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National Programme for the Implementation of Directive 2001/81/EC - update

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EXECUTIVE SUMMARY

The implementation of the current legislation with effect on emissions of SO_2, NO_x, NH_3 and VOC; including measures taken within the framework of climate change policy; allows Lithuania to meet the emission ceilings set for 2010 for these pollutants.

The EU Thematic Strategy on air pollution (COM(2005) 446 final) foresees a review of the NEC Directive. The ceilings for SO_2, NO_x, VOC and NH_3 will not only be reviewed, but also a new ceiling for primary PM2.5 will be introduced. For the moment, it is not clear at what level the ceilings for the individual Member States will be set, but the following global reduction targets have been put forth for the EU25 for 2020 relative to the base year 2000:

- SO_2 : -82%
- NO_x : -60%
- NH_3 : -27%
- VOC : -51%
- PM2.5 : -59%

The implementation of the current legislation with effect on emissions of SO_2, NO_x, NH_3, VOC and PM2.5; including measures taken within the framework of climate change policy; does not allow to reach the global reduction targets of the Thematic Strategy on Air Pollution applied to the national emissions for either of the pollutants. So it is clear that additional measures will have to be proposed because it is highly unlikely that national emission ceilings for Lithuania will remain unaltered in the future.

The selection of which measures to implement additionally will depend on the height of the ceilings for the individual pollutants and on the marginal cost of the individual measures.

The maximum feasible reduction scenario, as calculated by the RAINS model, provides the emission reduction that is technically feasible without changes in the energy vectors (compared to the current legislation scenario) and without accounting for the marginal cost of the individual measures. Both the current legislation and the maximum feasible reduction scenario consider the phase-out of nuclear electricity production by 2010. Implementation of this maximum feasible reduction scenario allows to reach the global EU25 reduction targets on the national level (even distribution of these targets over the various Member States) for all pollutants except NH_3. For all pollutants, except SO_2, this implies that a number of additional measures are implemented that can not be considered as cost efficient when compared to the external cost of air pollution on the national level.

The most likely outcome of the review of the National Emissions Ceilings Directive is that ceilings will be set in between the currently set ceilings and the ceilings derived from the maximum feasible reduction scenario. The measures that are most cost efficient to take in order to meet these ceilings are the measures of the beginning of the marginal cost curve for the maximum feasible reduction scenario.

1 INTRODUCTION

Directive 2001/81/EC on National Emission Ceilings for Certain Atmospheric Pollutants seeks to limit emissions of pollutants that give rise to acidification, eutrophication and ground-level ozone formation. The pollutants covered by the Directive are sulphur dioxide (SO_2), nitrogen oxides (NO_x), ammonia (NH_3) and volatile organic compounds excluding methane (NMVOC).

Under Directive 2001/81/EC, Member States must keep annual emissions of SO_2, NO_x, VOC and NH_3 under negotiated ceilings by the year 2010 at the latest. The Directive defines national emission ceilings as the maximum amount of a substance (expressed in kilotonnes), which may be emitted by a Member State in a calendar year. According to Article 6 of the Directive, Member States had to draw up programmes for the progressive reduction of national emissions, implementation of which would result in the attainment of the emission ceilings by the year 2010, by October 1, 2002.

The National Emission Ceilings for Lithuania have been negotiated during the accession period and were set at the following values:

National emission ceilings for Lithuania (ktonne/yr)			
SO_2	*NO_x*	*NH_3*	*NMVOC*
145	110	92	84

Taking into account implementation of current legislation as planned, there will be no problem for Lithuania to meet the requirements of the NEC Directive by 2010.

The EU Thematic Strategy on air pollution (COM(2005) 446 final) foresees a review of the NEC Directive. The ceilings for SO_2, NO_x, VOC and NH_3 will not only be reviewed, but also a new ceiling for primary PM2.5 will be introduced. Based on calculations with the RAINS programme, the following global reduction goals for the EU25 have been set for the year 2020 relative to the base year 2000:

- SO_2 : -82%
- NO_x : -60%
- NH_3 : -27%
- VOC : -51%
- PM2.5 : -59%

If these global reduction goals are translated to the national level for Lithuania, this would lead to the following ceilings for 2020[1]. 2000 emissions have been derived from IIASA's current legislation scenario accounting for the effects of implementing climate change policy (CP_CLE_Aug04(Nov04)).

[1] It is very unlikely that the global EU25 will be distributed evenly over the Member States, but assuming an even distribution provides an indication of what future ceilings might be.

Pollutant	*2000 emission*	*Potential 2020 ceiling*
	ktonne/year	*ktonne/year*
SO_2	43.361	7.805
NO_x	49.053	19.621
NH_3	50.010	36.507
VOC	74.170	36.343
PM2.5	17.485	7.169

In this report it will be checked whether the current legislation scenario accounting for the effects of implementing climate change policy (CP_CLE_Aug04(Nov04)) is sufficient for reaching these potential ceilings by 2020. If this is not the case, the potential of IIASA's maximum feasible reduction scenario accounting for the effects of implementing climate change policy (CP_CLE_Nov04(Nov04)) for reaching these potential 2020 ceilings will also be evaluated. Both scenarios take into account the phase-out of nuclear electricity production, meaning that electricity production from nuclear energy in 2005 is half of the amount produced in 2000 and that from 2010 onward there will no longer be electricity production from nuclear energy (full closure of Ingnalina NPP). Electricity consumption from 2010 onwards is entirely covered by classical production in Lithuania's existing power plants. As no political decision has been taken yet regarding the fate of nuclear electricity production in Lithuania, future emissions may be lower than predicted in this report if part of the electricity production would still be based on nuclear in the future. The figures presented in this report represent a 'worst case' scenario.

The cost efficiency of the measures proposed in the current legislation and the maximum feasible reduction scenario will also be discussed by using marginal cost curves.

2 SO_2

2.1 EVOLUTION OF EMISSIONS

2.1.1 Current legislation scenario

Full implementation of the current legislation regarding climate change policy and SO_2 emission reduction in Lithuania will lead to a decrease of the yearly SO_2 emissions from 43.361 ktonnes in 2000 to 21.721 ktonnes in 2020 (Figure 2.1.1); a decrease by 49.9%.

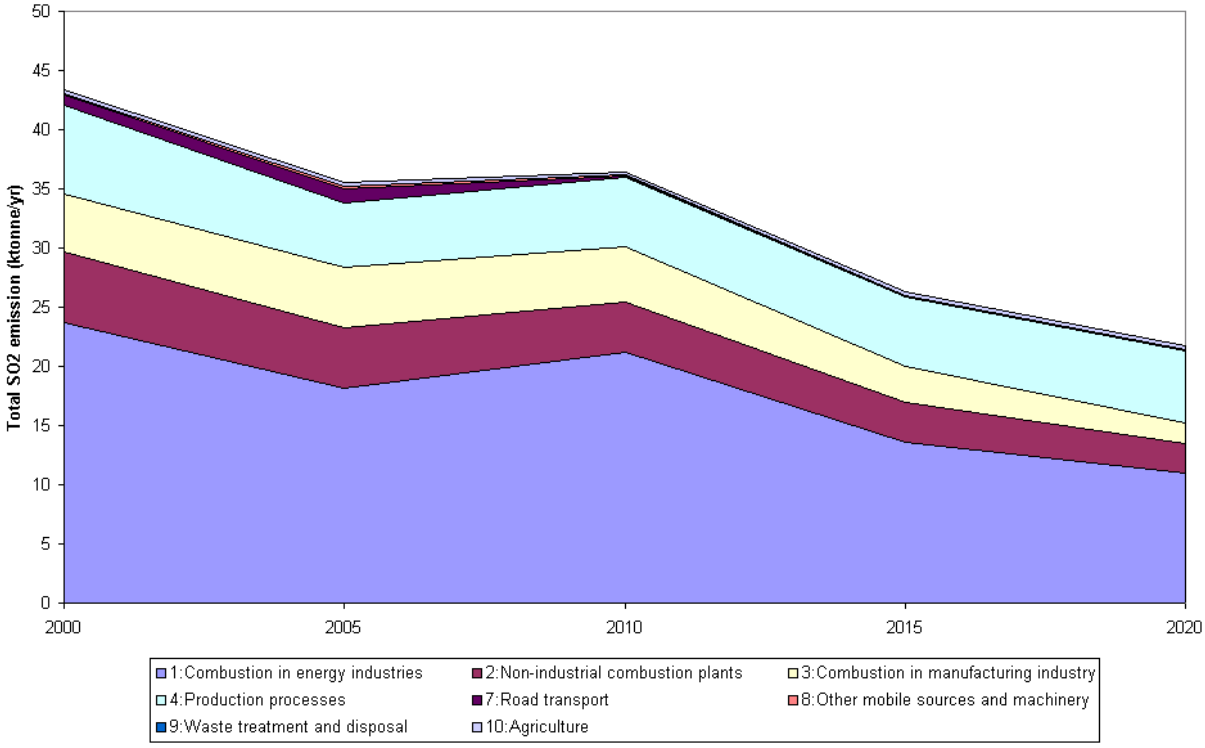

Figure 2.1.1: Evolution of the SO_2 emissions under the current legislation scenario (IIASA, CP_CLE_Aug04 (Nov04))

