bi – Road Transport Passenger Cars

In the 2013 scenario the NO_x emission factor for Euro 5 passenger cars had to be revised upwards following measurements by the University of Technology Graz (TU Graz) within the framework of updating emission factors of HBEFA 3.1 (Hausberger & Rexeis 2012).

Depending on the traffic situation, Euro 5 NO_x emissions are now up to 27% higher than Euro 4 compared to the previous submission. Latest measurements for the Euro 6 NO_x emission factor for diesel passenger cars have also been incorporated in the current calculations (Hausberger & Rexeis 2012). The measurements for Euro 6 show a significantly lower emission level than Euro 5 and slightly lower levels than Euro 4, but emissions are still above the level originally predicted. These revisions explain why the NO_x emissions are higher in the 2013 submission.

The update of HBEFA 3.1. has also resulted in updated emission factors for the other air pollutants. NMVOC emissions for example are lower because of an overestimate in the previous submission (HAUSBERGER & REXEIS 2012).

1 A 3 b i R.T. Passenger cars			
in kt	**2015**	**2020**	**2030**
NO_x	6,21	6.17	4.86
NMVOC	–0.60	–0.37	–0.36

Table 22: Major changes in the WEM scenario compared to the previous submission for sector 1 A 3 b i Road transport passenger cars

1A3biii – R.T. Heavy Duty Vehicles

The latest available measurements of heavy duty vehicles for the Euro V standard within the update of HBEFA 3.1 have necessitated an increase in the NO_x emission factor by 44% for the current calculations. For Euro VI trucks, however, NO_x emissions have been lower than previously expected (–36% vs. previous emission factors for Euro VI) (HAUSBERGER & REXEIS 2012). Emissions for 2015 in the current scenario are thus slightly higher compared to the last submission, and are assumed to decrease more and more until 2030 as the share of Euro VI heavy duty vehicles is expected to increase.

The update of HBEFA 3.1. has also resulted in updated emission factors for the other air pollutants. NMVOC emissions for example are lower because of an overestimate in the previous submission (HAUSBERGER & REXEIS 2012).

1 A 3 b iii R.T. Heavy duty vehicles			
in kt	**2015**	**2020**	**2030**
NO_x	1.44	0.08	–1.27
NMVOC	–0.50	–0.40	–0.37

Table 23: Major changes in the WEM scenario compared to the previous submission for sector 1 A 3 b iii Road transport heavy duty vehicles

Mobile off-road sources (1A2f2 – industry and 1A4c2 – agriculture)

In the 2013 scenario the new emission standard Stage 4 for off-road machinery (mobile sources) was taken into account for the first time. Based on a study recently completed by the TU Graz, measurements of the current real Stage 3b emissions levels are approximately in the range of the limit values. Thus, NO_x emissions of Stage 3b are already much lower than with Stage 3a. Compliance with the Stage 4 limits that will be valid from 2014 onwards (bringing NO_x emissions down from minus 80% to minus 87% compared with Stage 3b, depending on the machine size class) appears quite possible. This explains why the calculated emissions are lower than in the last submission.

Using the Stage 4 emission standard also has an impact on other off-road machines and mobile sources in the sub-sectors households, agriculture and forestry.

Other Transportation – Pipeline Compressors (NFR 1 A 3 e)

In the 2011 scenario, projections were based on expansion plans provided by plant operators. These plans have not been realised to date and are unlikely to be realised at all. Thus, the current projections are based on historical trends.

5.3 Solvents

Projections for NMVOC and $PM_{2.5}$ emissions from Solvent and Other Product Use have not been updated since the submission of the Austria's National Air Emission Projection in 2012 (UMWELTBUNDESAMT 2012c), as no significant changes have occurred with respect to the input data.

5.4 Agriculture

Projected activity data of the WEM scenario are a result of calculations carried out within the Positive Agricultural Sector Model Austria (PASMA), developed by the Austrian Institute of Economic Research (WIFO) (SINABELL et al. 2011a). Data are the same as those used in the projection reports 2011 and 2012.

In the WAM scenario several additional policy measures have been considered endogenously, e.g. an increased efficiency of mineral fertiliser application, specific treatment options for manure storage and application etc. The measures are consistent with those considered in the 2013 WAM scenario for greenhouse gases (Umweltbundesamt 2013b).

Based on expert judgement (OFNER-SCHRÖCK & PÖLLINGER 2013) the share of cattle kept in tie stall housing systems is expected to be reduced to 30% in 2020, to 25% in 2025 and to 20% in 2030. The increased share of loose housing systems results in higher ammonia emissions in both scenarios (see the following table).

