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# **Adjusted historic emission data, projections, and optimized emission reduction targets for 2030 – A comparison with COM data 2013**

**Part A: Results for EU-28**

**TSAP Report #16A**

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## Executive Summary

With the new information that has been provided by Member States in the course of the bilateral consultations, an updated emission control scenario has been developed that results in the same relative reduction in premature mortality as the original Commission proposal (52% by 2030 compared to 2005) with the same gap closure of 67%. Hence the overall reduction of PM precursor emissions (primary PM<sub>2.5</sub>, NO<sub>x</sub>, SO<sub>2</sub>, VOC and NH<sub>3</sub>) converted into 'PM equivalent emission quantities' remains the same compared to the earlier proposal. However, the improved information on the structure of PM<sub>2.5</sub> emission sources in 2005 and their likely future development suggests a larger decline of PM<sub>2.5</sub> emissions in the baseline case, which thus requires less additional measures to achieve the targeted reduction in premature mortality. This also softens the emission reduction requirements for the other pollutants, and reduces costs for the additional measures by one third compared to the original proposal.

From the updated data, it could be derived that about half of the PM equivalent emission reductions that emerge as cost-effective in 2030 have already been achieved in 2012, and about 60% should be attained by the time 2020 (Gothenburg Protocol) targets are met. Compliance prospects for the latter are rather favourable. Moreover, current emission control legislation and projected activity changes resulting from the revised baseline should achieve almost 90% of the required SO<sub>2</sub> reductions by 2030, and more than 95% of the NO<sub>x</sub> reductions. Implementation of new EU-wide legislation (i.e., new BAT conclusions, MCP and NRMM directives) would result in additional reductions that would largely fill the remaining gap towards the required reductions for SO<sub>2</sub> and NO<sub>x</sub>. For PM<sub>2.5</sub>, current legislation is expected to achieve 60% of the required emission reduction, and the IED, MCP, NRMM and Ecodesign directives would further deliver a large part of the additional reduction required. With respect to NH<sub>3</sub> and VOC, current emission control legislation and projected activity changes would deliver about 30% of the reduction for NH<sub>3</sub> and 85% for VOC.

Where the national scenarios provided by MSs showed features that could not be matched with coherent EU-wide scenarios, a sensitivity analysis was carried out. This demonstrates the attainability of re-optimized emission ceilings with available technical emission control measures for the 19 Member States that provided such national projections. A notable exception emerges for Hungary, where the 71 % higher livestock number projected in the national scenario would not allow achieving the NH<sub>3</sub> reduction requirement.

National scenarios are also less optimistic about the effects of climate policies and imply for 2030 higher CO<sub>2</sub> emissions compared to the baseline scenario that has been used by the Commission for the original proposal in 2013 (and not reflecting the outcome of the Climate and Energy Policy Package that has been agreed upon in 2014). The Climate and Energy Policy Package envisages substantially lower CO<sub>2</sub> emissions in the future, and would result as a co-benefit in lower SO<sub>2</sub>, NO<sub>x</sub> and PM<sub>2.5</sub> emissions compared to what has been assumed for the Clean Air Policy Package. Thus, the recent agreement on climate and energy policy offers an additional margin for the attainability of the emission reduction requirements.

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## 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 Report #16', the following scenarios can be examined in an interactive mode:

- WPE2014-CLE: The updated 'current legislation' projection for 2030 of the PRIMES 2013 REFERENCE activity projection
- WPE2014-MTFR: The updated 'maximum technically feasible emission reduction' projection for 2030 of the PRIMES 2013 REFERENCE activity projection
- WPE2014-OPT: The re-optimized 67% gap closure scenario of the PRIMES 2013 REFERENCE activity projection for 2030
- NAT2014-CLE: The updated 'current legislation' scenario for 2030 for the national activity projections
- NAT2014-MTFR: The updated 'maximum technically feasible emission reduction' scenario for 2030 for the national activity projections

## List of acronyms

CAPRI	Agricultural model developed by the University of Bonn
CH <sub>4</sub>	Methane
CLE	Current legislation
CO <sub>2</sub>	Carbon dioxide
COM	European Commission
ERC	Emission Reduction Commitments
EU	European Union
GAINS	Greenhouse gas - Air pollution Interactions and Synergies model
GDP	Gross domestic product
IED	Industrial Emissions Directive
IIASA	International Institute for Applied Systems Analysis
kt	kilotons = 10 <sup>3</sup> tons
MTFR	Maximum technically feasible emission reductions
NEC	National Emission Ceilings
NH <sub>3</sub>	Ammonia
NMVOC	Non-methane volatile organic compounds
NO <sub>x</sub>	Nitrogen oxides
PJ	Petajoule = 10 <sup>15</sup> joule
PM10	Fine particles with an aerodynamic diameter of less than 10 µm
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 <sub>2</sub>	Sulphur dioxide
TSAP	Thematic Strategy on Air Pollution
VOC	Volatile organic compounds
WPE	Working Party on Environment of the European Council
YOLL	Years of life lost

## 1 Background

Current levels of air pollution in Europe cause substantial health and environmental impacts. For instance, in 2010 more than 400,000 premature mortalities annually are linked to exposure to fine particulate matter (EC 2013a). In 2013, the European Commission has proposed a Clean Air Policy Package with the aim to reduce in 2030 health impacts from air pollution by 52% compared to 2005 (EC 2013b).

It is important to note that fine particles remain in the atmosphere for several days during which they are transported over several hundreds of kilometres. As a consequence, locally occurring PM ambient air quality levels are to a significant extent influenced by emission sources in other countries. The analyses for all Member States that are provided in TSAP Report #12 (Kiesewetter and Amann 2014) remain relevant.

To provide a realistic chance for local and national authorities to take effective measures for achieving compliance with air quality limit values, the Clean Air Policy Package includes a proposal for amending the Directive on National Emission Ceilings. To limit the transboundary exchange of emissions, the proposal contains national emission reduction commitments for the five main precursor emissions of fine particulate matter in ambient air and for methane. In addition, the proposal will have further positive side-effects in relation to ground-level ozone, acidification and eutrophication problems.

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. These analyses have been carried out by the International Institute for Applied Systems Analysis (IIASA) using the GAINS Integrated Assessment Modelling suite (<http://gains.iiasa.ac.at>). Final results are presented, inter alia, in the impact assessment accompanying the Commission proposal (EC 2013a) and the TSAP Report #11 (Amann et al. 2014a).

For the analysis for the Clean Air Policy Package, IIASA has compiled 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, after 2012, many Member States have come forward with revised statistical information on emission inventories for the year 2005, with numerous significant changes compared to the 2012 submission.

After the start of the deliberations on the Clean Air Policy Package of the Council Working Party on Environment (WPE), between March and July 2014 IIASA held bilateral meetings with all 28 Member States involving more than 110 experts to review and update input data in view of new statistical information.

Outcomes of these bilateral consultations are summarized in TSAP Report #13 (Amann et al. 2014b). The new information emerging from the consultations has been incorporated into the GAINS databases (TSAP Report #14, Amann et al. 2014c). Due to late information from Member States, some adjustments could not be accounted for in that report. In general, for national totals, the new GAINS estimates for 2005 now 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. Remaining discrepancies between updated GAINS estimates and reported number for 2005 can be explained by objective reasons.

Changes in the 2005 GAINS estimates also affect projections of future emissions and mitigation potentials. As shown in TSAP Report #14, the originally proposed health and environmental targets as well as the resulting emission reduction requirements remain technically achievable also in the updated context (i.e., for the revised emission baseline projections), although not necessarily cost-effective. Since the Commission has proposed cost-effectiveness as an important criterion for setting national emission reduction commitments, this TSAP Report #16 presents an updated set of emission reduction commitments that would meet the health and environmental targets proposed by European Commission in the Clean Air Policy Package in a cost-effective way, based on the revised historic emission estimates and the consequently adapted projections.

This report addresses emissions of air pollutants SO<sub>2</sub>, NO<sub>x</sub>, PM<sub>2.5</sub>, NH<sub>3</sub> and VOC. Although the Commission proposal also includes emission reduction commitments for methane (due to its role as an ozone precursor), this report does not deal with CH<sub>4</sub> emissions, as they are subject of ongoing deliberations between the Member States and the Commission in the context of the 2014 Climate and Energy Package. To maintain consistency with the Climate and Energy Package, no further changes on CH<sub>4</sub> were introduced in GAINS at this time, pending further discussions in Council and Parliament on synergies between the Climate and Energy Package and the Air Quality Package.

The remainder of this report is organized as follows: Section 2 summarizes the changes that have been introduced in the GAINS databases based on the bilateral consultations. The consequences on baseline emissions in 2030 and the scope for further emission reductions are discussed in Section 3. Section 4 presents an updated optimized emission control scenario that meets the health targets established in the Clean Air Policy Package, taking into account the new statistical information. The robustness of the resulting emission reduction requirements in view of alternative national projections of future activity levels is discussed in Section 5. Conclusions are drawn in Section 6. Results at the Member States level, including explanations of the differences to the original 2013 Commission Proposal, are provided in Part B of this report.



## 2 Recent changes in the GAINS database

As mentioned above, the bilateral consultations with national experts resulted in a number of updates in the GAINS databases compared to status of the analyses for the Commission proposal of the Clean Air Policy Package (documented in TSAP Report #11). The main updates relate to the representation of the structure of emission sources in 2005, for which new and sometimes more detailed statistical information has emerged after 2012. In many cases, this new information has also impacts on the future the evolution of emissions due to, e.g., different structures of emission sources in the base year and their foreseen evolution until 2030, or modified implementation schedules for current legislation. In addition, national experts provided also alternative projections of energy or agricultural activities, which have now been implemented in the GAINS database as a separate scenario to facilitate sensitivity analyses.

The bilateral discussions revealed that most of the discrepancies between the 2005 GAINS estimates for the Commission proposal and the latest (2014) submissions of national inventories for 2005 are related to four factors:

- changes in national 2005 estimates between the 2012 and 2014 submissions,
- different coverage of sources,
- IIASA's use of a uniform calculation methodology, and
- discrepancies between national and international official 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 estimates have been developed with national experts for inclusion in the international cost-effectiveness analysis. 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 is documented in detail in TSAP Report #14 (Amann et al. 2014c). However, some of the information came in too late to be included into the TSAP report #14. Updated emission estimates have been performed, resulting in a largely improved match of GAINS estimates with national inventories while preserving international comparability, as documented in this report. In general, for national totals, the new GAINS estimates for 2005 match the latest reported estimates for 2005 (2014 national submissions) quite closely, and differences are now typically within a few percentage points.

Nevertheless, there remain notable exceptions where differences for national totals are significant. 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 updated GAINS estimate. Also, the remaining differences at the sectorial level, often being larger, can be explained

by objective reasons. Unresolved differences have been discussed with national experts, quantified and well documented.

Compared to the 2005 GAINS estimates used for the Commission proposal, largest differences occur for SO<sub>2</sub>, where for the EU-28 the updated GAINS inventory for 2005 is six percent lower than before due to significant downwards revisions of the recent national inventories in a few countries (especially Bulgaria, Germany, Hungary and Portugal). For VOC, EU-28 emissions in 2005 are estimated now four percent lower (mainly due to changes in France, Italy, Romania, Spain, Czech Republic and Finland). Total NO<sub>x</sub> declined by two percent (Italy and Spain), PM2.5 by one percent, and the total NH<sub>3</sub> estimate for the EU-28 remains constant.

Changes in the 2005 GAINS estimates (e.g., different sector splits, implementation levels of emission control measures, etc.) will also affect projections of future emissions and further mitigation potentials. Member States experts have also provided pieces of new information that affects the likely future evolution of emissions. This includes, e.g., modified implementation schedules of specific emission control measures in a country, or physical circumstances that limit the applicability of emission control measures (e.g., different size distributions of installations, etc.). To the extent that this new information was well documented and coherent with data and assumptions for other Member States, changes have been incorporated into the baseline scenario of the GAINS database. Other proposed modifications (as long as they are internally consistent), together with alternative projections of emission generating activities, have been included into a 'NATIONAL PROJECTIONS' scenario that is used for the sensitivity analysis presented in this report.

### 3 Revised baseline emissions and the scope for further reductions in 2030

Suggested changes to the historic emission estimates and projections that have been incorporated in the GAINS database have resulted in a revised baseline and MTR. These were used as the basis for the re-optimization (Table 4.1).

The largest changes emerge for PM<sub>2.5</sub>, where the new reduction in baseline emissions for the EU-28 in 2030 is five percentage points greater than before. A large part of this relates to the revised 2005 inventory reported for France for its industrial non-combustion process emissions. The remaining part of the difference largely relates to updated data on emissions of agricultural waste burning and more detailed structural information on small combustion sources.