The EU Thematic Strategy on air pollution (COM(2005) 446 final), however, sets a global reduction goal of the EU-25 SO_2 emissions by 82% in 2020 relative to the 2000 level. Allthough no distribution of the effort over the various Member States has been proposed yet, it is very likely that additional measures might be required.

2.1.2 Maximum feasible reduction scenario

The maximum feasible reduction scenario considers all possible additional measures that can be taken to further reduce SO_2 emissions without changing the use of the various energy vectors (e.g. increased use of gaseous fuels is not an option). Full implementation of the maximum feasible reduction scenario would lead to a reduction of the total SO_2 emissions from 43.361 ktonnes in 2000 to 5.146 ktonnes in 2020 (Figure 2.1.2); a decrease by 88.1% and would permit to reach the global EU25 reduction goal for SO_2 on the national level.

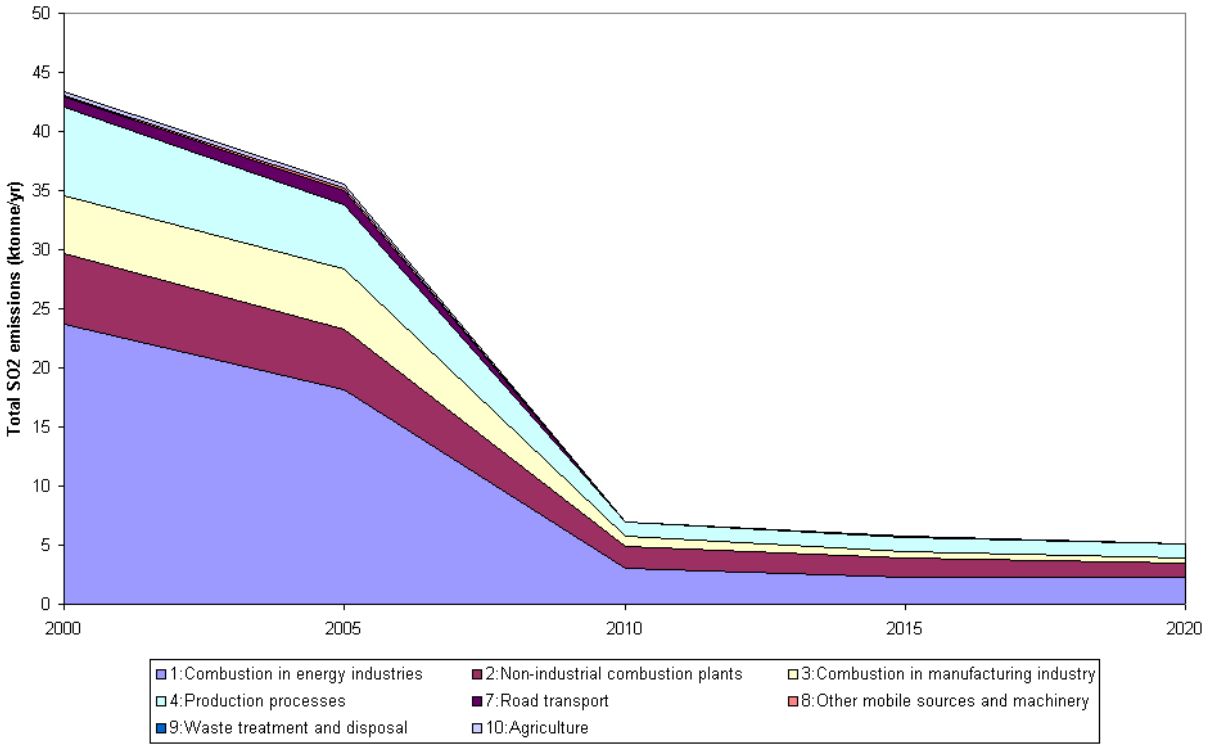

Figure 2.1.2: Evolution of the SO_2 emissions under the maximum feasible reduction scenario (IIASA, CP_MFR_Nov04 (Nov04))

2.2 MEASURES TAKEN

In order to reach the reduction in the current legislation scenario, Lithuanian policy mainly considers switching to fuels with a lower sulphur content. Switching to fuels with a lower sulphur content means switching towards gaseous fuels and meeting increased demand for primary energy from 2010 onward mainly by natural gas (Figure 2.2.1), as well as supplying the market with low S alternatives for heavy fuel oil, gasoil/diesel and gasoline (Annex 1). Flue gas desulphurisation is only foreseen for new power and district heating plants on brown or hard coal, that will be automatically equipped with wet flue gas desulphurisation (Annex 1).

The reduction in the maximum feasible reduction scenario is mainly reached by the implementation of flue gas desulphurisation for combustion plants (existing as well as new plants) and by switching to low sulphur fuels for domestic heating and transport (Annex 2).

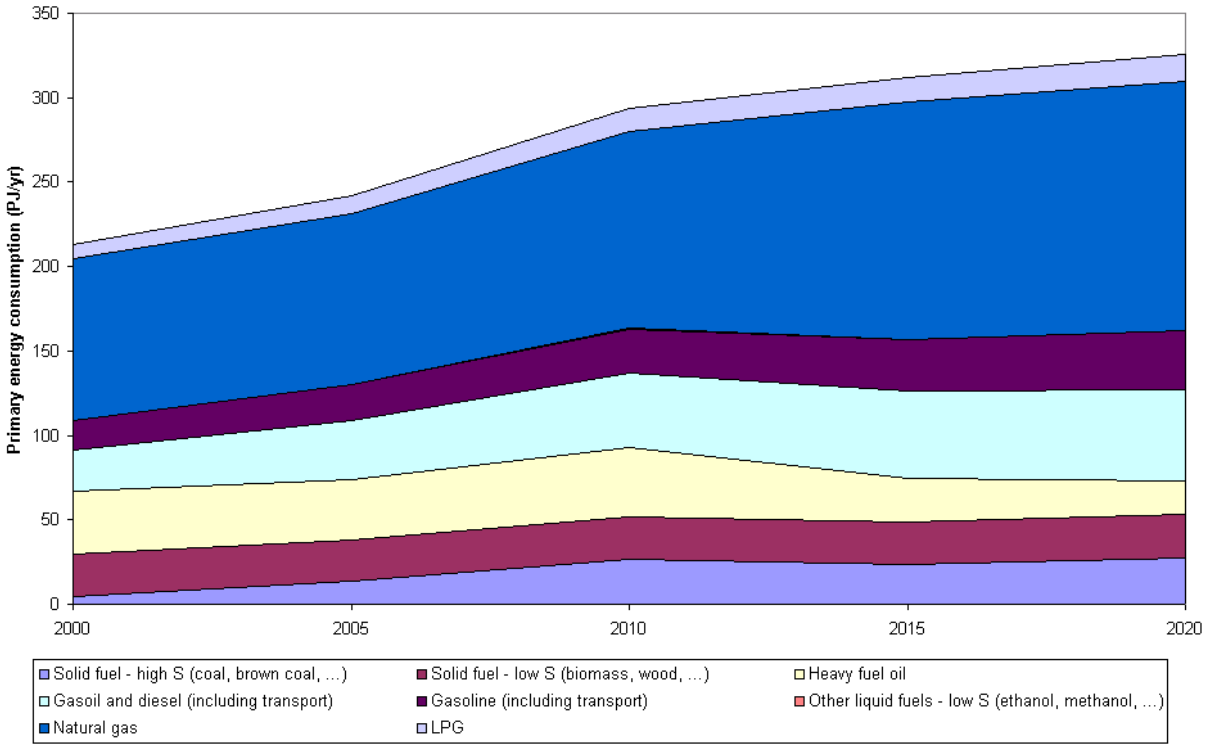

Figure 2.2.1: Evolution of the use of various energy vectors (IIASA)

2.3 ASSOCIATED COSTS

Finally, it should be assessed whether the envisaged measures are cost efficient, meaning that these costs should not exceed the benefits associated with the emission reduction. Therefore, a comparison is made between the unit reduction costs and the external costs of air pollution. External costs of air pollution by SO_2 for Lithuania have been calculated to vary between 2400 and 6800 €/tonne of SO_2 emitted (AEA Technology Environment, 2005); the variation resulting from uncertainties in the estimation method.