Table 24: Major changes in the WEM scenario compared to the previous submission for sector 4 B Animal husbandry and manure

4 B Animal husbandry and manure			
in kt	**2015**	**2020**	**2030**
NH_3	2.05	3.76	5.50

5.5 Waste

Revisions with respect to the projections submitted in 2011 have been carried out for:

6 A – Waste Disposal on Land:

- revised assumptions about the future development of residues/stabilised waste from mechanical-biological treatment plants.

6 D – Other Waste:

- revised (historical) activity data.
- revised assumptions on future amounts of waste undergoing a mechanical-biological treatment (MBT).

However, these small changes did not lead to any significant differences from the previous submission.

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ANNEX 1: NATIONAL PROJECTION ACTIVITY DATA

Table 25: Assumptions on general economic parameters (Source: Umweltbundesamt).

	Unit	2010	2015	2020	2030
1. Gross Domestic Product	Value (billion €)	286.40	311.92	339.84	352.17
2. Population	Thousand people	8 382	8 555	8 733	9 034
3. International coal prices	€ (2010) / boe	15.21	16.37	17.06	18.14
4. International oil prices	€ (2010) / boe	58.85	81.77	90.85	103.46
5. International gas prices	€ (2010) / boe	31.38	41.00	46.02	52.72

Table 26: Assumptions for the energy sector – with existing measures (Source: Umweltbundesamt).

	Unit	2010	2015	2020	2030
Total gross inland consumption*					
1. – Oil (fossil)	Petajoule (PJ)	549	561	562	570
2. – Gas (fossil)	Petajoule (PJ)	347	309	316	360
3. – Coal	Petajoule (PJ)	141	136	131	141
4. – Biomass without liquid biofuels (e.g. wood)	Petajoule (PJ)	223	230	247	245
5. – Liquid biofuels (e.g. bio-oils)	Petajoule (PJ)	IE	IE	IE	IE
6. – Solar	Petajoule (PJ)	6	9	13	18
7. – Other renewable (wind, geothermal etc)	Petajoule (PJ)	148	165	183	196
Total electricity production by fuel type*					
8. – Oil (fossil)	GWh	1 274	1 089	1 021	1 074
9. – Gas (fossil)	GWh	14 348	10 786	11 474	15 747
10. – Coal	GWh	6 703	6 442	5 469	5 740
11. – Renewable	GWh	45 132	49 994	55 584	57 564

* *Fossil waste is not included in this table*

Table 27: Assumptions for the energy sector – with additional measures (Source: Umweltbundesamt).

	Unit	2010	2015	2020	2030
Total gross inland consumption*					
1. – Oil (fossil)	Petajoule (PJ)	549	532	518	522
2. – Gas (fossil)	Petajoule (PJ)	347	305	303	323
3. – Coal	Petajoule (PJ)	141	137	131	139
4. – Biomass without liquid biofuels (e.g. wood)	Petajoule (PJ)	223	227	244	242
5. – Liquid biofuels (e.g. bio-oils)	Petajoule (PJ)	IE	IE	IE	IE
6. – Solar	Petajoule (PJ)	6	9	14	23
7. – Other renewable (wind, geothermal etc)	Petajoule (PJ)	148	165	183	211
Total electricity production by fuel type*					
8. – Oil (fossil)	GWh	1.274	1.089	1.021	1.074
9. – Gas (fossil)	GWh	14.348	10.622	10.964	13.831
10. – Coal	GWh	6.703	6.409	5.469	5.747
11. – Renewable	GWh	45.132	49.996	55.903	63.346

* *Fossil waste is not included in this table*

Table 28: Assumptions for the industry sector (Source: Umweltbundesamt).

	Unit	2010	2015	2020	2030
12. The share of the industrial sector in GDP and growth rate	Value (EUR billion)	59.66	64.98	70.79	85.43
13. Growth of the industrial sector in GDP	growth rate (%) per year				
Iron and Steel	%	2.77	2.47	2.36	2.33
Chemical Industry	%	5.56	5.28	5.26	5.27
Food Industry	%	–0.16	0.71	0.69	0.69
Pulp and Paper	%	1.96	1.88	1.88	1.90
Wood	%	1.94	1.80	1.78	1.77
Other		2.20	2.02	2.16	2.23

Table 29: Assumptions for the transport sector (fuel sold; incl. fuel export) – with existing measures (Source: Umweltbundesamt).

	Unit	2010	2015	2020	2030
15. Passenger person kilometres	million km	119 713	119 806	125 686	139 319
16. Growth of freight tonne kilometres	million tonne	131 501	171 311	192 449	236 212

Table 30: Assumptions for the transport sector (fuel sold; incl. fuel export) – with additional measures (Source: Umweltbundesamt).