The reduction in baseline emissions of VOC in 2030 would be one percentage point less than before, resulting from the new inventory information. For NO<sub>x</sub>, again, the reduction in baseline emissions in 2030 is two percentage points less than before (due especially to lower emissions in the industrial sectors, inter alia, of Germany and Spain). Finally, changes in the baseline emissions for SO<sub>2</sub> and NH<sub>3</sub> are very limited (less than one percentage point difference at the EU-28 level).

In summary, and in relation to the respective 2005 levels, the decline in the EU-28 baseline emissions for 2030 is now 74% instead of 73% for SO<sub>2</sub>, 63% instead of 65% for NO<sub>x</sub>, 8% instead of 7% for NH<sub>3</sub> and 40% instead of 41% for VOC. The largest difference occurs for PM<sub>2.5</sub>, where the revised baseline leads to a 32% reduction in 2030 compared to 2005 instead of the 27% decline that was estimated before.

The differences between the revised and former estimates of the Maximum Technically Feasible Reductions (relative to 2005) are less than two percentage points for all pollutants. There is an exception for VOC, where updated information on the applicability of low solvents paints, coating and inks provided by some countries and extrapolated to all Member States reduces the emission reduction potential by five percentage points.

In 2030, the larger baseline decline in PM<sub>2.5</sub> emissions lead to slightly higher overall emission reductions in terms of PM<sub>eq</sub> (-50% instead of -49%). At the same time, estimated costs for implementation of current legislation are slightly lower (€89.6bn/yr instead of €90.2bn/yr), mainly as a consequence of the more detailed information on the structure of non-road mobile machinery.

## 4 Re-optimized emission reduction targets

### 4.1 Re-optimizing whilst keeping the health target of the initial Clean Air Policy Package

In its 2013 Clean Air Policy Package, the Commission proposed for 2030 a 67% gap closure in terms of PM health impacts, corresponding to reduction of air pollution related mortality of 52% between 2005 and 2030. The proposal defines the 'gap closure' as the additional percentage improvement of premature mortality between what will be achieved with current legislation and what can be achieved with implementation of all available technical measures

The updated statistical information that has emerged from the consultations with Member States has implications for a cost-effective achievement of this target. First, the boundaries of the 'gap closure', i.e., the current legislation (CLE) starting point as well as the scope for further measures (MTR) in 2030, are different from what has been assumed for the original Commission proposal in absolute terms (Figure 4.1, left panel).

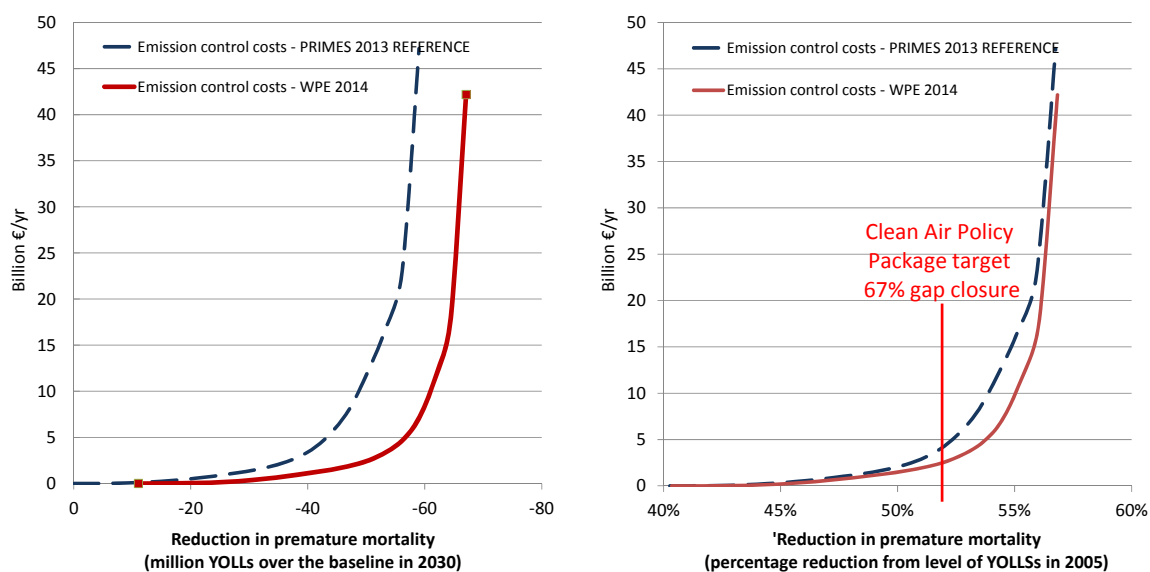


Figure 4.1: Costs for additional improvements of premature mortality beyond the CLE baselines in 2030

However, at the same time the reference point, i.e., the situation in 2005, has been updated too. It turns out that, while for 2030 the absolute values of emissions and resulting health impacts have changed as a consequence of the bilateral consultations, there are only minor differences in the relative change to 2005 if the scope for further emission reductions is compared to the updated 2005 reference level (Figure 4.1, right panel).

On this basis, an updated emission control scenario has been explored that achieves the same gap closure of 67% as in the original Commission proposal. This gap closure results in the same relative reduction in premature mortality compared to 2005 (-52%) as the original Commission proposal.

## 4.2 Main results

### 4.2.1 Emission reductions

To achieve the same 52% reduction in health impacts relative to 2005, the reduction in total emissions - measured in terms of PM-equivalents (see TSAP Report #15) - remains the same in the new optimized scenario (-63% relative to 2005).

However, as a consequence of the updated information on the structure of emission sources in 2030, costs for additional emission reductions beyond the current legislation are now lower than estimated before. While technology costs for emission control measures have not been modified, new information about the current and envisaged structure of emission sources has revealed a larger potential for cheaper reductions beyond the current legislation case.

Especially for PM<sub>2.5</sub>, there is now a larger potential beyond the baseline for low cost measures to reduce PM<sub>2.5</sub> emissions. The new statistics about the structure of solid fuel use in households and more conservative expectations about the turnover of existing stoves in the current legislation case enlarge the scope for implementation of relatively cheap cleaner devices (e.g., improved stoves) to achieve further emission reductions beyond current legislation. Also, the updated information on industrial process emissions in the French emission inventory results in a steeper decline in baseline emissions (-32% instead of -27%). Thus, the need for additional cuts in PM<sub>2.5</sub> to achieve the 67% gap closure (and the 52% health improvement) declines from 24 to 22 percentage points. In turn, this results in lower marginal abatement costs in the new scenario, not only for PM<sub>2.5</sub> but also for the other pollutants, so that the new scenario does not employ some of the most expensive measures that were contained in the original Commission proposal (Table 4.2).

For these reasons, emission control costs (on top of current legislation) for the 67% gap closure level decline from €3.3bn/yr to €2.2bn/yr (Figure 4.1, right panel). This results also in lower marginal costs of the cost-effective set of measures,

Table 4.1: Summary table for EU-28, emission changes relative to 2005 (2005 and 2012: reported by Parties to CLRTAP in 2014; 2020: Gothenburg protocol commitments; 2030: COM 2013: Commission proposal 2013, WPE 2014: re-optimized ceilings based on the bilateral consultations carried out for the Council Working Party on Environment; figures relative to the GAINS estimates for 2005)

EU28	2005 [kt] <sup>1</sup>	2012	2020 GP	2030 COM 2013			2030 WPE 2014			Difference		
				CLE	67%GC	MTFR	CLE	67%GC	MTFR	CLE	67%GC	MTFR
SO <sub>2</sub>	7710	-48%	-59%	-73%	-81%	-83%	-74%	-81%	-84%	+1%	0%	+1%
NO <sub>x</sub>	11531	-27%	-42%	-65%	-69%	-74%	-63%	-65%	-73%	-2%	-4%	-1%
PM <sub>2.5</sub>	1414	-12%	-22%	-27%	-51%	-63%	-32%	-54%	-62%	+5%	+3%	-1%
NH <sub>3</sub>	3878	-5%	-6%	-7%	-27%	-35%	-8%	-25%	-35%	+1%	-2%	0%
VOC	8775	-24%	-28%	-41%	-50%	-66%	-40%	-46%	-61%	-1%	-4%	-5%
PM <sub>eq</sub>	5315	-29%	-38%	-49%	-63%	-69%	-50%	-63%	-69%	+1%	0%	0%

<sup>1</sup> Figures reported by Member States, not adjusted for spatial (e.g., Canary Island) and sectoral (e.g., soil NO<sub>x</sub>) coverage

While at the EU-28 level emission reductions requirements (relative to 2005) remain almost constant for PM<sub>eq</sub>, there are larger reductions for PM<sub>2.5</sub> (a 54% cut compared to a 51% decline in the original proposal). This enhanced PM<sub>2.5</sub> reduction is a consequence of the steeper decline in baseline emissions and the larger potential for low cost measures (as explained above). Indeed, as a

consequence of the higher cuts in PM2.5 emissions, emission reduction requirements for the other pollutants are softened: NO<sub>x</sub> from 69% to 65%, VOC from 50% to 46%, NH<sub>3</sub> from 27% to 25% (relative to 2005). The cut in SO<sub>2</sub> emissions does not change at the EU-28 level. Results by pollutant and Member State, together with the main reasons for differences, are presented in Part B of TSAP Report #16.

It is noteworthy that, in relation to 2005, about half of the emission reductions (in terms of PMeq) that emerge as cost-effective in 2030 have already been achieved in 2012 according to the latest reporting, and about 60% should be attained by the Gothenburg Protocol in 2020.

#### 4.2.2 Emission control costs

To achieve the 52% improvement in premature mortality (equivalent to the 67% gap closure), the re-optimized scenario requires less additional emission reductions at costs of €2.2bn/yr, i.e., 0.008% of the envisaged GDP in 2030 (Table 4.2). For comparison, the original Commission proposal involved costs of €3.3bn/yr, i.e., 0.012% of GDP in 2030.

Table 4.2: Summary table for EU-28, emissions control costs

EU28	2030 COM 2013			2030 WPE 2014			Difference WPE-COM		
	CLE	67%GC	MTFR	CLE	67%GC	MTFR	CLE	67%GC	MTFR
Costs on top of CLE		3.3	50.3		2.2	40.0		-1.1	-10.3
Total costs	90.2	93.5	140.7	89.6	91.8	130.6	-0.6	-1.7	-10.1

### 4.3 Implications for individual Member States

As discussed above, the new information on the structure of emission sources makes the achievement of the health target established in the Clean Air Policy Package (i.e., a 67% gap closure, equivalent to a 52% reduction in premature mortality between 2005 and 2030) less costly. Overall, largest differences occur for PM2.5 emissions (Table 7.3), where the updated structures of emission sources (mainly for industrial processes and household heating) imply in many countries a larger baseline cut in PM2.5 emissions than considered before (especially in France, the UK, Italy and Bulgaria). Although the re-optimized scenario relaxes the need for additional measures in all countries, the nominal changes (relative to 2005) in these countries are still larger than in the original Commission proposal. For other countries (e.g., Estonia, Denmark, Belgium, Austria, etc.), emission reduction requirements decline by up to 11 percentage points.

For NO<sub>x</sub>, the overall reduction requirement in the EU-28 shrinks from 69% to 65%, i.e., by four percentage points (Table 7.2). Relaxations occur for all Member States, with particularly large changes for Estonia (-15 percentage points), Portugal and Slovakia (-10 percentage points), Malta and Spain (-9 percentage points) and the Netherlands (-7 percentage points). For two countries (Sweden and the UK) the updated emission reduction requirements relative to 2005 are slightly higher than in the original case, while for Luxemburg the updated emission reduction requirement is 6 percentage points higher. For Luxemburg and Sweden this is caused by larger baseline reductions from current legislation, and no additional measures for these two countries are suggested in the new scenario.

Also for VOC, reduction requirements of the re-optimized are generally lower, due to the lower marginal costs at which the 67% gap closure target can be achieved (Table 7.5). Largest relaxations occur for the Netherlands (-13 percentage points), Lithuania (-11 percentage points), Belgium, Denmark, the UK (-10 percentage points), Estonia, Luxembourg and Spain (-9 percentage points) and Austria, Germany and Slovakia (-8 percentage points). The new information on the structure of emission sources in Bulgaria and Romania, however, leads to somewhat higher emission reduction requirements in these countries, which are a direct consequence of larger reductions that are already achieved in these countries by the current legislation baseline.

