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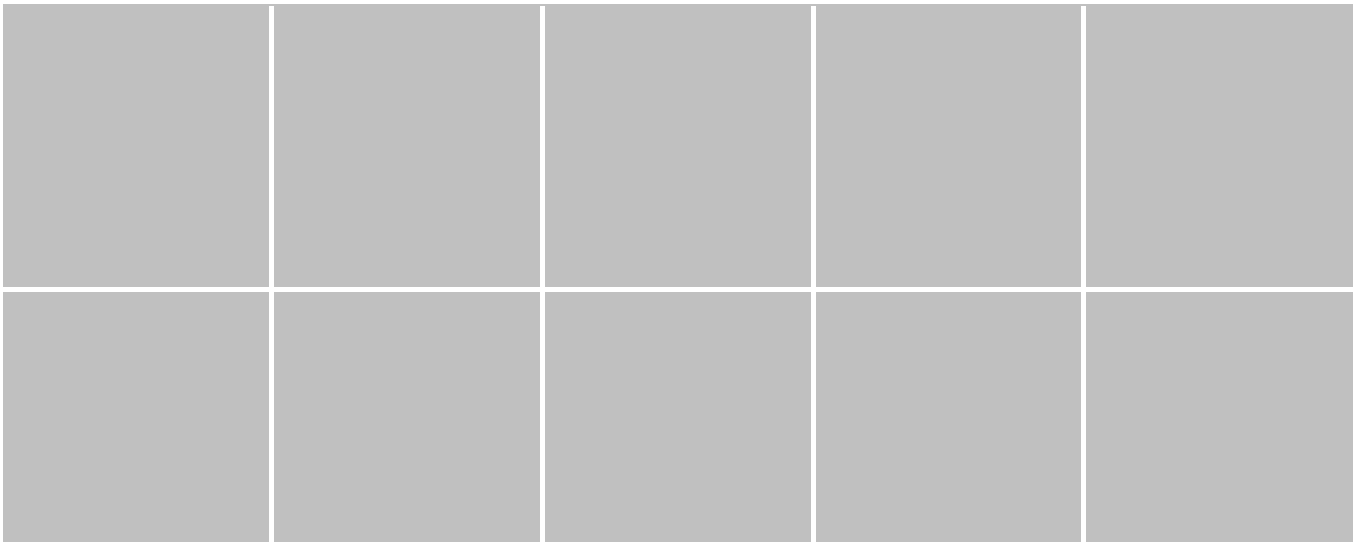

Analysis of the Costs and Benefits of Proposed Revisions to the National Emission Ceilings Directive

NEC CBA Report 3. National Emission Ceilings for 2020 based on the 2008 Climate & Energy Package

European Commission DG ENV.C.5

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Executive Summary

This is the final report describing the Cost-Benefit Analysis (CBA) undertaken by the European Commission to assess proposals for a revised National Emission Ceilings Directive (NECD). This analysis, led by AEA Energy & Environment, is based on the CBA methodology developed by a wider consortium under the Clean Air for Europe (CAFE) Programme (Holland et al. 2005a).

The CBA analysis seeks to provide a comparison of potential costs associated with a policy proposal versus the benefits that result from its implementation. Such an analysis provides policy makers with important information concerning whether a policy proposal is justified, and whether it could be amended to further reduce costs / increase benefits.

In the context of the NECD proposals, the costs are those associated with delivering emission reductions to meet national ceilings in 2020 whilst the benefits are the reductions in air pollution impacts resulting from reducing pollutant emissions and meeting the NECD ceilings.

The CBA approach used for this analysis is wholly consistent with that developed for the Clean Air for Europe (CAFE) programme. It takes abatement costs required for meeting the TSAP objectives (which will be reflected as Member State ceilings) based on model runs undertaken using the GAINS model, and compares these against health and other benefits associated with reductions in air pollution.

Core scenario runs all reflect the TSAP objectives. The key results are shown in the table below; CE is the most cost–effective case, whilst CE-4 / CE-32 place caps on abatement costs of individual countries so that they do not exceed 0.04% and 0.032% of GDP respectively. CE-MECP is the same as CE except with the recent IMO agreement on shipping included.

Overall the analysis shows that benefits exceed costs for all scenarios, even with the low estimate of benefits. With the low estimate the benefit to cost ratio (B-C ratio) ranges between 14.3 to 16. The highest benefit to cost ratio corresponds to the case which includes the MECP57 based on the recent IMO agreement to reduce emissions from ships. With the high estimate of benefits the range is between 45.6 and 51.7. Again the highest benefit to cost ratio is with the case including the MECP57. Adding materials benefits at the EU27 level increases the B-C ratio marginally. Concerning uncertainty in these estimates, analysis suggests that the probability of benefits not exceeding costs is extremely low.

Monetised Benefits-health	Units	CE-MECP	CE	CE-4	CE-32
Total with Mortality – VOLY – low (median)	€ million	15,174	21,511	**21,516**	**21,504**
Total with Mortality – VOLY – high (mean)	€ million	28,501	40,404	40,410	40,393
Total with Mortality – VSL – low (median)	€ million	26,031	37,033	37,029	37,007
Total with Mortality – VSL – high (mean)	€ million	48,847	69,514	69,503	69,465
Monetised Benefits-non-health	€ million	-	326	330	333
Total costs	€ million	946	1,490	1,493	1,531
Net benefits (Monetised Benefits minus Total Costs)					
Total with Mortality – VOLY – low (median)	€ million	14,228	20,348	20,353	20,306
Total with Mortality – VOLY – high (mean)	€ million	27,556	39,240	39,247	39,195
Total with Mortality – VSL – low (median)	€ million	25,085	35,869	35,866	35,809
Total with Mortality – VSL – high (mean)	€ million	47,901	68,350	68,340	68,268
Benefit-Cost Ratio (Monetised Benefits divided by Total Costs)					
Total with Mortality – VOLY – low (median)	Ratio	16.0	14.7	14.6	14.3
Total with Mortality – VOLY – high (mean)	Ratio	30.1	27.3	27.3	26.6
Total with Mortality – VSL – low (median)	Ratio	27.5	25.1	25.0	24.4
Total with Mortality – VSL – high (mean)	Ratio	51.7	46.9	46.8	45.6

Note: Annualised benefits include health, materials and crop damage, damage to the environment as well as damage from natural and secondary particulates

At the Member State level benefits exceed costs except for a couple of Member States (Cyprus and Ireland) when using the low estimate of valuation of health damage. With high estimate of valuation of health damage all Member States have benefits that exceed the costs.

Non-health benefits from reductions in air pollution include reductions in damage to ecosystems, crops and buildings. Ecosystem impacts are expressed in terms of critical exceedances, whilst damage to crops and buildings has been estimated in monetary terms. Benefits of reduced crop damage in 2020 from meeting TSAP objectives are approximately €200 million and for buildings, just under €130 million.

In addition to the benefits to the EU27, European policy proposals have benefits for other European countries outside of the EU27, as measured by reduction in health impacts. These have been estimated at approximately €2.3 billion (based on the low value estimate) in meeting TSAP objectives for the central case (CE).

Model simulations with GEM-E3 have been undertaken to assess the macroeconomic impacts of the policy proposals. Whilst at an aggregate level, they do allow an assessment of the full economic effects. They can complement the detailed results from GAINS with the impact of air quality policies on the economy. The conclusions one can draw from the results are:

- The macroeconomic cost of air pollution reduction remains limited compared to the benefits obtained in terms of air quality, health and ecosystem
- The benefits return mainly to the EU citizens.
- The effect on the competitiveness of the sectors remains small because the price effect is limited and all EU countries participate in the abatement effort.
- The overall cost depends on the climate/energy policy included in the assessment i.e. with or without the Climate and Energy Package.

There are a few important caveats. First these results hold as long as the allocation of the efforts over the sectors and countries is cost efficient. Second no implementation and monitoring cost have been taken into account. Third we have used the low estimate for the environmental damage.

Acknowledgements

The authors want to thank all their colleagues who have contributed to the development of the NECD scenario analysis. In particular, we acknowledge the contributions of:

The health benefits team, in particular Fintan Hurley and Alistair Hunt, who worked with us to develop the benefits methodology.

The team at IIASA (International Institute for Applied Systems Analysis) under the leadership of Markus Amann.

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1 Introduction

This is the final report describing the Cost-Benefit Analysis (CBA) undertaken by the European Commission to assess proposals for a revised National Emission Ceilings Directive (NECD). This analysis, led by AEA Energy & Environment, is based on the CBA methodology developed by a wider consortium under the Clean Air for Europe (CAFE) Programme (Holland et al. 2005a).

The CBA analysis seeks to provide a comparison of potential costs associated with a policy proposal versus the benefits that result from its implementation. Such an analysis provides policy makers with important information concerning whether a policy proposal is justified, and whether it could be amended to further reduce costs / increase benefits.

In the context of the NECD proposals, the costs are those associated with delivering emission reductions to meet national ceilings in 2020 whilst the benefits are the reductions in air pollution impacts resulting from reducing pollutant emissions and meeting the NECD ceilings. Cost estimates are based on work undertaken by IIASA using the GAINS model (as reported in Amann et al. 2008).

1.1 Background

In May 2001, the European Commission launched the CAFE Programme, a knowledge based approach with technical/scientific analyses and policy analysis that led to the adoption of the Thematic Strategy on Air Pollution in September 2005[1]. The Thematic Strategy outlines the approach towards cleaner air in Europe and establishes interim objectives with respect to health, forests and natural ecosystems for the year 2020. The Strategy also announced the revision of the National Emission Ceilings (2001/81/EC) as a means of achieving the interim objectives. These interim objectives are shown in Table 1.1 below.

Table 1.1 Environmental objectives for 2020 as % improvement against 2000 from the Thematic Strategy on Air Pollution

Indicator	Unit	% Improvement compared to 2000 TSAP
Premature mortality from exposure to $PM_{2.5}$	Years of life lost	47%
Area of freshwater ecosystem where the critical load for acid deposition is exceeded	km^2	39%
Area of forest ecosystem where the critical load for acid deposition is exceeded	km^2	74%
Area of ecosystems where nitrogen deposition exceeds the critical load for eutrophication	km^2	43%
Premature mortality from exposure to ozone	Number of cases	10%
Area of forest where the critical load of ozone is exceeded (1)	km^2	15%

(1) The area for forest ozone damage was calculated *ex-post* of the RAINS model.

Using the GAINS model, an assessment of the emission reductions required to meet the above targets has been undertaken, and the corresponding costs. Using these data, a cost benefit analysis of the proposals has been undertaken, consistent with that undertaken for the Thematic Strategy.

A number of developments to the CBA methodology have been undertaken in the intervening period since the Thematic Strategy including:

[1] Thematic Strategy on Air Pollution (COM(2005) 446) http://eur-lex.europa.eu/LexUriServ/site/en/com/2005/com2005_0446en01.pdf

- Inclusion of Bulgaria and Romania in the analysis
- Improvements to the CAFE-CBA benefits assessment methodology (Holland and Pye 2006b), and development of the data used e.g. population estimates and agricultural stock-at-risk.
- Analysis based on average meteorology over 5 years – 1996, 1997, 1998, 2000 and 2003. The earlier analysis was based solely on meteorology for 1997, considered at the time to be the most representative of the 5 years.

Compared to previous CAFE analysis, this analysis includes estimates for Bulgaria and Romania. The extent of the modeling covers other European countries such as Norway, Turkey, Switzerland, fYRoM, and Croatia.

1.2 Scenarios investigated

The CBA analysis has investigated a number of different scenarios relevant to the NECD proposals, including:

- **Baseline** assuming no NECD policy change **(BASE)**. Assumes all current legislation, including meeting the 2010-national ceilings of the current NECD (at least by 2020), Euro 5/6, and the proposal for a revised directive on industrial emissions and the EURO VI-proposal. It also assumes the full impact of the Climate and Energy Package assuming that the non-ETS targets are met in each Member State and that there is full trade of renewables and JI/CDM is enabled as so that carbon prices do not exceed €30/t CO_2.[2]
- **Cost-effective measures (CE)**. Setting national ceilings for 2020 for all five pollutants (incl. $PM_{2.5}$) in a least-cost way so that all objectives of the TSAP are met in 2020.
- **Fairness aspects (CE-4/CE-32)**. As for CE but limiting (capping) the additional costs as percentage of GDP for less wealthy Member States to not more than 0.04% (CE-4) and 0.032% (CE-32) of GDP in 2020.
- **Cost-effective measures based on the IMO MEPC57 agreement (CE-MECP)** that includes new standards for marine fuels and engines, the requirements for emission control areas, but not the 2020 global low sulphur fuel standard as this step is to be reviewed in 2018.

A number of sensitivity cases have also been considered:

- As for BASE / CE excluding the Climate and Energy Package from the baseline (S-BASE / S-CE).
- A cost-effective case except with more stringent targets following an interpretation of the 2006 resolution of the European Parliament on the Strategy calling for a higher level of ambition (S-CE-EP). The resolution has been interpreted as follows:
    - YOLL target set at 50% improvement relative to 2000.
    - Ozone related mortality set at 16.1% relative to 2000.
    - Other objectives (relating to ecosystems) remain the same

All of the abatement cost data used in this analysis are sourced from IIASA, based on estimates from the GAINS model (Amann et al. 2008). Simply stated, the GAINS model assesses the emission reductions required to meet the TSAP objectives (or more stringent objectives), and then runs an optimisation routine to establish, across all the pollutants, the least cost set of abatement technologies required (across all Member States) to realise the necessary reductions.

The health benefits of the reductions are calculated using PM and ozone concentration values from the parameterised (approximated) concentration data output by the GAINS model. The approximation is derived from full EMEP model runs, and is based on the relationship between emissions and concentrations of different pollutants. A grid scale of 50x50 km is used, though data are enhanced by results of the CITY-DELTA project to factor in higher urban concentrations of PM in densely populated

[2]Impact Assessment Package of Implementation Measures for the EU's objectives on climate change and renewable energy for 2020 (SEC(2008))85/3

areas. The model calculates changes in the anthropogenic contribution to ambient concentrations of $PM_{2.5}$ in Europe resulting from changes in emissions of primary $PM_{2.5}$, SO_2, NO_X, VOC and NH_3. Note that the model does not consider the contribution from natural sources (e.g., mineral dust, organic carbon, etc.). Similarly, changes in concentrations of secondary organic aerosols (SOA) associated with anthropogenic emissions are not included in the model.

Other benefits (due to the reduction in damage on crops and materials) are calculated from outputs from the full EMEP model runs as these benefits estimates require data on the variation of pollution over the year e.g. the growing season. The EMEP model runs are also used to cross-check the GAINS model approximation results.

The full range of inputs into the CBA methodology to inform the estimates of costs and benefits are provided in Table 1.2 below.

Table 1.2 Inputs into the NECD cost-benefit analysis

Data category	Data input	Model	Lead organisation
Costs[1]	Abatement costs	GAINS	IIASA
Benefits[1]	Air pollution impacts	BENEFITS	AEA
Benefits	Ecosystem impacts	GAINS	IIASA
Other costs	Macro-economic costs	GEM-E3	KU Leuven
Pollution data	Metrics to estimate Outside Europe impacts, and impacts on crops / buildings	EMEP	met.no
Pollution data	Metrics to estimate health impacts[2]	GAINS	IIASA

1 Used in B-C assessment
2 GAINS approximation methodology based on EMEP source-receptor relationship

2 CBA methodology

The CAFE CBA methodology was described in three volumes (Holland et al, 2005a, 2005b; Hurley et al, 2005) available from http://cafe-cba.aeat.com/html/reports.htm . The development of the CAFE CBA methodology can be traced back to the beginning of the EC DG Research ExternE Programme that started in 1991 and continues to the present day. Further to this, the methodology used here was the subject of intense consultation in 2003 and 2004 with stakeholders from the European Union Member States, academic institutes, environment agencies, industry and non-governmental organisations. It was also subject to formal peer review by senior experts in the USA and Europe (the peer review report is available at the above website).

It is important to differentiate the roles of the GAINS and CBA models. The GAINS model identifies a cost-effective set of measures for meeting pre-defined health and environmental quality targets. The CBA model adds to this analysis by assessing the magnitude of benefits and assesses whether overall benefits are higher or lower than the estimated costs; thus informing decision makers on the balance of costs and benefits of different options. It should be noted that the CBA does not include valuation of all environmental benefits, notably the omission of benefits to ecosystems.

This approach for quantifying the benefits of reducing air pollution follows a logical progression through the following stages:

1. Quantification of emissions (here, using results from the GAINS model);
2. Description of pollutant dispersion and chemistry across Europe (again, here based on outputs from the GAINS model);
3. Quantification of exposure of people, environment and buildings that are affected by air pollution (linking the pollution concentrations with the 'stock at risk' e.g. population data);
4. Quantification of the impacts of air pollution, using relationships linking pollution concentrations with physical impacts;
5. Valuation of the impacts where possible; and
6. Assessment of the potential importance of uncertainty with regard to the balance of the costs of pollution control quantified by the GAINS model and their associated benefits.

Data sources are shown in Table 2.1.

Table 2.1. Sources of data for the benefits assessment

	Stock at risk	Response functions	Valuation
Health	UN population data, with additional factors for sensitivity of the population from Eurostat	Working group convened by WHO	Surveys undertaken in NewExt and other projects and debate under CAFE.
Materials	EC ExternE Project	ICP Materials working under LRTAP Convention	Repair cost data from architectural sources
Crops	Stockholm Environment Institute	ICP Vegetation working under LRTAP Convention	World market prices from FAO
Ecosystems	Coordinating Center for Effects	Coordinating Center for Effects via GAINS, providing outputs in terms of exceedance areas	None

In this report, impacts on health, crops and buildings are quantified, while ecosystem effects are included based on results generated by GAINS.

Table 2.2 provides an overview of the impacts quantified and excluded from this analysis.

Table 2.2. Effects of the pollutants included in the NEC revision and the extent of assessment

Effect	Impact quantified and valued	Impact only quantified	Qualitative assessment	Comments
Health				
Primary PM, NO_3 and SO_4 aerosols				
acute – mortality, morbidity	✓	✓		Care taken to avoid double counting
chronic – mortality, morbidity	✓	✓		with chronic effects
infant mortality	✓	✓		
Ozone				Less clear linkage between O_3 and
acute – mortality	✓	✓		mortality than for PM_{10}
chronic – mortality			✓	No information on possible chronic
acute – morbidity	✓	✓		effects
chronic – morbidity			✓	
Direct effects of SO_2			✓	Limited importance to CAFE
Direct effects of VOCs			✓	Lack of data on speciation, etc.
Direct effects of NO_2			✓	Lack of clear information of effects at ambient levels
Social impacts			✓	Limited data availability
Altruistic effects			✓	Reliable valuation data unavailable
Agricultural production				
Direct effects of SO_2 and NO_x			✓	Negligible according to past work
Direct effects of O_3 on crop yield	✓		✓	Quantified
Indirect effects on livestock			✓	
N deposition as crop fertiliser			✓	Negligible according to past work
Visible damage to marketed produce			✓	
Interactions between pollutants, with pests and pathogens, climate…			✓	Exposure-response data unavailable
Acidification/liming			✓	Negligible according to past work
Materials				
SO_2/acid effects on utilitarian buildings	✓		✓	2.1.1.1 Quantified
Effects on cultural assets, steel in re-inforced concrete			✓	Lack of stock at risk inventory and valuation data
Effects of O_3 on paint, rubber			✓	Effect to be quantified in future assessments
Ecosystems				
Effects on biodiversity, forest production, etc. from excess O_3 exposure		✓	✓	Valuation of ecological impacts is currently too uncertain
Effects on biodiversity, etc., from excess N deposition		✓	✓	Valuation of ecological impacts is currently too uncertain
Effects on biodiversity, etc., from excess acid deposition		✓	✓	Valuation of ecological impacts is currently too uncertain
Visibility: Change in visual range			✓	Impact of little concern in Europe.
Change in greenhouse gas emissions		✓	✓	Valuation too uncertain
Macroeconomic effects				Considered using the GEM-E3 model
Drinking water supply and quality			✓	Limited data availability, unlikely to be significant

Following the valuation of impacts at stage 5 in the above list, the core estimates of the benefits of the different scenarios considered in the report are compared with the costs. At this stage only limited account is taken of uncertainty, specifically with respect to the use of different options for valuation of chronic effects on mortality as this impact dominates the benefit estimates. Accounting for the views of different stakeholders and the peer review we quantify chronic mortality both in terms of the change in longevity (valued using the value of a life year or 'VOLY' concept) and in terms of deaths brought forward (valued using the value of statistical life or 'VSL' concept). Clearly the results of these two approaches should be seen as alternatives and are not to be added together.

For valuation, the analysis has been able to take advantage of new research under the EC DG Research NewExt Project. There has been some debate as to whether it is appropriate to take the mean or median values from the NewExt analysis of VSL and VOLY. The most relevant measure of society's willingness to pay (WTP) is the mean, though this can be affected significantly by a few extreme values. In contrast, the median, though less relevant as an indicator of the average societal WTP, is more robust. Being pragmatic, we use both. Altogether this gives four alternatives on valuation as shown in Table 2.3.

Table 2.3. Values for use in CAFE CBA: Effects of chronic exposure on mortality

	VSL	VOLY	Derived from:
Median (NewExt)	€980,000	€52,000	Median value
Mean (NewExt)	€2,000,000	€120,000	Mean value

Some new values for VOLY have recently been estimated, based on work undertaken in the NEEDS project (Desaigues et al 2007). These new values have not been used, as we understand they are subject to further updates based on new country survey data, and have not yet been fully peer reviewed. However, as indicated in section 5 on uncertainties, using the new values proposed has limited impact on the outcomes of this analysis concerning costs versus benefits.

The actual difference in mortality damage quantified using VOLY and VSL-based methods is not as great as Table 2.3 might suggest. Much of the difference between VSL and VOLY is cancelled out by the difference between the number of premature deaths quantified compared to the number of life years lost, and there is extensive overlap in the ranges. This issue is addressed in greater depth in Volume 3 of the CAFE-CBA Methodology Report[3]. These uncertainties are considered sufficiently important to be considered throughout the report, not just in the detailed appraisal of uncertainties towards the end of the report.