	Unit	2010	2015	2020	2030
15. Passenger person kilometres	million km	119 713	119 004	123 982	139 110
16. Growth of freight tonne kilometres	million tonne	131 501	153 316	163 854	210 442

Table 31: Assumptions for buildings residential and commercial or tertiary sector), (Source: Umweltbundesamt).

	Unit	2010	2015	2020	2030
21. Number of dwellings (permanently occupied)	1 000	3 638	3 820	3 957	4 166

Table 32: Assumptions for the agriculture sector – with existing measures (Source: Umweltbundesamt).

	Unit	2010	2015	2020	2030
23. Beef cattle	1 000 heads	1 481	1 484	1 487	1 480
24. Dairy cows	1 000 heads	533	541	550	544
25. Sheep	1 000 heads	358	306	301	294
26. Pigs	1 000 heads	3 134	2 945	2 925	2 790
27. Poultry	1 000 heads	14 644	12 456	12 361	11 695
28. Mineral fertiliser	t N	197	209	208	193

Table 33: Assumptions for the agriculture sector – with additional measures (Source: Umweltbundesamt).

	Unit	2010	2015	2020	2030
23. Beef cattle	1 000 heads	1 481	1 471	1 461	1 453
24. Dairy cows	1 000 heads	533	548	563	557
25. Sheep	1 000 heads	358	306	301	294
26. Pigs	1 000 heads	3 134	2 945	2 925	2 790
27. Poultry	1 000 heads	14 644	12 456	12 361	11 695
28. Mineral fertiliser	t N	197	205	199	186

Table 34: Assumptions for the waste sector (Source: Umweltbundesamt).

	Unit	2010	2015	2020	2030
31. Municipal solid waste disposed to landfills*1	tonnes	0	0	0	0
33. Municipal solid waste disposed composted*2	tonnes	242 000	202 000	168 000	121 000

*1 *since 2009 no MSW has been allowed to be landfilled directly (= without being pre-treated), therefore reported as zero*

*2 *covering waste deposited after pre-treatment in mechanical, biological and mechanical-biological treatment plants.*

ANNEX 2: AGRICULTURE POLICIES AND MEASURES

I. WEM Agricultural measures

Common Agricultural Policy (CAP)

The CAP reform 2003 decoupled premiums for production which were directly linked to outputs and implemented so called "single farm payments" instead. This type of subsidy is provided to farmers in the form of direct payments to maintain the land in good agronomic condition. All farmers receiving direct payments have to comply with the so-called cross compliance obligations.

In 2014, a new CAP reform will be implemented. Its impacts cannot be predicted at present. But it can be expected that environmental issues will still be important in the new CAP framework (key word "greening").

Fulfilling cross compliance requirements

The Cross Compliance (CC) requirements have to be fulfilled by farmers in order to receive direct payments. They have to guarantee that e.g. their agricultural land is kept in good agricultural and environmental condition. Other requirements refer to a range of regulations and standards related to soil protection, maintenance of soil organic matter and structure, avoiding the deterioration of habitats, and water management. The minimum standard for "good ecological condition" is set in the INVENKOS Ordinance (Federal Law Gazette II No. 31/2008).

For the next CAP period 2014-2020 all direct payments have to fulfil the cross compliance requirements.

Programme for rural development 2007-2013
(followed by the Programme for rural development 2014-2020)

Although the programme expires in 2013, most of the measures included hereunder will continue to be effective in the next programme period (2014-2020) and have therefore been included in the WEM projections.

Modulation of direct payments

Modulation is a compulsory transfer of a percentage of funds from Pillar 1 to Pillar 2 which has to be carried out each year,. Direct payments to larger farms (above a threshold of € 5,000) will be gradually reduced.

II. WAM Agricultural measures

The following measures comply with those considered in the greenhouse gas WAM scenario 2013.

Promote the grazing of cows

The grazing of cattle causes lower emissions than indoor husbandry. It is intended to increase, or at least keep, pasture management by providing advice and financial support. In animal husbandry the share of suckler cows kept outdoors could be increased, whereas this scarcely seems possible in dairy farming.

Assumptions:

In suckler cow husbandry, the share of manure excreted on pastures is currently 14.3 % (according to the Austrian GHG Inventory). It is assumed that this rate will increase by 5 %: in 2020 the expected percentage of manure excreted on pasture by suckler cows will be 19.3 per cent.

Decoupling of premiums for suckler cows

One of the few production-linked direct payments under the CAP is the premium for suckler cows.