Overall for the EU-28, the lower marginal costs of the re-optimized scenario relaxes the emission reduction requirements for NH<sub>3</sub> from -27% to -25%, relative to 2005 (Table 7.4). Particularly large relaxations emerge for Spain and France (-7 to -8 percentage points) caused by updated livestock data, and for Estonia (-7% due to less reductions in the baseline). In contrast, emission reduction requirements (relative to 2005) tighten by up to 10 percentage points for Bulgaria, Hungary and Lithuania, as a direct implication of sharper emission reductions from the current legislation. However, as in all other countries, there is less need for additional reductions (on top of the current legislation case).

For SO<sub>2</sub>, overall reductions for the EU-28 as a whole do not change. However, emission reduction requirements tighten for a few countries as a consequence of steeper emission cuts resulting from current legislation. For Denmark, Estonia and Finland, where no need for further SO<sub>2</sub> cuts are identified in the re-optimized scenario, the changes in the baseline translate directly into modified emission reduction requirements. In the UK, additional emission cuts remain as computed before, but the lower baseline projection results in lower emissions due to a more accurate representation of industrial process emissions. For Luxemburg, Portugal and Slovakia, requirements for additional measures decrease; however, as their baseline projections decline to a larger extent, the resulting net emission reduction requirements (relative to 2005) are higher than in the original Commission proposal. Other countries see relaxed emission reduction requirements, e.g., Hungary by 15 percentage points, Austria by nine percentage points and Lithuania by seven percentage points.

#### 4.4 Indicative sectoral emission reductions and instruments

The changes in emissions between 2005 and the re-optimized emission reduction requirements in 2030 are brought about through three different mechanisms:

- Activity changes between 2005 and 2030: changes in the volumes and structures of emission generating activities between 2005 and 2030 (as reflected in the PRIMES 2013 REFERENCE scenario,
- Current legislation measures: emission reductions resulting from progressing implementation of current legislation (e.g., following the turnover of capital stock), and
- Additional measures: additional emission controls beyond current legislation.

The extents at which these three mechanisms contribute to the WPE 2014 emission reduction requirements are listed in Table 4.3 to Table 4.7. These tables provide information on the cost-effective emission reductions per sector as calculated by GAINS in the re-optimized scenario. As such, these tables provide a possible pathway on how the required reductions can be achieved and should be considered as indicative. In particular, the sectorial reductions indicated should not be interpreted as sectorial emission reduction commitments.

For SO<sub>2</sub>, two thirds of the emission reductions of the optimized scenario are a mere consequence of the changes in activity levels between 2005 and 2030 that are projected in the underlying energy scenario (e.g., declining use of solid fuels). Another quarter comes from the further penetration of existing emission control legislation (e.g., the current IED). Thus, the reductions in optimized scenario through additional measures account for nine percent of the total emission decline between 2005 and 2030.

For NO<sub>x</sub>, changes in activity levels will deliver 18% of the required emission reductions. 78% are achieved by continuing implementation of existing legislation (e.g., EURO-6 standards), so that only four percent of the suggested reductions require additional measures.

The situation is different for PM2.5, where changes in activity levels would hardly affect emissions (less than 0.5%); 60% of the proposed reductions emerge from current legislation. Additional measures, especially for small combustion sources, will be needed to attain the remaining 40% of the total reductions (Figure 4.2).

For NH<sub>3</sub>, about 30% of the emission reduction of the optimized scenario would be delivered by current legislation; additional emission cuts would involve emissions from pigs, cattle and fertilizer application to similar shares.

The major share of the decline in VOC emissions will emerge from progressing implementation of current legislation (70% of the total reduction), enhanced by structural changes of economic activities, which will deliver another 15%. More than 80% of the additional reduction would result from a ban of agricultural waste burning.



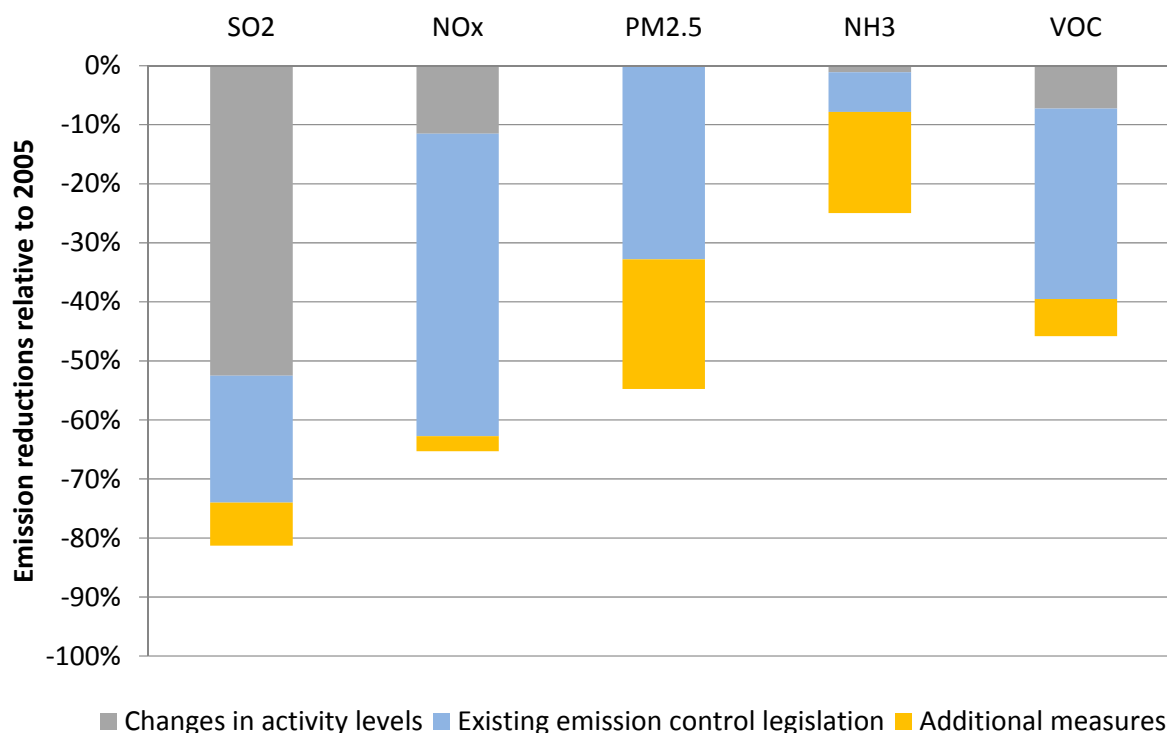


Figure 4.2: Contributions to the emission reductions of the re-optimized scenario (relative to 2005 emissions)

Especially for PM<sub>2.5</sub>, additional legislation will be essential to achieve the emission reductions of the optimized scenario. EU legislation (e.g., the IED, MCP, NRMM, Eco-design directives) is currently under discussion to offer Community-wide instruments to achieve these additional emission reductions. If agreed, it is expected that these instruments would account for more than half of the additional SO<sub>2</sub>, NO<sub>x</sub> and PM<sub>2.5</sub> reductions of the proposal. For SO<sub>2</sub> and NO<sub>x</sub>, additional required reductions would mainly be delivered by the IED, while for PM<sub>2.5</sub> most contribution is expected from the Eco-design directive. For NH<sub>3</sub>, the additional required emission cuts can be achieved by selecting from the measures referred to in Annex III to the new proposed NEC Directive, and making use of the UNECE Guidance Document for Preventing and Abating Ammonia Emissions and the expected revised BAT conclusions under Directive 2010/75/EU as referred to in the chapeau of Annex III.

Table 4.3: SO<sub>2</sub> emission reductions of the optimized scenario by category, relative to 2005 for the EU-28 (kilotons)

	Activity changes 2005-2030	Baseline control measures 2005-2030	Additional control measures 2030	Total reduction
<b>Power and heating plants</b>	<b>-3335.7</b>	<b>-1056.1</b>	<b>-28.5</b>	<b>-4420.4</b>
<b>Domestic combustion</b>	<b>-251.4</b>	<b>-44.2</b>	<b>-98.1</b>	<b>-393.7</b>
<b>Industry</b>	<b>-403.6</b>	<b>-358.9</b>	<b>-379.1</b>	<b>-1141.6</b>
of which				
Refineries	-239.4	-147.5	-128.4	-515.3
Other industries	-164.2	-211.5	-250.6	-626.3
<b>Road transport</b>	<b>2.8</b>	<b>-30.8</b>	<b>0.0</b>	<b>-28.0</b>
of which				
Light duty	0.2	-16.8	0.0	-16.5
Heavy duty	2.6	-14.1	0.0	-11.5
<b>Non-road mobile</b>	<b>-26.3</b>	<b>-148.1</b>	<b>0.0</b>	<b>-174.4</b>
<b>Other sectors</b>	<b>-19.7</b>	<b>-12.3</b>	<b>-51.7</b>	<b>-83.7</b>
<b>TOTAL</b>	<b>-4033.8</b>	<b>-1650.4</b>	<b>-557.4</b>	<b>-6241.7</b>

Table 4.4: NO<sub>x</sub> emission reductions of the optimized scenario by category, relative to 2005 for the EU-28 (kilotons)

	Activity changes 2005-2030	Baseline control measures 2005-2030	Additional control measures 2030	Total reduction
<b>Power and heating plants</b>	<b>-1157.1</b>	<b>-398.8</b>	<b>-88.8</b>	<b>-1644.7</b>
<b>Domestic combustion</b>	<b>-136.8</b>	<b>-26.4</b>	<b>0.0</b>	<b>-163.2</b>
<b>Industry</b>	<b>-44.9</b>	<b>-353.5</b>	<b>-143.6</b>	<b>-542.0</b>
of which				
Refineries	-83.9	-30.9	-20.7	-135.6
Other industries	39.0	-322.6	-122.9	-406.4
<b>Road transport</b>	<b>200.7</b>	<b>-4213.3</b>	<b>0.0</b>	<b>-4012.6</b>
of which				
Light duty	-125.8	-1479.0	0.0	-1604.8
Heavy duty	326.5	-2734.3	0.0	-2407.8
<b>Non road mobile</b>	<b>-189.2</b>	<b>-753.1</b>	<b>-32.8</b>	<b>-975.2</b>
<b>Other sectors:</b>	<b>29.6</b>	<b>-21.8</b>	<b>-27.7</b>	<b>-20.0</b>
<b>TOTAL</b>	<b>-1297.8</b>	<b>-5766.9</b>	<b>-292.9</b>	<b>-7357.7</b>

Table 4.5: PM2.5 emission reductions of the optimized scenario by category, relative to 2005 for the EU-28 (kilotons)

	Activity changes 2005-2030	Baseline control measures 2005-2030	Additional control measures 2030	Total reduction
<b>Power and heating plants</b>	<b>-31.5</b>	<b>-35.5</b>	<b>-22.8</b>	<b>-89.8</b>
<b>Domestic combustion</b>	<b>-37.8</b>	<b>-164.5</b>	<b>-139.1</b>	<b>-341.4</b>
<b>Industry</b>	<b>11.7</b>	<b>-31.9</b>	<b>-70.9</b>	<b>-91.1</b>
of which				
Refineries	-3.8	-0.8	-2.0	-6.7
Other industries	15.6	-31.1	-68.9	-84.4
<b>Road transport</b>	<b>60.1</b>	<b>-230.6</b>	<b>0.0</b>	<b>-170.5</b>
of which				
Light duty	42.5	-149.1	0.0	-106.6
Heavy duty	17.6	-81.5	0.0	-63.9
<b>Non road mobile</b>	<b>-18.0</b>	<b>-75.0</b>	<b>-3.0</b>	<b>-96.0</b>
<b>Other sectors:</b>	<b>23.4</b>	<b>-8.6</b>	<b>-129.8</b>	<b>-114.9</b>
<b>TOTAL</b>	<b>7.9</b>	<b>-546.1</b>	<b>-365.6</b>	<b>-903.8</b>

Table 4.6: NH<sub>3</sub> emission reductions of the optimized scenario by category, relative to 2005 for the EU-28 (kilotons)

	Activity changes 2005-2030	Baseline control measures 2005-2030	Additional control measures 2030	Total reduction
<b>Pigs</b>	<b>-8.1</b>	<b>-77.4</b>	<b>-153.7</b>	<b>-239.1</b>
<b>Poultry</b>	<b>40.2</b>	<b>-115.6</b>	<b>-76.1</b>	<b>-151.6</b>
<b>Cattle</b>	<b>-10.4</b>	<b>-40.0</b>	<b>-218.8</b>	<b>-269.3</b>
of which				
Dairy	<b>63.0</b>	<b>-31.0</b>	<b>-165.5</b>	<b>-133.6</b>
Meat	<b>-73.4</b>	<b>-9.0</b>	<b>-53.3</b>	<b>-135.7</b>
<b>Other animals</b>	<b>-1.8</b>	<b>-0.8</b>	<b>-6.6</b>	<b>-9.3</b>
<b>Mineral fertilizers</b>	<b>-9.8</b>	<b>-11.3</b>	<b>-183.9</b>	<b>-205.0</b>
<b>Other non -agricultural sources</b>	<b>-53.4</b>	<b>-19.2</b>	<b>-35.6</b>	<b>-108.2</b>
<b>TOTAL</b>	<b>-43.3</b>	<b>-264.4</b>	<b>-674.7</b>	<b>-982.5</b>