In order to assess the cost efficiency of the proposed measures, used is made of the marginal cost curves. A marginal cost curve shows the total emission in the X-axis (to be read from right to left) and the marginal reduction cost (€/tonne emission abated) in the Y-axis. The starting point of the cost curve (on the right) indicates the unabated emission. Each step of the curve presents an emission reduction measure. The total emission reduction that can be reached by implementing this measure has to be read from the X-axis. In order to make interpretation easier, all of the following cost curves also show the external cost of air pollution as a horizontal, shaded band. All measures (steps in the curve) falling under or within this shaded band can be regardes as being cost efficient measures. The EU global reduction goal, applied to Lithuania, is shown as the red vertical line.

The marginal cost curve for SO_2 for the current legislation scenario is shown in Figure 2.3.1 and presented in a tabulated form in Annex 1. All measures considered in the current legislation scenario can be considered to be cost efficient but these measures are not sufficient to reach the EU global reduction goal on the national level.

The marginal cost curve for SO_2 in the maximum feasible reduction scenario is shown in Figure 2.3.2 and presented in a tabulated form in Annex 2. From this cost curve it is clear that the EU global reduction goal on the national level can be reached by means of cost efficient measures.

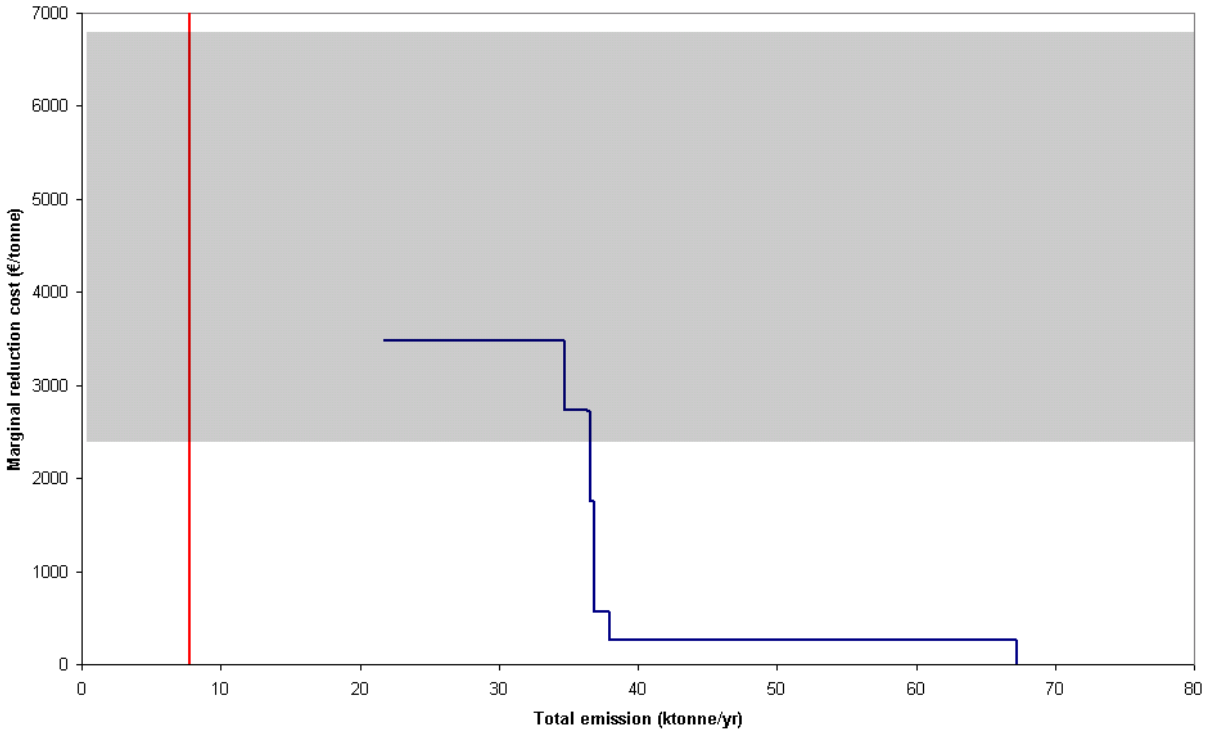

Figure 2.3.1: Marginal cost curve for SO_2 in 2020 for the current legislation scenario

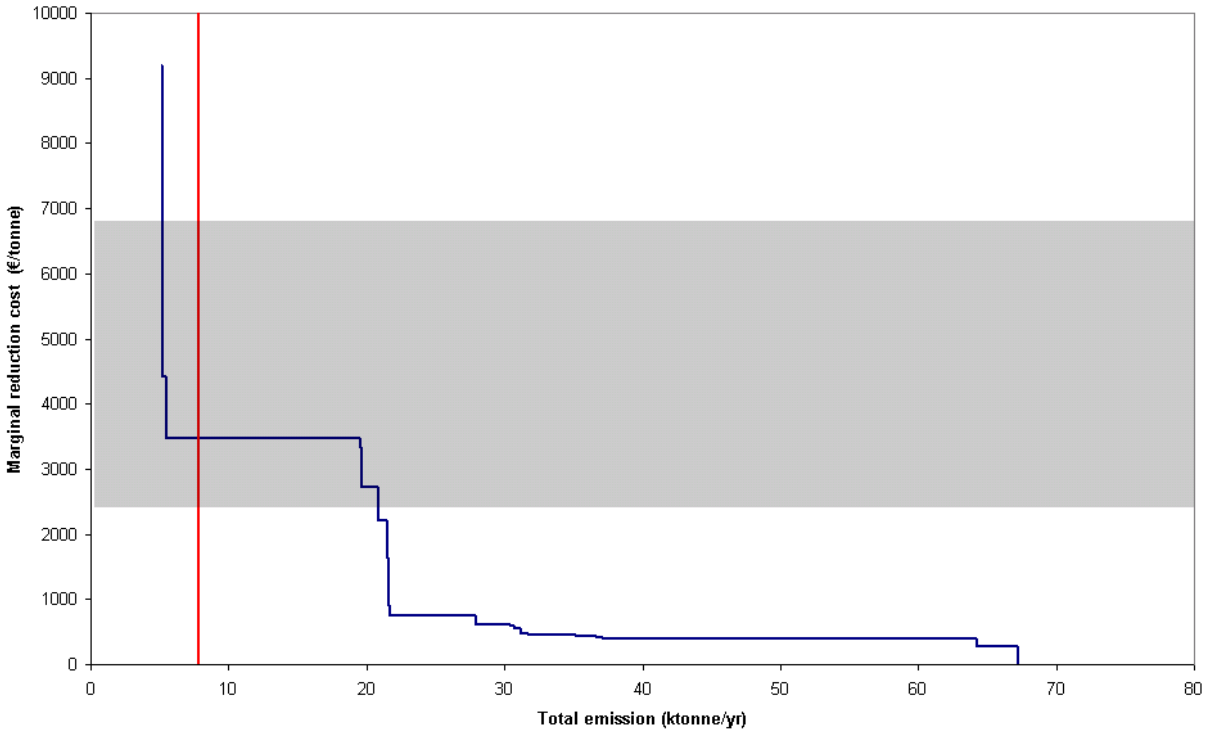

Figure 2.3.2: Marginal cost curve for SO_2 in 2020 for the maximum feasible reduction scenario

3 NO_X

3.1 EVOLUTION OF EMISSIONS

3.1.1 Current legislation scenario

Full implementation of the current legislation regarding climate change policy and NO_x emission reduction in Lithuania will lead to a decrease of the yearly NO_x emissions from 49.053 ktonnes in 2000 to 26.947 ktonnes in 2020 (Figure 3.1.1); a decrease by 45.1%.