For acute mortality from ozone, the analysis quantifies the number of 'premature deaths' (deaths brought forward)[4]. These cases are valued using a VOLY approach, assuming that on average, each premature death leads to the loss of 12 months of life. The range for the VOLY is therefore applied to these impacts.

Following the initial comparison of core estimates of cost and monetised benefit for each scenario the analysis continues with a detailed uncertainty analysis that addresses the question of the probability of benefits exceeding costs for each scenario. This takes account of statistical variation in inputs, sensitivities to model assumptions and unquantified biases in the analysis. The latter includes biases linked to the EMEP model (e.g. omission of secondary organic aerosols) and to the GAINS model (e.g. potential for error in cost estimation) as well as biases in the benefits assessment such as the omission of ecosystem benefits from monetised estimates.

[3] http://cafe-cba.aeat.com/files/cba_method_vol3.pdf
[4] This is to signify that people whose deaths are brought forward by higher air pollution are likely to have serious pre-existing cardio-respiratory disease and so in at least some of these cases, the actual loss of life expectancy is likely to be small – the death might have occurred within the same year and, for some, may only be brought forward by a few days.

3 Benefits analysis results

In this section of the report, the results of the analysis estimating the benefits associated with the studied options are presented. It is split into two sections – health impacts and non-health impacts, which include crop and building damage, and ecosystem impacts. In the health impacts section, an additional section outlines results of sensitivity cases undertaken.

3.1 Health impacts

The benefits numbers are primarily driven by the reduction in health impacts due to improvements in air quality. In this section, we present estimates of health benefits, as reductions in actual health effects and as monetised health benefits.

The scenarios considered are listed below:

Table 3.1. NECD scenarios

Analysis type	Run Name	Run Code	Abbr. name
Core	Baseline (including C&EP)	0B	BASE
	Baseline (including C&EP) plus IMO agreement		BAS-MECP
	Cost-effective case to meet TSAP objectives	1B	CE
	Abatement cost cap (0.04% GDP)	fair40	CE-4
	Abatement cost cap (0.032% GDP)	fair32	CE-32
	Cost-effective case to meet TSAP objectives plus IMO agreement		CE-MECP
Sensitivity	Baseline excluding C&EP	0A	S-BASE
	Cost-effective case to meet TSAP objectives (excluding C&EP)	1A	S-CE
	Cost-effective case to meet EP objectives(excluding C&EP)	2B	S-CE-EP

NB. Grey-shaded options are referred to as Central Case options in Amann et al. 2008

Impacts on human health

Impacts on health are split into mortality (i.e. premature deaths) and morbidity (i.e. illness) by pollutant (PM and ozone). The quantification of health impacts addresses the impacts related to both long-term (chronic) and short-term (acute) exposures. The analysis includes impacts associated with $PM_{2.5}$ (anthropogenic – excluding PM from natural sources and for secondary organic aerosols) and ozone (using the metric SOMO35 – the sum of the daily maximum 8-hour mean ozone concentration with a cut-off at 35 ppb[5]). These data are provided as outputs from the GAINS model.

A number of other impacts (e.g. allergic rhinitis consultations (from O3 exposure) and asthma consultations (from PM exposure)) were identified in the CAFE Methodology report for application in sensitivity analysis (Holland et al. 2005a), but are not listed here.

The results show the number of events that happen in each year (i.e. the annual number of impacts or new cases)[6]. The chronic mortality impacts from $PM_{2.5}$ shown here are not directly comparable with the figures provided by IIASA. Both methods are based on an underlying analysis using life tables, applying the same hazard rates. However, for the purposes of optimisation GAINS quantifies total impacts over the lifetime of the cohort exposed in 2020, assuming no change in future emissions (termed as cumulative YOLLs). In other words, this value represents the impacts of a given population now over its entire lifetime. For the purpose of the CBA it is necessary to quantify the annual equivalent of this figure, in order that annual benefits can be compared with annual costs: in

[5] This means that for days with ozone concentration above 35 ppb as maximum 8-hour mean, only the increment exceeding 35 ppb is used to calculate effects. No effects of ozone on health are calculated on days below 35 ppb as maximum 8-hour mean. It is likely that the overall effects of ozone on mortality are underestimated by this approach.

[6] For chronic mortality, this involves a different metric to the output from the GAINS model, which works with the change in years of life lost from sustained pollution levels over 80 years, i.e. it works with a total 'stock' concept, rather than an annualised metrics.

summary, the CBA reports the effects of an 'annualised 1 year pulse of pollution' to provide an annualised value (annualised YOLLs) for comparing against annualised costs. The GAINS value looks at the total value of life years (cumulative YOLLs) saved from sustained pollution changes, as a metric for input in the cost-optimization.

Another issue of comparability in the past has been the issue of population estimates used by the CBA team and by IIASA. In the past, IIASA have not adjusted for changing demographics, while the CBA analysis has, so 2020 estimates were based on 2000 data. For the latest round of calculations, IIASA have used a constant population value for estimating YOLLS in both 2000 and 2020 optimizations, based on 2010 population values. Such a method ensures that changes in the population structure and age do not skew the results. Total population in the EU27 does not differ substantially between 2010 (492.9 million) and 2020 (496.4 million) although the age structure does e.g. increasing elderly population.

As outlined in the previous section, two alternative approaches are used for quantification of chronic mortality effects of $PM_{2.5}$, to derive years of life lost and premature deaths. These two estimates should not be added together.

The results for total impacts are shown in Table 3.2. Table 3.3 shows the benefits of meeting the TSAP objectives under the most cost-effective case (CE) and under the GDP cap cases (CE-4/CE-32) relative to the baseline that includes the effects of the Climate and Energy Package. The results of the CE-MECP are also presented, and compared against the specified baseline (BAS-MECP).

Annual mortality impacts across the EU27 due to **ozone** (O_3) are estimated at just over 21,000 deaths brought forward in the year 2020 under baseline. However, ozone also leads to much larger numbers of estimated morbidity health impacts, with tens of millions of minor restricted activity days and respiratory medication use days each year. These are clearly less serious effects at the level of the affected individual, but they affect a much greater number of people.

Reductions in annual health impacts are estimated under the optimised cases. At the EU27 level, limited differences are observed between CE and CE-4/CE-32, as the GDP cap tends to lead to re-distribution of benefits across Member States but does not change the aggregate estimates. Meeting the TSAP objectives across cases CE and CE-4/CE-32 results in a reduction of 3% across ozone-related health end points e.g. 19,700 deaths brought forward. For the MECP case, the reduction is 2%; this is lower than under the other TSAP cases as a result of the optimisation balancing the requirements of different objectives, with the *mortality from ozone* objective exceeded.

Annual chronic (long-term) mortality impacts from **PM** across the EU27 are estimated at just under 2.4 million years of life lost each year in 2020 under the baseline. PM also leads to an estimated additional 390 premature deaths each year amongst infants aged between 1 month and 1 year, and to much larger numbers of estimated morbidity health impacts. The estimated morbidity effects of PM in 2020 range from around 63,500 hospital admissions to much larger numbers of less serious effects, for example several hundred million respiratory medication use days and restricted activity days each year. Impacts tend to be lower (by about 4%) under the MECP baseline as a result of emission reductions from shipping as part of the IMO agreement.

Reductions in annual health impacts under the optimised TSAP cases (CE and CE-4/CE-32) associated with PM are approximately 12%. PM related mortality is reduced to just over 2 million years of life lost each year, and 55,800 hospital admissions. For other morbidity endpoints, some absolute reductions are much larger due to the size of impacts in the baseline e.g. over 25 million less restricted activity days. For the MECP optimised case, reductions are approximately 9% relative to the baseline as a result of lower impacts under the baseline with IMO agreement.

Member State-specific results are provided in a separate Annex (1) to this report.

Table 3.2. Estimated annual health impacts in 2020 due to air pollution in the EU27 for core scenarios (including Climate and Energy Package) (Values rounded to the nearest 100 – except for infant mortality)

End point	Population at risk	Impact	Poll	BASE	CE	BAS MECP	CE- MECP	CE-4	CE-32
Acute Mortality	All	Premature deaths	O3	21,100	20,400	21,000	20,600	20,400	20,400
Respiratory Hospital Admissions (RHAs)	Elderly	Cases	O3	19,800	19,300	19,800	19,400	19,300	19,300
Minor Restricted Activity Days (MRADs)	Adults	Days	O3	42,941,100	41,693,900	42,830,100	41,934,500	41,670,600	41,670,300
Respiratory medication use	Children	Days	O3	12,444,500	12,121,300	12,414,100	12,178,900	12,117,600	12,115,700
Respiratory medication use	Adults	Days	O3	8,231,800	7,992,000	8,210,500	8,038,900	7,987,500	7,987,400
Cough and LRS	Children	Days	O3	65,436,800	63,598,800	65,268,600	63,940,900	63,566,000	63,564,100
Chronic Mortality - YOLL (Years of life lost)*	All	Life years lost	PM	2,364,600	2,076,000	2,275,200	2,071,600	2,075,900	2,076,000
Chronic Mortality – deaths*	All	Premature deaths	PM	255,700	224,400	246,500	224,600	224,400	224,400
Infant Mortality	Infants	Premature deaths	PM	389	339	377	342	339	340
Chronic Bronchitis	Adults	Cases	PM	120,000	105,200	115,600	105,200	105,200	105,300
Respiratory Hospital Admissions	All	Cases	PM	39,300	34,500	37,800	34,400	34,500	34,500
Cardiac Hospital Admissions	All	Cases	PM	24,200	21,300	23,300	21,200	21,300	21,300
Restricted Activity Days (RADs)	Adults	Days	PM	207,975,800	182,457,800	200,185,300	182,189,900	182,455,400	182,492,700
Respiratory medication use	Children	Days	PM	1,765,500	1,555,200	1,690,900	1,542,200	1,555,300	1,553,500
Respiratory medication use	Adults	Days	PM	19,474,500	17,088,600	18,752,100	17,070,000	17,088,200	17,090,600
LRS symptom days	Children	Days	PM	81,827,600	71,909,100	78,566,600	71,547,100	71,911,600	71,900,100
LRS among adults with chronic symptoms	Adults	Days	PM	193,169,800	169,563,500	185,937,300	169,295,400	169,561,200	169,570,800

*Note two alternative metrics are used for the presentation of chronic mortality from PM. Firstly in terms of years of life lost and secondly in terms of numbers of premature deaths. These are not additive.

Table 3.3. Estimated annual health benefits in EU27 in 2020 due to meeting TSAP objectives under core scenarios (including Climate and Energy Package) (Values rounded to the nearest 100 – except for infant mortality)

End point	Population at risk	Impact	Poll	CE	CE-MECP	CE-4	CE-32
Acute Mortality	All	Premature deaths	O3	700	400	700	700
Respiratory Hospital Admissions	Elderly	Cases	O3	500	400	500	500
Minor Restricted Activity Days (MRADs)	Adults	Days	O3	1,247,200	895,600	1,270,500	1,270,800
Respiratory medication use	Children	Days	O3	323,200	235,200	326,900	328,800
Respiratory medication use	Adults	Days	O3	239,800	171,600	244,300	244,400
Cough and LRS	Children	Days	O3	1,838,000	1,327,700	1,870,800	1,872,700
Chronic Mortality - YOLL (Years of life lost)*	All	Life years lost	PM	288,600	203,600	288,700	288,600
Chronic Mortality – deaths*	All	Premature deaths	PM	31,300	21,900	31,300	31,300
Infant Mortality	Infants	Premature deaths	PM	50	35	50	49
Chronic Bronchitis	Adults	Cases	PM	14,800	10,400	14,800	14,700
Respiratory Hospital Admissions	All	Cases	PM	4,800	3,400	4,800	4,800
Cardiac Hospital Admissions	All	Cases	PM	2,900	2,100	2,900	2,900
Restricted Activity Days (RADs)	Adults	Days	PM	25,518,000	17,995,400	25,520,400	25,483,100
Respiratory medication use	Children	Days	PM	210,300	148,700	210,200	212,000
Respiratory medication use	Adults	Days	PM	2,385,900	1,682,100	2,386,300	2,383,900
LRS symptom days	Children	Days	PM	9,918,500	7,019,500	9,916,000	9,927,500
LRS among adults with chronic symptoms	Adults	Days	PM	23,606,300	16,641,900	23,608,600	23,599,000

*Note two alternative metrics are used for the presentation of chronic mortality from PM. Firstly in terms of years of life lost and secondly in terms of numbers of premature deaths. These are not additive.

Valuation of human health impacts

The health impacts and benefits outlined above have been expressed in monetary terms, using the approach outlined in the CAFE CBA methodology reports. Strictly speaking, the CAFE CBA methodology is only applicable for assessing the changes between scenarios. However, we have estimated the total monetary damage from health impacts for the baseline as an illustration of their economic importance, as well as the changes in benefits.

Estimates of monetised morbidity and mortality impacts for the EU27 are presented in Table 3.4 to Table 3.7. Total health impacts are presented – using the four different estimates of total annual damage. The health impacts of air pollution are dominated by PM mortality, although PM related morbidity is also significant. The most important effects (in monetised terms) for PM related morbidity are restricted activity days and cases of chronic bronchitis.

Monetised benefits associated with the reduction in health impacts as a result of meeting the TSAP objectives (CE / CE-4/CE-32) range from between €21.5 to €69.5 billion. Under the MECP case, benefits range from between €15.2 and 48.8 billion. Benefits associated with reduction in mortality impacts are the most significant driver, accounting for 71% of total benefits for the lower value (based on median VOLY estimate) and 91% for the higher value (based on mean VSL estimate).

Limited differences can be observed (at the aggregate level) between the three optimisation cases (without IMO agreement), which is not surprising given that the two equity cases (CE-4/CE-32) are about redistribution of costs between Member States but without changing overall EU objectives.

Table 3.4. Morbidity-related monetised annual health impacts under the baseline, and under the Thematic Strategy objectives in the EU27 (€Million)

End point	End point output	Function	Poll	BASE	CE	BAS-MECP	CE-MECP	CE-4	CE-32
Respiratory hospital admissions	Cases	Core	O_3	40	39	40	39	39	39
Minor Restricted Activity Days (MRADs)	Days	Core	O_3	1,650	1,602	1,645	1,611	1,601	1,601
Respiratory medication Use (Children)	Days	Core	O_3	12	11	12	11	11	11
Respiratory medication Use (Adults)	Days	Core	O_3	8	7	8	8	7	7
Cough and LRS (children)	Days	Core	O_3	2,514	2,443	2,507	2,456	2,442	2,442
Total O_3 morbidity				**4,223**	**4,103**	**4,212**	**4,125**	**4,100**	**4,100**
Chronic bronchitis	Cases	Core	PM	22,487	19,724	21,666	19,720	19,723	19,728
Respiratory hospital admissions	Cases	Core	PM	79	69	76	69	69	69
Cardiac hospital admissions	Cases	Core	PM	49	43	47	43	43	43
Restricted activity days (RADs)	Days	Core	PM	17,345	15,217	16,695	15,195	15,217	15,220
Respiratory medication Use (children)	Days	Core	PM	2	1	2	1	1	1
Respiratory medication Use (adults)	Days	Core	PM	18	16	18	16	16	16
LRS (including cough) among children	Days	Core	PM	3,144	2,763	3,018	2,749	2,763	2,762
LRS in adults with chronic symptoms	Days	Core	PM	7,421	6,514	7,143	6,504	6,514	6,514
Total PM morbidity				**50,544**	**44,347**	**48,665**	**44,296**	**44,346**	**44,353**
TOTAL MORBIDITY IMPACTS				**54,767**	**48,449**	**52,877**	**48,421**	**48,446**	**48,454**

Table 3.5 Morbidity-related monetised annual health benefits under the Thematic Strategy objectives in the EU27 (€Million)

End point	End point output	Function	Poll	CE	CE-MECP	CE-4	CE-32
Respiratory hospital admissions	Cases	Core	O_3	1	1	1	1
Minor Restricted Activity Days (MRADs)	Days	Core	O_3	48	34	49	49
Respiratory medication Use (Children)	Days	Core	O_3	0	0	0	0
Respiratory medication Use (Adults)	Days	Core	O_3	0	0	0	0
Cough and LRS (children)	Days	Core	O_3	71	51	72	72
Total O_3 morbidity				120	**87**	122	122
Chronic bronchitis	Cases	Core	PM	2,764	1,947	2,764	2,760
Respiratory hospital admissions	Cases	Core	PM	10	7	10	10
Cardiac hospital admissions	Cases	Core	PM	6	4	6	6
Restricted activity days (RADs)	Days	Core	PM	2,128	1,501	2,128	2,125
Respiratory medication Use (children)	Days	Core	PM	0	0	0	0
Respiratory medication Use (adults)	Days	Core	PM	2	2	2	2
LRS (including cough) among children	Days	Core	PM	381	270	381	381
LRS in adults with chronic symptoms	Days	Core	PM	907	639	907	907
Total PM morbidity				6,198	**4,369**	6,199	6,191
TOTAL MORBIDITY BENEFITS				6,318	**4,456**	6,321	6,313

Table 3.6 Mortality-related and total monetised annual health impacts under the baseline, and under the Thematic Strategy objectives in the EU27 (€Million)

End point	End point output	Function Group		BASE	CE	BAS-MECP	CE-MECP	CE-4	CE-32
Acute Mortality *(VOLY median)**	Premature deaths	Core	O_3	1,101	1,069	1,098	1,075	1,068	1,068
Acute Mortality *(VOLY mean*)*	Premature deaths	Core	O_3	2,471	2,399	2,465	2,413	2,397	2,397
Total Ozone Mortality									
VOLY median*				1,101	1,069	1,098	1,075	1,068	1,068
VOLY mean*				2,471	2,399	2,465	2,413	2,397	2,397
Chronic Mortality *(VOLY median)**	Life years lost	Core	PM	123,632	108,541	118,960	108,314	108,540	108,543
Chronic Mortality *(VOLY mean*)*	Life years lost	Core	PM	277,506	243,633	267,020	243,125	243,631	243,639
Chronic Mortality *(VSL median)**	Premature deaths	Core	PM	250,355	219,743	241,384	219,881	219,750	219,764
Chronic Mortality *(VSL mean*)*	Premature deaths	Core	PM	515,085	452,102	496,628	452,388	452,117	452,145
Infant Mortality (0-1yr) *(VSL median)**	Premature deaths	Core	PM	547	477	529	480	477	478
Infant Mortality (0-1yr) *(VSL mean*)*	Premature deaths	Core	PM	1,094	954	1,058	960	954	956
Total PM Mortality									
VOLY median*				124,178	109,017	119,489	108,794	109,017	109,021
VOLY mean*				278,600	244,586	268,078	244,084	244,585	244,595
VSL median*				250,902	220,220	241,913	220,361	220,227	220,242
VSL mean*				516,179	453,056	497,686	453,347	453,071	453,101
TOTAL Mortality									
VOLY median*				125,279	110,086	120,587	109,869	110,085	110,089
VOLY mean*				281,071	246,985	270,543	246,497	246,982	246,992
VSL median*				252,003	221,288	243,012	221,436	221,295	221,310
VSL mean*				518,651	455,455	500,151	455,760	455,468	455,499
TOTAL Health impacts									
VOLY median*				180,046	158,535	173,464	158,290	158,531	158,543
VOLY mean*				335,838	295,434	323,420	294,918	295,428	295,446
VSL median*				306,770	269,737	295,889	269,857	269,741	269,763
VSL mean*				573,418	503,904	553,028	504,181	503,914	503,952

Table 3.7 Mortality-related and total monetised annual health benefits under the Thematic Strategy objectives in the EU27 (€Million)

End point	End point output	Function Group		CE	CE-MECP	CE-4	CE-32
Acute Mortality *(VOLY median)*	Premature deaths	Core	O_3	32	23	33	33
Acute Mortality *(VOLY mean)*	Premature deaths	Core	O_3	73	52	74	74
Total Ozone Mortality							
VOLY median*				32	23	33	33
VOLY mean*				73	52	74	74
Chronic Mortality *(VOLY median)*	Life years lost	Core	PM	15,091	10,645	15,092	15,088
Chronic Mortality *(VOLY mean**	Life years lost	Core	PM	33,873	23,895	33,875	33,868
Chronic Mortality *(VSL median)*	Premature deaths	Core	PM	30,613	21,503	30,606	30,592
Chronic Mortality *(VSL mean**	Premature deaths	Core	PM	62,983	44,240	62,968	62,940
Infant Mortality (0-1yr) *(VSL median)*	Premature deaths	Core	PM	70	49	70	69
Infant Mortality (0-1yr) *(VSL mean)*	Premature deaths	Core	PM	140	98	140	138
Total PM Mortality							
VOLY median				15,161	10,695	15,162	15,157
VOLY mean				34,014	23,994	34,015	34,005
VSL median				30,683	21,552	30,675	30,661
VSL mean				63,123	44,339	63,108	63,078
TOTAL Mortality							
VOLY median				15,193	10,718	15,195	15,190
VOLY mean				34,086	24,045	34,089	34,079
VSL median				30,715	21,575	30,708	30,694
VSL mean				63,196	44,391	63,182	63,152
TOTAL Health impacts							
VOLY median				21,511	15,174	21,516	21,504
VOLY mean				40,404	28,501	40,410	40,393
VSL median				37,033	26,031	37,029	37,007
VSL mean				69,514	48,847	69,503	69,465

Table 3.8 to Table 3.9 show the lower and upper estimated monetised damage by EU27 Member State.

Some differences can be seen at the Member State level, between the cost-effective case (CE) or CE-4/CE-32 cases. This is a function of increasing / reducing abatement action in a given Member State and the net impact that this has on air quality in that Member State. Concerning the MECP case, the estimates are of course lower.

There are limited changes in cost re-distribution under the 0.04% GDP cap case. Lithuania, Germany and Romania see reductions in abatement costs of around €6-7 million – and subsequent reductions in overall benefits. Relative to overall costs, these reductions are small, ranging from 0.04% for Germany to 1.4% for Lithuania. Poland incurs an increase of €21 million in abatement costs (or 0.3% increase in overall costs), but see an increase in benefits (of 1.4%).

Under the 0.032% GDP cap case, Romania and Lithuania again see reductions in costs, of €21 and €10 million – and resulting decreases in health benefits (8% and 11% respectively). Increased abatement costs fall on Germany, Italy and Czech Republic of between €12 and 15 million. As expected, benefits also increase, although not in the case of the Czech Republic.

