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Updates to the GAINS Model Databases after the Bilateral Consultations with National Experts in 2014

TSAP Report #14

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Markus Amann, Editor
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Executive Summary

The proposal of the European Commission for amending the Directive on National Emission Ceilings and setting out national emission reduction commitments for six main pollutants (EC 2013a) has been informed by quantitative modelling of the benefits and cost-effectiveness of further emission controls. In order to avoid unfair distortions in the distribution of emission reductions between countries, the unbiased EU-wide cost-effectiveness analysis started from an internationally consistent emission inventory that covers the full set of emission sources with plausible data, even where a sector was not reported by a country or a country applied a different methodology. It is important to maintain this consistency throughout the analysis. At the same time, the harmonized emission inventory should align with national submissions as closely as possible, in order to demonstrate the credibility of the figures and ensure the technical feasibility of the reduction commitments.

To improve the understanding of the model results and underlying assumptions, to examine the 2005 discrepancies and to correct any errors, the Council Presidency, supported by the Member States and the Commission, allowed for a round of bilateral consultations with national experts. Between March and July 2014, IIASA held bilateral meetings with all 28 Member States involving more than 110 experts.

The bilateral discussions revealed that most of the discrepancies between the 2005 GAINS estimates for the Commission proposal and the latest submission of national inventories for 2005 are related to four factors: (i) changes in national 2005 estimates between the 2012 and 2014 submissions, (ii) different coverage of sources, (iii) IIASA's use of a uniform calculation methodology, and (iv) discrepancies between national and international statistics.

The new information emerging from the consultations has been incorporated into the GAINS databases, and updated emission estimates have been produced. In general, for national totals, the new GAINS estimates for 2005 match the latest 2014 national submissions quite closely, and differences are now typically within a few percentage points, which is well within the range in which national submissions have changed between 2012 and 2014.

However, there remain notable exceptions where discrepancies are significantly larger. In all such cases, there are important and objective reasons that explain these differences and these have been better documented.

There remain also discrepancies at the sectorial level, for which there are also objective explanations. These discrepancies are often relatively larger than for the national totals, partly because in some cases estimates are problematic for a few sectors only, partly because national classifications of emission sources are not always consistent with the EMEP reporting system, and partly because some of the sources are not reported.

Changes in the 2005 GAINS estimates will also affect projections of future emissions and mitigation potentials. Despite the significant modifications in the 2005 data, the suggested emission reduction requirements for 2030 remain within the technical feasibility that is estimated by the GAINS model, even with updated information on applicability limits for emission control measures. The only notable exception is SO_2 for Hungary, where the 2005 inventory dropped by 66% between 2012 and 2014. Further work is necessary to explore the implications on emission control costs of the proposed emission reductions requirements.

List of acronyms

CH_4	Methane
CLE	Current legislation
EMEP	Co-operative programme for monitoring and evaluation of long range transmission of air pollutants in Europe
EUROSTAT	Statistical office of the European Union GAINS Greenhouse gas - Air pollution Interactions and Synergies model
GDP	Gross domestic product
GNFR	Aggregated Gridding NFR sectors of the EMEP emission reporting system
IIASA	International Institute for Applied Systems Analysis
kt	kilotons = 10^3 tons
MTFR	Maximum technically feasible emission reductions
NEC	National Emission Ceilings
NH_3	Ammonia
NMVOC	Non-methane volatile organic compounds
NO_x	Nitrogen oxides
PM2.5	Fine particles with an aerodynamic diameter of less than 2.5 µm
PRIMES	Energy Systems Model of the National Technical University of Athens
SO_2	Sulphur dioxide
TSAP	Thematic Strategy on Air Pollution
UNFCCC	United National Framework Convention on Climate Change
VOC	Volatile organic compounds
WebDab	Emission database of EMEP
WPE	Working Party on Environment of the European Council

Country codes refer to the Internet two-letter country-code top-level domains.

More information on the Internet

All details data of the updated GAINS emission inventory and projections for 2030 can be retrieved from the GAINS-online model (http://gains.iiasa.ac.at/gains/EUN/index.login?logout=1).

Under the Scenario group 'TSAP _Cons_2014', the following scenarios can be examined in an interactive mode:

- TSAP Consultation 2014 CLE: Includes the updated 2005 and 2010 data, as well as the current legislation (CLE) projection for 2030
- TSAP Consultation 2014 MTFR: Includes the updated maximum technically feasible (MTFR) scenario for 2030

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1 Introduction

1.1 Context

In January 2014, the Council Working Party on Environment (WPE) started deliberations on the Clean Air Policy Package adopted by the European Commission on December 18, 2013. The package aims to further reduce the impacts of harmful emissions from industry, traffic, energy plants and agriculture on human health and the environment (EC 2013a). Inter alia, it includes a proposal for amending the Directive on National Emission Ceilings, setting out national emission reduction commitments for six main pollutants.

The proposal of the European Commission has been informed by quantitative modelling of baseline emissions and associated impacts, the scope for further emission reduction options, and cost-effective emission reduction strategies using the GAINS Integrated Assessment Modelling suite, carried out by the International Institute for Applied Systems Analysis (IIASA). Final results are presented, inter alia, in the impact assessment accompanying the Commission proposal (EC 2013b) and the TSAP 11 report (Amann et al. 2014a).

1.2 A harmonized emission database as a starting point for a cost-effectiveness analysis

The GAINS cost-effectiveness analysis responds to scientific evidence that, even at traffic stations in European cities, a substantial fraction of PM2.5 in ambient air originates from emission sources in other countries. Thus, effective reduction of ambient PM2.5 requires measures within the city, in the surrounding areas of the same country, as well as measures in other countries. Furthermore, all source categories contribute through their primary PM and secondary aerosol precursor emissions to PM2.5 in ambient air. Cost-effective strategies that achieve given PM2.5 targets at least cost need to balance measures across countries, pollutants and sectors. The GAINS model facilitates this search for such balanced least-cost portfolios of measures, based on detailed information on the current structure of emission sources in each country, their anticipated future evolution, and the potential and costs for additional emission reductions at all sources. Thus, the cost-effectiveness of an identified solution will critically depend on the quality of this information, and in particular on the comparability and coherence of information across different countries and sectors.

For the analysis for the Clean Air Policy package, IIASA has compiled this information from a variety of different statistical sources, with the aim to reproduce as closely as possible the emission inventories for the year 2005 as they were reported by countries in 2012 while matching international energy, agricultural, transport and industrial statistics. However, in order to avoid unfair distortions in the distribution of emission reductions between countries, it is equally important to start from an internationally consistent emission inventory covering the full set of emission sources with plausible data, even if a sector is not reported by a country.

In addition, not all countries apply the same methodology for estimating their emissions, and the simplified approaches that are often used, e.g., for estimating NH_3 and PM emissions, often miss important country-specific circumstances that would objectively lead to rather different emission

estimates (e.g., milk yields of cattle). In order to establish comparability across countries, GAINS employs a uniform approach to all countries, which reflects the most important local factors (in general comparable to the Tier 2 approach of the EMEP Emission Factor Guidebook).

While the inclusion of missing sources, as well as the use of a harmonized methodology, obviously results in differences to nationally reported numbers, these differences seem not only acceptable but in fact necessary to allow an unbiased EU-wide cost-effectiveness analysis.

1.3 Bilateral consultations with national experts on GAINS input data

These reasons (i.e., the harmonization of emission inventories by gap filling and the use of a unified methodology in GAINS, together with the national inventory submissions of 2012 as the reference) led to apparent discrepancies between the 2005 emission estimates in GAINS and the latest national inventories reported in 2014. To identify the major reasons for these differences, a series of bilateral consultations between national experts and IIASA was organized.

Between March and July 2014, IIASA held bilateral meetings with all 28 Member States involving more than 110 experts to review input data and results of the GAINS modelling exercise. Outcomes of these bilateral consultations are summarized in the TSAP 13 report (Amann et al. 2014b). Discussions aimed at eliminating potential misunderstandings, spotting and correcting obvious mistakes in input data, identifying differences in perspectives on future development, and assessing their relevance on overall outcomes. Discussions focused on the air pollutants SO_2, NO_x, PM2.5, NH_3 and VOC. CH_4 was not addressed as the GAINS reference scenario for CH_4 is in the year 2005 completely consistent with emissions reported for 2005 by countries to the UNFCCC in April 2012 (see section 2.1.5 of TSAP report #13). While some Members States have also changed their 2005 inventory estimate for CH_4 since 2012, any changes to GAINS now would undermine consistency with the Climate and Energy Package. If significant, the issue can be returned to in future analysis.

Subsequently, the new information has been incorporated into the GAINS model to obtain an updated set of 2005 emission inventories that better resembles the latest inventory submissions while maintaining international comparability. In addition, the implications of this information (e.g., of different structures of emission sources) on future baseline emissions, as well as on the scope for further emission reductions, has been explored.

While these discrepancies on the historic (2005) emissions can be transparently quantified and reconciled with the latest national information, there remain different perspectives of individual countries on the future emission reduction potentials. There was little overlap of specific concerns among countries, and national perspectives on future energy and agricultural activities are often different from what has been assumed for the Clean Air Policy package. However, only few countries indicated the ready availability of internally coherent alternative projections, and only a limited number of national projections have been received by IIASA to date.

1.4 Structure of this report

Section 2 of this report presents the outcomes of these bilateral consultations on the representation of national emission inventories for 2005 in the GAINS model. (The focus is on the 2005 data given the limited availability of national projections; these can be dealt with in a subsequent step.) Section 3 analyses the implications on the baseline 'current legislation' and 'MTFR' projections of future emissions in 2030, and the scope for further measures. It also explores to what extent the updated

information would affect the technical feasibility of the proposed emission reduction commitments that have been suggested by the European Commission in its Clean Air Policy package. Conclusions are drawn in Section 4. The Annex lists for all Member States the changes that have been implemented in GAINS in response to the issues that emerged from the bilateral consultations.

2 Emissions in 2005

While international comparability of the emission sources is a prerequisite for an accurate and fair cost-effectiveness analysis, the acceptability of resulting outcomes is also influenced by the extent that nationally reported inventories are reproduced, at least for the base year. As mentioned above, mainly four factors led to apparent discrepancies between the GAINS estimates for the Commission proposal and the latest submission of national inventories: (i) changes in national 2005 estimates between the 2012 and 2014 submissions, (ii) the completeness of the inventories, (iii) the use of a uniform calculation methodology, and (iv) discrepancies between national and international statistics.