Table 4.7: VOC emission reductions of the optimized scenario by category, relative to 2005 for the EU-28 (kilotons)

	Activity changes 2005-2030	Baseline control measures 2005-2030	Additional control measures 2030	Total reduction
<b>Power plants</b>	<b>-7</b>	<b>-6</b>	<b>-25</b>	<b>-38</b>
<b>Domestic combustion</b>	<b>9</b>	<b>-408</b>	<b>-270</b>	<b>-668</b>
<b>Industry (combustion and processes, excluding solvent use)</b>	<b>92</b>	<b>-74</b>	<b>-6</b>	<b>12</b>
<b>Road transport</b>	<b>-708</b>	<b>-886</b>	<b>0</b>	<b>-1594</b>
of which				
Light duty	-737	-714	0	-1451
Heavy duty	29	-172	0	-143
<b>Non road mobile</b>	<b>-10</b>	<b>-348</b>	<b>-23</b>	<b>-381</b>
<b>Refineries (processes)</b>	<b>-40</b>	<b>-44</b>	<b>-7</b>	<b>-91</b>
<b>Production, storage and distribution of oil products</b>	<b>-202</b>	<b>-36</b>	<b>-4</b>	<b>-242</b>
<b>Solvent use</b>	<b>252</b>	<b>-1050</b>	<b>-60</b>	<b>-858</b>
<b>Other sectors</b>	<b>-28</b>	<b>-2</b>	<b>-162</b>	<b>-193</b>
of which				
ban of agr. waste burning	24	0	-140	-115
<b>TOTAL</b>	<b>-641</b>	<b>-2856</b>	<b>-557</b>	<b>-4053</b>

## 5 Sensitivity analyses

### 5.1 National activity projections

During bilateral consultations, some national experts requested that the feasibility be tested using national perspectives on economic development and energy policies that are sometimes different from the Europe-wide coherent scenario that has been employed by the Commission for its Clean Air Policy Package proposal (as well as for developing other policy initiatives such as CEP). Different national perspectives on the future evolution of emission generating activities, i.e., energy, transport, agricultural and industrial activities, were considered most relevant by national experts as these would affect baseline emissions in the future as well as the potential and costs for additional cuts in emissions.

To facilitate an analysis of potential implications of such different perspectives on the overall feasibility of the targets, alternative national projections of activity levels have been considered for 19 Member States that provided such information during the consultations to IIASA (Table 5.1).

Table 5.1: Coverage of national activity projections provided by Member States for the year 2030

	Energy use, industrial production	Transport	Agriculture	VOC-related activities
AT	x	x	x	
BE				x
BG				
HR				x
CY	x	x	x	
CZ	x	x		
DK			x	
EE	x	x		x
FI				
FR				
DE	x	x	x	
GR				
HU			x	
IE	x	x	x	
IT	x	x	x	x
LV				
LT	x	x	x	
LU				
MT	x	x		
NL		x	x	x
PL				
PT	x	x		
RO	x	x		
SK			x	
SI			x	
ES				
SE				
UK			x	x

The available national projections to IIASA have been implemented into a common 'NATIONAL PROJECTIONS' scenario in the GAINS database. However, not all Member States have provided national projections, and in many cases the alternative projections do not cover all emission sources.

In total, alternative data have been supplied for roughly one third of the major source categories (i.e., energy, transport, agriculture and VOC-related activities). As the GAINS analysis requires full coverage of countries and emission source categories, data for missing sectors or countries have been filled with the respective data of the PRIMES 2013 REFERENCE scenario. This means that the NATIONAL PROJECTIONS scenario differs from the PRIMES 2013 REFERENCE scenario only for those sectors and countries for which national data have been supplied to IIASA.

Such an incomplete alternative scenario is not suitable as a basis for a (EU-wide) cost-effectiveness analysis, as it would introduce serious distortions across countries depending on the degree that national scenarios have been supplied. Furthermore, while IIASA has attempted to validate internal consistency of the projections (e.g., balancing demand and supply of energy) to the extent possible without contradicting supplied information, the available projections are not mutually consistent, e.g., in terms of international trade of energy and agricultural products. Furthermore, they are not always in line with established targets of EU policies. For instance, the energy patterns of the national scenarios from the 11 Member States alone that have provided data on energy use would lead in 2030 to two percent higher CO<sub>2</sub> emissions than those of the PRIMES REFERENCE scenario. This means that the CO<sub>2</sub> emissions would decline only by 25% between 2005 and 2030, compared to 27% of the PRIMES REFERENCE scenario, which in turn does not consider the recent agreements on climate and energy policy. For comparison, a scenario that would achieve these recent targets (40 % GHG reduction compared to 1990) would reduce CO<sub>2</sub> emissions by 34% in 2030 relative to 2005.

For livestock numbers, the national projections of just the 12 Member States that supplied data increase the numbers of pigs in the EU-28 by nine percent, and the number of dairy cattle by five percent compared to the Commission scenario.

Given these shortcomings in the national projections, a sensitivity analysis has been conducted that examines, for the 19 Member States that have provided national projections, the technical feasibility of the emission reduction commitments of the updated policy scenario presented above under these alternative projections.

For these countries, the current legislation case would reduce SO<sub>2</sub>, NO<sub>x</sub> and VOC emissions by two percentage points less than the WPE 2014 scenario; CLE baseline reductions of NH<sub>3</sub> would be three percentage points lower, and the decline of PM2.5 would be four percentage points less (Table 5.2).

Differences for the maximum technically feasible (MTFR) reductions are significantly smaller, with a two percentage points smaller potential for NH<sub>3</sub> emissions and a one percentage point lower potential for PM2.5. These differences are not caused by differences in assumptions on the applicability of measures between the WPE 2014 scenario and the national projections scenario, but solely by differences in activity projections.

As a main finding, with the exception of the NH<sub>3</sub> targets for three countries, the re-optimized emission reduction requirements can be technically achieved in all countries that have supplied national activity projections.

On average (for these 19 countries), the margin of the re-optimized emission reduction commitment to MTFR under the national projections scenario for SO<sub>2</sub> is four percent; for NO<sub>x</sub> the margin is nine percent, for PM2.5 10 percent, for NH<sub>3</sub> 17 percent, and for VOC 26 percent. Details for individual Member States are provided in Part B of TSAP Report #16.

Table 5.2: The re-optimized emission reduction commitments (relative to 2005) of the 19 Member States that supplied national activity projections<sup>1)</sup>, compared to the current legislation (CLE) and maximum technically feasible reduction (MTFR) scenarios, for the NATIONAL PROJECTIONS and the WPE 2014 scenarios

	WPE 2014 Re- optimized	NATIONAL PROJECTIONS			WPE 2014		
		CLE	MTFR	Average margin of the re-optimized scenario to MTFR	CLE	MTFR	Average margin of the re-optimized scenario to MTFR
SO <sub>2</sub>	-78%	-68%	-82%	+4%	-70%	-82%	+5%
NO <sub>x</sub>	-66%	-61%	-73%	+9%	-63%	-73%	+9%
PM2.5	-55%	-30%	-62%	+10%	-34%	-63%	+12%
NH <sub>3</sub>	-27%	-6%	-33%	+17%	-9%	-35%	+22%
VOC	-43%	-36%	-59%	+26%	-38%	-59%	+27%
PM <sub>eq</sub>	-61%	-45%	-66%	+8%	-48%	-67%	+9%

<sup>1)</sup> Not all 19 Member States provided projections for all sectors and pollutants. For this table, lacking sectorial projections have been filled with the PRIMES 2013 REFERENCE scenario

As mentioned above, while on average there is a reasonable margin for feasibility of the re-optimized emission reduction requirements under the assumptions of the national activity projections, exceptions occur for the NH<sub>3</sub> targets of Hungary, Slovakia and the UK, although only for Hungary the MTFR level under national assumptions exceeds the re-optimized emission level for the WPE 2014 scenario significantly.

The main factor responsible for the difficulties with achieving the proposed emission reductions emissions relates to strong increases in livestock numbers that are assumed in many national scenarios. Particularly large increases have been provided by Hungary and Slovakia, where cattle and pig numbers, after their decline in the 1990s, are assumed to recover in the coming years to the pre-2000 levels. In contrast, the Europe-wide scenario, based on livestock projections of the CAPRI agricultural model, foresees only slight recovery from today onwards, constrained inter alia by international competition on the agricultural market. In 2030, total livestock numbers in the national projections are for Hungary 71% and for Slovakia 41% higher than the corresponding CAPRI projections.

Also the UK national projection suggests strong growth of dairy cows (+20%) and pig (+28%) numbers, while the CAPRI projection anticipates a slight decline. Thereby, national livestock projections for dairy cattle, pigs, and sheep are about 20%, 36%, and 25% higher than in the EU-wide CAPRI scenario. Under these high growth assumptions, the emission reduction requirements for NH<sub>3</sub> optimized for the WPE 2014 scenario would not be achievable with the measures currently considered in the GAINS model.

It should be mentioned that also many other countries provided national agricultural projections with substantial increases in livestock numbers. As explained above, projections of just the 12 Member States that supplied national projections would increase in 2030 the overall livestock numbers in the EU-28 for pigs by nine percent and for dairy cattle by five percent (assuming no differences for the countries that have not supplied national projections). However, despite these increases, the emission reduction requirements of the optimized scenario are still achievable in all other countries.

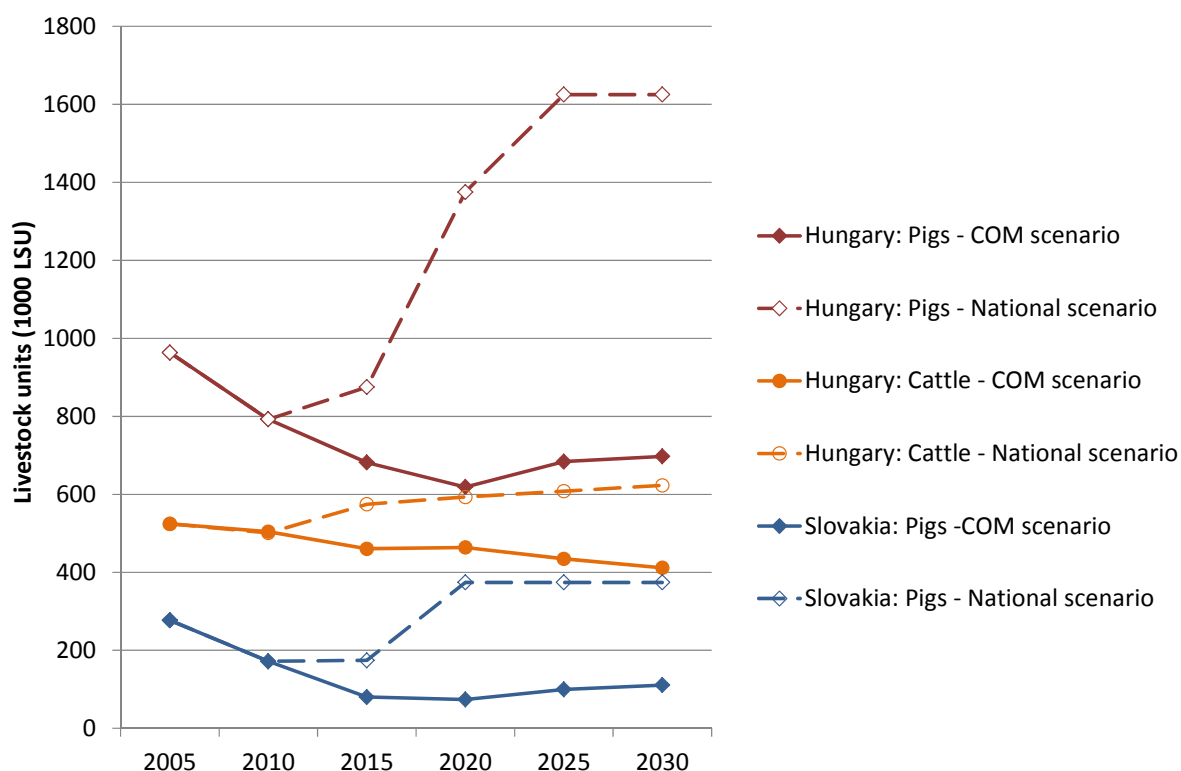


Figure 5.1: Livestock projections for Hungary and Slovakia, the NATIONAL PROJECTIONS (dashed lines) against the PRIMES 2013 REFERENCE scenario (solid lines)

## 5.2 Impacts of the 2014 Climate and Energy Policy Package

There are important interactions between climate and air quality policies (e.g., Barker et al. 2007). In particular, stringent climate and energy efficiency policies will reduce the consumption of polluting fuels, which in turn will alleviate air pollution damage for human health and the environment, and lower the costs for further air pollution control measures.