Table 3.8. Lower estimates (based on valuation of mortality using the median VOLY) of annual health impacts / benefits for each core scenario (€million)

	IMPACTS							BENEFITS			
Country	**BASE**	**CE**	**BAS-MECP**	**CE-MECP**	**CE-4**	**CE-32**		**CE**	**CE-MECP**	**CE-4**	**CE-32**
Austria	2,840	2,526	2,805	2,588	2,526	2,524		314	218	315	316
Belgium	6,097	5,418	5,749	5,256	5,418	5,396		679	493	679	701
Bulgaria	2,919	2,547	2,908	2,666	2,550	2,576		372	242	369	343
Cyprus	224	221	224	222	221	221		3	2	3	3
Czech Republic	4,289	3,726	4,214	3,825	3,722	3,724		563	389	567	565
Denmark	1,823	1,669	1,578	1,459	1,668	1,669		153	119	154	154
Estonia	310	293	288	274	293	293		17	14	17	17
Finland	962	914	894	858	915	915		48	37	48	47
France	20,591	18,242	19,848	18,137	18,245	18,206		2,349	1,711	2,346	2,385
Germany	36,003	31,829	34,418	31,304	31,841	31,757		4,174	3,114	4,162	4,246
Greece	3,954	3,701	3,942	3,762	3,704	3,710		253	180	250	244
Hungary	4,329	3,690	4,291	3,846	3,681	3,692		640	444	649	637
Ireland	718	649	685	642	649	648		69	43	69	70
Italy	20,330	18,088	20,214	18,894	18,092	18,021		2,242	1,320	2,237	2,308
Latvia	680	616	652	599	617	618		64	54	63	62
Lithuania	1,031	941	991	924	945	951		91	67	86	81
Luxembourg	221	195	213	194	195	194		26	19	26	27
Malta	169	161	169	165	161	161		8	4	8	8
Netherlands	9,375	8,534	8,507	7,879	8,534	8,497		840	628	840	878
Poland	18,293	15,304	17,891	15,619	15,261	15,450		2,989	2,271	3,032	2,843
Portugal	2,646	2,130	2,630	2,256	2,131	2,094		515	374	515	552
Romania	10,981	9,317	10,928	9,817	9,340	9,448		1,663	1,111	1,640	1,533
Slovakia	2,261	1,917	2,234	2,002	1,913	1,922		344	232	348	339
Slovenia	715	631	709	652	631	630		84	57	84	85
Spain	8,386	7,434	8,315	7,788	7,435	7,398		952	527	951	987
Sweden	1,765	1,638	1,547	1,448	1,639	1,642		126	99	125	123
United Kingdom	18,134	16,202	16,621	15,215	16,203	16,184		1,931	1,406	1,931	1,950
Total (EU27)	**180,046**	**158,535**	**173,464**	**158,290**	**158,531**	**158,543**		**21,511**	**15,174**	**21,516**	**21,504**

Table 3.9. Upper estimates (based on valuation of mortality using the mean VOSL) of annual health impacts / benefits for each core scenario (€million)

	IMPACTS							BENEFITS			
Country	**BASE**	**CE**	**BAS-MECP**	**CE-MECP**	**CE-4**	**CE-32**		**CE**	**CE-MECP**	**CE-4**	**CE-32**
Austria	8,655	7,686	8,547	7,876	7,685	7,681		969	671	970	974
Belgium	18,737	16,631	17,655	16,127	16,632	16,562		2,106	1,528	2,105	2,175
Bulgaria	10,841	9,440	10,799	9,891	9,454	9,551		1,401	908	1,387	1,290
Cyprus	527	519	526	521	519	520		8	4	8	8
Czech Republic	13,854	12,023	13,609	12,341	12,008	12,015		1,831	1,268	1,847	1,839
Denmark	6,018	5,507	5,198	4,802	5,503	5,505		512	396	515	513
Estonia	1,121	1,059	1,040	988	1,060	1,060		61	52	61	61
Finland	3,026	2,873	2,811	2,695	2,875	2,876		153	116	151	150
France	58,869	52,039	56,701	51,726	52,047	51,934		6,830	4,975	6,822	6,935
Germany	120,594	106,456	115,207	104,654	106,496	106,211		14,139	10,553	14,099	14,383
Greece	14,004	13,090	13,958	13,309	13,101	13,123		914	649	903	881
Hungary	15,606	13,277	15,465	13,848	13,244	13,287		2,329	1,617	2,362	2,319
Ireland	1,761	1,586	1,679	1,569	1,586	1,585		175	109	175	176
Italy	72,765	64,563	72,345	67,516	64,579	64,318		8,202	4,829	8,186	8,447
Latvia	1,750	1,583	1,678	1,539	1,586	1,590		167	139	164	159
Lithuania	4,787	4,362	4,597	4,282	4,384	4,409		425	315	403	378
Luxembourg	514	453	495	450	453	451		61	45	61	62
Malta	480	457	479	469	457	456		23	10	23	24
Netherlands	27,566	25,078	24,995	23,136	25,079	24,967		2,488	1,859	2,487	2,599
Poland	55,777	46,593	54,540	47,558	46,464	47,043		9,185	6,982	9,313	8,734
Portugal	8,648	6,916	8,595	7,340	6,916	6,793		1,732	1,255	1,732	1,855
Romania	36,863	31,222	36,684	32,920	31,300	31,668		5,641	3,764	5,562	5,195
Slovakia	6,692	5,666	6,611	5,919	5,654	5,680		1,026	692	1,038	1,012
Slovenia	2,343	2,063	2,323	2,134	2,063	2,061		280	188	280	282
Spain	26,423	23,341	26,194	24,499	23,344	23,225		3,082	1,696	3,079	3,198
Sweden	5,447	5,052	4,765	4,454	5,055	5,064		395	311	392	383
United Kingdom	49,749	44,368	45,532	41,617	44,370	44,317		5,380	3,915	5,379	5,432
Total (EU27)	**573,418**	**503,904**	**553,028**	**504,181**	**503,914**	**503,952**		**69,514**	**48,847**	**69,503**	**69,465**

Sensitivity cases

Two different sensitivity cases were undertaken – 1) an assessment without accounting for the Climate and Energy Package and 2) a more stringent target (beyond that proposed in the TSAP) based on European Parliament proposals. Note that the European Parliament case is consistent with the baseline used in the core scenario assessment i.e. does include the effect of the Commission's Climate and Energy Package

Table 3.10. Estimated annual health impacts / benefits in 2020 due to air pollution in the EU27 for sensitivity cases excluding Climate and Energy Package (Values rounded to the nearest 100 – except for infant mortality)

End point	Population at risk	Impact	Poll	S-BASE	S-CE		Reduction
Acute Mortality	All	Premature deaths	O3	21,400	20,600		800
Respiratory Hospital Admissions (RHAs)	Elderly	Cases	O3	20,200	19,400		800
Minor Restricted Activity Days (MRADs)	Adults	Days	O3	43,609,200	42,007,900		1,601,300
Respiratory medication use	Children	Days	O3	12,636,600	12,226,800		409,800
Respiratory medication use	Adults	Days	O3	8,361,000	8,053,100		307,900
Cough and LRS	Children	Days	O3	66,452,200	64,091,200		2,361,000
Chronic Mortality - YOLL (Years of life lost)*	All	Life years lost	PM	2,436,800	2,076,600		360,200
Chronic Mortality – deaths*	All	Premature deaths	PM	263,400	224,400		39,000
Infant Mortality	Infants	Premature deaths	PM	400	338		62
Chronic Bronchitis	Adults	Cases	PM	123,600	105,200		18,400
Respiratory Hospital Admissions	All	Cases	PM	40,500	34,500		6,000
Cardiac Hospital Admissions	All	Cases	PM	25,000	21,300		3,700
Restricted Activity Days (RADs)	Adults	Days	PM	214,264,700	182,415,100		31,849,600
Respiratory medication use	Children	Days	PM	1,823,900	1,560,800		263,100
Respiratory medication use	Adults	Days	PM	20,063,700	17,087,100		2,976,600
LRS symptom days	Children	Days	PM	84,375,000	71,988,000		12,387,000
LRS among adults with chronic symptoms	Adults	Days	PM	199,050,500	169,592,000		29,458,500

*Note two alternative metrics are used for the presentation of chronic mortality from PM. Firstly in terms of years of life lost and secondly in terms of numbers of premature deaths. These are not additive.

The level of health impacts under the cost-effective case is consistent with the equivalent case in the core scenarios. The level of reduction is however greater due to higher impacts under the baseline (S-BASE) due to higher emissions in the absence of climate measures.

The impacts of more stringent objectives (as proposed under the European Parliament proposal) are shown in Table 3.11. Aggregate reductions across EU27 in O_3 related health effects are around 6% (compared to 3% under TSAP objectives). Reductions in PM-related health effects are 17% lower than the base case in 2020 (compared to 12% under TSAP objectives).

Table 3.11. Estimated annual health impacts / benefits in 2020 due to air pollution in the EU27 for sensitivity case based on European Parliament proposals (Values rounded to the nearest 100 – except for infant mortality)

End point	Population at risk	Impact	Poll	BASE	S-CE-EP		Reduction
Acute Mortality	All	Premature deaths	O3	21,100	19,700		1,400
Respiratory Hospital Admissions (RHAs)	Elderly	Cases	O3	19,800	18,600		1,200
Minor Restricted Activity Days (MRADs)	Adults	Days	O3	42,941,100	40,214,500		2,726,600
Respiratory medication use	Children	Days	O3	12,444,500	11,691,400		753,100
Respiratory medication use	Adults	Days	O3	8,231,800	7,707,700		524,100
Cough and LRS	Children	Days	O3	65,436,800	61,329,900		4,106,900
Chronic Mortality - YOLL (Years of life lost)*	All	Life years lost	PM	2,364,600	1,958,800		405,800
Chronic Mortality – deaths*	All	Premature deaths	PM	255,700	211,700		44,000
Infant Mortality	Infants	Premature deaths	PM	389	320		69
Chronic Bronchitis	Adults	Cases	PM	120,000	99,300		20,700
Respiratory Hospital Admissions	All	Cases	PM	39,300	32,600		6,700
Cardiac Hospital Admissions	All	Cases	PM	24,200	20,100		4,100
Restricted Activity Days (RADs)	Adults	Days	PM	207,975,800	172,166,300		35,809,500
Respiratory medication use	Children	Days	PM	1,765,500	1,467,300		298,200
Respiratory medication use	Adults	Days	PM	19,474,500	16,123,400		3,351,100
LRS symptom days	Children	Days	PM	81,827,600	67,876,700		13,950,900
LRS among adults with chronic symptoms	Adults	Days	PM	193,169,800	159,986,600		33,183,200

*Note two alternative metrics are used for the presentation of chronic mortality from PM. Firstly in terms of years of life lost and secondly in terms of numbers of premature deaths. These are not additive.

Monetised impacts and benefits for the sensitivity cases are shown in the following tables. Under the sensitivity case excluding the Climate and Energy Package, overall benefits range from €26.9 to 86.7 billion compared to the core case of €21.5 to 69.5 billion (where the Climate and Energy Package is included in the baseline).

The European Parliament case leads to increased benefits of €30.3 to 97.9 billion.

Table 3.12. Morbidity-related monetised annual health impacts / benefits in the EU27 (€Million) for sensitivity cases excluding Climate and Energy Package

End point	End point output	Function	Poll	S-BASE	S-CE		Reduction
Respiratory hospital admissions	Cases	Core	O_3	40	39		1
Minor Restricted Activity Days (MRADs)	Days	Core	O_3	1,675	1,614		62
Respiratory medication Use (Children)	Days	Core	O_3	12	11		0
Respiratory medication Use (Adults)	Days	Core	O_3	8	8		0
Cough and LRS (children)	Days	Core	O_3	2,553	2,462		91
Total O_3 morbidity				4,288	**4,134**		**154**
Chronic bronchitis	Cases	Core	PM	23,162	19,715		3,447
Respiratory hospital admissions	Cases	Core	PM	81	69		12
Cardiac hospital admissions	Cases	Core	PM	50	43		7
Restricted activity days (RADs)	Days	Core	PM	17,870	15,213		2,656
Respiratory medication Use (children)	Days	Core	PM	2	1		0
Respiratory medication Use (adults)	Days	Core	PM	19	16		3
LRS (including cough) among children	Days	Core	PM	3,241	2,766		476
LRS in adults with chronic symptoms	Days	Core	PM	7,647	6,515		1,132
Total PM morbidity				52,072	**44,338**		**7,733**
TOTAL MORBIDITY IMPACTS				56,360	**48,472**		**7,888**

Table 3.13 Mortality-related and total monetised annual health impacts / benefits in the EU27 (€Million) for sensitivity cases excluding Climate and Energy Package

End point	End point output	Function Group		S-BASE	S-CE		Reduction
Acute Mortality *(VOLY median)**	Premature deaths	Core	O_3	1,118	1,077		42
Acute Mortality *(VOLY mean*)*	Premature deaths	Core	O_3	2,511	2,417		93
Total Ozone Mortality							
VOLY median*				1,118	1,077		42
VOLY mean*				2,511	2,417		93
Chronic Mortality *(VOLY median)**	Life years lost	Core	PM	127,406	108,573		18,834
Chronic Mortality *(VOLY mean*)*	Life years lost	Core	PM	285,980	243,705		42,275
Chronic Mortality *(VSL median)**	Premature deaths	Core	PM	257,898	219,718		38,179
Chronic Mortality *(VSL mean*)*	Premature deaths	Core	PM	530,603	452,052		78,550
Infant Mortality (0-1yr) *(VSL median)**	Premature deaths	Core	PM	562	475		87
Infant Mortality (0-1yr) *(VSL mean*)*	Premature deaths	Core	PM	1,123	949		174
Total PM Mortality							
VOLY median*				127,968	109,047		18,921
VOLY mean*				287,103	244,654		42,449
VSL median*				258,459	220,193		38,266
VSL mean*				531,726	453,001		78,724
TOTAL Mortality							
VOLY median*				129,086	110,124		18,962
VOLY mean*				289,613	247,071		42,542
VSL median*				259,578	221,270		38,308
VSL mean*				534,236	455,419		78,818
TOTAL Health impacts							
VOLY median*				185,447	158,596		26,850
VOLY mean*				345,973	295,543		50,430
VSL median*				315,938	269,742		46,195
VSL mean*				590,596	503,891		86,705

Table 3.14. Morbidity-related monetised annual health impacts / benefits in the EU27 (€Million) for sensitivity cases assessing European Parliament proposals

End point	End point output	Function	Poll	BASE	S-CE-EP		Reduction
Respiratory hospital admissions	Cases	Core	O_3	40	37		3
Minor Restricted Activity Days (MRADs)	Days	Core	O_3	1,650	1,545		105
Respiratory medication Use (Children)	Days	Core	O_3	12	11		1
Respiratory medication Use (Adults)	Days	Core	O_3	8	7		0
Cough and LRS (children)	Days	Core	O_3	2,514	2,356		158
Total O_3 morbidity				**4,223**	**3,956**		**266**
Chronic bronchitis	Cases	Core	PM	22,487	18,609		3,878
Respiratory hospital admissions	Cases	Core	PM	79	65		14
Cardiac hospital admissions	Cases	Core	PM	49	40		8
Restricted activity days (RADs)	Days	Core	PM	17,345	14,359		2,987
Respiratory medication Use (children)	Days	Core	PM	2	1		0
Respiratory medication Use (adults)	Days	Core	PM	18	15		3
LRS (including cough) among children	Days	Core	PM	3,144	2,608		536
LRS in adults with chronic symptoms	Days	Core	PM	7,421	6,146		1,275
Total PM morbidity				**50,544**	**41,844**		**8,701**
TOTAL MORBIDITY IMPACTS				**54,767**	**45,800**		**8,967**

Table 3.15 Mortality-related and total monetised annual health impacts / benefits in the EU27 (€Million) for sensitivity cases assessing European Parliament proposals

End point	End point output	Function Group		BASE	S-CE-EP		Reduction
Acute Mortality *(VOLY median)**	Premature deaths	Core	O_3	1,101	1,031		70
Acute Mortality *(VOLY mean*)*	Premature deaths	Core	O_3	2,471	2,313		158
Total Ozone Mortality							
VOLY median*				1,101	1,031		70
VOLY mean*				2,471	2,313		158
Chronic Mortality *(VOLY median)**	Life years lost	Core	PM	123,632	102,416		21,216
Chronic Mortality *(VOLY mean*)*	Life years lost	Core	PM	277,506	229,885		47,621
Chronic Mortality *(VSL median)**	Premature deaths	Core	PM	250,355	207,302		43,054
Chronic Mortality *(VSL mean*)*	Premature deaths	Core	PM	515,085	426,506		88,580
Infant Mortality (0-1yr) *(VSL median)**	Premature deaths	Core	PM	547	450		97
Infant Mortality (0-1yr) *(VSL mean*)*	Premature deaths	Core	PM	1,094	901		193
Total PM Mortality							
VOLY median*				124,178	102,866		21,312
VOLY mean*				278,600	230,786		47,814
VSL median*				250,902	207,752		43,150
VSL mean*				516,179	427,406		88,773
TOTAL Mortality							
VOLY median*				125,279	103,897		21,383
VOLY mean*				281,071	233,099		47,972
VSL median*				252,003	208,782		43,221
VSL mean*				518,651	429,720		88,931
TOTAL Health impacts							
VOLY median*				180,046	149,697		30,349
VOLY mean*				335,838	278,899		56,939
VSL median*				306,770	254,583		52,188
VSL mean*				573,418	475,520		97,898

3.2 Non-Health Impacts

Damage to crops and materials

Crops

The approach used for assessing damage to crops was summarised in the methodology section earlier and also in the methodology report, volume 1 (Holland et al. 2005a). Account has been taken of the work of ICP Vegetation, though it is noted that they express concerns about the use (as here) of AOT40 as a metric for crop damage assessment. Analysis will shift to flux based methods as soon as these become available.

The valuation of impacts on agricultural production is reasonably straightforward, with estimated yield loss being multiplied by world market prices as published by the UN's Food and Agriculture Organization (2004 data). World market prices are used as a proxy for shadow price on the grounds that they are less influenced by subsidies than local European prices (in other words, they are closer to the 'real' price of production).

Table 3.16 presents the total crop damage costs in € 000 from ozone exposure for the EU27 for the baseline and optimised TSAP scenarios in 2020. Benefits are estimated relative to the baseline for the optimised cases.

Table 3.16. Estimated annual agricultural damage costs / benefits in the EU27 (€ 000) under the baseline, and optimised TSAP cases

	IMPACTS				BENEFITS		
Country	**BASE**	**CE**	**CE-4**	**CE-32**	**CE**	**CE-4**	**CE-32**
Austria	21,478	19,280	19,232	19,203	2,198	2,247	2,275
Belgium	48,948	45,624	45,599	45,445	3,324	3,349	3,503
Bulgaria	60,818	54,291	54,194	54,061	6,527	6,624	6,757
Cyprus	916	884	883	881	32	33	36
Czech Republic	37,458	32,952	32,846	32,760	4,505	4,611	4,698
Denmark	15,639	14,195	14,084	14,064	1,444	1,556	1,575
Estonia	295	268	268	268	26	27	27
Finland	706	648	647	646	58	59	60
France	199,857	177,779	177,633	177,195	22,078	22,224	22,662
Germany	214,162	190,163	189,862	188,903	23,999	24,301	25,260
Greece	181,014	167,836	167,791	166,547	13,177	13,223	14,466
Hungary	83,942	73,944	73,335	73,057	9,998	10,607	10,885
Ireland	2,619	2,399	2,396	2,393	219	222	225
Italy	453,221	416,922	416,622	416,475	36,299	36,599	36,746
Latvia	1,447	1,300	1,304	1,309	147	143	138
Lithuania	6,177	5,679	5,686	5,719	499	491	458
Luxembourg	660	594	593	590	66	67	70
Malta	291	256	256	256	34	35	35
Netherlands	81,464	76,243	76,183	75,906	5,221	5,281	5,557
Poland	168,411	151,691	149,870	150,957	16,720	18,542	17,454
Portugal	25,486	22,469	22,470	22,487	3,016	3,016	2,999
Romania	148,666	135,625	135,277	135,170	13,042	13,389	13,496
Slovakia	18,355	15,752	15,594	15,556	2,603	2,761	2,799
Slovenia	3,406	3,120	3,115	3,113	287	292	294
Spain	210,017	183,811	183,815	183,962	26,206	26,202	26,055
Sweden	3,645	3,271	3,246	3,245	374	399	399
United Kingdom	84,076	77,698	77,600	77,476	6,379	6,477	6,601
EU 27	**2,073,174**	**1,874,693**	**1,870,400**	**1,867,645**	**198,481**	**202,774**	**205,529**

Under the base case, total monetised agricultural impacts are estimated at €2 billion. Meeting TSAP objectives reduces damage by around €200 million.

The analysis of crop damage shows that these effects are small in economic terms in relation to health effects overall (i.e. including $PM_{2.5}$ effects), though effects from ozone on crops are similar in magnitude to ozone-related health damage.

Estimates of benefits under the MECP case have not been derived but would be broadly similar to those observed for the TSAP cases above.

Materials

Like the crops analysis, the approach used for assessing damage to materials was summarized in the methodology section earlier and also in the methodology report, volume 1. Account has been taken of the work of ICP Materials. Table 3.17 presents the total material damage from acid deposition to utilitarian applications for EU27 with baseline ozone pollution concentrations in 2020, and for the TSAP ambition levels. The total damage in the year 2020 are estimated at just under €1.05 billion/year– with estimated benefits of the TSAP cases at €0.13 billion/year above the baseline.

Table 3.17. Estimated annual damage to materials used in utilitarian applications from acid deposition in 2020 in the EU27 under the baseline and TSAP scenarios (€ million).

	IMPACTS					BENEFITS		
Country	**BASE**	**CE**	**CE-4**	**CE-32**		**CE**	**CE-4**	**CE-32**
EU27	1047	919	919	919		127	127	127

Estimates have not been provided on a Member State basis due to some significant gaps in the building stock-at-risk map; hence, the above EU27 estimates are likely to be an underestimate.

Estimates of benefits under the MECP case have not been derived but would be broadly similar to those observed for the TSAP cases above.