The national emission estimates used in this report for 2005 are those reported in the latest submissions to EMEP/WebDab (including submissions until June 2014, downloaded on September 10, 2014, see http://www.ceip.at/webdab-emission-database).

2.1 The evolution of emission estimates for 2005

A considerable number of Member States have revised their emission estimates for the year 2005 in the last two years as compared to the 2012 submission of national inventories against which the GAINS model was calibrated after the last round of bilateral consultations in 2012 (Figure 2.2, Figure 2.2, Table 2.2).

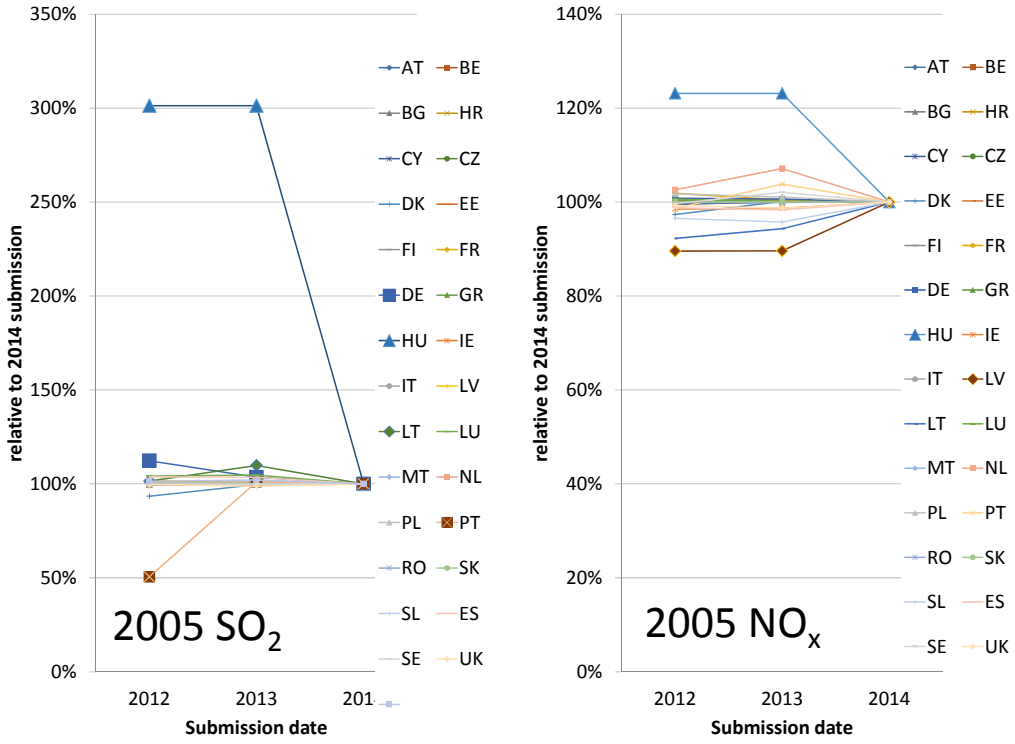

Figure 2.1: Changes between the 2012-2014 submissions of SO_2 and NO_x national emission inventories for 2005

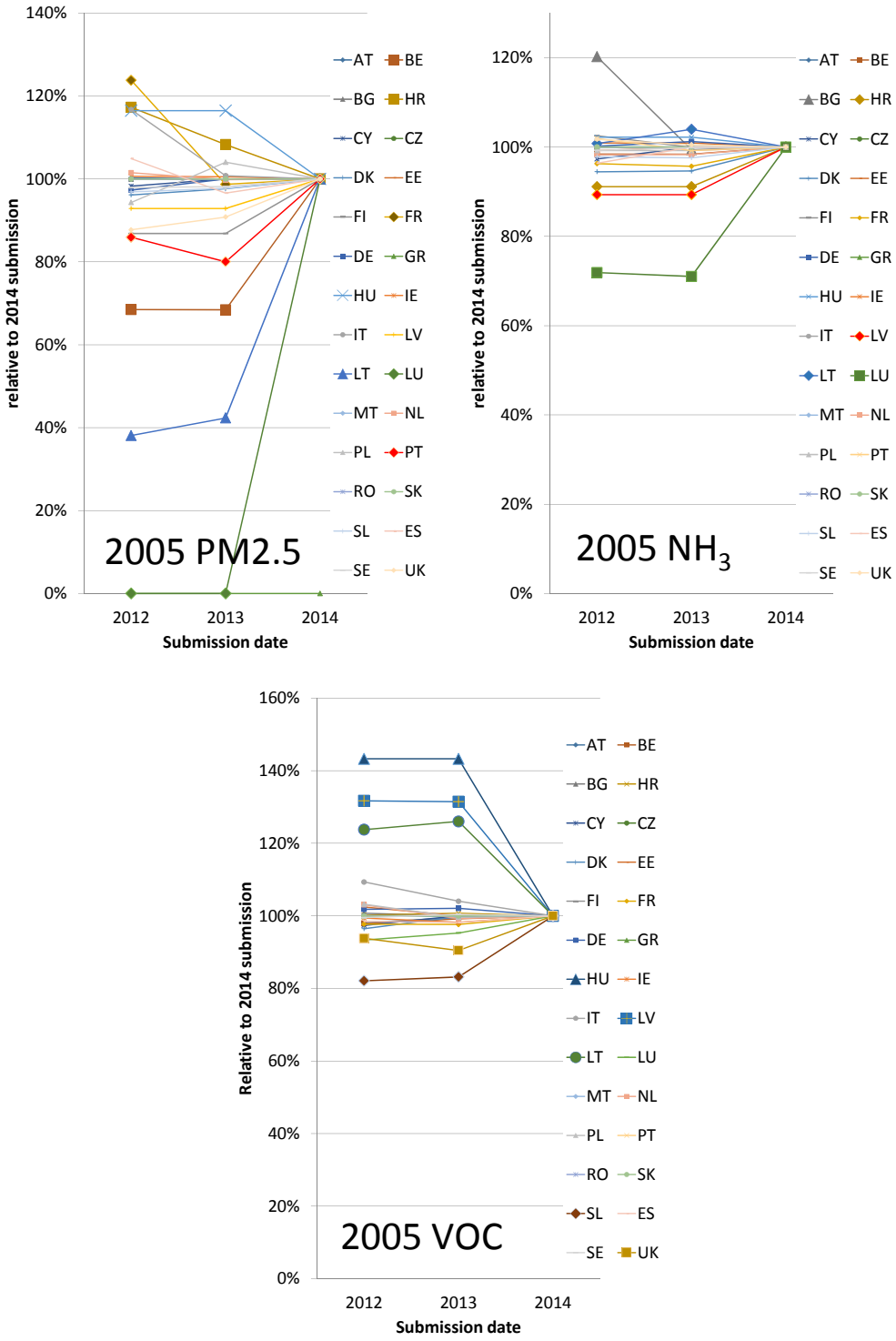

Figure 2.2: Changes between the 2012-2014 submissions of PM2.5, NH_3 and VOC national emission inventories for 2005

For instance, of SO_2 inventories submitted in 2012 differ between -50% and +200% compared to the latest (June 2014) submissions to EMEP/WebDab. Differences in earlier NO_x inventories range between -10% and +30% of the 2014 submissions, PM2.5 between -60% and +25%, NH_3 between -30% and +20%, and VOC between -20% and +45%. In the bilateral consultations, national experts offered different calculation methodologies, new measurements, new data on capital stock, etc. as explanations for these revisions.

Table 2.1: Emissions for 2005 reported by Member States in 2012, 2013 and 2014 (kilotons). Data are taken from the trend tables at the EMEP/CEIP web site (September 20, 2014)

	SO_2			NO_x			PM2.5			NH_3			VOC		
	2012	2013	2014	2012	2013	2014	2012	2013	2014	2012	2013	2014	2012	2013	2014
AT	27.1	27.1	27.2	236.2	237.5	237.3	22.3	22.3	22.3	62.7	62.7	62.7	162.0	164.7	165.3
BE	145.2	145.2	143.9	291.0	291.8	290.5	24.4	24.3	35.6	71.3	71.3	72.4	142.7	144.7	145.8
BG	776.3	776.3	776.3	153.9	153.9	153.9	26.7	26.8	26.8	58.1	48.0	48.3	86.1	85.4	85.4
HR	63.4	63.6	63.6	81.2	81.4	81.0	12.6	11.6	10.7	40.4	40.4	44.3	101.2	101.7	101.0
CY	37.9	38.1	38.1	21.1	21.2	21.2	2.9	2.9	2.9	5.8	5.9	5.9	13.9	14.3	14.3
CZ	218.6	218.6	218.6	277.8	277.8	277.8	20.9	20.9	20.9	68.4	68.4	68.4	181.8	181.8	181.8
DK	22.9	24.4	24.5	181.1	186.3	186.0	25.4	25.8	26.4	82.7	82.8	87.5	110.3	114.1	114.3
EE	76.3	76.3	76.3	36.6	36.6	36.6	19.9	19.9	19.9	9.8	9.8	9.7	41.1	40.1	40.1
FI	69.2	69.2	69.3	169.4	169.4	169.4	36.0	36.0	41.5	38.8	37.8	37.8	136.5	136.5	136.4
FR	467.3	463.5	459.9	1429.9	1409.5	1403.6	304.0	242.3	245.5	660.9	656.8	686.3	1232.3	1231.2	1261.4
DE	517.3	477.2	460.5	1578.1	1575.4	1565.2	121.2	124.5	124.5	573.2	579.4	572.2	1143.9	1147.2	1123.7
GR	537.9	540.5	540.7	418.6	416.7	416.5	NR	NR	NR	67.5	67.5	67.5	220.1	220.2	220.3
HU	129.2	129.2	42.9	203.1	203.1	164.9	31.0	31.0	26.6	80.1	80.1	78.4	177.5	177.5	123.8
IE	71.1	71.1	71.6	127.3	127.4	129.2	10.9	10.9	10.8	109.1	110.0	110.0	56.5	55.8	56.8
IT	402.5	405.2	405.3	1212.2	1213.1	1214.0	165.8	143.2	142.1	415.9	416.1	416.4	1316.6	1252.8	1204.4
LV	6.6	6.6	6.6	37.3	37.3	41.6	27.4	27.4	29.5	15.6	15.6	17.4	73.3	73.2	55.6
LT	43.7	47.3	43.1	57.6	58.9	62.5	8.7	9.7	22.8	39.4	40.7	39.1	84.1	85.7	68.0
LU	2.6	2.6	2.5	62.1	61.8	61.7	0.0	0.0	3.7	5.0	4.9	6.9	11.7	12.0	12.6
MT	11.4	11.4	11.4	9.3	9.3	9.3	1.3	1.3	1.3	1.6	1.6	1.6	3.3	3.3	3.3
NL	64.5	64.5	64.5	345.6	360.8	336.8	19.5	19.1	19.2	140.5	140.6	142.9	177.5	171.0	172.2
PL	1223.9	1232.8	1217.4	865.8	859.9	850.8	132.8	146.4	140.8	269.5	269.6	271.7	593.2	572.3	574.7
PT	89.3	178.5	176.5	252.6	265.8	256.1	59.4	55.3	69.1	51.3	49.9	50.3	206.0	207.2	206.5
RO	642.6	642.6	642.6	309.1	309.1	309.1	105.7	105.7	105.7	198.5	198.5	198.5	424.8	424.8	424.8
SK	89.0	89.0	89.0	101.9	101.9	101.9	36.7	36.7	36.7	28.6	28.6	28.6	73.1	73.2	73.2
SL	40.7	40.7	40.8	46.7	46.3	48.3	15.2	15.3	15.7	18.7	18.6	19.1	39.3	39.8	47.9
ES	1325.6	1323.4	1278.2	1403.6	1397.6	1421.1	98.2	90.4	93.6	365.6	379.4	379.3	817.5	814.5	829.9
SE	35.9	35.9	35.9	174.1	178.3	174.7	29.3	29.4	29.9	55.2	55.5	55.6	196.7	198.5	197.7
UK	706.0	700.2	708.6	1580.1	1570.3	1591.6	81.3	84.2	92.7	307.5	303.7	302.2	1088.2	1049.3	1159.9
EU-28	7844.1	7901.1	7735.6	11663.0	11658.3	11612.4	1439.3	1363.3	1417.1	3841.6	3844.3	3881.4	8911.0	8792.6	8801.3