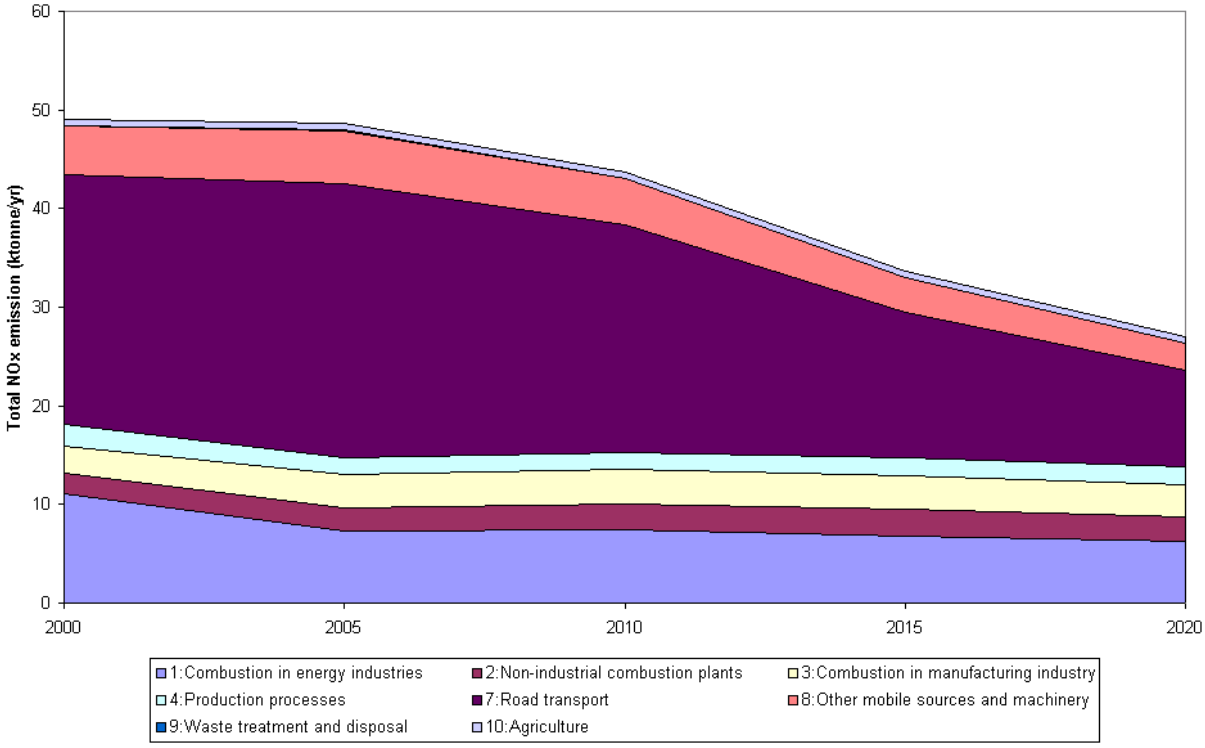

Figure 3.1.1: Evolution of the NO_x emissions under the current legislation scenario (IIASA, CP_CLE_Aug04 (Nov04))

The EU Thematic Strategy on air pollution (COM(2005) 446 final), however, sets a global reduction goal of the EU-25 NO_x emissions by 60% in 2020 relative to the 2000 level. Allthough no distribution of the effort over the various Member States has been proposed yet, it is very likely that additional measures might be required.

3.1.2 Maximum feasible reduction scenario

The maximum feasible reduction scenario considers all possible additional measures that can be taken to further reduce NO_x emissions without changing the use of the various energy vectors. Full implementation of the maximum feasible reduction scenario would lead to a reduction of the total NO_x emissions from 49.053 ktonnes in 2000 to 15.252 ktonnes in 2020 (Figure 3.1.2); a decrease by 68.9% and would permit to reach the global EU25 reduction goal for NO_x on the national level.

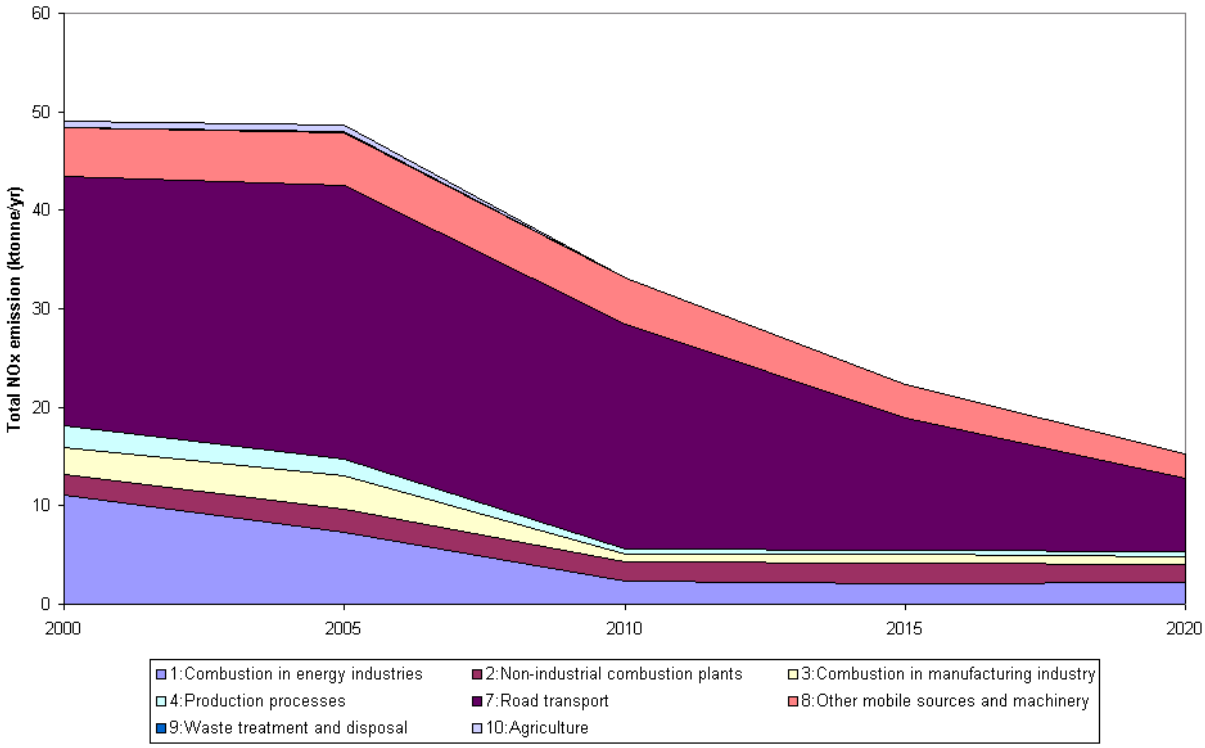

Figure 3.1.2: Evolution of the NO_x emissions under the maximum feasible reduction scenario (IIASA, CP_MFR_Nov04 (Nov04))

3.2 MEASURES TAKEN

In order to reach the reduction in the current legislation scenario, Lithuanian policy mainly considers combustion modification for industrial combustion and existing power and district heating plants, together with a gradual introduction of cleaner engines for road and other transport (Annex 3). Selective catalytic reduction is only foreseen for new power and district heating plants, that will be automatically equipped with selective catalytic reduction (Annex 3).

The reduction in the maximum feasible reduction scenario is mainly reached by the implementation of combustion modification + selective (non) catalytic reduction in the industry sector and by enhanced introduction of cleaner engines for road and other transport (Annex 4).

3.3 ASSOCIATED COSTS

Finally, it should be assessed whether the envisaged measures are cost efficient, meaning that these costs should not exceed the benefits associated with the emission reduction. Therefore, a comparison is made between the unit reduction costs and the external costs of air pollution. External costs of air pollution by NO_x for Lithuania have been calculated to vary between 1800 and 5000 €/tonne of NO_x emitted (*); the variation resulting from uncertainties in the estimation method.