Ecosystem impacts

Valuation of ecosystem impacts is not yet possible because of limited research in this area that has specific relevance to reductions in air pollutant emissions. This, in turn, reflects the difficulty of carrying out a meaningful analysis of the economics of biodiversity changes. GAINS data provides information on the state of ecosystems with respect to exceedance of critical loads and levels for acidification, eutrophication and ground level ozone. The GAINS analysis addresses risks from:

- Acid deposition to forest ecosystems (area/percentage of forest area receiving acid deposition above the critical loads);
- Acid deposition to semi-natural ecosystems (area/percentage of semi-natural ecosystems receiving acid deposition above the critical loads);
- Acid deposition to freshwater bodies (catchments) (area/percentage of freshwater ecosystems area receiving acid deposition above the critical loads);
- Excess nitrogen deposition (eutrophication) (area/percentage of ecosystems receiving nitrogen deposition above the critical loads for eutrophication).

The GAINS model has used the concept of critical loads as a quantitative indicator for sustainable levels of sulphur and nitrogen deposition. The analysis is based on the critical loads databases compiled by the Coordination Centre on Effects under the UNECE Working Group on Effects. For most ecosystem types (e.g., forests), critical loads are calculated for both acidity and eutrophication. Other receptor types, such as streams and lakes, have only critical loads for acidity, on the assumption that airborne nitrogen does not contribute significantly to eutrophication in these ecosystems.

The GAINS analysis groups ecosystems into three classes (forests, semi-natural vegetation such as nature protection areas and freshwater bodies) and performs separate analyses for each class. The GAINS analysis has assessed the deposition to these ecosystems with the critical loads and thus provides an indication to what extent the various types of ecosystems are still at risk of acidification under different baseline conditions. This indicator cannot be directly interpreted as the actual damage occurring at such ecosystems. To derive damage estimates, the historic rate of acid deposition as well as dynamic

chemical processes in soils and lakes need to be considered, which can lead to substantial delays in the occurrence of acidification as well as in the recovery from acidification.

Acid deposition to forest ecosystems

The percentage of forest area in each Member State receiving acid deposition above the critical loads in 2020 is shown in Table 3.18. Under the base case, the exceedance area in the year 2020 is approximately 119,000 km^2. With its environmental objectives, the TSAP cases would bring this area below 50,000 km^2. The worst affected country in terms of % area affected is the Netherlands, by some considerable distance.

Table 3.18 Percentage of forest area receiving acid deposition above the critical loads under base and TSAP scenarios in 2020. The shading highlights countries where the area subject to exceedance is 50% or more than forest ecosystem area (black) or between 25% and 49% of forest ecosystem area (grey).

Country	Total forest area (km^2)[1]	BASE	CE	BAS-MECP	CE-MECP	CE-4	CE-32
Austria	35,745	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	6,315	15.12	10.75	13.37	10.43	10.75	10.68
Bulgaria	48,330	0.00	0.00	0.00	0.00	0.00	0.00
Cyprus	2,320	0.00	0.00	0.00	0.00	0.00	0.00
Czech Republic	11,178	29.77	17.92	28.81	19.25	17.85	17.44
Denmark	3,149	1.92	1.25	0.68	0.60	1.25	1.25
Estonia	21,450	0.00	0.00	0.00	0.00	0.00	0.00
Finland	240,403	1.23	1.11	1.09	0.94	1.15	1.15
France	170,657	3.14	2.22	3.03	2.17	2.22	2.22
Germany	100,954	27.91	18.72	26.21	18.54	18.84	18.55
Greece	9,326	2.72	2.21	2.70	2.21	2.21	2.21
Hungary	10,448	0.00	0.00	0.00	0.00	0.00	0.00
Ireland	4,254	13.12	9.54	12.20	10.08	9.54	9.54
Italy	89,560	0.00	0.00	0.00	0.00	0.00	0.00
Latvia	27,014	0.00	0.00	0.00	0.00	0.00	0.00
Lithuania	17,651	53.54	48.30	51.07	48.16	49.51	49.62
Luxembourg	821	20.18	20.18	20.18	20.18	20.18	20.18
Malta[2]							
Netherlands	5,640	86.93	85.46	84.98	83.64	85.47	85.30
Poland	88,383	12.57	2.63	10.91	3.84	2.53	2.63
Portugal	21,220	4.91	4.50	4.90	4.87	4.50	4.12
Romania	62,807	0.63	0.21	0.47	0.22	0.21	0.21
Slovakia	19,253	8.30	6.02	8.22	6.91	5.98	5.98
Slovenia	5,264	0.04	0.04	0.04	0.04	0.04	0.04
Spain	85,225	0.06	0.06	0.06	0.06	0.06	0.06
Sweden	225,264	7.87	5.76	4.26	2.99	5.81	5.89
United Kingdom	19,748	14.03	10.82	12.40	9.93	10.82	10.81
Total (EU27)	1,332,379						

Source: Amann et al (2008)
[1]) Ecosystems area for which critical loads data have been supplied
[2]) Data for Malta are not available

Acid deposition to semi-natural ecosystems

A number of countries have provided estimates of critical loads for semi-natural ecosystems. This group typically contains nature and landscape protection areas, many of them designated as Natura2000 areas under the EU Habitats Directive. While this group of ecosystems includes open land and forest areas, GAINS uses a conservative estimate grid-average deposition rate for comparison with critical loads, which systematically underestimates deposition for forested land.

As in other parts of this section, the aggregate data provide only limited guidance on the scale of the problem, given that different types of ecosystem will be affected to very differing extents. This reflects differences in deposition patterns at finer scales than can be investigated in the current analysis, and variation in the sensitivity of ecosystems. Results are not complete (given the number of countries not represented, and the limited area considered in some countries for which data are available), and for

this reason, the information on area exceeded in km^2 is not provided. Again, the worst affected country in terms of % area affected is the Netherlands, by some considerable distance.

Table 3.19 Percentage of semi-natural areas receiving acid deposition above the critical loads under base and TSAP scenarios in 2020. The shading highlights countries where the area subject to exceedance is 50% or more than total area of semi-natural ecosystem (black) or between 25% and 49% of total area of semi-natural ecosystem (grey).

Country	Area (km^2)[1]	BASE	CE	BAS-MECP	CE-MECP	CE-4	CE-32
Belgium	737	12.12	7.90	9.91	5.98	7.90	6.79
Cyprus	1,742	0.00	0.00	0.00	0.00	0.00	0.00
France	9,444	20.98	4.44	19.12	6.91	4.44	4.44
Germany	3,241	6.76	2.81	6.02	2.81	2.84	2.78
Ireland	4,681	0.05	0.00	0.02	0.00	0.00	0.00
Italy	36,312	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	1,713	51.61	48.86	39.09	37.19	48.89	48.59
United Kingdom	50,133	5.73	3.82	4.88	3.56	3.82	3.83
Total (EU27)	**108,003**						

Source: Amann et al (2008)
[1]) Ecosystems area for which critical loads data have been supplied

Acid deposition to freshwater bodies

The effects of acidification on freshwater ecosystems are better understood than impacts on terrestrial ecosystems. The impact of greatest public concern has been the loss of game fish (salmon and trout) from rivers and lakes in acid sensitive areas, particularly in northern Europe.

The GAINS analysis has estimated exceedance of critical loads for the catchments of freshwater bodies (lakes and streams) in Finland, Italy, Norway, Sweden, Switzerland and the UK only.

Table 3.20 Percentage of freshwater ecosystems area receiving acid deposition above the critical loads under base and TSAP scenarios in 2020.

Country	Area (km^2)[1]	BASE	CE	BAS-MECP	CE-MECP	CE-4	CE-32
Finland	26,426	0.11	0.10	0.10	0.09	0.10	0.10
Italy	6	0.00	0.00	0.00	0.00	0.00	0.00
Sweden	294,079	6.88	6.51	5.71	5.40	6.54	6.54
United Kingdom	7,788	2.64	2.10	2.31	2.09	2.10	2.10
Total (EU27)	**328,299**	**9.63**					

Source: Amann et al (20087)
[1]) Ecosystems area for which critical loads data have been supplied

Excess nitrogen deposition (eutrophication)

Excess nitrogen deposition poses a threat to plant communities in a wide range of ecosystems. The GAINS analysis has estimated exceedance of critical loads across Europe and maintained the same methodology based on grid-average deposition that was used for the setting of objectives under the TSAP. This is the approach that has been used in the optimisation routines. Estimates are shown below in Table 3.21.

It is immediately clear that exceedance of critical loads for eutrophication is widespread. Under the TSAP and EP cases, there is significant improvement, though the area subject to exceedance is still large. Improvements over time are gradual, mainly as a result of the small differences in emission of ammonia. Further to this, it should be recognised that these effects will not be equally spread across all types of ecosystem, but will instead be far more serious for some than for others.

Table 3.21 Percentage of total ecosystems area receiving nitrogen deposition (based on grid average deposition) above the critical loads under base and TSAP scenarios in 2020. The shading highlights countries where the area subject to exceedance is 50% or more than total area of ecosystem (black) or between 25% and 49% of total area of ecosystem (grey).

Country	Area (km^2)	BASE	CE	BAS-MECP	CE-MECP
Austria	35,745	51.23	28.22	50.89	29.15
Belgium	7,052	46.75	29.64	45.4	29.91
Bulgaria	48,330	34	17.11	34	17.11
Cyprus	4,062	35.4	33.36	34.74	33.03
Czech Republic	11,178	80.23	59.04	79.52	60.29
Denmark	3,149	23.87	11.97	22.42	9.37
Estonia	22,411	2.71	0.62	2.04	0.33
Finland	240,403	22.62	18.46	21.2	17.3
France	180,102	63.53	48.39	63.06	48.77
Germany	104,195	74.89	57.09	74.31	58.1
Greece	9,326	70.59	62.05	69.89	62.05
Hungary	10,448	21.42	15.26	21.42	15.71
Ireland	8,936	56.97	51.36	56.48	51.42
Italy	125,878	26.29	19.4	26.23	19.66
Latvia	27,014	87.3	78.63	85.67	76.54
Lithuania	17,651	98.63	94.21	98.47	94.08
Luxembourg	821	97.54	95.25	97.54	95.25
Malta					
Netherlands	4,393	71.27	66.67	71.26	66.86
Poland	88,383	76.64	70.39	76.11	70.83
Portugal	21220	14.76	1.27	12.27	1.48
Romania	62,807	92.21	86.4	92.12	86.69
Slovakia	19,253	69.57	54.71	69.16	57.82
Slovenia	5,264	97.5	93.3	97.39	93.36
Spain	85,225	43.18	32	42.95	32.5
Sweden	225,264	6.47	5.87	6.27	5.83
United Kingdom	74,204	1.12	0.35	1.04	0.34
Total (EU27)	**1,442,714**				

The alternative measurement basis used in previous assessments was based on ecosystem-specific deposition and the extent of exceedance of critical loads for Nitrogen. Analysis for the EU27 is summarised in Table 3.22.

Table 3.22 Percentage of total ecosystems area receiving nitrogen deposition (based on ecosystem specific deposition) above the critical loads under base and TSAP scenarios in 2020. The shading highlights countries where the area subject to exceedance is 50% or more than total area of ecosystem (black) or between 25% and 49% of total area of ecosystem (grey).

Country	Area (km^2)	BASE	CE	BAS-MECP	CE-MECP	CE-4	CE-32
Austria	35,745	80.28	64.96	79.49	66.32	64.78	65.35
Belgium	7,052	88.37	79.81	86.76	79.95	79.81	79.61
Bulgaria	48,330	83.84	74.05	83.84	74.05	74.05	74.05
Cyprus	4,062	72.36	68.63	70.14	66.23	68.63	68.61
Czech Republic	11,178	97.47	95.35	97.46	95.94	95.16	95.11
Denmark	3,149	79.70	76.98	78.60	76.38	76.98	76.98
Estonia	22,411	34.94	26.59	31.89	20.99	26.50	25.58
Finland	240,403	34.28	28.56	32.81	26.89	28.57	28.69
France	180,102	87.41	75.80	87.11	76.68	75.80	75.80
Germany	104,195	93.59	86.53	93.45	87.02	86.51	86.41
Greece	9,326	100.00	100.00	100.00	100.00	100.00	100.00
Hungary	10,448	76.66	46.57	75.01	52.01	43.87	43.36
Ireland	8,936	67.62	63.98	67.00	63.93	63.99	63.99
Italy	125,878	54.76	42.98	54.03	43.42	42.98	42.98
Latvia	27,014	95.23	95.08	95.23	95.07	95.08	95.07
Lithuania	17,651	100.00	100.00	100.00	100.00	100.00	100.00
Luxembourg	821	100.00	99.67	100.00	99.67	99.67	99.67
Malta							
Netherlands	4,393	86.58	82.38	86.20	82.36	82.38	82.38
Poland	88,383	94.89	90.85	94.75	91.14	90.50	89.83
Portugal	21220	92.12	84.65	91.99	85.09	84.65	84.65
Romania	62,807	95.56	94.94	95.56	94.96	94.94	94.94
Slovakia	19,253	92.88	79.46	92.64	82.45	78.83	77.54
Slovenia	5,264	99.66	98.94	99.66	98.96	98.94	98.94
Spain	85,225	71.84	63.54	71.55	64.27	63.60	63.60
Sweden	225,264	9.11	8.35	8.49	7.78	8.35	8.35
United Kingdom	74,204	17.07	14.67	16.72	14.44	14.67	14.67
Total (EU27)	**1,442,714**						

Source: Amann et al (2008)

4 Comparison of costs and benefits

The information in Section 3.1 on health, crops and materials benefits has been compared against the annualised abatement costs of the optimisation scenario, as estimated by the GAINS model.

Costs (from GAINS model analysis) for the TSAP optimized cases (CE and CE-4/CE-32) are estimated at between €1.49 and 1.53 billion. For the MECP case, costs are around €0.95 billion, lower than the other cases due to the additional costs assumed in the baseline. The distribution of costs across Member States is shown in Table 4.1.

Table 4.1 Annualised costs in Million € in 2020 – Baseline and TSAP scenarios

	TOTAL COSTS					ADDITIONAL COSTS			
Country	**BASE**	**CE**	**CE-MECP**	**CE-4**	**CE-32**	**CE**	**CE-MECP**	**CE-4**	**CE-32**
Austria	1,601	1,615	1,614	1,614	1,613	14	12	13	12
Belgium	1,950	1,987	1,973	1,987	1,992	36	22	36	42
Bulgaria	1,054	1,072	1,067	1,071	1,070	17	12	17	16
Cyprus	172	175	175	175	175	3	3	3	3
Czech Rep.	1,933	1,976	1,953	1,977	1,990	43	20	44	57
Denmark	1,239	1,254	1,253	1,256	1,256	15	14	17	17
Estonia	300	303	304	303	305	3	4	3	5
Finland	975	985	985	984	984	11	10	10	9
France	10,091	10,284	10,235	10,284	10,286	193	144	193	195
Germany	14,867	15,077	14,998	15,071	15,089	210	131	204	222
Greece	1,857	1,868	1,867	1,868	1,868	11	10	10	11
Hungary	1,103	1,142	1,126	1,147	1,151	39	23	43	47
Ireland	760	818	807	817	817	57	47	57	57
Italy	9,035	9,220	9,132	9,219	9,235	185	98	185	200
Latvia	434	440	441	441	444	7	7	8	10
Lithuania	453	478	473	471	468	25	19	18	14
Luxembourg	328	329	329	329	330	1	1	1	2
Malta	148	148	148	148	148	0	0	0	0
Netherlands	3,128	3,138	3,135	3,138	3,149	10	7	10	21
Poland	7,680	7,836	7,762	7,857	7,831	156	82	177	151
Portugal	1,655	1,688	1,676	1,688	1,693	32	21	32	37
Romania	2,116	2,196	2,148	2,190	2,175	80	33	74	59
Slovakia	531	550	535	550	553	18	4	19	22
Slovenia	372	383	381	383	383	11	9	11	11
Spain	8,621	8,808	8,739	8,808	8,813	187	118	187	192
Sweden	1,667	1,687	1,690	1,683	1,681	19	23	15	13
UK	5,890	5,996	5,962	5,996	5,996	106	72	106	106
EU-27	**79,962**	**81,452**	**80,908**	**81,456**	**81,493**	**1,490**	**946**	**1,493**	**1,531**

Source: **Amann et al (2008)**. 'BASE' is equivalent to GAINS 'Current policy' costs basis

The ratio of benefits to costs (B-C) is for each Member State is shown below. In all cases, benefits exceed costs, even under the low benefit values assumptions.

Table 4.2 Ratio of Benefits to Costs for the TSAP cost-effective and equity cases. Lower estimate with mortality valued using the median VOLY (€million). Higher estimate with mortality valued using the mean VSL (€million)

Country	Low value CE	High value CE	Low value CE-MECP	High value CE-MECP	Low value CE-4	High value CE-4	Low value CE-32	High value CE-32
Austria	23.4	71.7	17.6	54.4	24.7	75.6	26.5	81.1
Belgium	18.8	58.0	22.1	68.6	18.8	58.0	16.8	51.9
Bulgaria	22.0	81.7	19.5	73.3	22.1	82.0	22.2	82.3
Cyprus	1.1	2.7	0.7	1.7	1.1	2.7	1.1	2.6
Czech Republic	13.1	42.3	19.7	64.2	12.9	41.9	10.0	32.3
Denmark	10.5	35.0	8.5	28.5	9.1	30.3	9.3	30.9
Estonia	5.4	19.5	3.9	14.3	5.2	19.0	3.5	12.9
Finland	4.5	14.1	3.6	11.5	4.9	15.5	5.3	16.7
France	12.3	35.5	11.9	34.6	12.3	35.5	12.4	35.7
Germany	20.0	67.4	23.9	80.8	20.5	69.3	19.3	65.0
Greece	25.2	87.7	18.6	67.2	25.8	89.7	23.5	81.4
Hungary	16.8	60.6	19.2	70.0	15.2	54.8	13.7	49.4
Ireland	1.2	3.1	0.9	2.3	1.2	3.1	1.2	3.1
Italy	12.3	44.5	13.5	49.5	12.3	44.5	11.7	42.4
Latvia	9.7	25.0	7.3	18.8	8.4	21.6	6.1	15.7
Lithuania	3.7	17.2	3.5	16.2	4.9	22.6	5.7	26.5
Luxembourg	24.4	57.3	25.5	60.1	24.1	56.5	17.7	41.5
Malta	76.6	219.6	33.5	95.3	84.2	241.3	79.3	227.5
Netherlands	81.2	239.4	85.6	253.4	81.1	239.2	41.2	121.6
Poland	19.3	59.0	27.6	84.9	17.2	52.7	18.9	57.9
Portugal	16.1	53.8	17.7	59.6	16.1	53.9	14.9	49.8
Romania	21.0	70.7	33.8	114.7	22.3	75.3	26.1	87.9
Slovakia	18.7	55.6	65.9	196.6	18.9	56.2	15.5	46.0
Slovenia	7.8	25.8	6.3	21.0	8.0	26.3	7.9	26.0
Spain	5.2	16.6	4.5	14.3	5.2	16.6	5.3	16.8
Sweden	6.6	20.4	4.3	13.6	8.1	25.3	9.2	28.8
United Kingdom	18.3	50.8	19.6	54.5	18.3	50.9	18.5	51.4
Total (EU27)	**14.6**	**46.8**	**16.0**	**51.7**	**14.5**	**46.7**	**14.2**	**45.5**
Total (EU27) with materials	**14.7**	**46.9**	**-**	**-**	**14.6**	**46.8**	**14.3**	**45.6**

B-C ratios include abatement costs and monetised benefits (health and crops). A B/C ratio for the EU as a whole (final table row) also includes materials in the estimate of monetised benefits.

Table 4.3 shows the monetised net benefits of the scenarios (benefits minus costs), and the benefit to cost ratio (benefits divided by costs). The former shows the level of quantifiable benefits achieved; the latter shows the effectiveness of the policies, where the larger the ratio, the more economically efficient the policy is.

Overall the analysis shows that benefits exceed costs for all scenarios, even with the low estimate of benefits. Under the TSAP cost-effective case, the benefit to cost is 14.6 and for the cases CE-4 and CE-32 slightly lower (14.5 and 14.2 respectively). The ratio with the high estimate of benefits is several times higher (with ratios of 46.8 for TSAP cost-effective, 46.7 for CE-40 and 45.5 for CE-32). Adding materials benefits at the EU27 level increases the B-C ratio marginally.

Under the MECP scenario, the benefits to cost ratio ranges from 16 to 51.7, slightly higher than under the other TSAP cases.

For the sensitivity case concerning the European Parliament described earlier, B-C ratios range from 7.6 to 24.6.

It is stressed that the analysis above does not include all air quality benefits – notably it excludes benefits to ecosystems, some health impacts, for instance those of secondary organic aerosols

(SOAs) and impacts on cultural heritage. These impacts are likely to add significant benefits to those already quantified. The importance of the un-monetised benefits is also evident from estimates of the extent of exceedance of critical levels for ozone and critical loads for acidification and eutrophication.

Table 4.3 Summary of annual additional costs and benefits in 2020 for different NECD proposals

Monetised Benefits-health	Units	CE	CE-MECP	CE-4	CE-32
Total with Mortality – VOLY – low (median)	€ million	21,511	15,174	**21,516**	**21,504**
Total with Mortality – VOLY – high (mean)	€ million	40,404	28,501	40,410	40,393
Total with Mortality – VSL – low (median)	€ million	37,033	26,031	37,029	37,007
Total with Mortality – VSL – high (mean)	€ million	69,514	48,847	**69,503**	**69,465**
Monetised Benefits-non-health	€ million	326	-	330	333
Total costs	€ million	1,490	946	1,493	1,531
Net benefits (Monetised Benefits minus Total Costs)					
Total with Mortality – VOLY – low (median)	€ million	20,348	14,228	20,353	20,306
Total with Mortality – VOLY – high (mean)	€ million	39,240	27,556	39,247	39,195
Total with Mortality – VSL – low (median)	€ million	35,869	25,085	35,866	35,809
Total with Mortality – VSL – high (mean)	€ million	68,350	47,901	68,340	68,268
Benefit-Cost Ratio (Monetised Benefits divided by Total Costs)					
Total with Mortality – VOLY – low (median)	Ratio	14.7	16.0	14.6	14.3
Total with Mortality – VOLY – high (mean)	Ratio	27.3	30.1	27.3	26.6
Total with Mortality – VSL – low (median)	Ratio	25.1	27.5	25.0	24.4
Total with Mortality – VSL – high (mean)	Ratio	46.9	51.7	46.8	45.6

Note: Annualised benefits include health, crops and materials, but exclude damage to other environments as well as damage from natural and secondary particulates

Additional benefits to non-EU27 countries

The additional improvements of air quality following this proposal have been evaluated for the EMEP domain, which approximately covers the whole of Europe. The changing emissions of pollution in the EU will reduce health impacts outside of the EU by substantial amounts, by about €2.3 billion in monetized health benefits. This compares to EU27 benefits of €21.5 billion, so is an additional 10% over such benefits. This analysis for the MECP case has not been undertaken but is likely to be a similar percentage value.