2.2 Comparison of updated GAINS estimates with the latest 2014 submissions

The findings from the bilateral consultations resulted in a large number of changes that have been implemented in the GAINS model (see Annex for details for all Member States). These include, inter alia, improved structural information about specific emission sources (e.g., the composition of emissions from non-road mobile machinery), about the state of implementation of emission control measures in 2005 (e.g., the share of old vehicles in 2005), and country-specific features (e.g., quantities of black liquor or oil shale) that are not always properly reported in (or are misclassified in) international statistics

As a consequence, the match between GAINS estimates and the latest submissions of the national inventories has been greatly improved. Since not all sources that are reported in national inventories are covered by GAINS, a valid comparison must adjust for these sources. These include, e.g., NOx and VOC emissions from agricultural soils, which are not counted as national anthropogenic emissions by GAINS, but computed endogenously by the EMEP atmospheric dispersion model taking into account actual temperature and humidity. Also, emissions outside the EMEP domain (e.g., for Spain) are not included in GAINS, while national reports include emissions from these territories. Furthermore, GAINS employs consistently the 'fuel sold' concept, while some countries only provide estimates based on 'fuel used'.

Table 2.2 to Table 2.6 provide for all Member States national total emissions reported in the 2014 submissions, the emissions that are not included in GAINS, and the adjusted number that can be readily compared to the GAINS estimate. It also gives the updated GAINS estimate for 2005, together with the main reasons for the remaining differences.

In general, for national totals, the new GAINS estimates for 2005 match the latest 2014 national submissions for SO_2 quite closely, and differences remain typically within a few percentage points, which is well within the range in which national submissions have changed between 2012 and 2014. For other pollutants, a similarly good fit could be achieved for many countries, but there remain notable exceptions where differences are significantly larger. In all cases, there are important and objective reasons that explain these differences, e.g., missing sectors in national inventories, different calculation methodologies, differences in statistical data (e.g., on fleet composition), or forthcoming new submissions that will be close to the current GAINS estimate. The main reasons for these differences are given for all Member States.

For the EU-28 as a whole, GAINS reproduces total SO_2 emissions to within 1%, and in only one country is the difference larger than 5%. A similar good fit at the overall level is achieved for NO_x and NH_3 (1% difference in total emissions), but differences are larger than 5% for six countries for NO_x, and for nine countries for NH_3. Latest total EU-28 VOC emissions are now reproduced in GAINS within a 3% margin. However, estimates differ for 11 countries by more than five percent. The largest discrepancies remain for PM2.5, where GAINS estimates in total 13% higher emissions, mainly because sources that are missing in national inventories are included in GAINS. Differences are larger than 5% for 12 countries (while, at the same time, national inventories are reproduced within a 5% margin for 16 countries).

Obviously, differences at the sectorial level are often larger, partly because in some cases estimates are problematic for a few sectors only, partly because national classifications of emission sources are not always consistent with the EMEP GNFR system, and partly because some of the sectors are not estimated in some countries.

While the residual discrepancies remain, it is important to mention that the unresolved differences have been discussed with national experts, quantified and well documented. They are maintained in the interest of creating a coherent basis for a robust and fair cost-effectiveness analysis. Information about these differences can also provide valuable orientation for future improvements of national inventories.

Table 2.2: Comparison of national total emissions of SO_2 in 2005 between reported in WebDab (Sept 10, 2014) as adjusted and estimated by GAINS

	WebDab	Reasons for adjustments	WebDab adjusted	GAINS updated	*Diff.*	Major reasons for differences
AT	27.2		27.2	27.4	*0.6%*	
BE	143.9	Fuel sold	144.0	138.4	*-3.9%*	
BG	776.3		776.3	761.7	*-1.9%*	
HR	63.6		63.6	65.3	*2.6%*	
CY	38.1		38.1	38.3	*0.5%*	
CZ	218.6		218.6	220.7	*1.0%*	
DK	24.5		24.5	24.3	*-1.1%*	
EE	76.3		76.3	75.7	*-0.8%*	
FI	69.2		69.2	68.8	*-0.6%*	
FR	459.9		459.9	464.5	*1.0%*	
DE	460.5		460.5	458.5	*-0.4%*	
GR	540.7		540.7	529.2	*-2.1%*	The national inventory reports heating oil with higher sulphur content used as transport fuel.
HU	42.9		42.9	42.4	*-1.1%*	
IE	71.6		71.6	70.7	*-1.3%*	
IT	405.3		405.3	406.5	*0.3%*	
LV	6.6		6.61	6.69	*1.1%*	
LT	43.1		43.1	41.4	*-3.8%*	
LU	2.5		2.46	2.60	*6.0%*	Uncertainty in the emission factors for fuels used in the domestic sector
MT	11.4		11.4	11.2	*-1.3%*	
NL	64.5		64.5	64.5	*0.1%*	
PL	1217.4		1217.4	1207.3	*-0.8%*	
PT	176.5		176.5	178.5	*1.1%*	
RO	642.6		642.6	640.3	*-0.4%*	
SK	89.0		89.0	89.9	*1.0%*	
SL	40.8		40.8	40.7	*-0.1%*	
ES	1278.1	Within EMEP	1252.2	1245.3	*-0.6%*	
SE	35.9		35.9	36.4	*1.2%*	
UK	708.6		708.6	721.4	*1.8%*	
EU-28	7735.6		7710	7679.1	*-0.4%*	

Table 2.3: Comparison of national total emissions of NO_x in 2005 between reported in WebDab (Sept 10, 2014) as adjusted and estimated by GAINS

	WebDab	Reasons for adjustments	WebDab adjusted	GAINS updated	Diff.	Major reasons for differences
AT	237.3	Soil NO_x	231.7	230.0	*-1%*	
BE	290.5	Fuel sold	302.9	302.9	*0%*	
BG	153.9		153.9	161.2	*5%*	Emissions from old cars underestimated in national inventory, agreed with BG.
HR	81.0	Soil NO_x	80.1	80.3	*0%*	
CY	21.2	Soil NO_x	20.8	21.3	*3%*	
CZ	277.9		277.9	294.4	*6%*	Road transport higher in GAINS due to higher share of old cars.
DK	186.0		186.0	178.0	*-4%*	
EE	36.6	Soil NO_x	35.8	40.3	*12%*	National inventory seems to underestimate emissions from old cars, discussed with national experts.
FI	169.4		169.4	184.1	*9%*	National inventory underestimates emissions from trucks and non-road mobile machinery, agreed with national experts
FR	1403.6		1403.6	1399.3	*0%*	
DE	1565.2	Soil NO_x	1452.9	1435.8	*-1%*	
GR	416.5		415.6	401.5	*-3%*	
HU	164.9	Soil NO_x	154.2	150.4	*-2%*	
IE	129.2		129.2	136.0	*5%*	Road emissions higher, though activity and age structure based on national input. Agreed with national experts.
IT	1214.0		1214.0	1188.6	*-2%*	
LV	41.6	Soil NO_x	41.6	41.1	*-1%*	
LT	62.5		62.5	49.9	*-20%*	GAINS estimates adjusted on forthcoming submission, not yet on WebDab.
LU	61.7	Soil NO_x	61.4	56.3	*-8%*	Despite implementation of all comments from experts, emissions from off-road and industrial combustion remain lower.
MT	9.3		9.3	9.0	*-3%*	
NL	336.8	Soil NO_x, Fuel sold	361.4	364.3	*1%*	
PL	850.8		785.8	773.5	*-2%*	Inconsistency in national time series for fuel consumption in agriculture
PT	256.1		256.1	245.6	*-4%*	Emission factors for small combustion not updated in 2005 national inventory
RO	309.1	Soil NO_x	308.3	305.2	*-1%*	
SK	101.9		91.1	91.3	*0%*	More fuel (hence emissions) in national inventory than reported to EuroStat and thus used in GAINS.