In 2014, the European Commission adopted its Communication ‘A policy framework for climate and energy in the period 2020-2030’, setting out climate and energy policy targets based on a 40% reduction in GHG emissions in 2030 (EC 2014a). Furthermore, on 23 July 2014, the European Commission adopted a Communication on ‘Energy efficiency and its contribution to energy security and the 2030 Framework for Climate and Energy policy’, in which it proposed an additional target on energy efficiency. In 2030, gross final energy consumption should be 30% lower than expected under the business-as-usual projection made in 2007 (EC 2014b).

Obviously, the lower energy consumption and the decarbonisation of the energy system that is necessary to achieve these targets will also affect air pollutant emissions. The implications of the new Climate and Energy policy on the Clean Air Policy Package have been explored in a study performed on request of the European Parliament’s Environment Committee (Amann 2014). Specifically, the Committee asked to identify the economically optimal ‘gap-closure’ based on an analysis of marginal costs and benefits of air quality policy measures in 2020, 2025 and 2030.

As mentioned above, a scenario that closely resembles the targets established in the Climate and Energy Policy Package would reduce CO<sub>2</sub> emissions in the EU-28 between 2005 and 2030 by 34%. For



comparison, in the PRIMES 2013 REFERENCE scenario that provided the starting point for all analyses for the Commission proposal on the Clean Air Policy Package, CO<sub>2</sub> emissions decline by 27% in the same period, and by 25% in the national projections on energy use that have been supplied by 11 Member States.

The study found that in 2030, under the CLIMATE AND ENERGY POLICY scenario, the originally proposed emission ceilings could be achieved at €5.5 bn/yr (or 5.7%) lower air pollution control costs than estimated in the Commission proposal. Thereby, the EU would spend €2.2 bn/yr less on air pollution controls than otherwise just for implementation of the current air pollution legislation. At the same time, cleaner air would provide an additional 2.2 million life years annually to the European population and increase statistical life expectancy by 4.4 months compared to 2005.

An economically optimal ambition would aim for a seven percent more stringent health target compared to the Commission proposal, which could be achieved at 66% lower air pollution control costs. In 2030, this would save an additional 140,000 life years annually, corresponding to monetized health benefits between €8.4 bn/yr and €50.8 bn/yr.

The analysis for the European Parliament was conducted on the original GAINS database that did not yet include the new statistical information that emerged during the bilateral consultations with Member States. While the quantitative findings might change for the updated data set, it is clear that the new climate and energy policy will significantly affect baseline emissions of SO<sub>2</sub>, NO<sub>x</sub> and PM. This will also affect the emission levels that could be achieved through the additionally available measures. For the particular version of the database, the CLIMATE AND ENERGY POLICY scenario would allow for PM<sub>2.5</sub> emissions to decline by three percentage points more than the PRIMES 2013 REFERENCE scenario. NO<sub>x</sub> could be lower by two percentage points, and SO<sub>2</sub> by one percentage point. It is likely that these features would apply for the updated GAINS dataset as well, so that the margin of the re-optimized emission reduction requirements to the feasibility limits would increase to similar extents compared to what is computed for the PRIMES 2013 REFERENCE scenario.

Table 5.3: Current legislation emissions (CLE) and Maximum technically feasible emission reductions (MTFR) for the CLIMATE AND ENERGY POLICY and the PRIMES REFERENCE scenarios in 2030 (emission changes relative to 2005). These estimates refer to the GAINS database employed for the Commission proposal, and do not consider new information that has emerged in the course of the bilateral consultations.

	Current legislation baseline (CLE)		Maximum technically feasible reductions (MTFR)	
	CLIMATE AND ENERGY POLICY scenario	PRIMES 2013 REFERENCE scenario	CLIMATE AND ENERGY POLICY scenario	PRIMES 2013 REFERENCE scenario
SO <sub>2</sub>	-75%	-73%	-84%	-83%
NO <sub>x</sub>	-68%	-65%	-76%	-74%
PM <sub>2.5</sub>	-34%	-27%	-66%	-63%
NH <sub>3</sub>	-7%	-7%	-35%	-35%
VOC	-43%	-41%	-66%	-66%

## 6 Summary

With the new information that has been provided by Member States in the course of the bilateral consultations, an updated emission control scenario has been developed that achieves the same relative reduction in premature mortality as the original Commission proposal (52% compared to 2005) with the same gap closure of 67%.

While the overall reduction of PM precursor emissions (primary PM<sub>2.5</sub>, NO<sub>x</sub>, SO<sub>2</sub>, VOC and NH<sub>3</sub>) converted into 'PM equivalent emission quantities' remains the same compared to 2005, the costs for implementation of current legislation and emission reductions beyond current legislation are lower than previously estimated. This is due to a shift in emission reductions across pollutants, with more reductions from primary PM<sub>2.5</sub>, and less from other pollutants compared to 2005. For the EU-28 as a whole, the cuts of primary PM<sub>2.5</sub> relative to 2005 increase to -54% from -51%, with much of the increase coming from current legislation (in fact the additional reductions on top of current legislation in 2030 are actually two percentage points lower than in the original proposal).

The cut in SO<sub>2</sub> emissions does not change at the EU-28 level, but emission reduction requirements for NO<sub>x</sub>, VOC and NH<sub>3</sub> are softened: NO<sub>x</sub> from 69% to 65%, VOC from 50% to 46% and NH<sub>3</sub> from 27% to 25% (all relative to 2005). About half of the PM equivalent emission reductions that emerge as cost-effective in 2030 have already been achieved in 2012 according to the latest reporting, and about 60% should be attained by the time the 2020 (Gothenburg Protocol) targets are met. In 2030, current emission control legislation and projected activity changes in the baseline should achieve almost 90% of the required SO<sub>2</sub> reductions, and more than 95% of the NO<sub>x</sub> reductions. Implementation of new EU-wide legislation (i.e., new BAT conclusions, MCP and NRMM directives) would result in additional reductions beyond what is expected to be delivered by current legislation that would largely fill the remaining gap towards the required reductions for SO<sub>2</sub> and NO<sub>x</sub>. For PM, current legislation is expected to deliver 60% of the required emission reduction, and the IED, MCP, NRMM and Ecodesign directives would further deliver a large part of the additional reductions required. With respect to NH<sub>3</sub> and VOC, current emission control legislation and projected activity changes resulting from the revised baseline would deliver about 30% of the reduction for NH<sub>3</sub> and 85% for VOC.

As agreed, some further sensitivity analysis has also been done based on national perspectives on economic development and energy policies, which sometimes differ from the Europe-wide coherent scenario used for the above analysis. National projections of activity levels were provided by 19 Member States, although most projections did not cover all emission sources. Furthermore, the alternative projections were not mutually consistent, were not always in line with established targets of EU policies, and led to less CO<sub>2</sub> emission reduction than the PRIMES reference scenario used for the Commission's proposal. However, a sensitivity analysis was conducted to examine - for the Member States that provided national projections - the technical feasibility of the emission reduction commitments of the updated policy scenario presented in this report, under the alternative national projections.

The outcome is that, with very few exceptions, the updated emission reduction requirements are also technically feasible under the alternative national projections. The only situations where the updated reduction requirement would not be attainable with the available technical emission control measures are the NH<sub>3</sub> targets for Hungary, Slovakia and the UK. Of these, UK and Slovakia are marginal, and the only substantive issue is with Hungary, due to the national scenario estimating total livestock number in 2030 at 71% higher than the corresponding EU (CAPRI) projection.

National scenarios are also less optimistic about the effects of climate policies and imply for 2030 higher CO<sub>2</sub> emissions than the baseline scenario that has been used by the Commission for the original proposal in 2013. The Climate and Energy Policy Package that has been agreed upon in 2014 envisages substantially lower CO<sub>2</sub> emissions in the future, and would result as a co-benefit in lower SO<sub>2</sub>, NO<sub>x</sub> and PM<sub>2.5</sub> emissions compared to what has been assumed for the Clean Air Policy Package. Thus, the recent agreement on climate and energy policy offers an additional margin for the attainability of the emission reduction requirements.

## References

- Amann M (2014) Complementary Impact Assessment on interactions between EU air quality policy and climate and energy policy. European Parliamentary Research Service, Brussels, Belgium
- 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) Updates to the GAINS Model Databases after the Bilateral Consultations with National Experts in 2014. International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria.
- Amann M, Borken-Kleefeld J, Cofala J, et al. (2014c) Updates to the GAINS Model Databases after the Bilateral Consultations with National Experts in 2014. TSAP Report #14. International Institute for Applied Systems Analysis, Laxenburg, Austria.
- Barker T, Bashmakov I, Alharti A, et al. (2007) Mitigation from a cross-sectoral perspective. Clim. Change 2007 Mitig. Contrib. Work. Group III Fourth Assess. Rep. Intergov. Panel Clim. Change
- EC (2013a) Impact Assessment accompanying the Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions on a Clean Air Programme for Europe. European Commission (EC), Brussels, Belgium
- EC (2013b) 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 (2014a) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, and the Committee of the Regions: A policy framework for climate and energy in the period from 2020 to 2030. European Commission (EC), Belgium, Brussels
- EC (2014b) Energy efficiency and its contribution to energy security and the 2030 Framework for climate and energy policy, Communication, COM (2014) 520 final. European Commission, Brussels, Belgium
- Kiesewetter G, Amann M (2014) Urban PM<sub>2.5</sub> levels under the EU Clean Air Policy Package. TSAP Report #12. International Institute for Applied Systems Analysis, Laxenburg

## 7 Annex: Results by Member State

### 7.1 Emission reduction requirements relative to 2005

Table 7.1: SO<sub>2</sub> emission reductions relative to 2005. 2012: reported in 2014, 2020: Gothenburg Commitment, 2030 numbers computed by GAINS, relative to GAINS 2005 estimates

	2005 <sup>1</sup>	2012	2020 GP	2030 Commission 2013			2030 WPE 2014			Difference WPE-COM		
				CLE	67% GC	MTFR	CLE	67% GC	MTFR	CLE	67% GC	MTFR
EU	7710	-48%	-59%	-73%	-81%	-83%	-74%	-81%	-84%	+1%	0%	+1%
AT	27	-36%	-26%	-47%	-50%	-55%	-38%	-41%	-52%	-9%	-9%	-3%
BE	144	-66%	-43%	-59%	-68%	-68%	-58%	-66%	-68%	-1%	-2%	0%
BG	776	-58%	-78%	-87%	-94%	-94%	-87%	-93%	-94%	-1%	-1%	0%
HR	64	-60%	-55%	-70%	-87%	-91%	-72%	-86%	-91%	+2%	-1%	0%
CY	38	-57%	-83%	-95%	-95%	-98%	-94%	-95%	-99%	0%	0%	0%
CZ	219	-28%	-45%	-64%	-72%	-73%	-68%	-73%	-75%	+3%	+1%	+2%
DK	25	-49%	-35%	-56%	-58%	-63%	-62%	-62%	-68%	+6%	+4%	+5%
EE	76	-47%	-32%	-67%	-71%	-78%	-72%	-72%	-89%	+5%	+2%	+11%
FI	69	-26%	-30%	-29%	-30%	-35%	-34%	-34%	-42%	+5%	+5%	+8%
FR	460	-50%	-55%	-74%	-78%	-79%	-71%	-77%	-80%	-2%	-1%	+1%
DE	460	-7%	-21%	-46%	-53%	-55%	-49%	-57%	-62%	+2%	+4%	+7%
GR	541	-55%	-74%	-90%	-92%	-95%	-90%	-92%	-95%	0%	0%	0%
HU	43	-26%	-46%	-79%	-88%	-88%	-57%	-73%	-75%	-22%	-15%	-13%
IE	72	-68%	-65%	-80%	-83%	-85%	-80%	-82%	-87%	0%	-1%	+2%
IT	405	-56%	-35%	-63%	-75%	-81%	-61%	-71%	-79%	-2%	-4%	-2%
LV	7	-64%	-8%	-40%	-46%	-54%	-38%	-42%	-49%	-2%	-4%	-5%
LT	43	-16%	-55%	-41%	-72%	-77%	-47%	-65%	-77%	+6%	-7%	0%
LU	2	-18%	-34%	-21%	-44%	-56%	-42%	-45%	-75%	+21%	+1%	+19%
MT	11	-32%	-77%	-97%	-98%	-99%	-95%	-95%	-98%	-2%	-3%	-1%
NL	64	-47%	-28%	-54%	-59%	-63%	-55%	-58%	-63%	+1%	-1%	0%
PL	1217	-30%	-59%	-64%	-78%	-79%	-66%	-77%	-79%	+2%	-1%	0%
PT	177	-75%	-63%	-56%	-77%	-84%	-73%	-83%	-90%	+16%	+6%	+6%
RO	643	-60%	-77%	-86%	-93%	-94%	-84%	-92%	-93%	-2%	-1%	0%
SK	89	-34%	-57%	-50%	-79%	-80%	-73%	-82%	-85%	+23%	+3%	+5%
SI	41	-75%	-63%	-85%	-89%	-89%	-86%	-88%	-90%	+1%	-1%	+1%
ES	1252	-69%	-67%	-83%	-89%	-90%	-83%	-87%	-90%	0%	-1%	0%
SE	36	-23%	-22%	-16%	-16%	-19%	-14%	-14%	-18%	-2%	-2%	-1%
UK	709	-40%	-59%	-75%	-84%	-85%	-80%	-89%	-91%	+5%	+5%	+6%