The estimates are presented in Table 4.4 below.

Table 4.4 Outside EU27 health impact / benefits (median VOLY valuation approach) - €million

	HEALTH IMPACTS					HEALTH BENEFITS**		
Country	**BASE**	**CE**	**CE-4**	**CE-32**		**CE**	**CE-4**	**CE-32**
Norway	652	624	624	624		28	28	27
Switzerland	1,812	1,640	1,641	1,635		172	172	177
Croatia	1,585	1,443	1,442	1,443		142	143	142
Turkey	20,325	19,884	19,892	19,928		442	433	397
Other*	69,263	67,677	67,681	67,740		1,586	1,582	1,523
TOTAL	93,637	91,266	91,280	91,371		2,371	2,357	2,266

* This covers the rest of the EMEP domain and includes a population in 2020 of 196 million.
** These are the benefits above the BASE case of meeting TSAP objectives

5 Uncertainty analysis

Uncertainties are present in both the costs and benefits of emission control. Methods for quantification of the uncertainty in benefits were described in Volume 3 of the CAFE-CBA methodology report (Holland et al, 2005b). These methods were further refined for assessments leading up to and including analysis of the Thematic Strategy on Air Pollution (Holland et al, 2005c). Uncertainty is described in terms of probability distributions for inputs to the health analysis covering the incidence rate of any given health effect, response functions and valuations. Monte Carlo analysis is then run over 10,000 iterations to determine the likely spread in final results. Sensitivity to assumptions on the true cost of abatement and approach to mortality valuation are investigated specifically.

The probability of the benefits of exceeding costs when moving from the baseline (BASE) to the cost-effective case (CE) is >99% irrespective of whether mortality is valued with the VOLY or VSL, and whether median or mean values are used.

An additional sensitivity analysis has been undertaken using a mortality factor set to 4% and VOLY to €40,000. The mortality (VOLY) valuation has been reduced from €52,000 to €40,000,[7] in line with preliminary recommendations made in the EC-funded NEEDS project (Desaigues et al, 2007). The Desaigues paper has yet to be fully peer reviewed and the values recommended from it are not formally part of the 'CAFE methodology' at this point in time[8].

Using this reduced VOLY estimate, the probability of the benefits of exceeding costs when moving from the baseline (BASE) to the cost-effective case (CE) still remains greater than 99%.

Some uncertainties on benefits are not addressed here. The most important are likely to be:

- The omission of impacts to crops, ecosystems and buildings. This would simply add to the benefits and would not change the conclusion that the probability of benefits being greater than costs is very high.
- The assumption that all types of particle are equally harmful (this analysis follows WHO advice not to differentiate between types of particle on the grounds that there is no empirical basis on which to make adjustments). If incorrect this assumption could work either to overestimate or to underestimate the probability that benefits would exceed costs, depending on the pollutants and sources subject to abatement.

Uncertainty is of course not confined to the quantification of health impacts, but is present also in the dispersion modelling and quantification of costs. Of the two it seems likely that the cost assessment is prone to greater uncertainty, drawing on evidence collected in past comparisons of ex-ante and ex-post cost estimates. For scenarios considered in the development of the Thematic Strategy on Air Pollution a range of -50% to +20% of the RAINS estimates of costs was assessed, the downward bias introduced in line with the finding that costs are often overestimated. Given the very low probability estimated above that costs would exceed benefits (typically <1%) the assumption that costs should be lower would have no effect on conclusions. The assumption that costs should be 20% higher was tested and found to make very little difference.

[7] This value includes survey data from Germany which was not included in earlier estimates

[8] It is worth remarking that the paper has reassessed the valuation of chronic bronchitis and concluded that the figures used to date under the CAFE benefits methodology are robust.

6 Assessment of the Macroeconomic Impact of the NEC Scenarios

As part of the revision of the NEC (National Emission Ceilings) Directive a set of scenarios for environmental targets within Europe have been constructed and evaluated with the GAINS model (Amann et al. 2008). The objective here is to complement the GAINS analysis with the evaluation of the macroeconomic impact of the scenarios with GEM-E3, a general equilibrium model for EU25. Two scenarios are considered for this evaluation. The environmental targets as derived for the Thematic Strategy on Air Pollution are the same in both scenarios but the background climate policy assumption is different. In one scenario (baseline) it is assumed that the climate/energy package for 2020 is implemented (BASE) while in the other a climate policy continuing Kyoto is assumed (S-BASE).[9]

In Annex 2, the calibration of GEM-E3 to the GAINS data is explained, and detailed results presented. In this section, the macroeconomic impact for the reduction scenarios evaluated with GEM-E3 is presented.

6.1 Reference scenarios[10]

Two reference scenarios are considered. They are based on the same background assumptions regarding World growth, World energy prices and autonomous energy efficiency and labour productivity improvement with world prices approximately doubling in 2020 compared to their 2000 levels. The policies regarding the local pollutants are assumed to be the same in both reference scenarios and reflect the actual policy in place. The two scenarios assume however a different climate/energy policy:

- **S-BASE**: assumes a moderate climate policy imposing a CO_2 tax of 20€/ton CO2 to all energy consumption in the EU after the Kyoto period.

- **BASE**: assumes that the EU climate/energy package for 2020 will be implemented. The policy assumptions are taken from one of the scenarios run with GEM-E3 for the impact assessment of the 2020 EU climate target[11], i.e. an EU wide permit system with auctioning for the ETS sectors and a domestic CO_2 tax for the other sectors. The allocation between ETS and non ETS sectors at EU level is based on cost efficiency, while the allocation between countries for the non ETS sectors is based on a combination of cost efficiency and GDP per head.

The projected average EU growth rate is 2.2% till 2020, slightly lower in the reference scenario with climate/energy package. In terms of emissions the results are more differentiated between both scenarios. CO_2 emissions continue to increase in the S-BASE scenario at 0.4% per year while they decrease at 0.6% per year in the BASE scenario. In 2020 the differences between the two reference scenarios are the greatest for CO_2 because of the climate/energy policy assumptions but also for NOx and SO_2 emissions which are more related to energy consumption as shown in Table 6.1.

[9] S-BASE included as a sensitivity case in earlier sections of the report

[10] Given the time schedule it was not possible to calibrate GEM-E3 and PRIMES jointly; therefore this exercise is based on a baseline constructed at CES for their policy studies which is in line with the macroeconomic growth used in PRIMES

[11] It is close to the PRIMES scenario used by IIASA (case 4 of the Climate & Energy Package, assuming full RES trade, non-ETS targets by country as well as JI/CDM (restricting carbon prices to €30/t CO2), but GEM-E3 cannot isolate renewables

Table 6.1 Difference in Emissions between S-BASE and BASE reference scenarios in 2020

Pollutant	2020
CO_2	-10%
NOx	-7%
SO_2	-5%
VOCs	-2%
PM	-1%
NH_3	-1%

The climate/energy policy assumed will thus clearly have an impact on the emission reduction targets to be imposed on the countries, given the air quality targets put forward by the EU.

6.2 Policy scenarios

The reduction targets imposed in GEM-E3 for the local pollutants are those derived by the GAINS model for the EU countries for the cost-efficient option, i.e. the option that meets the target of the Thematic Strategy on Air Pollution in the least-cost way for the EU27 as a whole. Table 6.2 gives the reduction targets for the EU as a whole. They differ for the two reference scenarios reflecting the impact of the associated climate/energy policy and the difference is more pronounced for the emissions closely linked to energy consumption.

Table 6.2 Emission reduction targets for the EU

Pollutant	S-CE	CE
SO_2	28.8%	20.1%
NOx	11.5%	9.3%
PM	22.4%	20.3%
VOCs	1.4%	1.2%
NH_3	16.7%	15.4%

The reduction effort is greater in the S-CE case as it does not benefit from the impact of the climate/energy package on the local pollutant emissions.

The national reduction targets have been implemented as national constraints into GEM-E3 in 2020. The associated costs are then computed endogenously in the model taking into account the marginal abatement cost curves by sector estimated on the basis of the data from GAINS, the substitution possibilities in GEM-E3 and the reduction in activity.

The policy scenarios as implemented in these simulations with GEM-E3 assume a national permit market with grandfathering as a policy instrument i.e. cost efficient reduction across any sector, except for NH_3 where a specific target is imposed on the agriculture sector. The allocation of the efforts over the sectors within a country is determined endogenously and is therefore cost efficient for the GEM-E3 structure and costs. There are neither information costs for the regulator, nor monitoring, nor enforcement cost in these scenarios.

The public deficit relative to GDP is assumed to remain at the level of the reference through changes in the social transfer to households. The current account at EU level is also assumed to remain constant relative to GDP compared to the reference avoiding a reallocation of resources towards or from the rest of the world.

6.3 Analysis results

The macroeconomic impact of the policy measures is negative in both scenarios but remains very small, especially when the climate/energy package is implemented as it reduces the reduction effort needed. The cost efficiency of the allocation of the reduction between sectors, with the policy

instrument implemented in the scenarios, limits the cost of the policy, as can be seen in Table 6.3 which gives the impact for the EU as a whole. The overall activity as measured by GDP is decreasing because of the cost increase and the loss of competitiveness of the economy. The impact on economic welfare (this means excluding the environmental benefits) is also negative. Private consumption is reduced, induced by the decrease in the real wages, in employment and by the cost of the emission reduction for heating equipment and transport.

The benefits from the reduction of local air pollution are around 0.1% of GDP at EU level, above the loss in GDP using the 'low' environmental damage estimate, given in Annex 2.

Imposing a cost efficient air pollution policy as part of the NEC revision has limited indirect impact on CO_2 emissions when it is associated with a strong climate/energy policy as in scenario CE.

Table 6.3 Macroeconomic impact at EU Level of the NEC revision air pollution control scenarios (% difference compared to reference scenario except for * where difference)

	S-CE	CE
Macroeconomic Aggregates	2020	2020
Gross Domestic Product	-0.07%	-0.02%
Employment	-0.05%	-0.02%
Private Consumption	-0.05%	-0.04%
Investment	-0.05%	-0.03%
Final Energy Consumption	-0.79%	-0.23%
*Share Coal**	-0.29%	-0.27%
*Share Oil**	0.04%	0.07%
*Share Gas**	0.07%	0.10%
*Share Electricity**	0.17%	0.09%
Exports to RW	-0.11%	0.01%
Imports	-0.01%	-0.01%
Real Wage Rate	-0.13%	-0.05%
Relative Consumer Price	0.09%	0.00%
Real Interest Rate	-0.04%	-0.04%
Terms of Trade	0.01%	-0.08%
*Current Account (% of GDP)**	0.00%	0.00%
Total Atmospheric Emissions		
CO2 Emissions	-2.14%	-0.69%
NOX Emissions	-11.38%	-9.15%
SO2 Emissions	-28.25%	-20.57%
VOC Emissions	-3.92%	-3.45%
PM Emissions	-21.63%	-20.07%
NH3 Emissions	-15.71%	-14.25%
Environmental Policy		
CO2 marginal abatement cost (Euro00/tn CO2)	21	53
NOx marginal abatement cost (Euro00/tn NOx)	1164	960
SO2 marginal abatement cost (Euro00/tn SO2)	2079	1093
VOC marginal abatement cost (Euro00/tn VOC)	7	0
PM marginal abatement cost (Euro00/tn PM)	15801	13022
Welfare		
Economic Welfare	-0.09%	-0.06%
*Local Benefits (% of GDP)**	0.14%	0.11%

The distribution of cost between the EU countries depends on the reduction target imposed on each country. As can be seen from Table 6.5 below, the reduction effort needed to attain the environmental

targets is the highest in most new Member States and this is mostly for SO_2, NOx and PM. This higher reduction target is reflected in the cost of the policy for these countries. The marginal abatement per pollutant and per country can differ substantially compared to the average figure for the EU given in Table 6.3. In terms of welfare and GDP, it is above the EU average.

Table 6.4 Macroeconomic impact at country level of the NEC air pollution scenario in 2020 (% difference compared to reference scenario)

	S-CE (TSAP objectives without CEP assumed)					CE (TSAP objectives without CEP assumed)				
	Economic Welfare	Gross Domestic Product	Employment	Exports	Final Energy Consumption	Economic Welfare	Gross Domestic Product	Employment	Exports	Final Energy Consumption
Austria	-0.01%	-0.02%	-0.02%	-0.08%	-0.38%	-0.09%	0.00%	-0.01%	0.05%	-0.04%
Belgium	0.00%	-0.06%	-0.03%	-0.20%	-0.60%	0.00%	-0.02%	-0.01%	-0.06%	-0.08%
Bulgaria	-0.52%	-0.43%	-0.06%	-0.62%	-2.05%	-0.50%	-0.20%	-0.02%	-0.14%	-1.40%
Czech Republic	-0.26%	-0.14%	-0.06%	-0.17%	-1.75%	-0.15%	-0.02%	-0.01%	0.02%	-1.07%
Denmark	-0.01%	-0.03%	-0.01%	-0.09%	-0.58%	-0.02%	0.00%	0.00%	0.01%	-0.01%
Estonia	-0.96%	-0.31%	-0.04%	-0.21%	-2.43%	-0.63%	-0.27%	-0.09%	-0.29%	-1.99%
Finland	0.01%	-0.03%	-0.01%	-0.11%	-0.61%	-0.05%	0.01%	0.01%	0.04%	0.06%
France	0.00%	-0.05%	-0.03%	-0.15%	-0.62%	-0.01%	-0.01%	-0.02%	-0.03%	-0.30%
Germany	0.00%	-0.03%	-0.02%	-0.14%	-0.60%	0.00%	-0.01%	-0.01%	-0.03%	-0.10%
Greece	-0.03%	-0.04%	-0.02%	-0.14%	-0.84%	-0.02%	0.01%	0.00%	0.06%	0.27%
Hungary	-0.42%	-0.25%	-0.14%	-0.16%	-2.84%	-0.25%	-0.09%	-0.07%	0.01%	-1.18%
Ireland	-0.08%	-0.01%	-0.08%	0.00%	-2.03%	-0.03%	0.01%	-0.05%	0.02%	-0.88%
Italy	0.03%	-0.04%	-0.02%	-0.21%	-0.50%	-0.01%	-0.01%	-0.01%	-0.05%	-0.03%
Latvia	-1.75%	-0.70%	-0.20%	-0.47%	-5.33%	-0.82%	-0.31%	-0.09%	-0.26%	-5.02%
Lithuania	-0.68%	-0.15%	-0.74%	-0.14%	-5.48%	-0.26%	-0.03%	-0.22%	0.01%	-2.25%
The Netherlands	0.09%	-0.05%	-0.02%	-0.28%	-0.98%	0.02%	0.00%	0.00%	-0.02%	0.01%
Poland	-0.78%	-0.41%	-0.10%	-0.21%	-6.00%	-0.38%	-0.10%	-0.01%	0.15%	-5.32%
Portugal	-0.18%	-0.47%	-0.20%	-0.77%	-2.70%	-0.19%	-0.29%	-0.13%	-0.24%	-0.85%
Romania	-0.81%	-0.47%	-0.07%	-0.49%	-2.61%	-0.69%	-0.22%	-0.01%	-0.09%	-2.49%
Slovakia	-0.60%	-0.37%	-0.09%	-0.41%	-2.21%	-0.42%	-0.13%	-0.03%	-0.06%	-1.38%
Slovenia	-0.12%	-0.10%	-0.06%	-0.14%	-0.90%	-0.05%	-0.05%	-0.03%	-0.08%	-0.38%
Spain	-0.01%	-0.09%	-0.04%	-0.29%	-0.92%	-0.07%	-0.03%	-0.01%	-0.01%	-0.17%
Sweden	0.04%	-0.02%	-0.02%	-0.09%	-0.17%	0.03%	0.00%	-0.01%	-0.04%	0.05%
UK	-0.02%	-0.05%	-0.03%	-0.04%	-0.88%	0.00%	-0.02%	-0.01%	-0.01%	-0.19%
EU	-0.04%	-0.07%	-0.05%	-0.11%	-0.79%	-0.03%	-0.02%	-0.02%	0.01%	-0.23%

Table 6.5 Emission reduction in the EU countries in 2020 (% difference compared to the reference)

	S-CE (TSAP objectives without CEP assumed)					CE (TSAP objectives without CEP assumed)				
	NOX Emissions	SO2 Emissions	VOC Emissions	PM Emissions	NH3 Emissions	NOX Emissions	SO2 Emissions	VOC Emissions	PM Emissions	NH3 Emissions
Austria	-2.0%	-3.0%	-4.6%	-6.9%	-12.4%	-3.6%	-2.1%	-3.5%	-6.4%	-8.6%
Belgium	-12.3%	-24.8%	-1.4%	-20.9%	-6.5%	-8.5%	-22.1%	-0.9%	-18.5%	-4.6%
Bulgaria	-18.7%	-42.3%	-2.9%	-44.5%	-4.8%	-16.8%	-2.8%	-4.0%	-43.6%	-5.1%
Czech Republic	-17.9%	-24.8%	-2.4%	-9.1%	-14.5%	-13.5%	-19.8%	-3.4%	-7.9%	-10.6%
Denmark	-10.0%	-5.0%	-2.2%	-11.0%	-2.4%	-7.7%	-4.7%	-0.3%	-4.9%	-3.2%
Estonia	-26.7%	-25.1%	-6.4%	-17.4%	-12.7%	-22.5%	-8.0%	-4.5%	-12.7%	-13.5%
Finland	-8.4%	-1.4%	-2.7%	-13.7%	-5.7%	-6.5%	-0.1%	-0.8%	-11.7%	-6.7%
France	-7.1%	-18.9%	-2.5%	-12.4%	-18.7%	-6.3%	-13.5%	-1.3%	-11.8%	-16.9%
Germany	-12.7%	-6.9%	-0.5%	-8.7%	-21.0%	-9.9%	-4.4%	-0.2%	-8.7%	-20.5%
Greece	-5.5%	-7.2%	-10.6%	-18.5%	-12.9%	-2.7%	-1.1%	-10.5%	-18.6%	-13.7%
Hungary	-22.9%	-54.4%	-4.6%	-22.4%	-30.1%	-16.6%	-57.7%	-5.5%	-18.1%	-27.4%
Ireland	-5.0%	-25.8%	-1.7%	-13.0%	-9.0%	-5.5%	-17.2%	-0.8%	-10.4%	-8.8%
Italy	-7.8%	-32.0%	-8.6%	-22.6%	-14.7%	-7.4%	-22.9%	-6.6%	-21.2%	-14.3%
Latvia	-20.1%	-31.9%	-11.6%	-33.9%	-28.4%	-20.5%	-17.7%	-16.6%	-28.6%	-24.3%
Lithuania	-13.5%	-48.0%	-12.7%	-30.5%	-19.1%	-14.0%	-19.6%	-12.4%	-24.9%	-15.6%
The Netherlands	-2.3%	-7.2%	-0.7%	-8.3%	-3.3%	-0.4%	-0.3%	-0.1%	-7.7%	-3.2%
Poland	-13.6%	-38.7%	-8.4%	-29.9%	-19.7%	-7.9%	-34.2%	-9.6%	-27.1%	-14.2%
Portugal	-10.2%	-36.1%	-11.5%	-43.3%	-13.8%	-8.9%	-23.6%	-11.1%	-38.9%	-12.2%
Romania	-18.4%	-46.0%	-7.7%	-42.8%	-19.6%	-15.6%	-35.2%	-9.1%	-38.9%	-19.3%
Slovakia	-20.1%	-47.0%	-7.6%	-33.1%	-14.0%	-15.6%	-28.5%	-9.3%	-28.2%	-10.9%
Slovenia	-3.3%	-34.5%	-3.7%	-15.9%	-16.2%	-3.3%	-32.4%	-4.9%	-13.6%	-16.5%
Spain	-15.5%	-40.2%	-3.9%	-18.8%	-14.2%	-13.2%	-26.9%	-2.2%	-16.1%	-14.2%
Sweden	-4.3%	-1.1%	-0.7%	-11.8%	-5.2%	-4.1%	-0.1%	-0.1%	-2.9%	-8.5%
UK	-13.1%	-25.1%	-1.4%	-16.9%	-13.7%	-9.9%	-16.5%	-0.5%	-13.6%	-10.7%
EU	-11.4%	-28.3%	-3.9%	-21.6%	-15.7%	-9.1%	-20.6%	-3.5%	-20.1%	-14.2%

s are calculated in GEM-E3 outside of the analysis undertaken by GAINS (but using GAINS cost abatement data)

On the sectoral side, the equipment goods sectors see the demand of abatement equipment increase while the consumer goods industry suffers from the lower private consumption. The energy intensive sectors see their competitiveness decrease. On the export market there is also a shift between countries because the loss in competitiveness is greater in the countries with the highest reduction targets.