Table2.3, ctd.: Comparison of national total emissions of NO_x in 2005 between reported in WebDab (Sept 10, 2014) as adjusted and estimated by GAINS

	WebDab	Reasons for adjustments	WebDab adjusted	GAINS updated	Diff.	Major reasons for differences
SL	48.3	Soil NO_x	46.7	47.9	*3%*	
ES	1421.1	Within EMEP soil NO_x	1298.2	1365.8	*5%*	Road fuel consumption higher in GAINS than in NFR
SE	174.7		174.7	200.4	*15%*	Lower fuel consumption for transport compared to EUROSTAT; confirmed by national experts.
UK	1591.5		1591.5	1520.0	*-4%*	
EU-28	11612.4		11316.3	11275.7	*0%*	

Table 2.4: Comparison of national total emissions of PM2.5 in 2005 between reported in WebDab (Sept 10, 2014) as adjusted and estimated by GAINS

	WebDab	Reasons for adjustments	WebDab adjusted	GAINS updated	Diff.	Major reasons for differences
AT	22.3		22.3	21.7	*-3%*	
BE	35.6	Fuel sold	35.6	37.0	*4%*	
BG	26.8		26.8	38.9	*45%*	No emissions from non-road mobile sources, open burning of residential and agricultural waste, agricultural activities in national inventory [1] .
HR	10.7		10.7	14.5	*36%*	No emissions from open burning of residential and agricultural waste in national inventory[1]. Emissions from agricultural activities much lower than in GAINS, but national upgrade ongoing.
CY	2.9		2.92	3.16	*8%*	Much lower emissions from open burning of agricultural waste and non-road mobile sources in national inventory.
CZ	20.9	1)	20.9	33.8	*62%*	No emissions from industrial processes, non-road mobile sources, open burning of municipal and agricultural waste, agr. activities in national inventory[1]. Emissions from biomass combustion in the domestic sector very low
DK	26.4		26.4	27.4	*4%*	
EE	19.9		19.9	20.4	*2%*	
FI	41.5		41.5	34.7	*-16%*	Major differences in emissions from residential combustion and fugitive emissions from pit production will be corrected by Finland in the next inventory. Difference should reduce to 5%. FI suggests using the corrected values for the establishment of the ceilings.
FR	245.5		248.1	244.6	*-1%*	
DE	124.5		124.6	120.6	*-3%*	
GR	NR		NR	60.5		
HU	26.6		26.6	32.2	*21%*	No emissions from open burning of agricultural waste in national inventory[1]. Emissions from non-road mobile machinery, open burning of municipal waste and from agricultural activities lower than in GAINS. Missing sectors or sectors with much lower emissions are responsible for 80% of the differences.
IE	10.8		10.8	10.8	*0%*	

*) Number taken from the Trend table of CEIP

[1] Also other smaller categories including cigarette smoking, barbecues and fireworks, mainly small tonnages.

Table 2.4 ctd.: Comparison of national total emissions of PM2.5 in 2005 between reported in WebDab (Sept 10, 2014) as adjusted and estimated by GAINS

	WebDab	Reasons for adjustments	WebDab adjusted	GAINS updated	*Diff.*	Major reasons for differences
IT	142.1		142.1	141.4	*0%*	
LV	29.5		29.5	29.7	*1%*	
LT	22.8		22.8	21.8	*-4%*	
LU	3.7		3.75	2.94	*-21%*	National inventory higher for small combustion, as well as mobile road and non-road sources.
MT	1.3		1.33	0.69	*-48%*	An order of magnitude higher estimate of non-exhaust emissions from transport in national inventory. Inconsistent with other countries.
NL	19.2	Fuel sold	20.2	24.0	*18%*	Emissions from agricultural waste burning not included in national inventory, emissions from agriculture much lower than in GAINS.
PL	140.8		140.8	219.4	*56%*	National inventory does not include use of non-commercial dirty coal by residential consumers (>50 kt), agreed by experts. Other differences: much lower emissions from agricultural activities and higher emissions from non-road mobile sources.
PT	69.1		62.7	59.3	*-5%*	No emissions from open burning of residential waste, agricultural activities (livestock, other) in national inventory[1]. Emissions from small combustion higher by 9 kt. The next inventory from small combustion will be adjusted to numbers close to GAINS estimates.
RO	105.7		105.7	144.0	*36%*	Emissions from mobile sauces (road and non-road) underestimated in the national inventory. No emissions from agricultural waste burning, other agricultural activities[1]. Emissions from municipal waste burning very low compared with GAINS estimate.
SK	36.7		36.7	34.6	*-6%*	Emissions from small combustion higher in national inventory (Tier 1 methodology); emissions from agriculture missing[1].
SL	15.7		15.7	15.4	*-2%*	

[1)] Also other smaller categories including cigarette smoking, barbecues and fireworks, mainly small tonnages.

Table 2.4 ctd.: Comparison of national total emissions of PM2.5 in 2005 between reported in WebDab (Sept 10, 2014) as adjusted and estimated by GAINS

	WebDab	Reasons for adjustments	WebDab adjusted	GAINS updated	*Diff.*	Major reasons for differences
ES	93.6	within EMEP	90.3	144.4	*60%*	PM emission from agricultural and municipal waste burning, other agricultural activities, although SO_2, NO_x and NMVOC from agricultural waste burning are reported[1]. The missing sectors contribute two thirds to the difference.
SE	29.9		29.9	32.0	*7%*	Higher emissions from non-road mobile sources in the national inventory.
UK	92.7		92.7	92.8	*0%*	
EU-28	1479.0		1473.0	1662.7	*13%*	

[1)] Also other smaller categories including cigarette smoking, barbecues and fireworks, mainly small tonnages.

Table 2.5: Comparison of national total emissions of NH_3 in 2005 between reported in WebDab (Sept 10, 2014) as adjusted and estimated by GAINS

	WebDab	Reasons for adjustments	WebDab adjusted	GAINS updated	Diff.	Major reasons for differences
AT	62.7		62.7	62.9	*0%*	
BE	72.4	Fuel sold	72.6	72.4	*0%*	
BG	48.3		48.3	39.0	*-19%*	National inventory uses Tier 1, i.a., for dairy cows. Discrepancies with animal numbers in EUROSTAT/UNFCCC inventory submission.
HR	44.3		44.3	39.6	*-11%*	National inventory use Tier 1 for livestock, with much larger emissions for dairy cows.
CY	5.9		5.9	6.0	*2%*	
CZ	68.4	Trend table	68.4	71.4	*4%*	
DK	87.5	Excl. crops, 2014 N-mineral fertilizer data	77.2	76.8	*-1%*	
EE	9.7		9.7	10.2	*5%*	
FI	37.8		37.8	39.7	*5%*	
FR	686.3		686.3	686.5	*0%*	
DE	572.2		572.2	586.7	*3%*	
GR	56.8	Trend table	56.8	56.9	*0%*	
HU	78.4		78.4	78.9	*1%*	
IE	110.0		110.0	110.0	*0%*	
IT	416.4		416.4	434.5	*4%*	
LV	17.4		17.4	14.9	*-15%*	National inventory uses rather high USEPA emission factors for combustion sources. Tier 1 for mineral fertilizers.
LT	39.1		39.1	35.1	*-10%*	GAINS estimates have been adjusted to forthcoming submission. The current national inventory applies Tier 1 for livestock, no distinction between liquid and solid systems.
LU	6.9	Fuel sold	6.5	6.0	*-7%*	National inventory has higher estimates for beef, cattle and pigs in national inventory due to different method.
MT	1.6		1.6	1.7	*7%*	
NL	142.9		142.9	146.2	*2%*	
PL	271.7		271.7	328.5	*21%*	Different emission factors.
PT	50.3		50.3	70.9	*41%*	Main differences for poultry and pigs.
RO	198.5		198.5	185.5	*-7%*	Tier 1 approach for dairy cows.
SK	28.6		28.6	28.4	*-1%*	
SL	19.1		19.1	18.7	*-2%*	
ES	381.7	Within EMEP	378.7	371.6	*-2%*	
SE	55.6		55.6	54.0	*-3%*	
UK	310.4		310.4	310.5	*0%*	
EU-28	3881.3		3867.8	3943.6	*2%*	

Table 2.6: Comparison of national total emissions of VOC in 2005 between reported in WebDab (Sept 10, 2014) as adjusted and estimated by GAINS

	WebDab	Reasons for adjustments	WebDab adjusted	GAINS updated	Diff.	Major reasons for differences
AT	165.3	Excl. agri. emissions	163.6	170.1	*4%*	
BE	145.8	Fuel sold	147.3	151.3	*3%*	
BG	85.4	Excl. agri. emissions	67.2	128.2	*91%*	Lower emissions from old cars in national inventories (75% of the difference). Incomplete coverage of solvent use.
HR	101.0		101.0	76.9	*-24%*	Different estimates for solvent use sectors and transport emissions.
CY	14.3	Excl. agri. emissions	11.8	11.4	*-3%*	
CZ	181.8	New 2005 inventory will be 202kt.	202.0	195.8	*-3%*	
DK	114.3	Excl. agri. emissions.	112.6	112.1	*0%*	
EE	40.1	Excl. agri. emissions	36.4	37.9	*4%*	
FI	136.4		136.4	117.8	*-14%*	Emissions from residential combustion will be revised in next national inventory closer to current GAINS numbers.
FR	1261.4		1261.4	1216.5	*-4%*	
DE	1123.7		1123.7	1182.6	*5%*	
GR	220.4		220.4	263.2	*19%*	National inventory has lower emissions for non-road machinery and for residential combustion.
HU	123.8		123.8	130.2	*5%*	GAINS includes open burning of agricultural waste
IE	56.8		56.8	59.2	*4%*	
IT	1204.4	Excl. agri. emissions	1203.8	1165.4	*-3%*	
LV	55.6	Excl. agri. emissions	54.8	55.7	*2%*	
LT	68.0		68.0	79.7	*17%*	GAINS estimates adjusted to forthcoming submission, not yet on WebDab. Open burning of agricultural waste not included.
LU	12.6	Excl. agri. emissions	12.4	13.7	*10%*	Different evaporative emissions from road transport.
MT	3.3		3.3	3.9	*16%*	Difference in solvent use sector, which is not disaggregated in the national inventory.
NL	172.2	Excl. agri. emissions, Fuel sold	173.9	187.8	*8%*	Nat. inventory lower for transport, oil and gas exploration and distribution.
PL	574.7		574.6	605.3	*5%*	

Table 2.6 ctd.: Comparison of national total emissions of VOC in 2005 between reported in WebDab (Sept 10, 2014) as adjusted and estimated by GAINS

	WebDab	Reasons for adjustments	WebDab adjusted	GAINS updated	Diff.	Major reasons for differences
PT	206.5		206.5	223.5	*8%*	Difference for residential wood combustion
RO	424.8	Excl. agri. emissions	340.3	389.9	*15%*	National inventory has lower emissions from old (=no catalyst) cars and solvent use. Open burning of agricultural waste not included.
SK	73.2	Excl. agri. emissions	72.7	70.9	*-2%*	
SL	47.9	Excl. agri. emissions	42.5	44.8	*5%*	
ES	829.9	Within EMEP	801.6	870.7	*9%*	Higher fuel consumption in road transport
SE	197.7		197.7	205.4	*4%*	
UK	1159.9	Excl. agri. emissions	1082.4	1062.8	*-2%*	
EU-28	8801.3		8598.9	8832.6	*3%*	

3 Emissions in 2030

Changes in the 2005 inventories (e.g., different sector splits, implementation levels of emission control measures, etc.) will also affect projections of future emissions and further mitigation potentials. In addition, national experts offered sometimes different perspectives on possible ranges of future emissions, e.g., due to different applicability of certain emission control measures. Also different national perspectives on the future evolution of emission generating activities, i.e., scenarios of energy, transport, agricultural and industrial activities will affect emissions in the future.