The marginal cost curve for NO_x for the current legislation scenario is shown in Figure 3.3.1 and presented in a tabulated form in Annex 3. The current legislation scenario already contains some measures that can be regarded as not being cost efficient. In spite of these cost inefficient measures, the EU global reduction goal on the national level can not be reached.

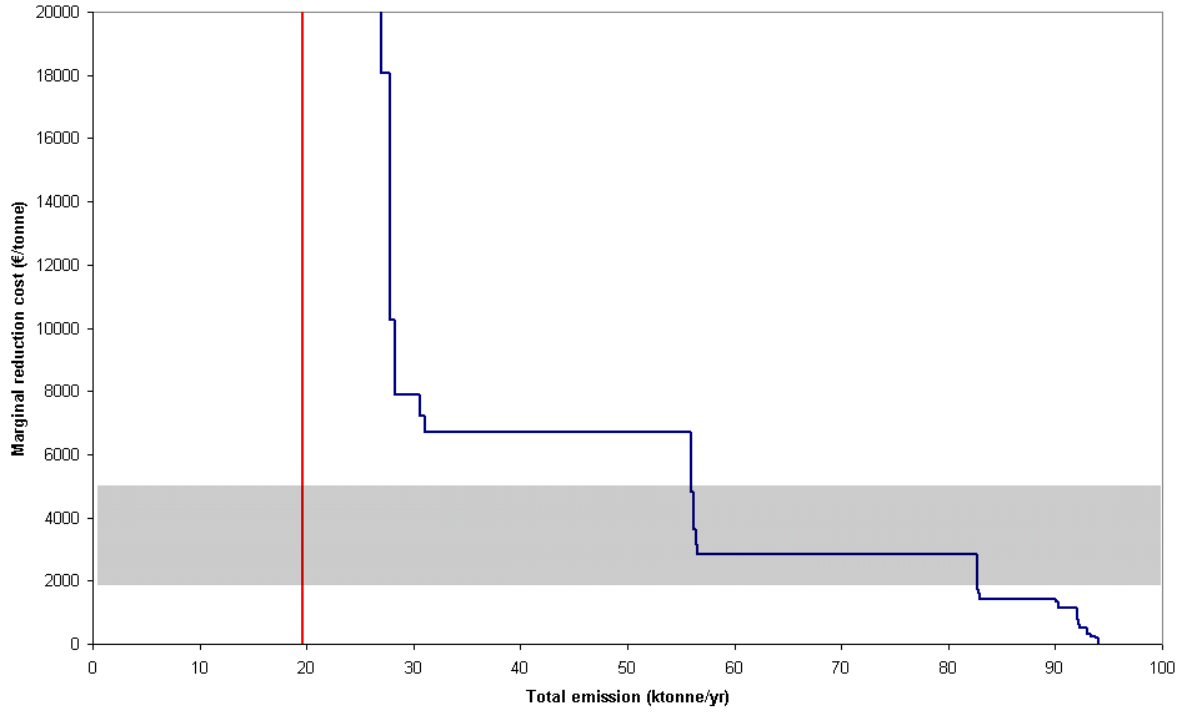

Figure 3.3.1: Marginal cost curve for NO_x in 2020 for the current legislation scenario

The marginal cost curve for NO_x in the maximum feasible reduction scenario is shown in Figure 3.3.2 and presented in a tabulated form in Annex 4. From this cost curve it is clear that the EU global reduction goal on the national level can be reached but requires that some measures that can not be considered as being cost efficient are taken.

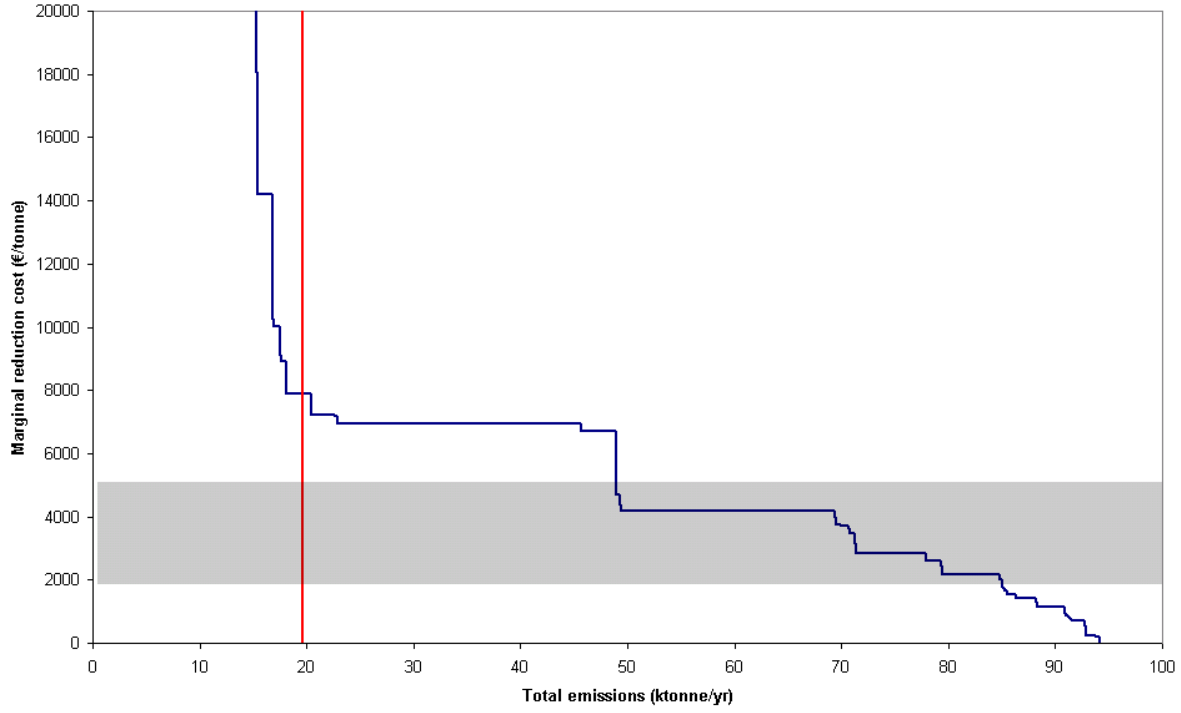

Figure 3.3.2: Marginal cost curve for NO_x in 2020 for the maximum feasible reduction scenario

4 NH_3

4.1 EVOLUTION OF EMISSIONS

4.1.1 Current legislation scenario

Lithuanian policy currently does not foresee any measures for reduction of NH_3 emissions and economic growth will lead to a increase of the yearly NH_3 emissions from 50.010 ktonnes in 2000 to 57.350 ktonnes in 2020 (Figure 4.1.1); an increase by 14.7%.