<sup>1</sup> Excluding emissions outside the EMEP region (e.g., Canary Islands)

Table 7.2: NO<sub>x</sub> emission reductions relative to 2005. 2012: reported in 2014, 2020: Gothenburg Commitment, 2030 numbers computed by GAINS, relative to GAINS 2005 estimates

	2005	2012	2020 GP	2030 Commission 2013			2030 WPE 2014			Difference WPE-COM		
				CLE	67% GC	MTFR	CLE	67% GC	MTFR	CLE	67% GC	MTFR
EU	11531	-27%	-42%	-65%	-69%	-74%	-63%	-65%	-73%	-2%	-3%	-2%
AT	237	-24%	-37%	-72%	-72%	-76%	-71%	-71%	-77%	-1%	-1%	0%
BE	290	-33%	-41%	-55%	-63%	-68%	-56%	-59%	-67%	+2%	-4%	-1%
BG	154	-20%	-41%	-64%	-65%	-75%	-62%	-63%	-74%	-1%	-3%	-1%
HR	81	-27%	-31%	-56%	-66%	-81%	-50%	-62%	-79%	-6%	-4%	-3%
CY	21	-1%	-44%	-70%	-70%	-81%	-69%	-70%	-80%	-1%	0%	0%
CZ	278	-24%	-35%	-62%	-66%	-72%	-61%	-64%	-71%	-1%	-2%	-1%
DK	186	-38%	-56%	-66%	-69%	-75%	-64%	-66%	-73%	-2%	-3%	-2%
EE	37	-12%	-18%	-61%	-61%	-74%	-46%	-46%	-71%	-15%	-15%	-3%
FI	169	-14%	-35%	-51%	-51%	-59%	-47%	-47%	-58%	-3%	-3%	-1%
FR	1404	-30%	-50%	-67%	-70%	-75%	-67%	-69%	-74%	0%	-1%	-1%
DE	1565	-19%	-39%	-62%	-69%	-73%	-60%	-64%	-71%	-2%	-5%	-2%
GR	417	-38%	-31%	-69%	-72%	-77%	-68%	-69%	-75%	-1%	-3%	-2%
HU	165	-26%	-34%	-66%	-69%	-77%	-62%	-66%	-75%	-5%	-4%	-2%
IE	129	-43%	-49%	-71%	-75%	-82%	-70%	-71%	-79%	-1%	-4%	-2%
IT	1214	-30%	-40%	-65%	-69%	-72%	-62%	-68%	-71%	-3%	-1%	-1%
LV	42	-15%	-32%	-44%	-44%	-58%	-40%	-41%	-54%	-4%	-4%	-4%
LT	62	-8%	-48%	-54%	-55%	-65%	-49%	-51%	-63%	-5%	-5%	-3%
LU	62	-26%	-43%	-79%	-79%	-80%	-85%	-85%	-86%	+6%	+6%	+6%
MT	9	-7%	-42%	-89%	-89%	-92%	-79%	-79%	-86%	-9%	-9%	-6%
NL	365	-27%	-45%	-62%	-68%	-72%	-59%	-61%	-67%	-3%	-7%	-6%
PL	851	-4%	-30%	-52%	-55%	-65%	-49%	-51%	-63%	-3%	-4%	-2%
PT	256	-37%	-36%	-65%	-71%	-79%	-59%	-61%	-75%	-6%	-10%	-4%
RO	309	-27%	-45%	-59%	-67%	-74%	-55%	-62%	-71%	-4%	-5%	-3%
SK	102	-20%	-36%	-51%	-59%	-67%	-44%	-48%	-63%	-6%	-10%	-4%
SI	48	-6%	-39%	-69%	-71%	-75%	-64%	-65%	-70%	-4%	-6%	-6%
ES	1311	-36%	-41%	-71%	-75%	-80%	-65%	-66%	-74%	-7%	-9%	-6%
SE	175	-25%	-36%	-65%	-65%	-70%	-66%	-66%	-70%	+1%	+1%	0%
UK	1592	-33%	-55%	-70%	-73%	-79%	-72%	-74%	-80%	+2%	+1%	+2%

<sup>1</sup> Excluding emissions outside the EMEP region (e.g., Canary Islands)

Table 7.3: PM2.5 emission reductions relative to 2005. 2012: reported in 2014, 2020: Gothenburg Commitment, 2030 numbers computed by GAINS, relative to GAINS 2005 estimates

	2005	2012	2020 GP	2030 Commission 2013			2030 WPE 2014			Difference WPE-COM		
				CLE	67% GC	MTFR	CLE	67% GC	MTFR	CLE	67% GC	MTFR
EU	1414	-12%	-22%	-27%	-51%	-63%	-32%	-54%	-62%	+5%	+3%	-1%
AT	22	-16%	-20%	-34%	-55%	-62%	-38%	-49%	-60%	+4%	-6%	-2%
BE	36	-11%	-20%	-33%	-47%	-53%	-15%	-41%	-51%	-18%	-6%	-2%
BG	27	10%	-20%	-30%	-64%	-75%	-41%	-66%	-72%	+11%	+2%	-3%
HR	11	-10%	-18%	-28%	-66%	-82%	-26%	-62%	-75%	-2%	-4%	-7%
CY	3	-39%	-46%	-70%	-72%	-75%	-69%	-78%	-80%	-1%	+5%	+5%
CZ	21	-4%	-17%	-25%	-51%	-65%	-28%	-50%	-56%	+3%	-2%	-8%
DK	26	-14%	-33%	-53%	-64%	-75%	-53%	-56%	-69%	0%	-9%	-7%
EE	20	-14%	-15%	-41%	-52%	-85%	-35%	-41%	-76%	-6%	-11%	-9%
FI	41	-10%	-30%	-30%	-39%	-62%	-28%	-34%	-48%	-2%	-5%	-14%
FR	246	-26%	-27%	-38%	-48%	-61%	-48%	-56%	-63%	+11%	+8%	+3%
DE	125	-10%	-26%	-32%	-43%	-49%	-33%	-42%	-47%	+1%	-1%	-2%
GR			-35%	-51%	-71%	-77%	-51%	-71%	-75%	0%	0%	-2%
HU	27	13%	-13%	-37%	-63%	-73%	-38%	-64%	-70%	0%	+1%	-3%
IE	11	-27%	-18%	-33%	-35%	-49%	-37%	-39%	-48%	+5%	+4%	-1%
IT	142	-11%	-10%	-19%	-45%	-53%	-35%	-54%	-59%	+16%	+9%	+5%
LV	29	-5%	-16%	-34%	-45%	-80%	-40%	-46%	-78%	+6%	0%	-2%
LT	23	7%	-20%	-28%	-54%	-75%	-32%	-48%	-74%	+3%	-5%	-1%
LU	4	-27%	-15%	-43%	-48%	-54%	-40%	-43%	-48%	-4%	-5%	-6%
MT	1	-38%	-25%	-76%	-80%	-83%	-72%	-76%	-79%	-4%	-4%	-3%
NL	19	-33%	-37%	-30%	-38%	-45%	-32%	-40%	-46%	+2%	+1%	+1%
PL	141	-2%	-16%	-12%	-40%	-56%	-11%	-46%	-53%	0%	+6%	-3%
PT	69	-19%	-15%	-35%	-70%	-74%	-39%	-68%	-71%	+4%	-1%	-3%
RO	106	7%	-28%	-25%	-65%	-80%	-39%	-69%	-76%	+14%	+5%	-4%
SK	37	-21%	-36%	-38%	-64%	-78%	-36%	-63%	-73%	-1%	0%	-5%
SI	16	9%	-25%	-40%	-70%	-76%	-23%	-76%	-77%	-17%	+7%	+1%
ES	90	-22%	-15%	-20%	-61%	-68%	-19%	-62%	-68%	-1%	+1%	-0%
SE	30	-10%	-19%	-19%	-23%	-56%	-16%	-17%	-48%	-3%	-6%	7%
UK	93	-17%	-30%	-6%	-47%	-56%	-28%	-53%	-57%	+22%	+7%	+2%

<sup>1</sup> Excluding emissions outside the EMEP region (e.g., Canary Islands)

Table 7.4: NH<sub>3</sub> emissions relative to 2005. 2012: reported in 2014, 2020: Gothenburg Commitment, 2030 numbers computed by GAINS, relative to GAINS 2005 estimates

	2005	2012	2020 GP	2030 Commission 2013			2030 WPE 2014			Difference WPE-COM		
				CLE	67% GC	MTFR	CLE	67% GC	MTFR	CLE	67% GC	MTFR
EU	3878	-5%	-6%	-7%	-27%	-35%	-8%	-25%	-35%	+1%	-2%	0%
AT	63	-1%	-1%	+8%	-19%	-26%	+12%	-18%	-31%	-4%	-1%	+5%
BE	72	-6%	-2%	-1%	-16%	-19%	0%	-13%	-22%	-1%	-3%	+3%
BG	48	-21%	-3%	-1%	-10%	-12%	-6%	-18%	-25%	+5%	+8%	+13%
HR	44	-6%	-1%	+2%	-24%	-36%	+3%	-23%	-38%	-1%	-1%	+2%
CY	6	-17%	-10%	-4%	-18%	-31%	-6%	-21%	-41%	+2%	+3%	+10%
CZ	68	-6%	-7%	-22%	-35%	-36%	-20%	-38%	-42%	-2%	+3%	+6%
DK	88	-13%	-24%	-31%	-37%	-47%	-27%	-32%	-46%	-4%	-5%	-1%
EE	10	11%	-1%	+9%	-8%	-29%	+15%	-1%	-26%	-6%	-7%	-3%
FI	38	-3%	-20%	-8%	-15%	-29%	-9%	-15%	-29%	+1%	0%	0%
FR	686	-1%	-4%	-5%	-29%	-37%	-8%	-23%	-32%	+3%	-6%	-5%
DE	572	-5%	-5%	-5%	-39%	-50%	-7%	-38%	-47%	+2%	-1%	-3%
GR	68	-9%	-7%	-16%	-26%	-32%	-21%	-31%	-38%	+5%	+5%	+6%
HU	78	-16%	-10%	-13%	-34%	-38%	-23%	-43%	-50%	+10%	+9%	+12%
IE	110	-5%	-1%	-3%	-7%	-18%	-6%	-10%	-25%	+3%	+3%	+7%
IT	416	-3%	-5%	-8%	-26%	-29%	-8%	-22%	-29%	0%	-4%	0%
LV	17	9%	-1%	+19%	6%	-3%	+15%	3%	-10%	+4%	+3%	+7%
LT	39	-3%	-10%	+15%	7%	-26%	+9%	-2%	-23%	+6%	+9%	-3%
LU	7	-3%	-1%	-11%	-24%	-27%	-9%	-24%	-28%	-2%	0%	+1%
MT	2	-4%	-4%	-8%	-24%	-35%	-8%	-24%	-37%	0%	0%	+2%
NL	143	-16%	-13%	-24%	-25%	-25%	-19%	-21%	-22%	-5%	-4%	-3%
PL	272	-3%	-1%	-3%	-26%	-33%	+1%	-22%	-37%	-4%	-4%	+4%
PT	50	-9%	-7%	+3%	-16%	-29%	-5%	-19%	-35%	+8%	+3%	+6%
RO	199	-20%	-13%	-12%	-24%	-31%	-13%	-28%	-34%	+1%	+4%	+3%
SK	29	-12%	-15%	-16%	-37%	-42%	-22%	-43%	-48%	+6%	+6%	+6%
SI	19	-8%	-1%	-12%	-24%	-28%	-10%	-26%	-32%	-2%	+2%	+4%
ES	376	0%	-3%	-5%	-29%	-43%	-6%	-21%	-42%	+1%	-8%	-1%
SE	56	-8%	-15%	-9%	-17%	-27%	-10%	-17%	-33%	+1%	0%	+6%
UK	302	-8%	-8%	-7%	-21%	-22%	-8%	-24%	-27%	+1%	+3%	+5%