Given the currently incomplete availability of national scenarios of future economic activities, this section discusses the implications of the new information on 2005 emissions and application potentials of emission control measures on emissions in the year 2030. A full analysis that includes also different activity scenarios will require internally coherent national projections from more Member States.

Table 3.1 to Table 3.5 provide, for the PRIMES 2013 Reference scenario that has been used for the Clean Air Policy package, the updated range of emissions in 2030 between the 'current legislation' (CLE) and the 'maximum technically feasible reduction' (MTFR) cases. In addition, they provide national emission ceilings as absolute numbers calculated by applying the proposed emission percentage reductions commitments that have been suggested by the Commission in the Clean Air Policy package to the updated GAINS 2005 emission estimates. These calculated national emission ceilings can be compared with the updated CLE and MTFR emission estimates for 2030 to check whether they still fall in the range of CLE and MTFR.

Most importantly, despite the significant changes in the 2005 inventories, the suggested emission reduction requirements for 2030 remain within the technical feasibility that is estimated by the GAINS model, even with updated information on application limits of emission control measures. The only notable exception is SO_2 for Hungary, where the emission reduction requirement computed from the 2012 Hungarian emission inventory included the desulfurization of existing power stations and large industrial boilers. While the 2012 submission, on which the GAINS analysis was based, reported these sectors without emission controls, the updated 2014 submission suggests significantly lower emissions, claiming that these emission controls have already been implemented in 2005. In such a case, the potential for additional emission reductions will obviously be lower, and the originally proposed relative emission reduction commitment cannot be realized for the new base year inventory.

Similar cases occur for some other countries, although to a much lower extent, and they do not compromise the technical achievability of the proposed emission reduction commitments. Costs for achieving the suggested reductions could be different (lower and higher) from the original estimate, and further work is required to quantify the impacts.

Table 3.1: Updated GAINS SO_2 estimates for 2005 and 2030, current legislation (CLE) and maximum technically feasible reductions (MTFR), in kilotons. Emission reduction commitments proposed in the Clean Air Policy package (in % relative to 2005), and resulting emission ceilings based on the updated GAINS estimate for 2005 (in kilotons)

	Updated GAINS estimates			Proposed emission reduction commitment rel. to 2005	Resulting emission ceiling
	2005	2030 CLE	2030 MTFR		[kt]
AT	27	17	13	-50%	14
BE	138	58	43	-68%	44
BG	762	101	43	-94%	46
HR	65	19	6	-87%	8
CY	38	2	1	-95%	2
CZ	221	71	56	-72%	62
DK	24	9	7	-58%	10
EE	76	18	10	-71%	22
FI	69	46	40	-30%	48
FR	464	133	92	-78%	102
DE	459	234	172	-53%	216
GR	529	51	25	-92%	42
HU	42	18	10	-88%	5
IE	71	14	9	-83%	12
IT	407	160	83	-75%	102
LV	7	4	3	-46%	4
LT	41	22	9	-72%	12
LU	3	2	1	-44%	1
MT	11	1	0	-98%	0
NL	65	29	24	-59%	26
PL	1207	410	249	-78%	266
PT	179	49	17	-77%	41
RO	640	97	43	-93%	45
SK	90	24	14	-79%	19
SL	41	5	4	-89%	4
ES	1245	216	125	-89%	137
SE	36	31	30	-16%	31
UK	721	146	63	-84%	115
EU-28	7679	1987	1193	-81%	1436

Table 3.2: Updated GAINS NO_x estimates for 2005 and 2030, current legislation (CLE) and maximum technically feasible reductions (MTFR), in kilotons. Emission reduction commitments proposed in the Clean Air Policy package (in % relative to 2005), and resulting emission ceilings based on the updated GAINS estimate for 2005 (in kilotons)

	Updated GAINS estimates			Proposed emission reduction commitment rel. to 2005	Resulting emission ceiling
	2005	2030 CLE	2030 MTFR		[kt]
AT	230	65	52	-72%	64
BE	303	131	97	-63%	112
BG	161	60	41	-65%	56
HR	80	39	16	-66%	27
CY	21	6	4	-70%	6
CZ	294	114	84	-66%	100
DK	178	62	46	-69%	55
EE	40	19	11	-61%	16
FI	184	94	75	-51%	90
FR	1399	451	343	-70%	420
DE	1436	559	405	-69%	445
GR	402	127	97	-72%	112
HU	150	57	37	-69%	47
IE	136	41	28	-75%	34
IT	1189	454	345	-69%	368
LV	41	25	19	-44%	23
LT	50	25	18	-55%	22
LU	56	8	8	-79%	12
MT	9.0	1.6	1.0	-89%	1.1
NL	364	149	112	-68%	117
PL	774	386	283	-55%	348
PT	246	99	61	-71%	71
RO	305	132	85	-67%	101
SK	91	51	34	-59%	37
SL	49	17	13	-71%	14
ES	1366	473	341	-75%	341
SE	200	67	59	-65%	70
UK	1520	422	284	-73%	410
EU-28	11276	4134	2999	-69%	3523

Table 3.3: Updated GAINS PM2.5 estimates for 2005 and 2030, current legislation (CLE) and maximum technically feasible reductions (MTFR), in kilotons. Emission reduction commitments proposed in the Clean Air Policy package (in % relative to 2005), and resulting emission ceilings based on the updated GAINS estimate for 2005 (in kilotons)

	Updated GAINS estimates			Proposed emission reduction commitment rel. to 2005	Resulting emission ceiling
	2005	2030 CLE	2030 MTFR		[kt]
AT	22	13	9	-55%	10
BE	37	32	18	-47%	20
BG	39	23	11	-64%	14
HR	15	11	4	-66%	5
CY	3	1	1	-72%	1
CZ	34	24	15	-51%	17
DK	27	13	9	-64%	10
EE	20	13	5	-52%	10
FI	35	25	18	-39%	21
FR	245	126	90	-48%	127
DE	121	81	64	-43%	69
GR	61	29	15	-71%	18
HU	32	20	10	-63%	12
IE	11	7	6	-35%	7
IT	141	92	58	-45%	78
LV	30	18	7	-45%	16
LT	22	15	6	-54%	10
LU	2.9	1.8	1.5	-48%	1.5
MT	0.69	0.18	0.13	-80%	0.14
NL	24	16	13	-38%	15
PL	219	195	103	-40%	132
PT	59	36	17	-70%	18
RO	144	88	35	-65%	50
SK	35	22	10	-64%	12
SL	15	11	3	-70%	5
ES	144	117	47	-61%	56
SE	32	27	17	-23%	25
UK	93	67	40	-47%	49
EU-28	1663	1125	628	-51%	807

Table 3.4: Updated GAINS NH_3 estimates for 2005 and 2030, current legislation (CLE) and maximum technically feasible reductions (MTFR), in kilotons. Emission reduction commitments proposed in the Clean Air Policy package (in % relative to 2005), and resulting emission ceilings based on the updated GAINS estimate for 2005 (in kilotons)

	Updated GAINS estimates			Proposed emission reduction commitment rel. to 2005	Resulting emission ceiling
	2005	2030 CLE	2030 MTFR		[kt]
AT	63	68	46	-19%	51
BE	72	72	58	-16%	61
BG	39	38	31	-10%	35
HR	40	41	26	-24%	30
CY	6	6	4	-18%	5
CZ	71	60	45	-35%	46
DK	77	56	42	-37%	49
EE	10	12	8	-8%	9
FI	40	36	29	-15%	34
FR	687	653	485	-29%	487
DE	586	543	336	-39%	358
GR	58	48	38	-26%	43
HU	79	68	48	-34%	52
IE	110	104	89	-7%	102
IT	435	400	308	-26%	322
LV	15	17	14	6%	16
LT	35	39	29	7%	38
LU	6	6	4	-24%	5
MT	1.7	1.6	1.1	-24%	1.3
NL	146	111	109	-25%	110
PL	329	333	217	-26%	243
PT	71	73	50	-16%	60
RO	186	163	122	-24%	141
SK	29	24	17	-37%	18
SL	19	17	14	-24%	14
ES	372	344	221	-29%	264
SE	54	49	39	-17%	45
UK	310	294	237	-21%	245
EU-28	3944	3673	2665	-27%	2883

Table 3.5: Updated GAINS VOC estimates for 2005 and 2030, current legislation (CLE) and maximum technically feasible reductions (MTFR), in kilotons. Emission reduction commitments proposed in the Clean Air Policy package (in % relative to 2005), and resulting emission ceilings based on the updated GAINS estimate for 2005 (in kilotons)

	Updated GAINS estimates			Proposed emission reduction commitment rel. to 2005	Resulting emission ceiling [kt]
	2005	2030 CLE	2030 MTFR		
AT	170	101	49	-48%	88
BE	151	111	70	-44%	85
BG	128	52	33	-62%	49
HR	77	48	25	-48%	40
CY	11	6	4	-54%	5
CZ	196	106	55	-57%	84
DK	112	57	33	-59%	46
EE	38	28	12	-37%	24
FI	118	61	38	-46%	64
FR	1216	594	399	-50%	608
DE	1183	764	448	-43%	674
GR	263	116	60	-67%	87
HU	130	71	35	-59%	53
IE	59	40	22	-32%	40
IT	1165	655	401	-54%	536
LV	56	32	11	-49%	28
LT	80	43	17	-57%	34
LU	14	7	4	-58%	6
MT	3.9	2.8	1.4	-31%	2.7
NL	188	138	101	-34%	124
PL	605	398	192	-56%	266
PT	223	133	91	-46%	121
RO	390	173	100	-64%	140
SK	71	53	28	-40%	43
SL	45	31	13	-63%	17
ES	871	595	359	-48%	453
SE	205	123	86	-38%	127
UK	1063	664	431	-49%	542
EU-28	8833	5277	3117	-50%	4387

4 Conclusions

The proposal of the European Commission for amending the Directive on National Emission Ceilings with national emission reduction commitments for six main pollutants (EC 2013a) has been informed by quantitative modelling of the benefits and cost-effectiveness of further emission control measures. In order to avoid unfair distortions in the distribution of emission reductions between countries, it is important that an unbiased EU-wide cost-effectiveness analysis starts from an internationally consistent emission inventory that covers the full set of emission sources with plausible data, even if a sector is not reported by a country or a country applies a different methodology. At the same time, the harmonized emission inventories should resemble national submissions as closely as possible, in order to increase political acceptability of results.