Table 6.6 Sectoral impact at EU level of the NEC air pollution scenario (% difference compared to reference scenario)

	S-CE	CE
Sectoral Aggregates	2020	2020
Domestic Production in Volume		
Agriculture	-0.37%	-0.25%
Energy Production	-0.81%	-0.18%
Ferrous and non ferrous metals	-0.35%	-0.14%
Chemical Products	-0.45%	-0.19%
Other energy intensive	-0.72%	-0.49%
Electric Goods	0.00%	0.05%
Transport equipment	-0.05%	0.03%
Other Equipment Goods	0.01%	0.05%
Consumer Goods Industries	-0.14%	-0.07%
Construction	-0.07%	-0.04%
Telecommunication Services	0.00%	0.01%
Transport	-0.14%	-0.02%
Services of credit and insurances	-0.01%	0.01%
Other Market Services	-0.03%	-0.01%
Non Market Services	0.00%	0.00%
Exports in Volume		
Agriculture	-0.53%	-0.38%
Energy Exports	-0.74%	-0.13%
Ferrous and non ferrous metals	-0.56%	-0.20%
Chemical Products	-0.60%	-0.21%
Other energy intensive	-1.01%	-0.67%
Electric Goods	0.01%	0.07%
Transport equipment	-0.04%	0.06%
Other Equipment Goods	0.00%	0.06%
Consumer Goods Industries	-0.20%	-0.07%
Construction	0.11%	0.13%
Telecommunication Services	0.15%	0.14%
Transport	-0.17%	0.07%
Services of credit and insurances	0.10%	0.11%
Other Market Services	0.07%	0.08%
Non Market Services	0.00%	0.00%
Price of Exports rel. EU average		
Agriculture	0.53%	0.36%
Ferrous and non ferrous metals	0.32%	0.10%
Chemical Products	0.27%	0.10%
Other energy intensive	0.65%	0.42%
Electric Goods	-0.01%	-0.03%
Transport equipment	0.01%	-0.03%
Other Equipment Goods	0.01%	-0.03%
Consumer Goods Industries	0.10%	0.04%
Construction	-0.10%	-0.10%
Telecommunication Services	-0.13%	-0.13%
Transport	0.06%	-0.07%

Services of credit and insurances	-0.09%	-0.10%
Other Market Services	-0.09%	-0.08%
Non Market Services	-0.05%	-0.06%

Two additional scenarios were also run by GAINS, in which the reduction targets for some countries were adapted to take into account the high additional cost in relation to GDP. These two 'fairness' cases cap the costs at 0.04% of GDP and 0.032% of GDP. The changes in emission reduction target remain very small[12] and concern only some pollutants. At a macroeconomic level, these cases will not change the results for the EU27 as a whole compared to the cost-effective cases analysed above. Therefore these scenarios were not evaluated with GEM-E3, as the overall impact would be too small and the differences not significant. For Romania and Lithuania which are the two countries benefiting mostly from the cap, the macroeconomic impact can be reduced.

GEM-E3 analysis has not been undertaken for the MECP case. The results however are assumed to be fairly similar, with respect to the magnitude of the macro-economic impacts.

6.4 Conclusions

The simulations with GEM-E3 remain at an aggregate level but allow an assessment of the full economic effects. They can complement the detailed results from GAINS with the impact of air quality policies on the economy. The first conclusions one can draw from this simulation are:

- The macroeconomic cost of air pollution reduction remains limited compared to the benefits obtained in terms of air quality, health and ecosystem
- The benefits return mainly to the EU citizens.
- The effect on the competitiveness of the sectors remains small because the price effect is limited and all EU countries participate in the abatement effort.
- The overall cost depends on the climate/energy policy associated with the air quality policy.

There are a few important caveats. First these results hold as long as the allocation of the efforts over the sectors and countries is cost efficient. Second no implementation and monitoring cost have been taken into account. Third we have used the low estimate for the environmental damage.

[12] Except the SO_2 target for Romania and Lithuania

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Annexes

Annex 1	Country results: Health impacts / valuation
Annex 2	GEM-E3 analysis

Annex 1:
Country results: Health impacts (monetised)

Provided in spreadsheet document labelled 'NECD MS_VALv1 EXP'

Annex 2:
GEM-E3 model calibration and detailed results

The modelling framework for emission reduction

In GEM-E3[13] the emissions of the primary pollutants (CO_2, NOx, SO_2, VOC, $PM_{2.5}$ and NH_3) are differentiated by countries, sectors, fuels, and durable goods (e.g. cars, heating systems) that use the fuels. They are either linked to the use of oil, coal, and gas and then the link concerns only the energetic use of these inputs or they are linked to the production of the sectors. For private consumption the major links between energy inputs and consuming durable goods are specified: cars and gasoline/diesel, heating systems and electric appliances and oil, coal, gas and electricity.

Three mechanisms of emission reduction are explicitly specified in the model:

- end-of-pipe abatement (where appropriate technologies are available),
- substitution between fuels and/or between energetic and non-energetic inputs for production,
- emission reduction through a decline in production and/or consumption.

For the emissions linked to energy the abatement activities are modelled such as to increase the user cost of the polluting input (here the price of energy) in the decision process of the firm. When an environmental tax is imposed it is paid to the government by the branch generating the pollution. This has the following implications for the *energy price* modelling:

- the price of energy, exclusive taxes and abatement cost, is used to value the delivery of the energy sectors to the other sectors;
- the price of energy inclusive abatement cost and taxes, is used in the decision process by the firm on production factors (at the energy level and implicitly at the level of aggregates); it represents the user's cost of energy.

For the emissions linked to production, the abatement activities increase directly the cost of the product.

In the modelling of the *abatement activities*, installing abatement technologies has been considered as an input for the firms and not as an investment. The major advantage of this formulation is its simplicity, especially as the available abatement cost functions are in terms of annualised cost, and because, with this framework, the abatement costs do not increase directly GDP as it would if modelled as investment. For the latter purpose a depreciation and replacement mechanism would have to be introduced. The user's cost of the abatement equipment would have to be added to the capital income, avoiding however any double counting. In the current model the demand of input for abatement by the firms is derived within the firms' cost minimisation decision process. It is then translated into deliveries by sectors in the following way:

- the demand for abatement inputs is allocated to the delivery sectors through fixed coefficients;
- the total delivery for abatement is added to the intermediate demand and these inputs are valued as the other intermediate deliveries.

Calibration

The emissions of the different pollutants (NOx, SO_2, VOC, $PM_{2.5}$ and NH_3) have been calibrated to the GAINS baseline scenario associating the GAINS activities with the GEM-E3 sectors. It includes the policy measures already decided regarding those pollutants, i.e. the current policy (Amann et al., 2007). A distinction is made between emissions linked to energy consumption and emissions linked to the production of a sector, depending on the source of emission identified in GAINS. Emission coefficients were computed for 2000 and then adapted for 2010-2020 to the changes of the GAINS implied emission factors.

The marginal abatement cost curves per sector and per country, either linked to energy or to production, were estimated based on the cost curves from GAINS, after allocating the GAINS data to the GEM-E3 classification. It was not possible to derive abatement cost curves for all pollutants and all

[13] A detailed description of the model can be found on www.gem-e3.net

sectors, because the number of abatement technologies considered in GAINS were too small for some pollutants and sectors, mostly pollutant from waste treatment.

It is important to mention that the translation of GAINS bottom up data into abatement cost curves for the GEM-E3 aggregate sectors can only be approximate. This increases the error margins in the results with GEM-E3. We believe however that at the aggregate level, GEM-E3 gives a first evaluation of the macroeconomic impact of air pollution policies.

The benefits of reducing air pollution are evaluated ex-post using the damage figures per ton of pollutant emitted in each EU country computed by AEA (M. Holland et al., 2005). These figures give per country the damage to the whole EU from one ton emitted in that country. This allows computing the total EU benefit from air pollution reduction in the EU countries but does not allow allocating this benefit to each country. The evaluations are done with the 'low' damage figure from AEA. There is no feedback from the reductions in air pollution damage in GEM-E3 on macroeconomic performance such as reduction in crop damage for agriculture or reduced health care costs. A previous study with GEM-E3 (Mayeres, I and D. Van Regemorter, 2008) has shown that introducing the feedback of reduced air pollution has only a marginal effect on welfare compared to its ex-post evaluation, at least for health related effects.

Detailed results

S-CE

2020		(% difference compared to reference except * where difference)											
NECAA with BL Policy compared to REFBLCLIM													
	Austria	Belgium	Bulgaria	Czech Republic	Denmark	Estonia	Finland	France	Germany	Greece	Hungary	Ireland	Italy
Macroeconomic Aggregates													
Gross Domestic Product	-0.02%	-0.06%	-0.43%	-0.14%	-0.03%	-0.31%	-0.03%	-0.05%	-0.03%	-0.04%	-0.25%	-0.01%	-0.04%
Employment	-0.02%	-0.03%	-0.06%	-0.06%	-0.01%	-0.04%	-0.01%	-0.03%	-0.02%	-0.02%	-0.14%	-0.08%	-0.02%
Private Consumption	-0.02%	-0.01%	-0.53%	-0.30%	-0.01%	-1.06%	0.01%	-0.02%	-0.01%	-0.03%	-0.54%	-0.12%	0.02%
Investment	-0.02%	-0.04%	-0.20%	-0.07%	-0.03%	-0.17%	-0.01%	-0.03%	-0.03%	-0.04%	-0.15%	-0.03%	-0.03%
Final Energy Consumption	-0.38%	-0.60%	-2.05%	-1.75%	-0.58%	-2.43%	-0.61%	-0.62%	-0.60%	-0.84%	-2.84%	-2.03%	-0.50%
*Share Coal**	-0.20%	-0.04%	-0.40%	-0.36%	-0.12%	-0.41%	-0.33%	-0.08%	-0.08%	-0.34%	-0.34%	-0.44%	-0.08%
*Share Oil**	0.06%	-0.10%	0.14%	0.14%	-0.10%	0.42%	0.02%	0.04%	-0.02%	0.21%	0.40%	0.22%	-0.11%
*Share Gas**	0.05%	-0.02%	0.01%	0.05%	0.06%	-0.07%	-0.03%	-0.01%	0.05%	0.03%	-0.23%	0.06%	0.12%
*Share Electricity**	0.09%	0.15%	0.25%	0.18%	0.17%	0.06%	0.33%	0.05%	0.05%	0.10%	0.17%	0.15%	0.07%
Exports	-0.08%	-0.20%	-0.62%	-0.17%	-0.09%	-0.21%	-0.11%	-0.15%	-0.14%	-0.14%	-0.16%	0.00%	-0.21%
Exports within EU	-0.11%	-0.24%	-1.09%	-0.23%	-0.08%	-0.36%	-0.06%	-0.17%	-0.15%	-0.31%	-0.17%	0.01%	-0.23%
Exports to RW	-0.05%	-0.16%	-0.33%	-0.06%	-0.09%	0.11%	-0.17%	-0.13%	-0.12%	-0.09%	-0.14%	-0.01%	-0.19%
Imports	-0.08%	-0.17%	-0.52%	-0.20%	-0.07%	-0.44%	-0.10%	-0.10%	-0.08%	-0.11%	-0.21%	-0.05%	-0.08%
Real Wage Rate	-0.09%	-0.14%	-0.93%	-0.58%	-0.05%	-1.32%	-0.05%	-0.14%	-0.12%	-0.16%	-1.18%	-0.39%	-0.11%
Relative Consumer Price	0.04%	0.02%	0.18%	0.38%	0.01%	0.09%	0.05%	0.12%	0.06%	0.04%	0.73%	0.36%	0.06%
Real Interest Rate	0.00%	0.00%	0.00%	0.00%	-0.04%	-0.03%	-0.05%	-0.05%	-0.03%	0.00%	-0.04%	-0.05%	0.00%
Terms of Trade	-0.03%	0.04%	0.21%	0.02%	0.00%	0.03%	0.07%	0.03%	0.03%	0.01%	0.04%	-0.01%	0.12%
*Public Surplus (% of GDP)**	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
*Current Account (% of GDP)**	-0.02%	0.01%	0.09%	0.04%	-0.01%	0.30%	0.01%	-0.01%	-0.01%	-0.01%	0.10%	0.04%	-0.01%
Total Atmospheric Emissions													
CO2 Emissions	-0.63%	-1.01%	-4.66%	-3.39%	-1.31%	-9.03%	-1.68%	-0.94%	-1.65%	-1.93%	-3.38%	-1.87%	-0.72%
NOX Emissions	-1.96%	-12.30%	-18.65%	-17.90%	-9.96%	-26.67%	-8.41%	-7.13%	-12.66%	-5.48%	-22.93%	-5.02%	-7.83%
SO2 Emissions	-3.05%	-24.81%	-42.28%	-24.82%	-5.01%	-25.07%	-1.44%	-18.94%	-6.88%	-7.15%	-54.44%	-25.81%	-31.99%
VOC Emissions	-4.60%	-1.36%	-2.89%	-2.38%	-2.16%	-6.40%	-2.69%	-2.47%	-0.50%	-10.56%	-4.65%	-1.72%	-8.58%
PM Emissions	-6.95%	-20.91%	-44.55%	-9.13%	-11.01%	-17.36%	-13.74%	-12.44%	-8.65%	-18.53%	-22.36%	-13.01%	-22.56%

NH3 Emissions	-12.39%	-6.50%	-4.84%	-14.46%	-2.40%	-12.67%	-5.69%	-18.70%	-20.96%	-12.90%	-30.15%	-8.95%	-14.67%
Environmental Policy													
*Energy Tax (% of GDP)**	0.00%	-0.01%	-0.01%	-0.02%	-0.01%	-0.01%	-0.01%	0.00%	-0.01%	0.00%	0.00%	0.00%	-0.01%
*Environmental Tax (% of GDP)**	0.00%	0.00%	-0.12%	-0.05%	0.00%	-0.17%	-0.01%	0.00%	-0.01%	-0.02%	-0.04%	-0.01%	0.00%
Increase of Social Benefits	-4.6%	-3.4%	-7.0%	-6.6%	-4.0%	-19.4%	-4.1%	-6.2%	-4.3%	-6.2%	-7.9%	-7.1%	-3.0%
NOx marginal abatement cost (Euro00/tn NOx)	0	1728	621	1369	1386	2615	1397	902	1909	404	1541	88	731
SO2 marginal abatement cost (Euro00/tn SO2)	0	1879	780	707	461	1237	9	2067	1434	452	755	2564	2144
VOC marginal abatement cost (Euro00/tn VOC)	0	11	7	0	0	31	0	0	0	0	0	0	0
PM marginal abatement cost (Euro00/tn PM)	12189	6013	4975	6995	1907	30955	2311	7658	12591	8235	27200	70807	13852
Welfare													
Economic Welfare	-0.01%	0.00%	-0.52%	-0.26%	-0.01%	-0.96%	0.01%	0.00%	0.00%	-0.03%	-0.42%	-0.08%	0.03%
	Latvia	Lithuania	The Netherlands	Poland	Portugal	Romania	Slovakia	Slovenia	Spain	Sweden	UK	EU	
Macroeconomic Aggregates													
Gross Domestic Product	-0.70%	-0.15%	-0.05%	-0.41%	-0.47%	-0.47%	-0.37%	-0.10%	-0.09%	-0.02%	-0.05%	-0.07%	
Employment	-0.20%	-0.74%	-0.02%	-0.10%	-0.20%	-0.07%	-0.09%	-0.06%	-0.04%	-0.02%	-0.03%	-0.05%	
Private Consumption	-1.86%	-1.01%	0.08%	-0.79%	-0.29%	-0.84%	-0.66%	-0.17%	-0.03%	0.03%	-0.04%	-0.05%	
Investment	-0.32%	-0.34%	-0.04%	-0.20%	-0.65%	-0.25%	-0.16%	-0.07%	-0.07%	-0.01%	-0.03%	-0.05%	
Final Energy Consumption	-5.33%	-5.48%	-0.98%	-6.00%	-2.70%	-2.61%	-2.21%	-0.90%	-0.92%	-0.17%	-0.88%	-0.79%	
*Share Coal**	-1.63%	-0.38%	-0.02%	-3.33%	-0.44%	-0.65%	-0.79%	-0.09%	-0.14%	-0.08%	-0.16%	-0.29%	
*Share Oil**	0.67%	0.14%	-0.40%	0.84%	0.45%	-0.04%	0.17%	0.03%	-0.16%	-0.01%	0.04%	0.04%	
*Share Gas**	0.10%	0.13%	0.30%	0.39%	-0.13%	0.02%	0.30%	0.01%	0.05%	0.00%	-0.04%	0.07%	
*Share Electricity**	0.85%	0.12%	0.12%	2.10%	0.12%	0.66%	0.33%	0.05%	0.25%	0.08%	0.16%	0.17%	
Exports	-0.47%	-0.14%	-0.28%	-0.21%	-0.77%	-0.49%	-0.41%	-0.14%	-0.29%	-0.09%	-0.11%	-	
Exports within EU	-2.52%	-1.51%	-0.40%	-0.39%	-2.58%	-0.30%	-0.57%	-0.11%	-0.43%	-0.09%	-0.35%	-	
Exports to RW	0.94%	1.07%	-0.14%	-0.05%	0.69%	-0.91%	-0.31%	-0.17%	-0.18%	-0.09%	-0.04%	-0.11%	
Imports	-0.96%	-0.97%	-0.20%	-0.41%	-0.43%	-0.63%	-0.41%	-0.16%	-0.20%	-0.05%	-0.06%	-0.01%	
Real Wage Rate	-3.28%	-5.39%	-0.02%	-1.31%	-1.06%	-1.22%	-1.09%	-0.40%	-0.18%	-0.02%	-0.13%	-0.13%	
Relative Consumer Price	1.37%	2.72%	-0.03%	0.64%	-0.41%	0.07%	0.48%	0.25%	0.00%	0.05%	0.10%	0.09%	
Real Interest Rate	-0.05%	-0.04%	0.00%	-0.05%	0.00%	-0.04%	-0.05%	-0.03%	-0.15%	-0.03%	-0.04%	-0.04%	
Terms of Trade	-0.09%	0.09%	0.13%	0.02%	0.00%	0.16%	0.14%	0.00%	0.10%	0.03%	0.02%	0.01%	
*Public Surplus (% of GDP)**	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	

*Current Account (% of GDP)**	0.27%	0.66%	0.03%	0.09%	-0.12%	0.23%	0.15%	0.01%	0.00%	-0.02%	-0.02%	0.00%	
Total Atmospheric Emissions													
CO2 Emissions	-8.95%	-5.36%	-1.60%	-8.37%	-3.71%	-4.66%	-4.71%	-2.77%	-1.68%	-0.84%	-1.71%	-2.14%	
NOX Emissions	-20.13%	-13.53%	-2.27%	-13.62%	-10.21%	-18.44%	-20.05%	-3.27%	-15.45%	-4.35%	-13.06%	-11.38%	
SO2 Emissions	-31.90%	-48.02%	-7.22%	-38.71%	-36.08%	-45.98%	-46.97%	-34.52%	-40.21%	-1.09%	-25.06%	-28.25%	
VOC Emissions	-11.60%	-12.69%	-0.70%	-8.44%	-11.54%	-7.65%	-7.56%	-3.74%	-3.87%	-0.73%	-1.40%	-3.92%	
PM Emissions	-33.89%	-30.46%	-8.32%	-29.92%	-43.34%	-42.78%	-33.14%	-15.92%	-18.76%	-11.82%	-16.92%	-21.63%	
NH3 Emissions	-28.36%	-19.05%	-3.29%	-19.65%	-13.80%	-19.62%	-14.02%	-16.22%	-14.25%	-5.16%	-13.66%	-15.71%	
Environmental Policy													
*Energy Tax (% of GDP)**	0.01%	0.02%	-0.01%	0.00%	-0.02%	-0.03%	-0.01%	0.00%	-0.01%	0.00%	-0.01%	-0.01%	
*Environmental Tax (% of GDP)**	-0.07%	-0.04%	-0.01%	-0.13%	-0.02%	-0.10%	-0.08%	-0.02%	-0.01%	0.00%	-0.01%	-0.01%	
Increase of Social Benefits	-35.9%	7.4%	-2.2%	-16.2%	-27.2%	-11.2%	-11.1%	-7.1%	-7.2%	-1.5%	-5.7%	-6.1%	
NOx marginal abatement cost (Euro00/tn NOx)	3104	704	0	914	68	1798	1574	687	1276	766	1711	1164	
SO2 marginal abatement cost (Euro00/tn SO2)	1858	2244	24973	1122	1368	2195	2672	1607	2648	0	2270	2079	
VOC marginal abatement cost (Euro00/tn VOC)	0	0	0	0	0	138	0	0	0	0	0	7	
PM marginal abatement cost (Euro00/tn PM)	21199	95493	7193	26944	83198	5413	20453	10477	16780	7480	20479	15801	
NH3 marginal abatement cost (Euro00/tn NH3)	0	0	0	0	0	0	0	0	0	0	0	0	
Welfare													
Economic Welfare	-1.75%	-0.68%	0.09%	-0.78%	-0.18%	-0.81%	-0.60%	-0.12%	-0.01%	0.04%	-0.02%	-0.09%	
*Local Benefits (% of GDP)**												0.14%	
Sectoral Aggregates	Austria	Belgium	Bulgaria	Czech Republic	Denmark	Estonia	Finland	France	Germany	Greece	Hungary	Ireland	Italy
Domestic Production in Volume													
Agriculture	-0.18%	-0.12%	-0.23%	-0.36%	-0.13%	-2.37%	-0.05%	-0.11%	-0.22%	-0.21%	-1.24%	-0.41%	-0.39%
Energy Production	-0.26%	-0.79%	-1.11%	-1.55%	-0.43%	-2.26%	-0.32%	-0.58%	-0.62%	-0.45%	-1.92%	-1.49%	-0.57%
Ferrous and non ferrous metals	-0.12%	-0.56%	-3.17%	-0.51%	-0.01%	0.05%	-0.41%	-0.29%	-0.20%	-0.24%	-0.56%	-0.18%	-0.20%
Chemical Products	-0.14%	-0.47%	-2.93%	-0.46%	-0.05%	-3.92%	-0.28%	-0.18%	-0.33%	-0.29%	-0.77%	0.24%	-0.19%
Other energy intensive	0.02%	-0.51%	-1.72%	-0.39%	-0.06%	-2.45%	0.11%	-0.20%	-0.29%	-0.99%	-1.82%	-2.23%	-0.37%
Electric Goods	0.02%	0.04%	0.04%	0.02%	-0.01%	0.07%	-0.04%	-0.04%	0.00%	-0.04%	0.15%	0.06%	-0.04%
Transport equipment	0.00%	0.01%	-0.26%	-0.02%	-0.02%	-0.01%	-0.10%	-0.06%	-0.06%	-0.03%	0.18%	-0.03%	-0.08%
Other Equipment Goods	0.02%	0.07%	0.34%	0.02%	0.02%	0.11%	-0.05%	-0.02%	0.01%	-0.01%	0.11%	0.06%	-0.01%