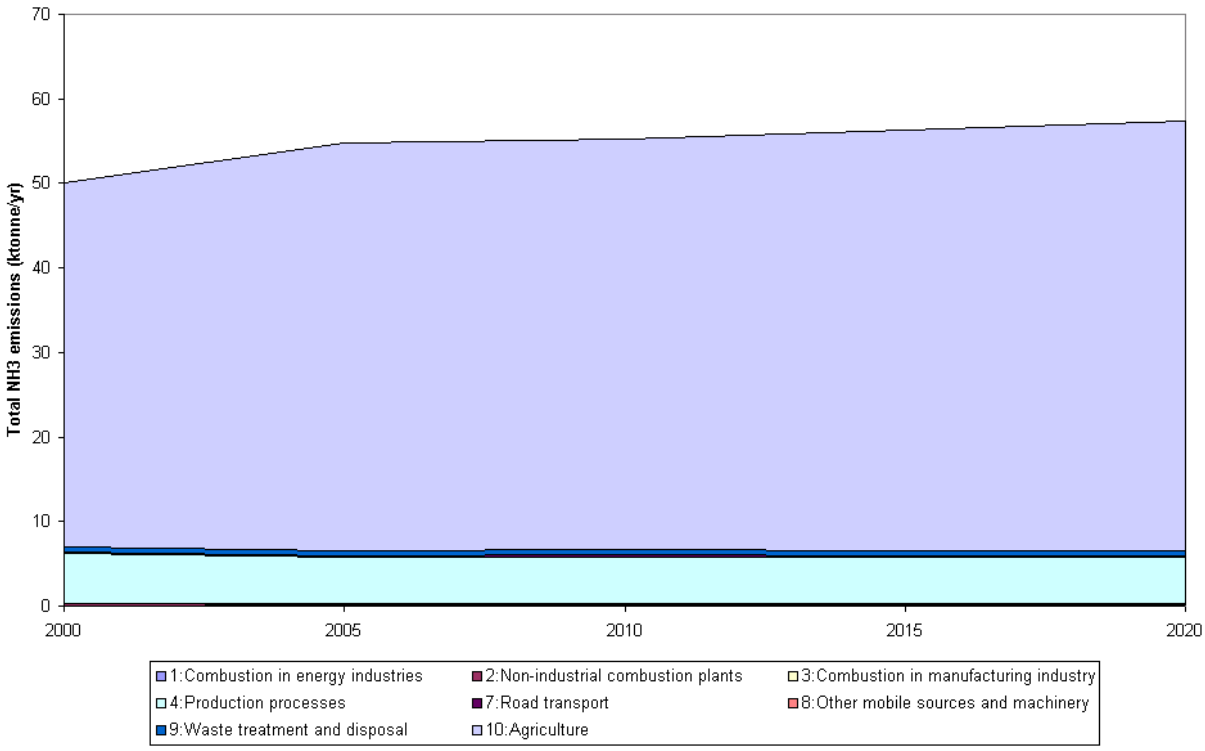

Figure 4.1.1: Evolution of the NH_3 emissions under the current legislation scenario (IIASA, CP_CLE_Aug04 (Nov04))

The EU Thematic Strategy on air pollution (COM(2005) 446 final), however, sets a global reduction goal of the EU-25 NH_3 emissions by 27% in 2020 relative to the 2000 level. Allthough no distribution of the effort over the various Member States has been proposed yet, it is clear that additional measures will be required.

4.1.2 Maximum feasible reduction scenario

The maximum feasible reduction scenario considers all possible additional measures that can be taken to further reduce NH_3 emissions without changing the use of the various energy vectors. Full implementation of the maximum feasible reduction scenario would lead to a reduction of the total NH_3 emissions from 50.01 ktonnes in 2000 to 38.49 ktonnes in 2020 (Figure 4.1.2); a decrease by 22.4%. This is insufficient to reach the EU-25 reduction goal on the national level

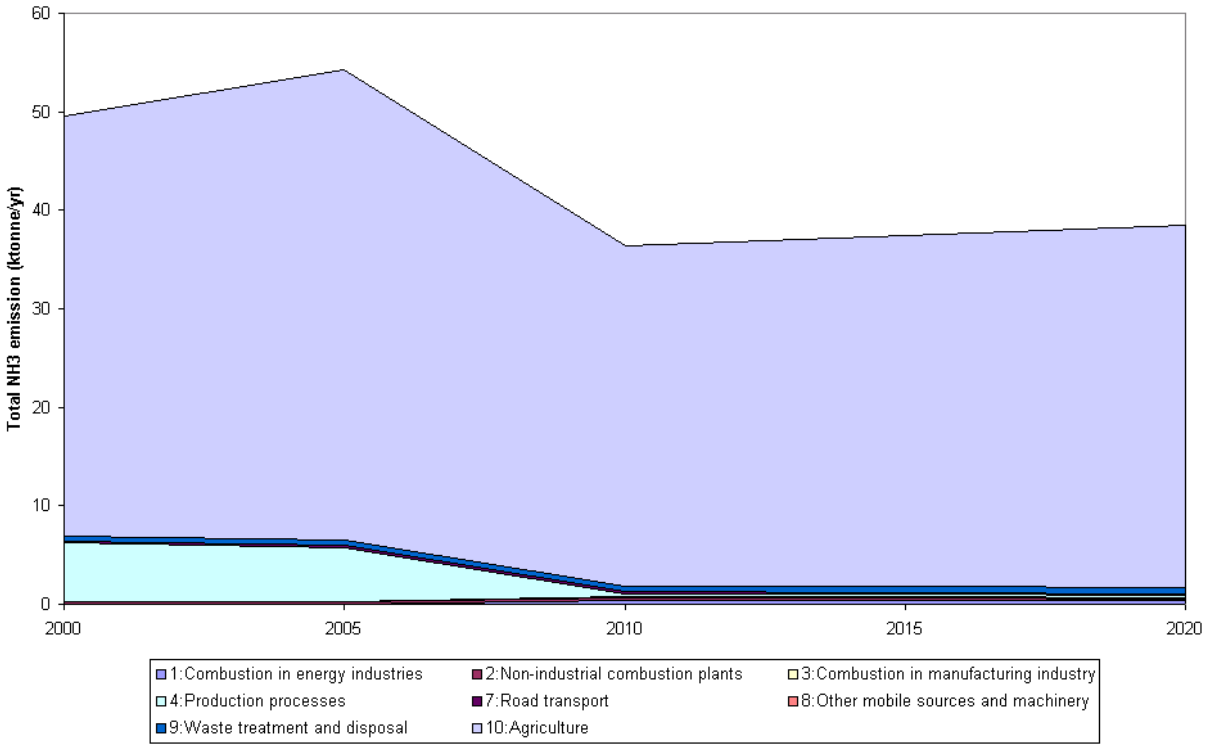

Figure 4.1.2: Evolution of the NH_3 emissions under the maximum feasible reduction scenario (IIASA, CP_MFR_Nov04 (Nov04))

4.2 MEASURES TAKEN

There are no specific measures for NH_3 reduction foreseen in the current legislation scenario.

The maximum feasible reduction scenario considers measures in the agricultural sector (manure management and fertiliser use) and in ammonia production (Annex 5).

4.3 ASSOCIATED COSTS

Finally, it should be assessed whether the envisaged measures are cost efficient, meaning that these costs should not exceed the benefits associated with the emission reduction. Therefore, a comparison is made between the unit reduction costs and the external costs of air pollution. External costs of air pollution by NH_3 for Lithuania have been calculated to vary between 1700 and 5000 €/tonne of NH_3 emitted (*); the variation resulting from uncertainties in the estimation method.

No specific NH_3 reducing measures are considered in the current legislation scenario, so no marginal cost curve can be made for this scenario.

The marginal cost curve for NH_3 in the maximum feasible reduction scenario indicates that most measures can be considered as not being cost efficient (Figure 4.3.1 and Annex 5). Despite the taking of these measures, it is not possible to reach the EU global reduction goal on the national level.

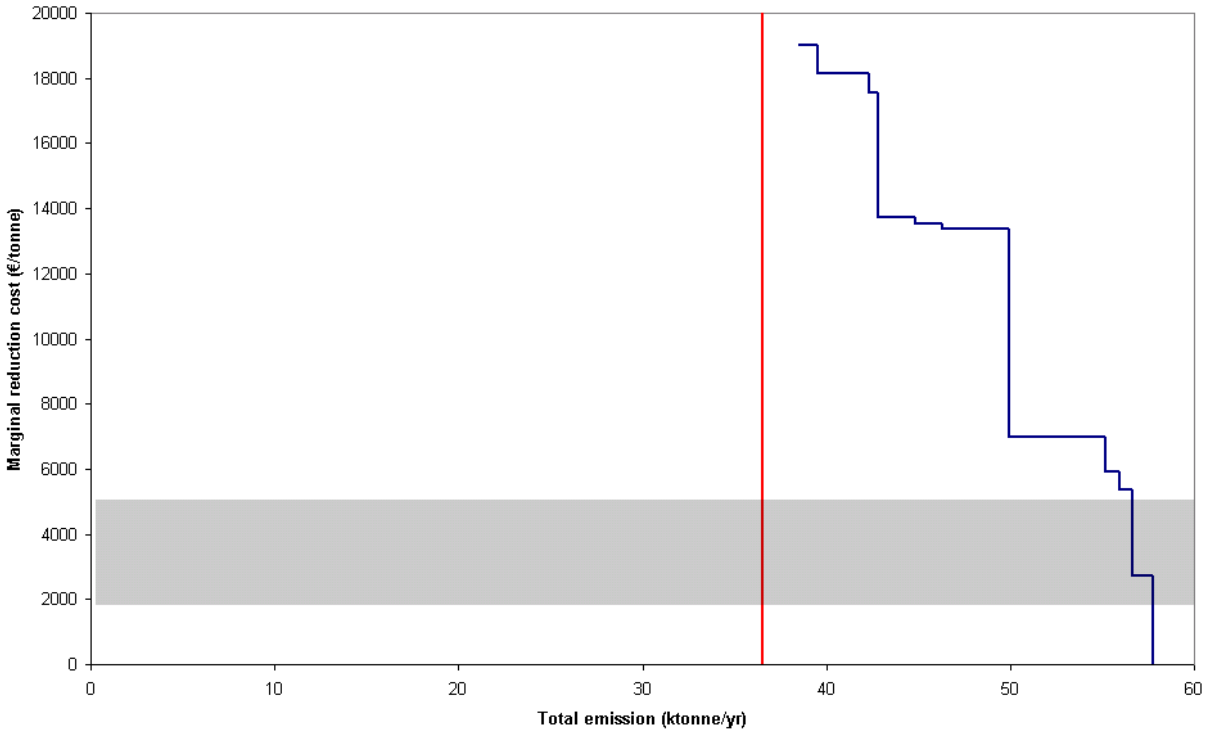

Figure 4.3.1: Marginal cost curve for NH_3 in 2020 for the maximum feasible reduction scenario