The proposal has been informed by quantitative modelling analyses of cost-effective emission reduction strategies with the GAINS integrated assessment model by the International Institute for Applied Systems Analysis (IIASA), with extensive consultation of Member States and stakeholders since 2011.

To improve the understanding of GAINS model results, underlying assumptions, and any errors therein prior to developing formal positions on the overall ambition level of the Commission proposal on the Clean Air Policy Package, the Council Presidency, supported by the Member States and the Commission, allowed for a round of bilateral consultations with national experts. Between March and July 2014, IIASA held bilateral meetings with all 28 Member States involving more than 110 experts.

The bilateral discussions revealed that most of the discrepancies between the GAINS estimates for the Commission proposal and the latest submission of national inventories are related to four factors: (i) changes in national 2005 estimates between the 2012 and 2014 submissions, (ii) the completeness of national inventories, (iii) the use of a uniform calculation methodology, and (iv) discrepancies between national and international statistics.

A considerable number of Member States have revised their emission estimates for the year 2005 in the last two years as compared to the 2012 submission of national inventories against which the GAINS model was calibrated after the last round of bilateral consultations in 2012. These changes were discussed at the bilateral meetings, and updated information was subsequently implemented in the GAINS databases. Sectors that are not reported in national inventories have been identified, and plausible surrogate estimates for the international cost-effectiveness analysis have been developed with national experts. This was also done for sources for which Member States applied simplified methodologies in the inventories that do not take account of important national circumstances with large impact on mitigation potentials. Finally, Member States provided additional statistical information to improve the accuracy of information derived from international statistics.

All this information has been incorporated into the GAINS databases, and updated emission estimates have been performed, resulting in a greatly improved match of GAINS estimates with national inventories while preserving international comparability. In general, for national totals, the new GAINS estimates for 2005 match the latest 2014 national submissions for quite closely, and differences are now typically within a few percentage points, which is well within the range in which national submissions have changed between 2012 and 2014.

However, there remain notable exceptions where differences are significantly larger. In all cases, there are important and objective reasons that explain these differences, e.g., missing sectors in national inventories, different calculation methodologies, differences in statistical data (e.g., on fleet composition), or forthcoming new submissions that will be close to the current GAINS estimate.

Obviously, differences at the sectorial level are often larger, partly because in some cases estimates are problematic for a few sectors only, partly because national classifications of emission sources are not always consistent with the GNFR reporting system, and partly because some of the sectors are missing at all in some countries.

Changes in the 2005 inventories will also affect projections of future emissions and further mitigation potentials. In addition, national experts offered sometimes different perspectives on possible ranges of future emissions, e.g., due to different applicability of certain emission control measures. It is found that, despite the significant changes in the 2005 inventories, the suggested emission reduction requirements for 2030 remain within the technical feasibility that is estimated by the GAINS model, even with updated information on applicabilities of emission control measures. The only notable exception is SO_2 for Hungary, where the 2005 inventory dropped by 66% between 2012 and 2014. Further work is necessary to explore the implications on emission control costs of the proposed emission reductions requirements.

References

Amann M, Borken-Kleefeld J, Cofala J, et al. (2014a) The Final Policy Scenarios of the EU Clean Air Policy Package. TSAP Report #11. International Institute for Applied Systems Analysis, Laxenburg, Austria.

Amann M, Borken-Kleefeld J, Cofala J, et al. (2014b) Summary of the Bilateral Consultations with National Experts on the GAINS Input Data. International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria.

EC (2013a) Proposal for a Directive of the European Parliament and of the Council on the reduction of national emissions of certain atmospheric pollutants and amending Directive 2003/35/EC. European Commission (EC), Brussels, Belgium

EC (2013b) Impact Assessment accompanying the documents Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions -a Clean Air Programme for Europe. European Commission (EC), Brussels, Belgium

Annex 1: Changes implemented in the GAINS database

For all countries:

- Non-exhaust PM2.5 emission factors have been revised, now with higher contribution from abrasion and less from tyre wear. Net effect is small.
- Where appropriate, vehicle mileage and vehicle stock has been adjusted to reflect changes in fuel consumption by vehicle category.
- Where appropriate, changes in fuel allocation or age structure of the year 2005 have been propagated up to 2030, using growth rates and absolute fuel consumption from the PRIMES 2013 Reference Scenario.

Austria

- Comments (provided in GAINS format) were included (available from IIASA upon demand)
- S content and control strategies for the domestic sector - light fuel oil modified
- SO2 emissions from process sources (cement and iron and steel industry) corrected
- Emissions from pipeline compressors included (previously treated as industrial combustion)
- PM - combustion devices structure and control strategy for the domestic sector changed following AT recommendations.
- Diesel allocation to light and heavy duty vehicles has been adjusted. Full agreement with experts on mobile source emissions, including projected values.
- Used national information to split biomass and waste into appropriate GAINS categories.
- National milk yield assumptions and evolution of livestock numbers have been implemented in a national scenario, but not for the CAPRI baseline currently used in GAINS
- Applicabilities of covered stores of slurry, low nitrogen feeding (phase feeding) for pigs, and for low nitrogen application of slurry implemented (but no major change for 2030).
- For decorative paints an error in the time series in GAINS was corrected, with growth linked to the development in the AT construction sector as projected in PRIMES.
- Comments on VOC emission factors for residential wood combustion in small boilers and stoves have been included.

Belgium

- Comments (provided in GAINS format) included (available from IIASA upon demand)
- Corrected PRIMES activity data in iron and steel industry for 2010 to international statistics (slightly different from BE suggestions)
- Projection I&S - total steel production as in PRIMES, share of electric arc steel kept constant, production of pig iron and sinter proportional to the production of basic oxygen steel
- Production levels of cement and glass as provided by PRIMES (consistent with international statistics).
- Other process activities changed to values suggested by BE

- Activities and emission factors for biomass use in the domestic sector corrected to the newest estimate by BE (higher activity, higher emission factors).
- Allocation of diesel to light and heavy duty vehicles has been adjusted.
- Small adjustments for waste water treatment based on the latest submission
- Missing emissions from agricultural waste burning in national inventory. GAINS estimate used.
- Maximum applicability of VOC specific measures adjusted.

Bulgaria

- Domestic sector emission factors for SO2/PM modified according to national data
- Controls for PM in the domestic sector adjusted
- Power plant emission factors for SO2/NO_x were modified according to national data
- Controls in power plant sector adjusted
- SO2 emission factor for sulfuric acid modified according to national data
- PM emissions from open burning of agricultural waste not in BG inventory. Gains value assumed.
- Complete check of mobile source calculation, but no revision necessary. GAINS assessment of higher emissions due to old, non-catalyst cars confirmed by Bulgarian experts.
- Comments on livestock numbers for historical years were accepted to the extent that they do not contradict EUROSTAT and UNFCCC statistics.
- Emission factors for livestock revised (However, some differences remain for dairy cattle for which Bulgaria relies on Tier 1.
- Emissions from water waste treatment adjusted.
- VOC emission factors for large scale (industrial boilers and power plants) combustion of coal have been harmonized with the national inventory and the recent edition of EMEP Guidebook.
- Emission factors for biomass heating stoves have been modified.
- Activity data and emission estimates for chemical industry adopted.
- Solvent use sector has been adjusted based on comments received. However, some differences remain due to lacking detail on statistical data.
- Comments on historical activity data implemented

Croatia

- Controls for PM in the domestic sector adjusted
- Controls for SO2/NOx in power plant sector adjusted
- Controls for SO2 in PR_SUAC adjusted
- Controls for SO2 in TRA_RD modified
- Emission factors for NOx in PR_CEM modified
- PM emissions from open burning of agricultural waste not in BG inventory. Gains value assumed.
- Livestock statistics and shares of cattle and pigs kept on solid and liquid manure systems adjusted.
- Emission factors harmonized to the possible extent, but maintaining difference to Tier 1 methodology used by Croatia, especially for cattle and pigs.
- Fertilizer production data and emission factors adjusted.
- Emission factors for mineral N fertilizers adopted.
- Emissions from latrines corrected.
- Detailed comments on emission factors, activity data, control strategy for selected sectors including domestic use of solvents, food and drink industry, chemical industry, glue application, dry cleaning have been obtained.

Cyprus

- Controls for PM in the domestic sector adjusted
- Controls for PM in PR_CEM adjusted.
- Livestock numbers adjusted for historical years, but in a few cases (especially for poultry and pigs) original GAINS numbers were retained to maintain consistency with EUROSTAT and UNFCCC statistics.
- Updated statistics on fertilizer use in 2005 and 2010.
- Updates of solvent sector emissions, including printing, glue application. Since some differences remain, more information is needed to improve the match between the inventory and GAINS.

Czech Republic

- Controls for PM in the domestic sector adjusted
- Distribution of coal use in the domestic modified according to national scenario
- SO2 emission factors and controls for coal use in the domestic sector adjusted
- Controls for NOx in power plant sector adjusted
- National inventory for PM is incomplete. Missing sectors: industrial processes, non-road mobile sources, cigarette smoking, barbecues and fireworks, open burning of municipal and agricultural waste, as well as emissions from agricultural activities.

- Emissions from small combustion installations are very low, CZ plans to revise estimates for small installations in the next inventory. Values as calculated by GAINS were regarded as realistic by national experts.
- New statistical data for poultry, rabbits and nitrogen fertilizers implemented.
- Emission factor for urea was adjusted.
- Allocation of diesel to light and heavy duty vehicles modified, less gasoline for mopeds.
- Age structure of trucks revised; age structure for cars reviewed but maintained.
- VOC emission factors for motorized two-wheelers and decorative paint adjusted.
- Car manufacturing statistics and reported plant emissions have been incorporated.
- Latest estimates of emissions from degreasing operations included.
- Recent estimates for printing and domestic solvent use included.