Consumer Goods Industries	-0.27%	-0.03%	-0.17%	-0.13%	-0.06%	-0.66%	-0.11%	-0.05%	-0.08%	-0.16%	-0.48%	-0.14%	-0.12%
Construction	-0.02%	-0.06%	-0.17%	-0.08%	-0.03%	-0.16%	-0.01%	-0.04%	-0.03%	-0.04%	-0.16%	-0.04%	-0.04%
Telecommunication Services	0.00%	0.01%	0.09%	0.00%	-0.01%	0.01%	-0.02%	0.00%	0.00%	-0.01%	0.08%	0.01%	0.00%
Transport	-0.01%	-0.22%	0.00%	-0.22%	-0.17%	0.35%	-0.09%	-0.14%	-0.14%	-0.18%	-0.24%	-0.09%	-0.14%
Services of credit and insurances	0.01%	0.02%	0.00%	-0.01%	0.00%	-0.03%	-0.01%	-0.01%	0.01%	-0.08%	0.08%	0.12%	0.00%
Other Market Services	-0.02%	-0.02%	-0.17%	-0.08%	-0.01%	-0.23%	-0.02%	-0.02%	-0.02%	-0.01%	-0.20%	0.02%	-0.02%
Non Market Services	0.00%	0.00%	-0.12%	-0.02%	0.00%	-0.15%	0.00%	0.00%	0.00%	0.00%	-0.01%	0.01%	0.00%
Exports in Volume													
Agriculture	-0.09%	-0.16%	0.33%	-0.82%	-0.20%	-3.47%	-0.18%	-0.22%	-0.52%	-0.30%	-2.31%	-0.92%	-0.97%
Energy Exports	-0.47%	-0.99%	-0.46%	-2.10%	-0.54%	-3.36%	-0.39%	-0.48%	-0.64%	-0.09%	-0.59%	-3.38%	-0.54%
Ferrous and non ferrous metals	-0.18%	-0.65%	-4.37%	-0.73%	-0.03%	0.30%	-0.59%	-0.55%	-0.33%	-0.40%	-0.72%	-0.17%	-0.42%
Chemical Products	-0.19%	-0.51%	-3.88%	-0.73%	-0.08%	-4.91%	-0.47%	-0.27%	-0.46%	-0.56%	-1.02%	0.25%	-0.33%
Other energy intensive	0.11%	-0.54%	-2.68%	-0.55%	-0.04%	-3.44%	0.19%	-0.31%	-0.43%	-2.06%	-2.98%	-3.61%	-0.74%
Electric Goods	0.04%	0.06%	-0.10%	0.07%	-0.01%	0.11%	-0.04%	-0.05%	0.01%	-0.01%	0.19%	0.06%	-0.09%
Transport equipment	0.00%	0.02%	-0.15%	0.04%	-0.02%	0.35%	-0.11%	-0.08%	-0.06%	-0.02%	0.24%	-0.03%	-0.11%
Other Equipment Goods	0.05%	0.07%	-0.08%	0.14%	0.03%	0.37%	-0.08%	-0.03%	0.02%	0.05%	0.19%	0.06%	-0.06%
Consumer Goods Industries	-0.47%	-0.02%	0.11%	-0.13%	-0.09%	-0.55%	-0.21%	-0.11%	-0.18%	-0.27%	-0.56%	-0.21%	-0.26%
Construction	0.00%	0.01%	0.03%	0.02%	-0.06%	0.42%	-	-	-0.07%	-0.11%	0.14%	-	-0.13%
Telecommunication Services	0.02%	0.14%	0.97%	0.29%	0.04%	1.31%	-0.05%	0.00%	0.02%	0.10%	0.70%	0.03%	0.00%
Transport	0.00%	-0.27%	0.37%	-0.31%	-0.18%	0.65%	-0.20%	-0.27%	-0.28%	-0.27%	-0.12%	-0.05%	-0.39%
Services of credit and insurances	0.05%	0.13%	0.81%	0.23%	0.06%	1.31%	-0.11%	0.01%	0.04%	0.03%	0.50%	0.16%	0.05%
Other Market Services	0.02%	0.08%	0.59%	0.14%	0.04%	0.76%	-0.11%	-0.03%	0.00%	0.06%	0.29%	0.06%	-0.04%
Non Market Services	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Price of Exports rel. EU average													
Agriculture	-0.27%	-0.27%	-0.69%	0.22%	-0.26%	2.15%	-0.36%	-0.27%	-0.06%	-0.19%	1.25%	0.21%	0.27%
Ferrous and non ferrous metals	-0.19%	0.04%	1.75%	0.03%	-0.26%	-0.41%	-0.02%	-0.03%	-0.14%	-0.14%	0.04%	-0.21%	-0.09%
Chemical Products	-0.16%	-0.02%	1.59%	0.05%	-0.21%	2.07%	-0.06%	-0.13%	-0.05%	-0.04%	0.21%	-0.35%	-0.10%
Other energy intensive	-0.49%	-0.21%	0.78%	-0.22%	-0.40%	1.18%	-0.47%	-0.23%	-0.21%	0.53%	0.90%	1.17%	-0.09%
Electric Goods	-0.01%	-0.03%	0.07%	-0.03%	0.00%	-0.03%	0.01%	0.02%	-0.01%	0.01%	-0.08%	-0.03%	0.03%
Transport equipment	-0.02%	-0.03%	0.07%	-0.04%	-0.01%	-0.16%	0.03%	0.01%	0.01%	-0.01%	-0.12%	-0.01%	0.03%
Other Equipment Goods	-0.02%	-0.03%	0.06%	-0.05%	-0.02%	-0.13%	0.03%	0.01%	-0.01%	0.00%	-0.07%	-0.03%	0.03%
Consumer Goods Industries	0.11%	-0.06%	-0.10%	-0.03%	-0.04%	0.14%	-0.01%	-0.04%	-0.02%	0.03%	0.15%	0.01%	0.01%
Construction	0.09%	0.09%	0.07%	0.05%	0.13%	-0.21%	0.16%	0.15%	0.13%	0.18%	-0.02%	0.22%	0.18%
Telecommunication Services	0.10%	0.02%	-0.54%	-0.12%	0.09%	-0.81%	0.13%	0.10%	0.08%	0.06%	-0.37%	0.10%	0.11%

Transport	-0.08%	0.07%	-0.28%	0.08%	0.02%	-0.41%	0.07%	0.08%	0.12%	0.05%	-0.04%	0.16%	0.15%
Services of credit and insurances	0.04%	-0.04%	-0.53%	-0.11%	0.02%	-0.92%	0.11%	0.04%	0.03%	0.02%	-0.32%	-0.03%	0.02%
Other Market Services	0.04%	-0.03%	-0.57%	-0.10%	0.03%	-0.66%	0.09%	0.04%	0.02%	0.03%	-0.32%	0.00%	0.07%
Non Market Services	0.06%	-0.06%	-0.22%	0.01%	0.02%	-0.44%	0.07%	0.05%	0.01%	-0.01%	-0.09%	0.16%	0.01%
Sectoral Aggregates	Latvia	Lithuania	The Netherlands	Poland	Portugal	Romania	Slovakia	Slovenia	Spain	Sweden	UK	EU	
Domestic Production in Volume													
Agriculture	-2.56%	-8.85%	0.01%	-1.28%	-1.29%	-0.65%	-0.87%	-0.30%	-0.42%	-0.07%	-0.24%	-0.37%	
Energy Production	-3.71%	-4.66%	-1.31%	-2.52%	-1.81%	-1.93%	-1.17%	-0.94%	-0.65%	-0.24%	-0.69%	-0.81%	
Ferrous and non ferrous metals	-0.25%	0.35%	-0.36%	-0.95%	-0.61%	-2.33%	-1.32%	-0.09%	-0.46%	-0.24%	-0.32%	-0.35%	
Chemical Products	-1.48%	-4.84%	-1.68%	-1.13%	-1.66%	-2.64%	-0.97%	-0.29%	-0.82%	-0.09%	-0.39%	-0.45%	
Other energy intensive	-1.20%	-3.25%	0.06%	-1.69%	-16.65%	-2.38%	-2.82%	-0.80%	-0.87%	0.13%	-0.41%	-0.72%	
Electric Goods	0.38%	1.53%	0.02%	0.12%	0.86%	0.23%	0.21%	0.03%	-0.05%	-0.05%	-0.05%	0.00%	
Transport equipment	0.27%	0.95%	0.03%	0.04%	-0.01%	-0.29%	0.19%	-0.05%	-0.12%	-0.05%	-0.08%	-0.05%	
Other Equipment Goods	0.85%	0.26%	0.04%	0.08%	0.60%	0.58%	0.23%	0.03%	0.07%	-0.04%	-0.05%	0.01%	
Consumer Goods Industries	-3.03%	-0.70%	-0.05%	-0.54%	-0.56%	-0.15%	-0.37%	-0.09%	-0.23%	-0.06%	-0.08%	-0.14%	
Construction	-0.42%	-0.25%	-0.04%	-0.27%	-0.88%	-0.22%	-0.20%	-0.08%	-0.09%	-0.02%	-0.04%	-0.07%	
Telecommunication Services	-0.01%	0.82%	0.04%	-0.14%	0.17%	0.12%	-0.03%	0.00%	-0.01%	-0.01%	-0.01%	0.00%	
Transport	0.79%	1.43%	-0.07%	-0.14%	-0.53%	-0.51%	-0.14%	-0.11%	-0.29%	-0.07%	-0.13%	-0.14%	
Services of credit and insurances	0.32%	0.26%	0.02%	-0.47%	0.17%	0.13%	-0.19%	-0.02%	0.02%	-0.01%	-0.03%	-0.01%	
Other Market Services	-0.47%	0.30%	0.01%	-0.45%	0.04%	-0.32%	-0.20%	-0.10%	-0.03%	-0.01%	-0.01%	-0.03%	
Non Market Services	-0.14%	0.04%	0.00%	-0.11%	0.01%	-0.29%	-0.08%	-0.02%	-0.01%	0.00%	0.00%	0.00%	
Exports in Volume													
Agriculture	-2.41%	-20.02%	0.07%	-3.65%	-1.17%	-0.33%	-1.61%	-0.67%	-0.64%	-0.25%	-0.70%	-0.53%	
Energy Exports	-1.32%	-1.20%	-1.16%	-2.28%	-0.09%	-0.86%	-0.52%	-0.73%	-0.44%	-0.55%	-0.74%	-0.74%	
Ferrous and non ferrous metals	0.63%	1.24%	-0.44%	-0.88%	0.06%	-2.61%	-1.54%	-0.08%	-0.85%	-0.38%	-0.70%	-0.56%	
Chemical Products	-1.84%	-5.83%	-1.72%	-1.66%	-1.89%	-3.54%	-1.12%	-0.35%	-1.39%	-0.16%	-0.70%	-0.60%	
Other energy intensive	-0.80%	-5.25%	0.18%	-2.99%	-35.53%	-3.95%	-3.88%	-1.03%	-1.78%	0.22%	-0.91%	-1.01%	
Electric Goods	1.42%	2.21%	0.02%	0.52%	1.34%	0.40%	0.27%	0.06%	-0.10%	-0.06%	-0.08%	0.01%	
Transport equipment	1.92%	0.97%	0.07%	0.45%	0.56%	-0.05%	0.30%	-0.02%	-0.11%	-0.07%	-0.11%	-0.04%	
Other Equipment Goods	1.21%	1.48%	0.04%	0.39%	0.93%	0.13%	0.19%	0.05%	0.00%	-0.06%	-0.11%	0.00%	
Consumer Goods Industries	-4.03%	-0.52%	-0.06%	-0.41%	-0.26%	0.21%	-0.24%	-0.08%	-0.39%	-0.18%	-0.25%	-0.20%	
Construction	1.00%	2.02%	0.01%	0.45%	-	0.29%	0.20%	-0.07%	-0.22%	-	-0.07%	0.11%	
Telecommunication Services	2.41%	3.79%	0.11%	0.75%	2.43%	1.63%	0.79%	0.21%	0.18%	-0.06%	0.03%	0.15%	

Transport	1.39%	2.79%	-0.10%	0.42%	0.37%	-0.10%	0.22%	-0.08%	-0.39%	-0.18%	-0.37%	-0.17%	
Services of credit and insurances	2.03%	2.18%	0.03%	-0.82%	2.49%	1.05%	0.59%	0.19%	0.20%	-0.05%	0.03%	0.10%	
Other Market Services	1.25%	2.12%	0.05%	0.35%	1.72%	0.41%	0.31%	0.00%	0.11%	-0.04%	0.04%	0.07%	
Non Market Services	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
Price of Exports rel. EU average													
Agriculture	1.41%	16.24%	-0.42%	2.21%	0.40%	-0.14%	0.75%	0.05%	0.03%	-0.24%	0.05%	0.53%	
Ferrous and non ferrous metals	-0.52%	-0.79%	-0.06%	0.13%	-0.24%	0.93%	0.42%	-0.22%	0.10%	-0.12%	0.03%	0.32%	
Chemical Products	0.37%	2.42%	0.57%	0.50%	0.64%	1.40%	0.28%	-0.11%	0.37%	-0.17%	0.07%	0.27%	
Other energy intensive	-0.22%	1.98%	-0.46%	0.91%	21.36%	1.40%	1.34%	0.01%	0.60%	-0.49%	-0.11%	0.65%	
Electric Goods	-0.62%	-0.92%	0.00%	-0.22%	-0.54%	-0.17%	-0.11%	-0.03%	0.05%	0.02%	0.04%	-0.01%	
Transport equipment	-0.86%	-0.41%	-0.04%	-0.21%	-0.22%	0.00%	-0.14%	-0.01%	0.03%	0.01%	0.03%	0.01%	
Other Equipment Goods	-0.54%	-0.57%	-0.02%	-0.17%	-0.36%	-0.04%	-0.08%	-0.02%	0.01%	0.02%	0.04%	0.01%	
Consumer Goods Industries	1.55%	0.17%	-0.05%	0.09%	0.09%	-0.13%	0.02%	-0.04%	0.06%	-0.02%	0.01%	0.10%	
Construction	-0.60%	-1.30%	0.09%	-0.22%	2.36%	-0.11%	-0.06%	0.13%	0.25%	0.17%	0.14%	-0.10%	
Telecommunication Services	-1.51%	-2.42%	0.03%	-0.40%	-1.49%	-0.99%	-0.44%	-0.04%	-0.01%	0.15%	0.10%	-0.13%	
Transport	-0.75%	-1.48%	-0.05%	-0.31%	-0.61%	-0.07%	-0.26%	-0.03%	0.10%	0.04%	0.12%	0.06%	
Services of credit and insurances	-1.38%	-2.25%	0.01%	0.60%	-1.66%	-0.68%	-0.46%	-0.10%	-0.08%	0.10%	0.07%	-0.09%	
Other Market Services	-0.96%	-1.62%	-0.02%	-0.24%	-1.25%	-0.36%	-0.26%	-0.03%	-0.05%	0.11%	0.06%	-0.09%	
Non Market Services	-0.46%	-1.53%	-0.01%	-0.27%	-0.92%	-0.27%	0.17%	0.00%	-0.03%	0.08%	0.05%	-0.05%	

CE

(% difference compared to reference except * where difference)

2020		
NECAA with CE Policy compared to REFCECLIM		

	Austria	Belgium	Bulgaria	Czech Republic	Denmark	Estonia	Finland	France	Germany	Greece	Hungary	Ireland	Italy
Macroeconomic Aggregates													
Gross Domestic Product	0.00%	-0.02%	-0.20%	-0.02%	0.00%	-0.27%	0.01%	-0.01%	-0.01%	0.01%	-0.09%	0.01%	-0.01%
Employment	-0.01%	-0.01%	-0.02%	-0.01%	0.00%	-0.09%	0.01%	-0.02%	-0.01%	0.00%	-0.07%	-0.05%	-0.01%
Private Consumption	-0.10%	0.00%	-0.49%	-0.16%	-0.02%	-0.74%	-0.04%	-0.02%	0.00%	-0.02%	-0.31%	-0.05%	-0.01%
Investment	-0.02%	-0.02%	-0.13%	-0.02%	0.00%	-0.18%	0.00%	-0.01%	-0.01%	-0.01%	-0.06%	-0.02%	-0.02%
Final Energy Consumption	-0.04%	-0.08%	-1.40%	-1.07%	-0.01%	-1.99%	0.06%	-0.30%	-0.10%	0.27%	-1.18%	-0.88%	-0.03%
*Share Coal**	-0.10%	0.01%	-0.58%	-0.47%	-0.02%	-0.12%	-0.05%	-0.03%	-0.01%	-0.23%	-0.52%	-0.25%	0.00%
*Share Oil**	0.01%	-0.05%	0.12%	0.09%	-0.02%	0.07%	0.01%	0.07%	-0.05%	0.20%	0.18%	0.20%	-0.17%
*Share Gas**	0.10%	0.03%	0.01%	0.07%	0.03%	-0.19%	0.00%	0.00%	0.08%	0.07%	0.33%	0.03%	0.17%
*Share Electricity**	-0.01%	0.02%	0.45%	0.31%	0.01%	0.24%	0.04%	-0.04%	-0.02%	-0.03%	0.01%	0.02%	0.01%
Exports	0.05%	-0.06%	-0.14%	0.02%	0.01%	-0.29%	0.04%	-0.03%	-0.03%	0.06%	0.01%	0.02%	-0.05%
Exports within EU	-0.02%	-0.08%	-0.28%	0.00%	-0.01%	-0.48%	0.08%	-0.05%	-0.05%	0.00%	0.00%	0.01%	-0.08%
Exports to RW	0.11%	-0.04%	-0.05%	0.06%	0.02%	0.08%	-0.01%	0.00%	-0.02%	0.08%	0.03%	0.03%	-0.02%
Imports	-0.05%	-0.06%	-0.33%	-0.07%	-0.01%	-0.46%	0.00%	-0.02%	-0.02%	-0.02%	-0.05%	-0.01%	-0.03%
Real Wage Rate	-0.14%	-0.06%	-0.66%	-0.22%	-0.01%	-1.20%	0.00%	-0.08%	-0.05%	-0.04%	-0.63%	-0.21%	-0.06%
Relative Consumer Price	-0.07%	-0.03%	0.09%	0.12%	-0.02%	0.03%	-0.02%	0.05%	0.01%	-0.05%	0.39%	0.14%	-0.03%
Real Interest Rate	0.00%	0.00%	0.00%	-0.04%	-0.04%	-0.03%	-0.05%	-0.05%	-0.06%	0.00%	-0.04%	-0.05%	-0.10%
Terms of Trade	-0.08%	0.03%	-0.02%	-0.03%	-0.02%	0.10%	0.00%	-0.02%	0.00%	-0.06%	-0.01%	-0.02%	0.01%
*Public Surplus (% of GDP)**	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
*Current Account (% of GDP)**	0.01%	0.01%	0.07%	0.05%	0.00%	0.43%	0.01%	-0.01%	-0.01%	0.01%	0.07%	0.00%	0.00%
Total Atmospheric Emissions													
CO2 Emissions	0.13%	0.20%	-2.06%	-1.36%	0.13%	-3.97%	0.26%	-0.07%	-0.08%	0.35%	-1.29%	-0.14%	0.16%
NOX Emissions	-3.58%	-8.46%	-16.82%	-13.47%	-7.73%	-22.53%	-6.53%	-6.31%	-9.90%	-2.74%	-16.56%	-5.49%	-7.40%
SO2 Emissions	-2.12%	-22.07%	-2.75%	-19.76%	-4.66%	-8.01%	-0.08%	-13.55%	-4.42%	-1.08%	-57.69%	-17.21%	-22.90%
VOC Emissions	-3.52%	-0.95%	-3.97%	-3.37%	-0.30%	-4.49%	-0.78%	-1.30%	-0.24%	-10.51%	-5.48%	-0.84%	-6.58%
PM Emissions	-6.37%	-18.53%	-43.62%	-7.88%	-4.94%	-12.68%	-11.72%	-11.76%	-8.72%	-18.57%	-18.11%	-10.38%	-21.23%
NH3 Emissions	-8.62%	-4.60%	-5.06%	-10.64%	-3.25%	-13.48%	-6.73%	-16.88%	-20.45%	-13.73%	-27.36%	-8.79%	-14.34%
Environmental Policy													