5 VOC

5.1 EVOLUTION OF EMISSIONS

5.1.1 Current legislation scenario

Full implementation of the current legislation regarding climate change policy and VOC emission reduction in Lithuania will lead to a decrease of the yearly VOC emissions from 74.170 ktonnes in 2000 to 42.913 ktonnes in 2020 (Figure 5.1.1); a decrease by 42.1%.

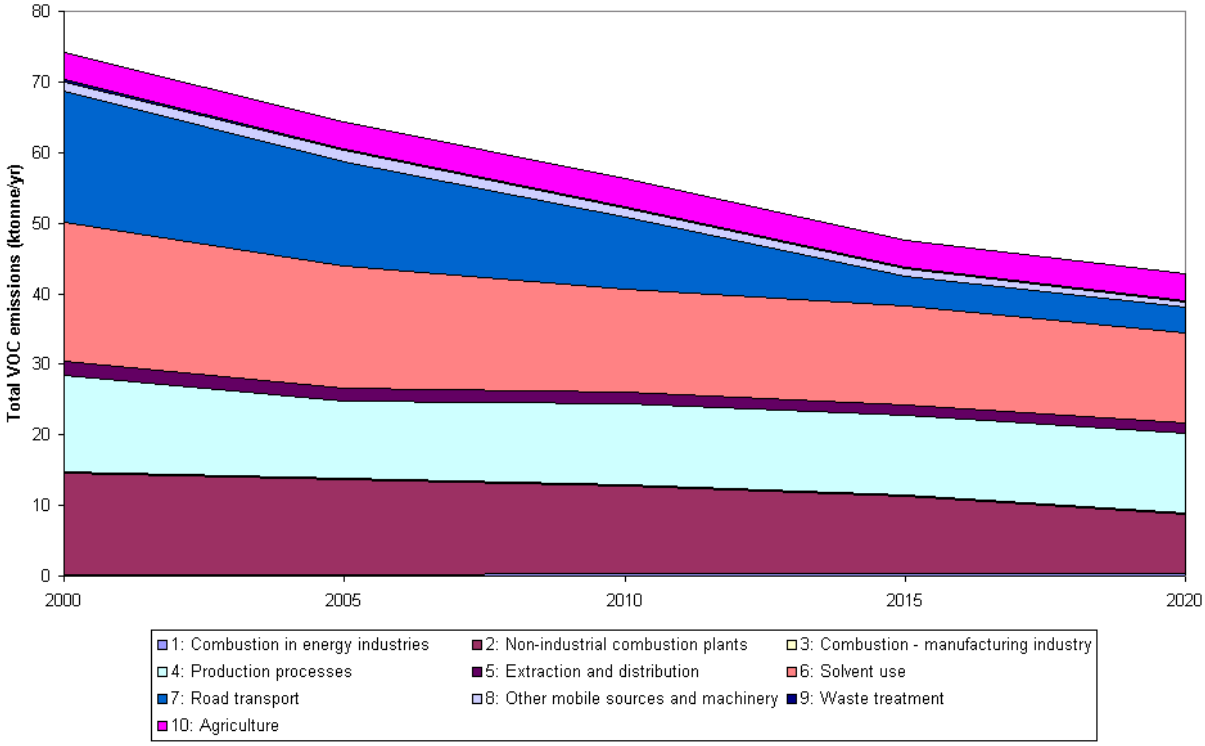

Figure 5.1.1: Evolution of the VOC emissions under the current legislation scenario (IIASA, CP_CLE_Aug04 (Nov04))

The EU Thematic Strategy on air pollution (COM(2005) 446 final), however, sets a global reduction goal of the EU-25 VOC emissions by 51% in 2020 relative to the 2000 level. Allthough no distribution of the effort over the various Member States has been proposed yet, it is very likely that additional measures might be required.

5.1.2 Maximum feasible reduction scenario

The maximum feasible reduction scenario considers all possible additional measures that can be taken to further reduce VOC emissions without changing the use of the various energy vectors. Full implementation of the maximum feasible reduction scenario would lead to a reduction of the total VOC emissions from 74.170 ktonnes in 2000 to 20.019 ktonnes in 2020 (Figure 5.1.2); a decrease by 73.0% and would permit to reach the global EU25 reduction goal for VOC on the national level.

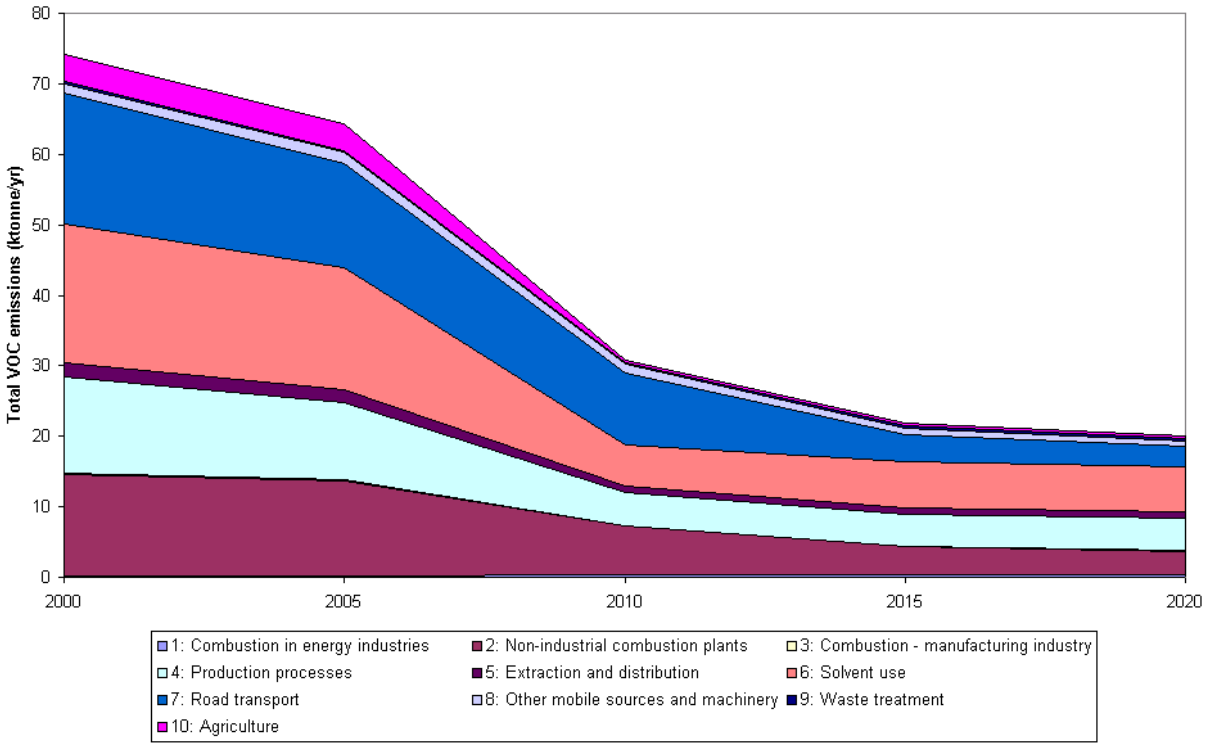

Figure 5.1.2: Evolution of the VOC emissions under the maximum feasible reduction scenario (IIASA, CP_MFR_Nov04 (Nov04))

5.2 MEASURES TAKEN

In order to reach the reduction in the current legislation scenario, Lithuanian policy mainly considers (Annex 6):

- switching to low solvent products or using end-of-pipe measures for solvent using processes;
- measures for gasoline distribution;
- small carbon canisters in gasoline cars;
- gradual introduction of cleaner engines for road and non-road transport.