Denmark

- Controls for SO2/PM in power plant sector adjusted.
- SO2 emissions from cement/lime adjusted.
- SO2 emission factors for shipping modified.
- PM controls for refineries adjusted.
- Changed emissions from iron and steel processes (SO2 - coke use).
- Changed distribution of coal use in the power sector (BC1/BC2).
- Changed emission factors for process sources (refineries, other emissions not included in GAINS).
- Adjusted control strategies for SO2 and NOx in the power sector.
- Adjusted NMVOC emission factors for biomass combustion in the domestic sector.
- Diesel allocation to light and heavy duty vehicles revised.
- Age structure of cars/LCV revised.
- Updated VOC evaporative emission factors and NOx emission factors for LDVs.
- Adjusted statistical livestock numbers.
- Updated shares of animals kept on liquid and solid manure systems.
- Updated emission factors for horses, sheep.
- Updated control strategies, i.e., penetration of mitigation measures.
- Updated emission factors for mineral nitrogen fertilizers (Denmark has reviewed them recently and recalculated the whole time series in their official estimates)
- Updated VOC emission factors for stationary gas engines.

Estonia

- Adjusted the amount of shale oil and gas produced from oil shale. Data based on PRIMES projections. National projections are higher, can be included in the national scenario.
- Changed emission factors for production of shale oil and shale oil gas (SO2, NOx, NMVOC)
- Changed emission factors for electricity production from oil shale.
- Changed emission factor for gas power plants (turbines).
- Age structure of cars/LCVs and HDVs adjusted.
- Allocation of more diesel fuel to non-road sectors.
- Statistical data for animal numbers (horses) were adjusted.
- Emission factors for pigs were reviewed and modified.
- Share of urea in N mineral fertilizers was adjusted for the most recent years.
- Emission estimates for non-agricultural sources, i.e., waste and industry have been adjusted following the most recent reporting.
- Comments of Estonia on the expected evolution and emissions from oil terminals were included; both historical and projections affected.
- Coating application (decorative and industrial) activity data and penetration rate of measures updated.
- Activity data and implied emission factors for printing updated.
- Emission factors for domestic use of solvents updated.
- Activity data and emission factors for chemical industry, wood preservation, degreasing, dry cleaning updated updated.

Finland

- Implemented FI -specific emission factors for SO2, NOx, and PM
- Emissions from peat mining and from small combustion adjusted to the values to be reported in the next update of the inventory.
- Data on housing days, milk yield, and nitrogen excretion rates modified
- Penetration of mitigation measures in the agricultural sector adjusted
- Shares of animals kept on solid/liquid manure systems modified.
- Adjustments for non-agricultural sources of NH_3.
- Maximum application rates for covered stores and low ammonia application techniques were adjusted.
- Emission factor PM abrasion has been increased to match Finnish value, which accounts for studded tyres;
- VOC emissions from cars reduced.
- Age structure of HDV adjusted, less old vehicles.
- Remaining difference in NOx is mainly due to differences in emission factors, with the FIN/LIPASTO model suggesting significantly lower values (except for NOC) than

GAINS/COPERT. Apparently, the FIN/LIPASTO values will be revised upwards in the near future.

- Non-road: Significantly lower EF for NOx and PM for agricultural and construction machinery in Finnish inventory. GAINS numbers consistent with EEA Guidebook and can remain.
- Differences in VOC emissions appear like different allocation between shipping and NRMM – the sum of these two sectors is ok between GAINS and the FIN inventory.
- Comments on emission factors for residential combustion sources implemented. Results are consistent with the information provided by FI experts, but about 10 kt lower than those officially reported to EMEP.
- Process emissions from refinery adjusted.
- Activity data and emission factors harmonized with national inventory for:
    - Coating operations (decorative and industrial paint application),
    - Pharmaceutical industry,
    - Domestic use of solvents,
    - Degreasing and dry cleaning,
    - Printing,
    - Chemical industry.

France

- Comments (provided in GAINS format) were included (available from IIASA upon demand)
- S-free heating oil for residential consumers is treated as viable option in the MTFR scenario (already available in some countries).
- Revised age structure for cars, LCV and HDV.
- Adjusted allocation of diesel fuel between light and heavy-duty vehicles.
- Historical data on number of cattle, pigs, and poultry adjusted
- Shares of animals kept on solid/liquid manure systems updated
- Applicabilities for improved urea application and for high efficiency application of cattle and pig manures (solid and liquid) adjusted.
- Emission factors for heating stoves adjusted
- Emissions from oil production and distribution adjusted
- Emission factors for domestic solvent use adjusted
- Statistics and projections for car manufacturing industry updated.
- Adjustments for of activity data for decorative painting, industrial glue application, printing (packaging), pharmaceutical industry.

Germany

- Emissions from iron and steel processes updated (SO2 - coke use)
- Changed distribution of coal use in the power sector (BC1/BC2)

- Changed emission factors for process sources (refineries, other emissions not included in GAINS)
- Adjusted control strategies for SO2 and NOx in the power sector
- Adjusted NMVOC emission factors for biomass combustion in DOMestic sector.
- Allocation of diesel fuel between light and heavy-duty vehicles changed.
- Revised age structure for cars, LCV and HDV.
- Statistical data on animal numbers for pigs, horses, mineral fertilizers (urea) harmonized
- Shares of animals kept on liquid and solid manure systems adjusted
- Grazing days for cattle adjusted
- Nitrogen excretion and NH3 volatilization adjusted
- Emission factor for urea and other N mineral fertilizers harmonized
- Penetration of control measures updated
- Activity data for coating, printing operations and chemical industry have been updated.
- Fugitive emissions from fuels have been updated.
- Residential combustion emission factors and the structure of installations were harmonized with the PM estimates.

Greece

- Emission factors and controls for SO2/NOx in the domestic sector were adjusted (although does not result in good fit for NOx)
- Emission factors for SO2 were modified for heavy fuel oil in industry combustion and fishery
- Controls for SO2 in industry and the power sector updated
- NOx from power plant engines adjusted (controls)
- Controls for NOx in the power sector and cement prod updated
- PM is not reported by Greece.
- Most importantly: about 20 PJ of heating oil was allocated to road transport sector based on national data.
- Adjusted allocation of gasoline and diesel over vehicle categories.
- Revised the age structure of the fleet.
- Reviewed evaporative emission factors (VOC).

Hungary

- Recent version of emission inventory from May 2014 used to recalibrate GAINS.
- Emission factors for SO2/NOx and PM in the domestic sector adjusted according to national data
- Controls for PM in the domestic sector adjusted

- Emission factors and controls for SO2/NOx/PM in power plant sector based on national data
- SO2/NOx from refineries and cement prod adjusted
- Gas use in power plant sector modified as suggested
- Emissions from agricultural waste burning not included in HU inventory, emissions from agriculture much lower than estimated according to GAINS methodology. No emissions from cigarette smoking etc. PM from missing sources add 17 % to national total.
- Full agreement with national expert on base year and projection for mobile sources emissions. No changes needed, national inventory will be changed to GAINS values.
- Agricultural activity data for historical years harmonized with the inventory.
- Emission factors for cattle modified.
- Revised of emission factors for stoves and domestic boilers.
- Control strategy for refineries updated.
- Several solvent sectors have been updated (activities, control strategies) using the recent UNECE submission and associated report, specifically degreasing, decorative paints.

Ireland

- Controls and emission factors for PM in the domestic adjusted.
- Controls for SO2/NOx in power plant sector adjusted based on national data.
- NOx emissions in industry sector adjusted.
- Controls for NOx in cement production adjusted.
- Allocation of diesel between light and heavy duty vehicles adjusted.
- Age structure of fleet adjusted according to national data.
- Statistical data (cattle, pigs, poultry) harmonized with national inventory for 2000-2010, including shares of animals kept on liquid and solid manure systems.
- There are still issues about increase of Nitrogen excretion with growing milk yield where Ireland assumes much higher increases; for now, more moderate increases estimated by GAINS are used.
- Control strategy for printing sector adjusted.
- Emission factor for domestic solvent use adjusted.

Italy

- Italian comments (in GAINS format) were included (available from IIASA upon demand)
- Italy provided adjusted energy data in GAINS format, in which fuel used for on-site co-generation of heat in industrial CHP plants was allocated to the power sector (consistent with PRIMES/GAINS methodology)
- Modified consumption of fuel wood in 2005 to include non-commercial fuel. (FWD in 2005 for the domestic sector multiplied by 1.7; 2010 values in national scenario similar to PRIMES).

- Changed PM emission factors for fuel wood in the domestic sector (multiplied by 0.6).
- Changed process data (OTHER_SO2, agricultural waste burning) to values suggested by IT
- Changed SO2 emission factors for process emissions in industry and factors for liquid fuels combustion in industry
- Changed fuel distribution in the power sector (turbines, boilers, CCGT plants, HC1 vs. HC2)
- Changed fuel allocated to pipeline compressors.
- Adopted the fuel redistributions in the transport sector as suggested by Italy, with some agreed adjustments for powered two-wheelers.
- VOC emission factor for two-stroke mopeds and cars as well as evaporative emission factors adjusted.
- Increased emission factor for PM abrasion.
- 2005 livestock statistics for other cattle corrected (numbers reported to EUROSTAT had double counting of buffaloes for 2005)
- Activity data for rabbits added in GAINS
- New estimates for open burning of agricultural waste have been provided; has impacts on emissions of PM, NMVOC too.

Latvia

- Emission factors for SO2/NOx/PM in the domestic sector were adjusted (wood and coal)
- Controls for SO2/PM in the domestic sector modified
- Power plant sector controls for SO2/NOx adjusted
- NOx emission factors for gas use in industry adjusted
- Process activities differ a lot between PRIMES and national assessment. Values for national inventory are provided directly by enterprises, without guarantee that all sources are included.
- OTH_SO2/OTH_NOx used for calibration.
- NMVOC evaporative emission factor for cars has been reduced.
- Allocation of diesel to light and heavy duty vehicles adjusted.
- Age structure of the fleet adjusted (less cars without catalyst)
- Livestock numbers for horses, sheep, and poultry corrected.
- Total mineral N fertilizer statistics introduced
- Shares of cattle kept on liquid and solid manure systems adjusted
- Emissions from waste water treatment included
- Nitrogen excretion rates for horses and sheep updated.
- Using IFA (statistical
- Data for urea vs other N fertilizers was updated, based on International Fertilizer Association) database.

- However, comments on NH_3 emissions from stationary combustion (representing ~15% of total Latvian NH_3) were not adopted as these numbers (taken from a draft US EPA report (2004) and listed in EMEP Guidebook) are much higher than in all other countries.
- Activity data and emission factors for solvent use have been updated.