*Energy Tax (% of GDP)**	0.00%	0.00%	-0.01%	-0.01%	0.00%	-0.03%	0.00%	0.00%	0.00%	0.01%	0.01%	0.00%	0.00%
*Environmental Tax (% of GDP)**	-0.19%	-0.12%	-0.37%	-0.17%	-0.10%	-0.24%	-0.16%	-0.14%	-0.12%	-0.25%	-0.36%	-0.23%	-0.13%
Increase of Social Benefits	-11%	-4%	-7%	-8%	-3%	-13%	-6%	-5%	-7%	-13%	-15%	-5%	-8%
CO2 marginal abatement cost (Euro00/tn CO2)	-5	-2	-1	-1	-3	-2	-4	-4	-2	-3	-3	-6	-3
NOx marginal abatement cost (Euro00/tn NOx)	1657	1167	580	974	1046	2688	1301	843	1415	259	1131	405	773
SO2 marginal abatement cost (Euro00/tn SO2)	0	1593	14	491	812	0	8	1403	1175	61	942	1638	1312
VOC marginal abatement cost (Euro00/tn VOC)	0	14	0	0	0	12	0	0	0	0	0	0	0
PM marginal abatement cost (Euro00/tn PM)	21530	5555	4701	2931	1427	46253	2648	9422	14276	8246	17078	64661	15299
Welfare													
Economic Welfare	-0.09%	0.00%	-0.50%	-0.15%	-0.02%	-0.63%	-0.05%	-0.01%	0.00%	-0.02%	-0.25%		
	Latvia	Lithuania	The Netherlands	Poland	Portugal	Romania	Slovakia	Slovenia	Spain	Sweden	UK	EU	
Macroeconomic Aggregates													
Gross Domestic Product	-0.31%	-0.03%	0.00%	-0.10%	-0.29%	-0.22%	-0.13%	-0.05%	-0.03%	0.00%	-0.02%	-0.02%	
Employment	-0.09%	-0.22%	0.00%	-0.01%	-0.13%	-0.01%	-0.03%	-0.03%	-0.01%	-0.01%	-0.01%	-0.02%	
Private Consumption	-0.88%	-0.36%	0.01%	-0.37%	-0.26%	-0.70%	-0.45%	-0.08%	-0.08%	0.03%	0.00%	-0.04%	
Investment	-0.16%	-0.11%	0.00%	-0.07%	-0.48%	-0.16%	-0.08%	-0.04%	-0.05%	0.00%	-0.01%	-0.03%	
Final Energy Consumption	-5.02%	-2.25%	0.01%	-5.32%	-0.85%	-2.49%	-1.38%	-0.38%	-0.17%	0.05%	-0.19%	-0.23%	
*Share Coal**	-3.17%	-0.57%	0.02%	-3.70%	-0.24%	-1.38%	-0.75%	-0.09%	-0.06%	-0.01%	-0.04%	-0.27%	
*Share Oil**	0.81%	0.21%	-0.07%	1.00%	0.47%	0.03%	0.11%	-0.02%	-0.08%	0.00%	-0.03%	0.07%	
*Share Gas**	0.21%	0.08%	0.04%	0.45%	-0.09%	0.07%	0.28%	0.00%	0.08%	0.00%	0.03%	0.10%	
*Share Electricity**	2.15%	0.27%	0.02%	2.25%	-0.13%	1.28%	0.36%	0.11%	0.06%	0.00%	0.05%	0.09%	
Exports	-0.26%	0.01%	-0.02%	0.15%	-0.24%	-0.09%	-0.06%	-0.08%	-0.01%	-0.03%	-0.04%	-	
Exports within EU	-1.18%	-0.35%	-0.04%	0.10%	-1.67%	0.00%	-0.15%	-0.07%	-0.15%	-0.01%	-0.15%	-	
Exports to RW	0.38%	0.33%	-0.01%	0.20%	0.90%	-0.29%	-0.01%	-0.09%	0.09%	-0.04%	-0.01%	0.01%	
Imports	-0.55%	-0.30%	-0.02%	-0.17%	-0.29%	-0.35%	-0.20%	-0.08%	-0.09%	0.00%	-0.01%	-0.01%	
Real Wage Rate	-1.55%	-1.71%	0.00%	-0.46%	-0.77%	-0.87%	-0.60%	-0.20%	-0.11%	0.02%	-0.05%	-0.05%	
Relative Consumer Price	0.59%	0.85%	-0.01%	0.14%	-0.58%	0.04%	0.24%	0.13%	-0.13%	0.02%	0.03%	0.00%	
Real Interest Rate	-0.05%	-0.05%	0.00%	-0.05%	0.00%	-0.04%	-0.05%	-0.03%	0.00%	-0.03%	-0.06%	-0.04%	
Terms of Trade	-0.03%	0.00%	-0.01%	-0.09%	-0.22%	0.04%	0.00%	0.00%	-0.04%	0.01%	0.01%	-0.08%	
*Public Surplus (% of GDP)**	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	
*Current Account (% of GDP)**	0.18%	0.23%	-0.01%	0.07%	-0.05%	0.19%	0.13%	0.00%	0.01%	-0.01%	-0.01%	0.00%	

Total Atmospheric Emissions													
CO2 Emissions	-12.23%	-4.25%	0.14%	-6.15%	-1.17%	-4.74%	-2.83%	-0.42%	-0.14%	0.09%	-0.08%	-0.69%	
NOX Emissions	-20.53%	-13.99%	-0.40%	-7.91%	-8.92%	-15.65%	-15.57%	-3.27%	-13.18%	-4.15%	-9.86%	-9.15%	
SO2 Emissions	-17.73%	-19.59%	-0.33%	-34.24%	-23.57%	-35.17%	-28.52%	-32.38%	-26.94%	-0.07%	-16.53%	-20.57%	
VOC Emissions	-16.64%	-12.44%	-0.07%	-9.61%	-11.14%	-9.11%	-9.27%	-4.94%	-2.17%	-0.06%	-0.47%	-3.45%	
PM Emissions	-28.62%	-24.92%	-7.74%	-27.11%	-38.93%	-38.95%	-28.15%	-13.62%	-16.11%	-2.87%	-13.57%	-20.07%	
NH3 Emissions	-24.30%	-15.57%	-3.16%	-14.18%	-12.23%	-19.30%	-10.88%	-16.54%	-14.22%	-8.46%	-10.68%	-14.25%	
Environmental Policy													
*Energy Tax (% of GDP)**	-0.01%	0.00%	0.00%	0.00%	0.01%	-0.03%	-0.01%	-0.01%	0.00%	0.00%	0.00%	0.00%	
*Environmental Tax (% of GDP)**	-0.08%	-0.15%	-0.06%	-0.40%	-0.42%	-0.34%	-0.29%	-0.09%	-0.25%	-0.05%	-0.10%	-0.14%	
Increase of Social Benefits	-26%	-3%	-2%	-14%	-40%	-9%	-14%	-9%	-8%	-2%	-6%	-7%	
CO2 marginal abatement cost (Euro00/tn CO2)	1	-1	-1	-1	-7	0	-1	-1	-4	-2	-2	-3	
NOx marginal abatement cost (Euro00/tn NOx)	2768	1181	114	353	153	1413	1186	931	1085	911	1228	960	
SO2 marginal abatement cost (Euro00/tn SO2)	0	597	1774	804	733	1355	1161	1413	1546	0	1424	1093	
VOC marginal abatement cost (Euro00/tn VOC)	0	0	0	0	0	0	0	0	0	0	0	0	
PM marginal abatement cost (Euro00/tn PM)	8858	25949	8006	9834	63406	4020	11342	5610	18968	1576	17407	13022	
Welfare													
Economic Welfare	-0.82%	-0.26%	0.02%	-0.38%	-0.19%	-0.69%	-0.42%	-0.05%	-0.07%	0.03%	0.00%	-0.06%	
*Local Benefits (% of GDP)**												0.11%	
Sectoral Aggregates	Austria	Belgium	Bulgaria	Czech Republic	Denmark	Estonia	Finland	France	Germany	Greece	Hungary	Ireland	Italy
Domestic Production in Volume													
Agriculture	-0.39%	-0.06%	-0.27%	-0.22%	-0.04%	-3.44%	0.01%	-0.05%	-0.18%	-0.13%	-0.73%	-0.35%	-0.38%
Energy Production	0.07%	-0.18%	-0.50%	-0.59%	-0.02%	-1.37%	0.08%	-0.12%	-0.14%	0.17%	-0.67%	-0.62%	-0.18%
Ferrous and non ferrous metals	-0.04%	-0.34%	-1.06%	0.14%	0.01%	0.17%	-0.12%	-0.18%	-0.06%	0.15%	-0.02%	-0.06%	-0.11%
Chemical Products	-0.09%	-0.24%	-2.12%	-0.19%	-0.01%	-5.04%	-0.11%	-0.08%	-0.20%	-0.12%	-0.41%	0.16%	-0.09%
Other energy intensive	-0.01%	-0.34%	-0.93%	-0.08%	0.01%	-2.10%	0.24%	-0.17%	-0.19%	-0.48%	-1.02%	-1.95%	-0.27%
Electric Goods	0.15%	0.06%	0.14%	0.07%	0.00%	0.12%	0.03%	0.02%	0.04%	0.02%	0.15%	0.09%	0.04%
Transport equipment	0.12%	0.04%	-0.11%	0.07%	0.01%	0.03%	0.00%	0.02%	0.03%	0.02%	0.19%	0.06%	0.01%
Other Equipment Goods	0.15%	0.07%	0.36%	0.07%	0.02%	0.15%	0.02%	0.03%	0.04%	0.01%	0.15%	0.08%	0.06%
Consumer Goods Industries	-0.39%	0.01%	-0.10%	-0.07%	-0.03%	-0.84%	-0.02%	0.00%	-0.04%	-0.03%	-0.22%	-0.10%	-0.06%

Construction	-0.02%	-0.02%	-0.10%	-0.03%	-0.01%	-0.16%	0.00%	-0.02%	-0.01%	-0.01%	-0.07%	-0.02%	-0.02%
Telecommunication Services	0.01%	0.02%	0.06%	0.00%	-0.01%	0.10%	-0.01%	0.01%	0.01%	0.04%	0.06%	0.05%	0.00%
Transport	0.01%	-0.01%	0.04%	-0.16%	0.05%	0.28%	0.03%	0.02%	-0.04%	0.26%	0.00%	0.00%	-0.09%
Services of credit and insurances	0.04%	0.02%	0.08%	0.00%	-0.01%	0.02%	-0.01%	0.01%	0.01%	-0.01%	0.08%	0.10%	0.00%
Other Market Services	-0.01%	0.00%	-0.14%	-0.02%	-0.01%	-0.14%	-0.01%	-0.01%	0.00%	0.00%	-0.08%	0.05%	-0.01%
Non Market Services	-0.02%	0.00%	-0.10%	-0.01%	0.00%	-0.12%	-0.01%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%
Exports in Volume													
Agriculture	-0.39%	-0.06%	0.05%	-0.52%	-0.03%	-5.35%	-0.14%	-0.09%	-0.42%	-0.21%	-1.42%	-0.78%	-0.98%
Energy Exports	0.01%	-0.26%	0.07%	-0.85%	-0.07%	-1.52%	-0.01%	-0.06%	-0.16%	0.02%	-0.14%	-0.96%	-0.23%
Ferrous and non ferrous metals	-0.01%	-0.38%	-1.30%	0.28%	0.00%	0.52%	-0.16%	-0.35%	-0.10%	0.26%	0.09%	0.03%	-0.21%
Chemical Products	-0.07%	-0.25%	-2.77%	-0.30%	-0.01%	-6.24%	-0.22%	-0.11%	-0.26%	-0.21%	-0.54%	0.17%	-0.13%
Other energy intensive	0.14%	-0.36%	-1.32%	-0.07%	0.08%	-2.81%	0.33%	-0.27%	-0.26%	-0.95%	-1.67%	-3.14%	-0.51%
Electric Goods	0.22%	0.08%	0.23%	0.11%	0.01%	0.16%	0.03%	0.03%	0.06%	0.09%	0.17%	0.09%	0.08%
Transport equipment	0.15%	0.06%	0.10%	0.12%	0.02%	0.43%	0.00%	0.03%	0.04%	0.04%	0.24%	0.03%	0.05%
Other Equipment Goods	0.24%	0.07%	0.26%	0.15%	0.02%	0.40%	0.02%	0.04%	0.06%	0.08%	0.21%	0.08%	0.08%
Consumer Goods Industries	-0.60%	0.02%	0.17%	-0.08%	-0.03%	-0.78%	-0.05%	0.00%	-0.09%	0.00%	-0.24%	-0.14%	-0.08%
Construction	0.22%	0.04%	0.22%	0.06%	-0.04%	0.50%	-	-	-0.02%	0.01%	0.12%	-	-0.01%
Telecommunication Services	0.25%	0.11%	0.77%	0.14%	0.00%	1.44%	-0.02%	0.03%	0.04%	0.17%	0.40%	0.11%	0.10%
Transport	0.17%	0.02%	0.29%	-0.24%	0.06%	0.57%	0.05%	0.05%	-0.07%	0.43%	0.17%	0.00%	-0.21%
Services of credit and insurances	0.23%	0.09%	0.68%	0.11%	0.00%	1.38%	0.02%	0.02%	0.04%	0.14%	0.31%	0.14%	0.12%
Other Market Services	0.23%	0.07%	0.51%	0.10%	0.01%	0.82%	0.02%	0.02%	0.02%	0.05%	0.21%	0.10%	0.07%
Non Market Services	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Price of Exports rel. EU average													
Agriculture	0.05%	-0.21%	-0.35%	0.11%	-0.25%	3.62%	-0.24%	-0.22%	0.01%	-0.13%	0.74%	0.26%	0.41%
Ferrous and non ferrous metals	-0.08%	0.08%	0.49%	-0.24%	-0.10%	-0.32%	-0.02%	0.06%	-0.06%	-0.22%	-0.13%	-0.11%	0.00%
Chemical Products	-0.07%	0.02%	1.22%	0.01%	-0.09%	2.92%	-0.02%	-0.05%	0.03%	-0.03%	0.14%	-0.17%	-0.04%
Other energy intensive	-0.34%	-0.12%	0.31%	-0.27%	-0.30%	1.05%	-0.39%	-0.10%	-0.13%	0.18%	0.46%	1.14%	-0.03%
Electric Goods	-0.07%	-0.01%	-0.07%	-0.03%	0.02%	-0.03%	0.01%	0.01%	-0.01%	-0.02%	-0.05%	-0.02%	-0.02%
Transport equipment	-0.04%	0.00%	-0.01%	-0.04%	0.02%	-0.15%	0.02%	0.01%	0.00%	0.01%	-0.08%	0.01%	0.00%
Other Equipment Goods	-0.07%	0.00%	-0.08%	-0.04%	0.01%	-0.14%	0.01%	0.01%	0.00%	0.01%	-0.06%	-0.01%	-0.01%
Consumer Goods Industries	0.21%	-0.03%	-0.08%	-0.01%	-0.01%	0.30%	-0.02%	-0.03%	0.00%	-0.02%	0.07%	0.03%	0.00%
Construction	-0.05%	0.07%	-0.06%	0.04%	0.12%	-0.26%	0.09%	0.10%	0.11%	0.09%	0.00%	0.15%	0.10%
Telecommunication Services	-0.06%	0.03%	-0.42%	-0.02%	0.11%	-0.87%	0.11%	0.08%	0.07%	0.00%	-0.18%	0.04%	0.03%
Transport	-0.07%	0.04%	-0.08%	0.19%	0.04%	-0.23%	0.03%	0.02%	0.10%	-0.14%	-0.11%	0.03%	0.18%

Services of credit and insurances	-0.09%	0.01%	-0.42%	-0.02%	0.07%	-0.94%	0.05%	0.04%	0.04%	-0.04%	-0.17%	-0.01%	-0.02%
Other Market Services	-0.11%	-0.01%	-0.41%	-0.03%	0.06%	-0.72%	0.04%	0.02%	0.02%	0.04%	-0.19%	-0.03%	0.00%
Non Market Services	-0.10%	-0.03%	-0.14%	0.02%	0.03%	-0.45%	0.03%	0.03%	0.01%	-0.02%	-0.05%	0.09%	-0.03%
Sectoral Aggregates	Latvia	Lithuania	The Netherlands	Poland	Portugal	Romania	Slovakia	Slovenia	Spain	Sweden	UK	EU	
Domestic Production in Volume													
Agriculture	-1.23%	-2.66%	-0.06%	-0.53%	-0.92%	-0.47%	-0.58%	-0.20%	-0.34%	0.02%	-0.16%	-0.25%	
Energy Production	-1.92%	-1.54%	-0.08%	-0.95%	-0.67%	-1.16%	-0.52%	-0.26%	-0.03%	0.03%	-0.08%	-0.18%	
Ferrous and non ferrous metals	-0.01%	0.13%	-0.08%	-0.16%	-0.32%	-0.71%	-0.33%	-0.01%	-0.26%	-0.04%	-0.20%	-0.14%	
Chemical Products	-0.73%	-1.20%	-0.11%	-0.37%	-1.14%	-1.58%	-0.40%	-0.23%	-0.51%	-0.06%	-0.23%	-0.19%	
Other energy intensive	-0.54%	-0.86%	0.13%	-0.49%	-13.27%	-1.53%	-1.37%	-0.51%	-0.67%	0.17%	-0.25%	-0.49%	
Electric Goods	0.13%	0.49%	0.03%	0.13%	0.85%	0.19%	0.18%	0.03%	0.06%	-0.03%	-0.01%	0.05%	
Transport equipment	0.15%	0.31%	0.01%	0.12%	0.17%	-0.05%	0.17%	0.00%	0.06%	-0.02%	-0.02%	0.03%	
Other Equipment Goods	0.22%	0.03%	0.02%	0.09%	0.47%	0.43%	0.15%	0.05%	0.11%	-0.02%	0.00%	0.05%	
Consumer Goods Industries	-1.44%	-0.14%	-0.05%	-0.15%	-0.28%	-0.06%	-0.24%	-0.06%	-0.12%	-0.02%	-0.04%	-0.07%	
Construction	-0.21%	-0.08%	-0.01%	-0.10%	-0.66%	-0.15%	-0.10%	-0.05%	-0.06%	0.00%	-0.01%	-0.04%	
Telecommunication Services	-0.02%	0.26%	0.00%	-0.05%	0.11%	0.07%	-0.04%	0.01%	0.01%	0.00%	0.00%	0.01%	
Transport	0.20%	0.34%	-0.02%	0.14%	0.02%	-0.33%	0.05%	-0.12%	0.07%	-0.02%	-0.06%	-0.02%	
Services of credit and insurances	0.10%	-0.06%	0.00%	-0.31%	0.13%	0.14%	-0.12%	-0.01%	0.02%	0.00%	-0.01%	0.01%	
Other Market Services	-0.23%	0.03%	0.00%	-0.18%	0.09%	-0.30%	-0.11%	-0.04%	-0.02%	0.00%	0.00%	-0.01%	
Non Market Services	-0.10%	-0.01%	0.00%	-0.06%	-0.01%	-0.20%	-0.06%	-0.01%	-0.02%	0.00%	0.00%	0.00%	
Exports in Volume													
Agriculture	-1.15%	-6.20%	-0.04%	-1.58%	-0.62%	-0.25%	-1.15%	-0.53%	-0.51%	-0.02%	-0.50%	-0.38%	
Energy Exports	-0.37%	-0.30%	-0.07%	-0.59%	0.31%	-0.45%	-0.23%	0.01%	-0.02%	-0.09%	-0.14%	-0.13%	
Ferrous and non ferrous metals	0.58%	0.44%	-0.11%	0.10%	0.47%	-0.66%	-0.29%	0.02%	-0.46%	-0.07%	-0.45%	-0.20%	
Chemical Products	-1.01%	-1.43%	-0.12%	-0.43%	-0.97%	-2.07%	-0.41%	-0.27%	-0.81%	-0.10%	-0.40%	-0.21%	
Other energy intensive	-0.18%	-1.34%	0.23%	-0.71%	-28.70%	-2.54%	-1.85%	-0.64%	-1.37%	0.25%	-0.56%	-0.67%	
Electric Goods	0.77%	0.73%	0.03%	0.38%	1.37%	0.34%	0.26%	0.07%	0.14%	-0.03%	-0.02%	0.07%	
Transport equipment	1.04%	0.31%	0.02%	0.39%	0.70%	0.22%	0.25%	0.03%	0.11%	-0.03%	-0.03%	0.06%	
Other Equipment Goods	0.65%	0.49%	0.02%	0.39%	1.04%	0.29%	0.22%	0.06%	0.17%	-0.03%	-0.03%	0.06%	
Consumer Goods Industries	-1.89%	-0.03%	-0.07%	0.07%	0.35%	0.23%	-0.13%	-0.08%	-0.10%	-0.09%	-0.13%	-0.07%	
Construction	0.52%	0.66%	-0.02%	0.31%	-	0.30%	0.18%	-0.05%	-0.06%	-	-0.04%	0.13%	
Telecommunication Services	1.25%	1.20%	-0.01%	0.36%	2.10%	1.12%	0.44%	0.11%	0.28%	-0.06%	0.02%	0.14%	

Transport	0.45%	0.71%	-0.03%	0.59%	1.47%	-0.03%	0.38%	-0.17%	0.37%	-0.10%	-0.19%	0.07%	
Services of credit and insurances	1.04%	0.70%	-0.02%	-0.61%	2.15%	0.81%	0.34%	0.10%	0.27%	-0.05%	0.03%	0.11%	
Other Market Services	0.64%	0.57%	0.00%	0.21%	1.64%	0.18%	0.21%	0.00%	0.22%	-0.03%	0.03%	0.08%	
Non Market Services	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
Price of Exports rel. EU average													
Agriculture	0.59%	4.25%	-0.22%	0.84%	0.17%	-0.07%	0.54%	0.08%	0.08%	-0.26%	0.05%	0.36%	
Ferrous and non ferrous metals	-0.34%	-0.30%	-0.05%	-0.14%	-0.24%	0.20%	0.04%	-0.10%	0.11%	-0.07%	0.11%	0.10%	
Chemical Products	0.18%	0.55%	-0.05%	0.10%	0.40%	0.85%	0.10%	0.01%	0.27%	-0.05%	0.09%	0.10%	
Other energy intensive	-0.29%	0.26%	-0.35%	0.02%	16.18%	0.89%	0.54%	-0.01%	0.51%	-0.36%	-0.08%	0.42%	
Electric Goods	-0.32%	-0.30%	0.01%	-0.14%	-0.53%	-0.13%	-0.09%	-0.01%	-0.03%	0.03%	0.03%	-0.03%	
Transport equipment	-0.44%	-0.11%	0.02%	-0.15%	-0.23%	-0.08%	-0.09%	0.01%	-0.02%	0.04%	0.04%	-0.03%	
Other Equipment Goods	-0.27%	-0.18%	0.02%	-0.15%	-0.37%	-0.10%	-0.07%	-0.01%	-0.04%	0.03%	0.04%	-0.03%	
Consumer Goods Industries	0.72%	-0.01%	0.00%	-0.04%	-0.10%	-0.11%	0.03%	0.00%	0.01%	0.01%	0.02%	0.04%	
Construction	-0.27%	-0.37%	0.11%	-0.12%	1.53%	-0.11%	-0.03%	0.13%	0.14%	0.14%	0.13%	-0.10%	
Telecommunication Services	-0.74%	-0.73%	0.11%	-0.14%	-1.29%	-0.66%	-0.20%	0.01%	-0.09%	0.14%	0.10%	-0.13%	
Transport	-0.16%	-0.30%	0.08%	-0.23%	-0.98%	0.06%	-0.16%	0.16%	-0.17%	0.12%	0.16%	-0.07%	
Services of credit and insurances	-0.67%	-0.66%	0.07%	0.48%	-1.43%	-0.50%	-0.21%	-0.02%	-0.12%	0.11%	0.07%	-0.10%	
Other Market Services	-0.45%	-0.39%	0.06%	-0.09%	-1.18%	-0.11%	-0.12%	0.00%	-0.12%	0.10%	0.06%	-0.08%	
Non Market Services	-0.04%	-0.45%	0.04%	-0.17%	-1.04%	-0.23%	0.18%	0.02%	-0.13%	0.08%	0.05%	-0.06%	