<sup>1</sup> Excluding emissions outside the EMEP region (e.g., Canary Islands)



Table 7.5: VOC emission reductions relative to 2005. 2012: reported in 2014, 2020: Gothenburg Commitment, 2030 numbers computed by GAINS, relative to GAINS 2005 estimates

	2005	2012	2020 GP	2030 Commission 2013			2030 WPE 2014			Difference WPE-COM		
				CLE	67% GC	MTFR	CLE	67% GC	MTFR	CLE	67% GC	MTFR
EU	8775	-24%	-28%	-41%	-50%	-66%	-40%	-46%	-61%	-2%	-5%	-5%
AT	165	-18%	-21%	-40%	-48%	-70%	-38%	-40%	-65%	-2%	-8%	-5%
BE	146	-28%	-21%	-37%	-44%	-57%	-25%	-35%	-46%	-12%	-10%	-12%
BG	85	-4%	-21%	-51%	-62%	-77%	-59%	-69%	-77%	+7%	+7%	0%
HR	101	-32%	-34%	-39%	-48%	-68%	-45%	-50%	-73%	+6%	+2%	+4%
CY	14	-35%	-45%	-53%	-54%	-69%	-47%	-50%	-65%	-6%	-4%	-4%
CZ	182	-29%	-18%	-44%	-57%	-72%	-43%	-50%	-68%	-1%	-7%	-5%
DK	114	-31%	-35%	-51%	-59%	-73%	-48%	-49%	-68%	-3%	-10%	-6%
EE	40	-16%	-10%	-31%	-37%	-75%	-24%	-28%	-66%	-6%	-9%	-10%
FI	136	-23%	-35%	-44%	-46%	-72%	-47%	-48%	-67%	+3%	+1%	-5%
FR	1261	-44%	-43%	-47%	-50%	-65%	-51%	-52%	-64%	+4%	+2%	-1%
DE	1124	-15%	-13%	-32%	-43%	-59%	-31%	-35%	-56%	-1%	-8%	-3%
GR	220	-31%	-54%	-59%	-67%	-79%	-56%	-64%	-75%	-3%	-3%	-4%
HU	124	-16%	-30%	-44%	-59%	-69%	-44%	-58%	-71%	0%	-1%	+2%
IE	57	-23%	-25%	-32%	-32%	-65%	-32%	-32%	-56%	0%	0%	-9%
IT	1204	-29%	-35%	-48%	-54%	-68%	-43%	-49%	-60%	-5%	-5%	-7%
LV	56	-3%	-27%	-46%	-49%	-77%	-39%	-42%	-78%	-7%	-7%	+1%
LT	68	-13%	-32%	-53%	-57%	-78%	-41%	-47%	-76%	-11%	-11%	-2%
LU	13	-32%	-29%	-55%	-58%	-67%	-47%	-49%	-65%	-7%	-9%	-1%
MT	3	-5%	-23%	-30%	-31%	-64%	-26%	-27%	-59%	-4%	-4%	-5%
NL	174	-16%	-8%	-31%	-34%	-50%	-19%	-22%	-37%	-12%	-13%	-12%
PL	575	10%	-25%	-34%	-56%	-69%	-34%	-55%	-67%	-1%	0%	-2%
PT	207	-19%	-18%	-40%	-46%	-60%	-40%	-44%	-56%	0%	-2%	-3%
RO	425	-16%	-25%	-48%	-64%	-79%	-54%	-67%	-80%	+6%	+4%	+1%
SK	73	-16%	-18%	-31%	-40%	-65%	-22%	-32%	-57%	-9%	-8%	-8%
SI	48	-17%	-23%	-33%	-63%	-75%	-31%	-59%	-68%	-2%	-4%	-7%
ES	802	-28%	-22%	-36%	-48%	-62%	-29%	-39%	-54%	-7%	-9%	-8%
SE	198	-6%	-25%	-37%	-38%	-53%	-39%	-39%	-54%	+2%	+2%	0%
UK	1160	-28%	-32%	-37%	-49%	-62%	-37%	-39%	-52%	1%	-10%	-10%

<sup>1</sup> Excluding emissions outside the EMEP region (e.g., Canary Islands)

Table 7.6: PMeq emission reductions relative to 2005. 2012: reported in 2014, 2020: Gothenburg Commitment, 2030 numbers computed by GAINS, relative to GAINS 2005 estimates

	2005	2012	2020 GP	2030 Commission 2013			2030 WPE 2014			Difference WPE-COM		
				CLE	67% GC	MTFR	CLE	67% GC	MTFR	CLE	67% GC	MTFR
EU	5315	-29%	-38%	-49%	-63%	-69%	-50%	-63%	-69%	+1%	0%	0%
AT	60	-18%	-22%	-37%	-51%	-58%	-36%	-47%	-57%	0%	-4%	0%
BE	113	-35%	-30%	-43%	-54%	-57%	-36%	-50%	-56%	-7%	-4%	-1%
BG	279	-48%	-68%	-77%	-86%	-88%	-77%	-86%	-89%	0%	0%	0%
HR	45	-33%	-32%	-46%	-70%	-80%	-43%	-65%	-76%	-3%	-4%	-4%
CY	17	-46%	-68%	-82%	-83%	-88%	-81%	-84%	-90%	0%	+1%	+1%
CZ	120	-21%	-34%	-47%	-61%	-66%	-52%	-62%	-66%	+4%	+1%	0%
DK	64	-23%	-38%	-51%	-58%	-67%	-50%	-53%	-64%	-1%	-6%	-3%
EE	47	-29%	-23%	-51%	-58%	-78%	-51%	-54%	-80%	0%	-4%	+1%
FI	82	-14%	-30%	-32%	-36%	-49%	-31%	-35%	-47%	-1%	-1%	-3%
FR	621	-27%	-32%	-43%	-54%	-62%	-48%	-55%	-62%	+5%	+2%	0%
DE	488	-10%	-23%	-36%	-50%	-56%	-37%	-50%	-56%	+1%	0%	0%
GR	204	-49%	-45%	-75%	-82%	-86%	-76%	-82%	-86%	+1%	0%	0%
HU	67	-8%	-23%	-54%	-69%	-74%	-42%	-61%	-67%	12%	-8%	-7%
IE	63	-35%	-33%	-45%	-48%	-56%	-45%	-48%	-58%	+1%	0%	+1%
IT	436	-26%	-22%	-38%	-54%	-60%	-42%	-55%	-61%	+4%	+1%	+1%
LV	38	-7%	-16%	-31%	-40%	-69%	-36%	-41%	-70%	+5%	+1%	+1%
LT	48	-2%	-30%	-26%	-47%	-64%	-31%	-46%	-66%	+5%	-1%	+2%
LU	10	-23%	-27%	-51%	-56%	-60%	-55%	-59%	-64%	+5%	+3%	+4%
MT	6	-29%	-57%	-87%	-89%	-91%	-84%	-85%	-90%	-3%	-3%	-1%
NL	92	-29%	-29%	-41%	-46%	-50%	-39%	-43%	-47%	-2%	-3%	-3%
PL	618	-19%	-42%	-41%	-59%	-67%	-41%	-60%	-66%	0%	+1%	-1%
PT	150	-40%	-37%	-41%	-66%	-72%	-51%	-69%	-76%	+11%	+3%	+3%
RO	360	-34%	-54%	-60%	-77%	-83%	-59%	-76%	-80%	-1%	-1%	-3%
SK	76	-25%	-42%	-42%	-67%	-75%	-49%	-67%	-74%	+7%	0%	0%
SI	35	-24%	-37%	-58%	-72%	-75%	-48%	-74%	-76%	-11%	+2%	+1%
ES	632	-49%	-48%	-60%	-75%	-79%	-58%	-72%	-78%	-2%	-3%	-2%
SE	65	-15%	-22%	-27%	-30%	-48%	-25%	-27%	-45%	-2%	-3%	-3%
UK	480	-30%	-45%	-53%	-67%	-71%	-58%	-70%	-74%	+5%	+3%	+2%

<sup>1</sup> Excluding emissions outside the EMEP region (e.g., Canary Islands)

## 7.2 Emissions (kilotons)

Table 7.7: SO<sub>2</sub> emissions of the WPE 2014 analyses compared with the calculations for the COM 2013 proposal

	2005 <sup>1)</sup>	WPE 2014 GAINS analysis						COM 2013 GAINS analysis			
		PRIMES 2013 REFERENCE scenario				NATIONAL PROJECTIONS		PRIMES 2013 REFERENCE scenario			
		2005 GAINS	CLE 2030	Optimized	MTFR 2030	CLE 2030	MTFR 2030	2005 GAINS	CLE 2030	Optimized	MTFR 2030
EU	7710	7681	1996	1439	1200	2064	1214	8172	2211	1530	1382
AT	27	27	17	16	13	22	16	25	13	12	11
BE	144	140	59	48	45	59	45	140	58	45	44
BG	776	762	101	51	43	101	43	890	112	53	52
HR	64	65	19	9	6	19	6	68	20	9	6
CY	38	38	2	2	1	2	1	38	2	2	1
CZ	219	221	71	59	56	82	58	208	74	59	56
DK	25	24	9	9	8	9	8	21	9	9	8
EE	76	76	21	21	9	29	12	66	22	19	15
FI	69	69	46	45	40	46	40	90	64	63	59
FR	460	465	134	108	92	134	92	444	117	97	92
DE	460	457	234	195	173	234	173	549	295	258	246
GR	541	529	51	42	25	51	25	505	50	38	25
HU	43	43	18	12	11	18	11	129	27	16	15
IE	72	71	14	13	9	15	9	71	14	12	11
IT	405	407	160	119	85	194	90	382	142	94	73
LV	7	7	4	4	3	4	3	5	3	3	2
LT	43	41	22	14	9	26	10	42	25	12	10
LU	2	3	2	1	1	2	1	2	2	1	1
MT	11	11	1	1	0	0	0	11	0	0	0
NL	64	65	29	27	24	29	24	70	32	29	26
PL	1217	1207	410	274	249	410	249	1256	453	276	261
PT	177	179	49	30	18	49	18	111	49	26	17
RO	643	642	100	51	44	107	45	706	99	51	45
SK	89	90	24	16	14	24	14	92	46	19	19
SI	41	39	5	5	4	5	4	40	6	5	4
ES	1252	1245	216	156	126	216	126	1328	232	152	130
SE	36	36	31	31	30	31	30	38	32	32	31
UK	709	721	146	79	63	146	63	850	214	138	124

<sup>1)</sup> National submission as of 2014, adjusted to the GAINS source coverage

Table 7.8: NO<sub>x</sub> emissions of the WPE 2014 analyses compared with the calculations for the COM 2013 proposal