Lithuania

- New emission inventory data for the historical years provided by LITH - implemented
- Emission factors for SO2/NOx/PM in the domestic sector adjusted (wood and coal)
- Emission factors and controls for SO2/NOx/PM in the power plant sector adjusted
- Use of low-sulphur diesel in the transport sector updated
- SO2/NOx from refineries and sulfuric acid production adjusted
- Emission factors for PM for heavy fuel oil modified in industry and power plant sector.
- Age structure of the fleet adjusted (less cars without catalyst)
- Number of horses and sheep adjusted according to recent statistics
- Share of cattle kept on solid/liquid manure systems updated
- Emission factors for fertilizer production and consumption updated
- Share of urea in mineral N fertilizer used updated using latest data from IFA (International Fertilizer Association)
- Emission factors for key livestock categories reviewed, but owing to methodological difference (Lithuania uses Tier 1 method) some differences remain, especially for cattle.
- VOC emission factors for domestic solvent use, food and drink industry updated
- Activity data for printing, coating applications, degreasing, dry cleaning updated
- Emissions from chemical industry harmonized with national inventory
- Control strategy for refineries updated

Luxemburg

- Use of low-sulphur diesel in the domestic sector was updated
- It is noted that glass production is missing in the PRIMES data (probably included in the Belgian statistics). Effect on emissions is very small.
- Allocation of diesel to light and heavy duty vehicles adjusted, vehicle total mileage and vehicle numbers modified accordingly.
- Reduced VOC hot and evaporative emissions from two-stroke mopeds and gasoline cars. However, national values for evaporative emissions still a factor 10 lower, resulting in lower overall VOC emissions.
- Activities in solvent sector updated
- Activity data and control strategy in the distribution of oil product sector updated.

Malta

- Suggestions for emission controls in the power sector for future years provided by Malta were implemented.
- Fuel consumption in 2005 for passenger cars adjusted to national statistics.
- Non-exhaust PM emissions have been reviewed. The value used by Malta seems one order of magnitude too high, resulting in 50% of national total PM2.5 emissions)

Netherlands

- Changes suggested by national experts have been included
- Comparisons with GAINS inventories are based on fuel sold concept
- Emissions from agricultural waste burning are not included in NL inventory, emissions from open burning of residential waste are much lower than estimated by GAINS. Emissions from cigarette smoking, barbecues and fireworks much lower than in GAINS.
- Based on the recent UNECE submission and associated reports, emission estimates for the base year and projections for the waste water treatment updated
- Update of non-agricultural sources of ammonia, based on comments received and latest inventory.
- Age structure of the car fleet adjusted.
- VOC evaporative emissions from gasoline cars reduced.
- Age structure and NOx emission factors for vessels adjusted.
- Vehicle kilometres for HDVT adjusted.
- Fuel consumption for fisheries adjusted.
- Note: Emissions from recreational boats are in GAINS allocated to ‘off-road’ category, while they are in the ‘inland shipping’ sector in the national inventory. Relevant for VOC emissions.
- Data for oil and gas exploration, storage of crude and oil products as well as their consecutive distribution have been reviewed.
- Emissions from chemical industry,
- The suggestion for solvent use developing parallel to GDP has not been taken up, as GAINS assumes for all countries saturation at high GDP/capita levels, supported by historic evidence.

Poland

- Emissions from agricultural waste burning were corrected based on Polish studies.
- Control strategies were corrected: controls for medium combustion sources were removed since they do not reflect current Polish legislation according to Polish experts.
- Control strategies for the power sector were corrected to be consistent with the inventory.
- Use of non-commercial dirty coal in households (as assumed in GAINS) was confirmed by Polish experts. New Polish studies suggest that PM2.5 emissions in the national inventory should be at least 50 kt higher. Since the Polish assessment is of preliminary character, the

"old" GAINS assumptions for this source, which result in slightly higher emissions, have been maintained.

- Emissions from agricultural tractors have been reviewed; however, national time series of fuel consumption are inconsistent and probably a factor 2 too high in year 2005. This explains a big difference for NOx emissions.
- Age structure of fleet reviewed.

Portugal

- The recent Portuguese survey of energy consumption in the domestic sector suggests different numbers for the share of wood combustion devices and for emission factors in the residential-commercial sector. This new information will lower emissions reported in the March 2014 inventory to values that are much closer to the original GAINS numbers.
- Emissions from agricultural waste burning were corrected
- Emissions from the power sector were made consistent with the inventory (important change in SO2 emissions compared with 2012 inventory)
- PT comments were included. Emissions from agricultural waste burning and other agricultural emissions (livestock, other) are not included in PT inventory. No emissions from cigarette smoking etc.
- Portuguese experts confirmed that In the next inventory emissions from small combustion will be adjusted to numbers close to GAINS estimates.
- Allocation of diesel to light and heavy duty vehicle, and the corresponding vehicle total mileage and vehicle numbers have been adjusted.

Romania

- Emission factors and controls for SO2/NOx/PM in the domestic sector were adjusted
- SO2 controls in power sector were adjusted
- NOx controls in the power sector were adjusted
- PM from AGR_WASTE burning is large and results in an overall big difference for national total emissions.
- Age structure for cars has been adjusted.
- Evaporative emissions from cars reduced.
- The key issue relates to the Tier 1 method used in the national l inventory for cattle. Current GAINS methodology retained, but input data updated to national statistics,
- Share of animals kept on liquid/solid systems updated
- Share of urea in total N mineral fertilizer use updated based on the recent IFA data.
- Adjustments made to the VOC emission factors for residential wood combustion; modifications were harmonized with PM estimates. However, full harmonization is not possible as Romania is using Tier-1 approach where differences between different types of stoves, boilers are not reflected.

- Several solvent use sectors were revised based on the national 2014 submission and the associated report.

Slovakia

- Emission factors and controls for SO2/NOx/PM in the domestic sector were adjusted
- Controls for SO2/NOx/PM in the power sector adjusted
- Emission factors for PM in the power sector modified
- The use of low-sulfur fuels in the transport sector was updated
- SO2 controls in industrial processes adjusted
- NOx and PM controls in industrial combustion adjusted
- Emission factors for PM from industrial processes modified.
- Main reason for difference in emissions from transport: Fuel consumption assumed in national inventory is much higher than reported to EUROSTAST, both HDV and cars.
- Slightly revised age structure for cars.
- SO2 emission factors for processes in metallurgy and chemical industry were adjusted
- PM emissions from small combustion are higher in the national inventory (due to Tier 1 methodology).
- Emissions from agriculture and cigarette smoking etc. missing in the national inventory.
- Adjustments were made to emission factors for residential wood combustion, harmonized with the changes to the structure of fuel use and PM estimates. However, full harmonization is not possible as Slovakia is using Tier-1 approach with only one emission factor for all types of stoves.

Slovenia

- Emission factors and controls for NOx/PM in the domestic sector were adjusted
- NOx controls in the power sector were adjusted (coal)
- Emission factors and controls for PM in the power sector adjusted
- Controls for cement production updated
- Correction of emissions from coke use in iron and steel industry
- Activity data and emission factors for non-road mobile sources were corrected
- Peat and petroleum coke use in the domestic sector was included
- Revised activities for process sources.
- Fuel consumption structure in the domestic sector (division between combustion devices types) was changed.
- Technology penetration for biomass devices in the domestic sector was adjusted.
- Age distribution of cars and LDV have been adjusted.
- Age distribution for non-road mobile machinery (NRMM) adjusted.

- Reduced NOx and VOC emission factors for NRMM.
- Livestock statistics updated.
- Shares of solid/liquid systems, also for the future, updated.
- Applicabilities for low nitrogen fodder and improved application or substitution of urea implemented.
- Slovenia has stopped producing mineral N fertilizers; GAINS database updated.
- Emission factors for domestic solvent use updated
- Emission from coal mining added
- Harmonization of the emission factors for large scale coal combustion plants, i.e., industrial boilers and power plants
- Shares of different residential combustion installations updated

Spain

- Corrected emissions from industrial processes (cement, iron and steel)
- Emissions from the power sector changed
- Activity data for national shipping and fishing modified according to the recent national assessment
- Other differences for PM due to missing (or very low) estimates in the Spanish inventory: Agricultural wastes, cigarette smoking, barbecues and fireworks, agricultural emissions - other, open burning of agricultural waste.
- Historical time series of mineral nitrogen fertilizers (including urea) revised.
- Updates of historical livestock numbers
- Emission factors for urea and other N fertilizers harmonized with national inventory
- Emissions from waste water treatment updated following the national inventory
- Based on the N excretion rates reported in the recent Spain's informative report associated with the 2014 submission to UNECE, emission factors for livestock were revised.
- Revised our controls for non-road mobile machinery (NRMM) to reflect a younger fleet.
- Lower NOx and VOC emission factors for NRMM.
- Lower shares of preEuro gasoline cars and LCV, hence much less VOC and also NOx emissions from road transport. The remaining difference is due to difference in fuel consumption.
- Note: Emissions from recreational boats are in GAINS allocated to 'off-road' category, while they are in the 'inland shipping' sector in the national inventory. Relevant for VOC emissions.

Sweden

- Corrected (lower) NOx emission factors for biomass consumption in the power and heat generation sector
- Corrected PM emissions from processes (cement and iron and steel metallurgy)
- Corrected SO2 emissions from metallurgical processes
- Major source of difference for PM - non-road mobile sources.
- Controls for gasoline LDV adjusted to reflect a somewhat younger fleet.
- Lower NOx emission factor for gasoline LDV.
- Key difference on NOx emissions: 20 PJ more diesel fuel reported to EUROSTAT (and hence higher emissions from road transport) than accounted for in national inventory calculation.
- Fuel consumption for national navigation adjusted.
- Controls for shipping adjusted to reflect national emission factors.
- Revised control shares for NRMM to reflect a younger fleet, and for 'other land based' sources.
- GAINS lumps emissions from forestry, lawnmowers, recreational boats and snowmobiles (all 2-strokes machines) together into category OT-LD2. This may not exactly match national NFR categories. Relevant for VOC comparisons.

UK

- UK comments (provided in GAINS format) included (available from IIASA upon demand)
- Correction of emissions from coke use in iron and steel industry
- Modified activities and emission factors for non-road mobile sources
- Inclusion of peat and petroleum coke use in the domestic sector
- Revised activities for process sources
- Fuel consumption structure in the domestic sector (division between combustion devices types) adjusted.
- Technology penetration for biomass devices in the domestic sector adjusted.
- Shares of animals kept on liquid and solid manure systems and its likely evolution updated
- Minor updates of livestock statistics
- NH_3 emission from non-agricultural sources updated.
- Fuel allocation to vehicle category and age structure of fleet adjusted.
- Harmonization of VOC emission factors for large scale coal combustion plants, i.e., industrial boilers and power plants.
- Comments for solvent use operations implemented.