Decoupling this premium would possibly reduce beef production, which, in turn, would lead to a decrease in the total number of cattle. A return to milk production seems only feasible for farms with both meat and milk production because of the expected investments. So, a further decline in grassland use by cattle and a slight increase in dairy farming can be predicted.

Assumptions:

Currently there are about 260,000 suckler cows. The number of suckler cows will be reduced by 10% (26,000 units). Half of the suckler cows will be converted to dairy cows.

Adapted feeding (phase feeding) of pigs

The composition of pig feed should be varied depending on the growth phases of the pigs. In the juvenile phase the supply of digestible protein should be higher than in later phases. Phase feeding can be planned and usually includes financial benefits. Phase feeding can have an influence on total N uptake and thus reduce N excretion in manure, thereby reducing emissions. Suitable advice could help increase the application of phase feeding.

Assumptions:

It is assumed that phase feeding lowers the N content of pig manure by 10%. The extent to which phase feeding is used in pig farming is unknown. It is assumed that 40% of the fattening pigs are not kept within a specific phase feeding programme. This percentage could be halved through consultations and investment support.

Covering slurry stores

The loss of ammonia through open slurry stores is significant. This goes along with nutrient losses. The promotion of technically appropriate and low-priced covers has hardly happened so far. Various instruments such as investment support (for covered slurry stores) and legal requirements for new buildings are under discussion.

Assumptions:

The available data on how many of the slurry stores are covered are not sufficient. It is assumed that currently about 40 % of the slurry produced is stored without adequate cover. By 2020, the proportion of open slurry storage should be halved (20%). For 2030 it is assumed that all slurry tanks will be covered.

Band spreading of liquid manure

The application of manure in the conventional way causes considerable ammonia air emissions and economic losses for the farms as it leads to losses of nitrogen. The plan to promote band spreading techniques has already been included in the ÖPUL programme. However, band spreading cannot be used on steep terrain.

Assumptions:

About 2.3 million m³ of liquid manure from cattle and swine are currently applied by band spreading. It is assumed that by 2020 band spreading techniques will have been increased to a share of 20%. For 2030 it is assumed that 30% of cattle and swine manure will be applied by band spreading techniques. This measure requires adequate investment in appropriate equipment.

ÖPUL measures that lead to a reduction in the use of mineral fertilisers

Existing ÖPUL measures have led to a significant reduction of mineral fertiliser application.

Assumptions:

Assuming a tightening up of the provisions within ÖPUL, a 5% reduction of the projected amount of mineral fertilisers can be expected. For the projected fertiliser use, the application of urea is assumed to be reduced by one third in 2020 and by two thirds in 2030.

Short-rotation areas

The expansion of areas where fast-growing plants (poplars, willows etc.) are planted reduces the need for fertiliser on agricultural land.

Assumptions:

Currently about 1,000 hectares are managed as short-rotation areas. By providing appropriate incentives, this area could be increased to 6,000 hectares. An evaluation of these additional 5,000 hectares of short rotation area has resulted in savings of 413 tonnes in N fertiliser.

Sustainable N management

This approach consists of a multitude of individual measures, which usually do not occur independently. Giving sufficient consideration to these measures should reduce the use of mineral fertilisers. They include for example the increase in fertiliser efficiency through customised storage for manure, proper use of fertilisers in general, or the introduction of manure exchange programmes. The application of manure could be done more efficiently through increased cooperation during application. The cultivation of legumes and the rapid incorporation of fertilisers as well as the use of compost all contribute to reducing the amount of mineral fertiliser used, provided that these measures are taken into account when planning the use of fertiliser.

Assumption:

By implementing all measures mentioned above, mineral fertiliser consumption (currently of the order of 100,000t N) can be reduced by 3% (± 2%).

Organic Farming

The efficient ÖPUL measure "organic farming" (achieved through systematic closed cycle management) avoids the use of mineral fertiliser. Currently about 414,000 hectares of agricultural land are managed using organic farming practices. An expansion of organic farming is thought to be feasible.

Assumption:

Organic cropland has been increased by 25,000 ha. The resulting lower fertiliser consumption rate has a positive effect on the calculated emissions.

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This report "Austria's National Air Emission Projections 2013 for 2015, 2020 and 2030" 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 2011 and 2012 (REP-0342 and REP-0397).
In the WAM scenario (which includes planned policies and measures with a realistic chance of being adopted and implemented in time to influence the emissions by 2030) current projections for NO_x show that a major reduction in emissions can be expected.
For SO_2 and ammonia no further significant reductions are expected. NMVOC and $PM_{2.5}$ emissions are projected to decrease after 2010.

ISBN 978-3-99004-261-8