	2005 <sup>1)</sup>	WPE 2014 GAINS analysis						COM 2013 GAINS analysis			
		PRIMES 2013 REFERENCE scenario				NATIONAL PROJECTIONS		PRIMES 2013 REFERENCE scenario			
		2005 GAINS	CLE 2030	Optimized	MTFR 2030	CLE 2030	MTFR 2030	2005 GAINS	CLE 2030	Optimized	MTFR 2030
EU	11316	11263	4198	3905	3081	4303	3134	11538	4051	3599	2948
AT	232	230	67	66	54	77	61	230	65	64	54
BE	303	303	133	124	100	133	99	295	134	108	95
BG	154	161	61	60	42	61	42	167	60	58	41
HR	80	80	40	30	17	40	17	76	33	26	14
CY	21	21	7	6	4	17	6	21	6	6	4
CZ	278	294	115	107	85	115	77	296	112	101	83
DK	186	177	63	60	48	63	48	182	61	57	46
EE	36	37	20	20	11	26	14	40	16	16	10
FI	169	184	97	97	77	97	77	201	99	99	82
FR	1404	1399	460	433	358	460	355	1351	441	401	332
DE	1453	1430	568	520	414	586	429	1397	530	439	380
GR	416	402	130	124	99	130	99	407	126	112	92
HU	154	150	57	52	37	57	37	155	52	48	35
IE	129	136	41	39	28	48	32	150	43	38	28
IT	1214	1188	453	383	345	485	383	1306	456	405	360
LV	42	41	25	24	19	25	19	36	20	20	15
LT	62	50	25	25	19	28	19	62	28	28	22
LU	61	56	8	8	8	8	8	47	10	10	9
MT	9	10	2	2	1	2	2	10	1	1	1
NL	361	362	149	140	120	144	111	380	143	122	105
PL	786	774	392	378	289	392	289	797	379	358	280
PT	256	246	100	96	62	98	61	268	92	76	57
RO	308	309	139	118	89	158	90	311	127	102	81
SK	91	91	51	47	34	51	34	95	47	39	31
SI	47	50	18	17	15	18	15	50	16	14	12
ES	1298	1366	482	468	349	482	349	1513	434	380	300
SE	175	200	68	68	60	68	60	216	76	76	64
UK	1592	1516	427	390	296	427	295	1480	441	397	316

<sup>1)</sup> National submission as of 2014, adjusted to the GAINS source coverage

Table 7.9: PM2.5 emissions of the WPE 2014 analyses compared with the calculations for the COM 2013 proposal

	2005 <sup>1)</sup>	WPE 2014 GAINS analysis						COM 2013 GAINS analysis			
		PRIMES 2013 REFERENCE scenario				NATIONAL PROJECTIONS		PRIMES 2013 REFERENCE scenario			
		2005 GAINS	CLE 2030	Optimized	MTFR 2030	CLE 2030	MTFR 2030	2005 GAINS	CLE 2030	Optimized	MTFR 2030
EU	1473	1665	1127	761	628	1158	636	1647	1200	804	607
AT	22	22	13	11	9	12	8	24	16	11	9
BE	36	37	32	22	18	32	18	28	19	15	13
BG	27	39	23	13	11	23	11	35	24	13	9
HR	11	15	11	6	4	11	4	15	11	5	3
CY	3	3	1	1	1	1	1	3	1	1	1
CZ	21	34	24	17	15	25	15	43	32	21	15
DK	26	27	13	12	9	13	9	28	13	10	7
EE	20	20	13	12	5	15	5	20	12	10	3
FI	41	35	25	23	18	25	18	29	20	17	11
FR	248	245	127	107	90	127	90	271	169	141	107
DE	125	122	82	71	64	82	64	123	84	70	62
GR		61	29	18	15	29	15	62	30	18	14
HU	27	32	20	12	10	21	10	29	18	11	8
IE	11	11	7	7	6	8	5	13	9	9	7
IT	142	141	92	65	58	114	64	147	119	80	69
LV	29	30	18	16	7	18	7	19	12	10	4
LT	23	22	15	11	6	15	6	15	11	7	4
LU	4	3	2	2	2	2	2	3	2	2	2
MT	1	1	0	0	0	0	0	1	0	0	0
NL	20	24	16	14	13	16	13	24	17	15	13
PL	141	219	195	119	102	195	102	225	198	135	98
PT	63	59	36	19	17	36	17	63	41	19	16
RO	106	145	89	45	35	94	37	113	84	40	23
SK	37	35	22	13	10	22	10	32	20	12	7
SI	16	15	11	4	3	11	3	9	6	3	2
ES	90	144	117	54	47	117	47	156	125	61	50
SE	30	32	27	26	17	27	17	31	25	24	14
UK	93	93	67	43	40	67	40	87	82	46	38

<sup>1)</sup> National submission as of 2014, adjusted to the GAINS source coverage

Table 7.10: NH<sub>3</sub> emissions of the WPE 2014 analyses compared with the calculations for the COM 2013 proposal

	2005 <sup>1)</sup>	WPE 2014 GAINS analysis						COM 2013 GAINS analysis			
		PRIMES 2013 REFERENCE scenario				NATIONAL PROJECTIONS		PRIMES 2013 REFERENCE scenario			
		2005 GAINS	CLE 2030	Optimized	MTFR 2030	CLE 2030	MTFR 2030	2005 GAINS	CLE 2030	Optimized	MTFR 2030
EU	3868	3938	3631	2956	2558	3708	2602	3928	3663	2871	2568
AT	63	62	69	51	43	70	44	63	68	51	47
BE	73	72	71	62	56	71	56	74	73	62	60
BG	48	39	37	32	29	37	29	65	64	59	57
HR	44	40	41	31	25	41	25	29	30	22	19
CY	6	6	6	5	4	6	4	6	6	5	4
CZ	68	71	57	44	41	58	42	80	62	52	51
DK	77	77	56	52	42	69	51	73	51	46	39
EE	10	10	12	10	8	12	8	12	13	11	8
FI	38	40	36	34	28	36	28	34	31	29	24
FR	686	694	638	537	469	638	469	675	639	476	424
DE	572	588	545	364	313	564	324	593	565	362	294
GR	57	58	46	40	36	46	36	57	48	42	39
HU	78	79	60	45	39	80	52	78	67	51	48
IE	110	111	104	99	83	118	94	104	101	97	86
IT	416	435	399	339	310	382	295	422	389	311	299
LV	17	15	17	15	13	17	13	13	15	14	13
LT	39	35	38	34	27	42	30	44	51	47	33
LU	7	6	6	5	4	6	4	6	6	5	5
MT	2	2	2	1	1	2	1	2	2	1	1
NL	143	144	117	114	113	115	110	146	111	110	109
PL	272	329	332	257	207	332	207	344	332	255	228
PT	50	54	51	44	35	51	35	71	73	60	50
RO	199	186	162	134	122	162	122	161	141	123	112
SK	29	29	23	16	15	27	17	28	24	18	17
SI	19	19	17	14	13	18	14	19	17	14	14
ES	379	377	354	298	219	354	219	366	349	258	209
SE	56	54	49	45	36	49	36	54	49	44	39
UK	310	310	286	235	227	305	238	308	287	245	239

<sup>1)</sup> National submission as of 2014, adjusted to the GAINS source coverage

Table 7.11: VOC emissions of the WPE 2014 analyses compared with the calculations for the COM 2013 proposal

	2005 <sup>1)</sup>	WPE 2014 GAINS analysis						COM 2013 GAINS analysis			
		PRIMES 2013 REFERENCE scenario				NATIONAL PROJECTIONS		PRIMES 2013 REFERENCE scenario			
		2005 GAINS	CLE 2030	Optimized	MTFR 2030	CLE 2030	MTFR 2030	2005 GAINS	CLE 2030	Optimized	MTFR 2030
EU	8599	8846	5350	4793	3486	5425	3512	9259	5460	4598	3191
AT	164	170	105	102	60	103	61	171	102	89	52
BE	147	151	114	99	82	114	82	158	99	88	67
BG	67	128	53	40	30	53	30	139	67	52	32
HR	101	101	56	51	28	56	28	79	48	41	25
CY	12	11	6	6	4	6	4	9	4	4	3
CZ	202	196	112	98	63	127	63	251	140	108	69
DK	113	112	58	57	36	58	36	130	63	53	35
EE	36	37	28	27	13	29	13	38	27	24	9
FI	136	118	62	62	39	62	39	173	96	92	48
FR	1261	1216	593	578	442	593	442	1117	591	556	396
DE	1124	1185	818	771	523	831	536	1235	840	708	502
GR	220	263	117	94	65	117	65	283	116	93	60
HU	124	130	73	55	38	73	38	144	81	60	45
IE	57	59	40	40	26	41	26	63	43	43	22
IT	1204	1165	670	597	460	711	470	1237	646	570	400
LV	55	56	34	32	12	34	12	69	37	35	16
LT	68	80	47	43	19	49	19	84	40	36	18
LU	12	14	7	7	5	7	5	13	6	5	4
MT	3	4	3	3	2	4	2	4	3	3	1
NL	174	172	139	134	108	158	123	205	141	134	103
PL	575	605	403	270	201	403	201	615	403	273	192
PT	207	223	134	124	98	134	98	227	137	123	92
RO	340	394	179	129	80	179	79	460	238	167	96
SK	73	71	56	48	31	56	31	77	53	46	27
SI	42	45	31	18	14	31	14	41	28	15	10
ES	802	871	615	532	405	615	405	934	596	484	358
SE	198	205	125	125	95	125	95	210	132	131	98
UK	1082	1063	673	651	509	657	496	1093	684	562	410

<sup>1)</sup> National submission as of 2014, adjusted to the GAINS source coverage

Table 7.12: PMeq emissions of the WPE 2014 analyses compared with the calculations for the COM 2013 proposal

	2005 <sup>1)</sup>	WPE 2014 GAINS analysis						COM 2013 GAINS analysis			
		PRIMES 2013 REFERENCE scenario				NATIONAL PROJECTIONS		PRIMES 2013 REFERENCE scenario			
		2005 GAINS	CLE 2030	Optimized	MTFR 2030	CLE 2030	MTFR 2030	2005 GAINS	CLE 2030	Optimized	MTFR 2030
EU	5356	5552	2756	2068	1720	2829	1744	5701	2890	2099	1744
AT	60	59	37	31	25	38	25	61	39	30	26
BE	114	115	73	57	50	73	50	106	60	48	45
BG	278	285	65	39	32	65	32	325	74	44	38
HR	45	48	27	17	12	27	12	47	25	14	9
CY	17	17	3	3	2	4	2	17	3	3	2
CZ	120	135	65	51	46	70	46	142	75	56	48
DK	62	62	31	30	22	34	24	62	30	26	20
EE	47	48	24	22	10	28	11	45	22	19	10
FI	82	76	53	50	41	53	41	77	52	49	39
FR	624	622	326	278	236	326	236	635	363	294	243
DE	480	479	303	241	209	308	212	506	324	253	222
GR	264	259	63	47	37	63	37	253	64	46	36
HU	66	72	42	28	23	46	26	94	44	29	25
IE	63	63	34	33	27	39	29	65	36	34	29
IT	436	437	253	197	171	285	178	441	273	201	176
LV	38	38	24	22	12	24	12	26	18	15	8
LT	48	45	31	24	15	33	16	41	30	22	15
LU	10	9	4	4	3	4	3	8	4	4	3
MT	6	5	1	1	1	1	1	5	1	1	0
NL	93	97	59	55	51	58	50	101	59	54	50
PL	614	700	411	279	238	411	238	724	427	294	241
PT	144	141	69	44	34	69	34	130	77	45	36
RO	359	397	161	95	78	170	81	379	152	87	64
SK	76	74	37	24	19	38	20	72	42	24	18
SI	35	34	18	9	8	18	8	29	12	8	7
ES	631	688	288	195	154	288	154	733	296	186	153
SE	65	69	51	50	37	51	37	69	50	48	36
UK	480	479	201	144	127	205	129	509	237	167	147

<sup>1)</sup> National submission as of 2014, adjusted to the GAINS source coverage



## 7.3 Emissions control costs

Table 7.13: Emission control costs (on top of current legislation) of the WPE 2014 analyses compared with the calculations for the COM 2013 proposal (€ million/year)

	WPE 2014 GAINS analysis		COM 2013 GAINS analysis		Difference	
	Optimized	MTFR	Optimized	MTFR	Optimized	MTFR
EU	2232	40996	3331	50575	-1098	-9579
AT	16	813	66	1099	-50	-286
BE	87	793	110	853	-23	-60
BG	45	485	67	752	-22	-267
HR	22	365	26	440	-5	-76
CY	0	54	0	47	0	7
CZ	43	975	106	1269	-63	-294
DK	2	677	18	814	-16	-137
EE	1	291	4	363	-3	-72
FI	3	799	5	1035	-2	-237
FR	132	6373	289	7828	-158	-1455
DE	316	5531	489	5702	-173	-170
GR	40	936	51	1142	-10	-206
HU	50	556	72	697	-21	-140
IE	3	530	8	518	-5	12
IT	299	3382	418	3967	-119	-585
LV	1	473	2	613	-1	-140
LT	7	539	14	664	-7	-125
LU	1	46	2	45	-1	1
MT	0	16	0	17	0	-1
NL	22	907	47	965	-26	-58
PL	557	4909	638	6849	-82	-1939
PT	40	620	67	922	-27	-303
RO	160	2033	180	3010	-20	-977
SK	52	674	78	852	-27	-177
SI	32	130	34	147	-2	-17
ES	128	4483	231	5130	-102	-647
SE	1	521	4	635	-3	-114
UK	173	3084	303	4199	-130	-1116