The reduction in the maximum feasible reduction scenario is mainly reached by (Annex 7):

- combination of low solvent product and end-of-pipe measures for solvent using processes;
- end-of-pipe measures and leak detection and repair in refineries and organic chemical industry;
- measures for storage and distribution of liquid fuels and organic chemicals;
- enhanced introduction of cleaner engines for road and non-road transport.

5.3 ASSOCIATED COSTS

Finally, it should be assessed whether the envisaged measures are cost efficient, meaning that these costs should not exceed the benefits associated with the emission reduction. Therefore, a comparison is made between the unit reduction costs and the external costs of air pollution. External costs of air pollution by VOC for Lithuania have been calculated to vary between 230 and 710 €/tonne of VOC emitted (*); the variation resulting from uncertainties in the estimation method.

The marginal cost curve for VOC for the current legislation scenario is shown in Figure 5.3.1 (full curve) and Figure 5.3.2 (detail) and presented in a tabulated form in Annex 6. The current legislation scenario already contains numerous measures that can be regarded as not being cost efficient. In spite of these cost inefficient measures, the EU global reduction goal on the national level can not be reached. Please not that some of the measures can be taken at negative marginal cost, meaning that the economic benefits of implementing those measures (e.g. due to recuperation of solvents or to use of cheaper technologies) are larger than the economic costs.

The marginal cost curve for VOC in the maximum feasible reduction scenario is shown in Figure 5.3.3 (full curve) and Figure 5.3.4 (detail) and presented in a tabulated form in Annex 7. From this cost curve it is clear that the EU global reduction goal on the national level can be reached but requires that some measures that can not be considered as being cost efficient are taken.

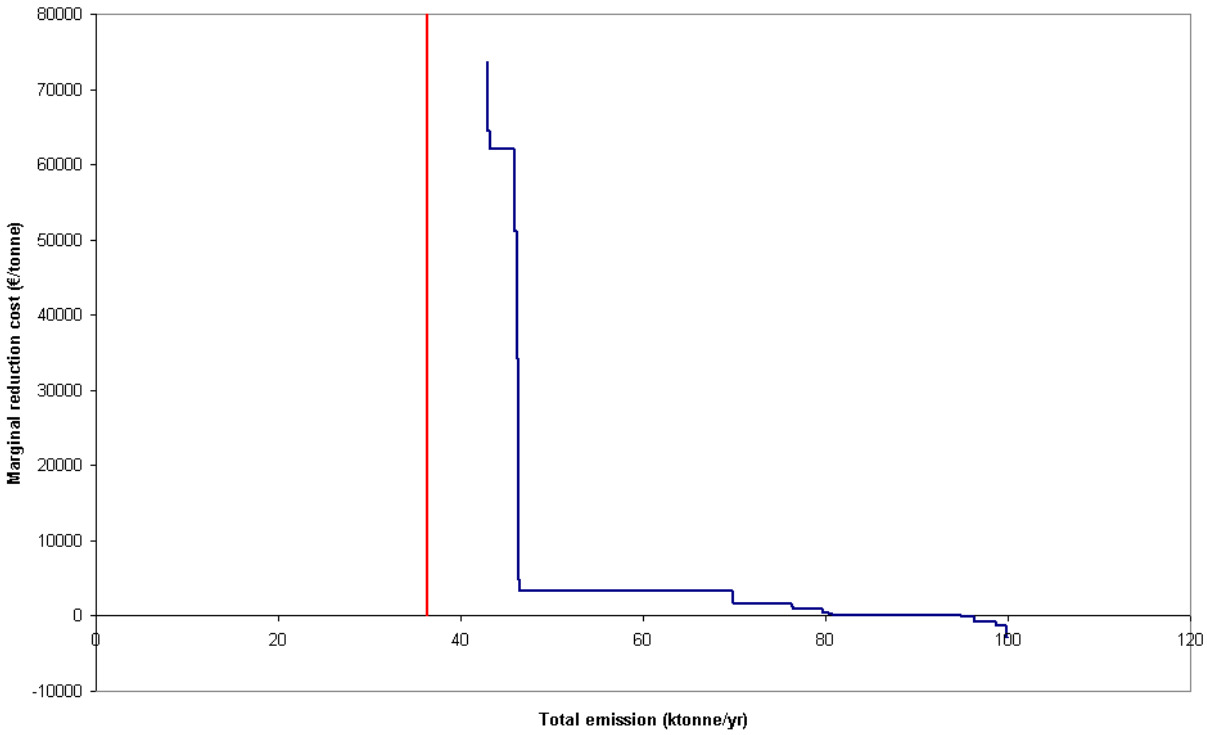

Figure 5.3.1: Marginal cost curve for VOC in 2020 for the current legislation scenario (full curve)

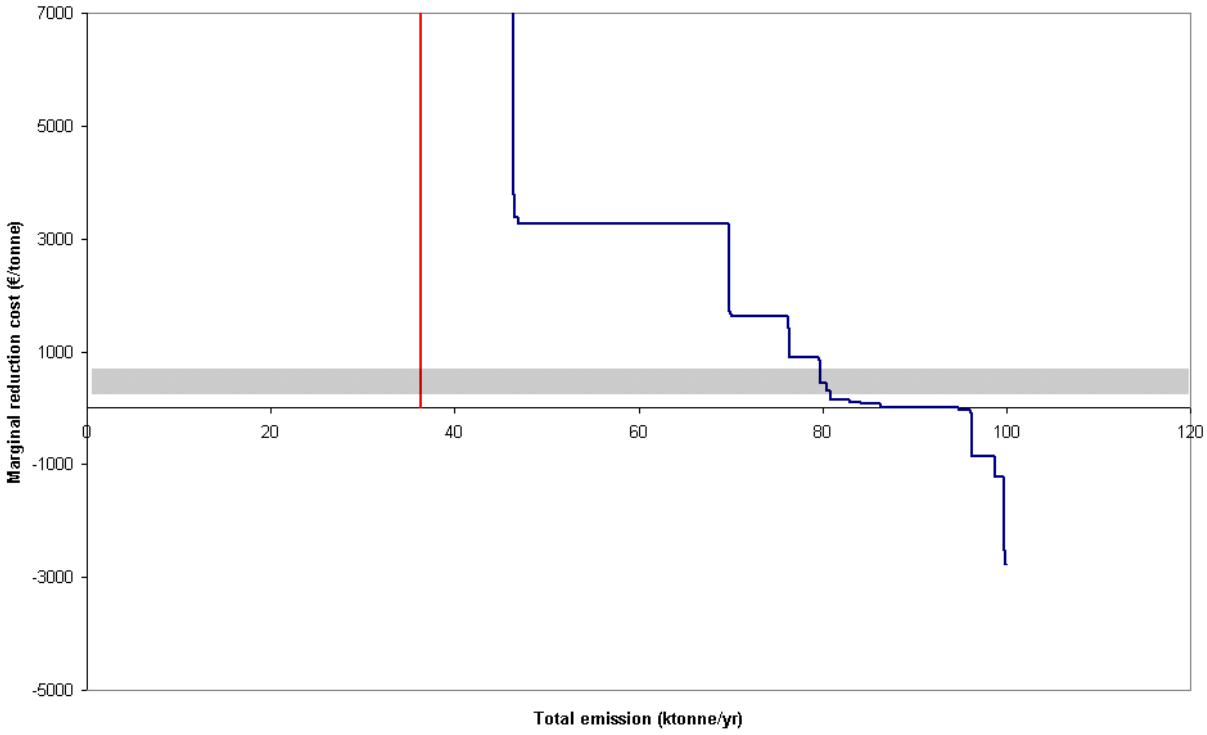

Figure 5.3.2: Marginal cost curve for VOC in 2020 for the current legislation scenario (detail)

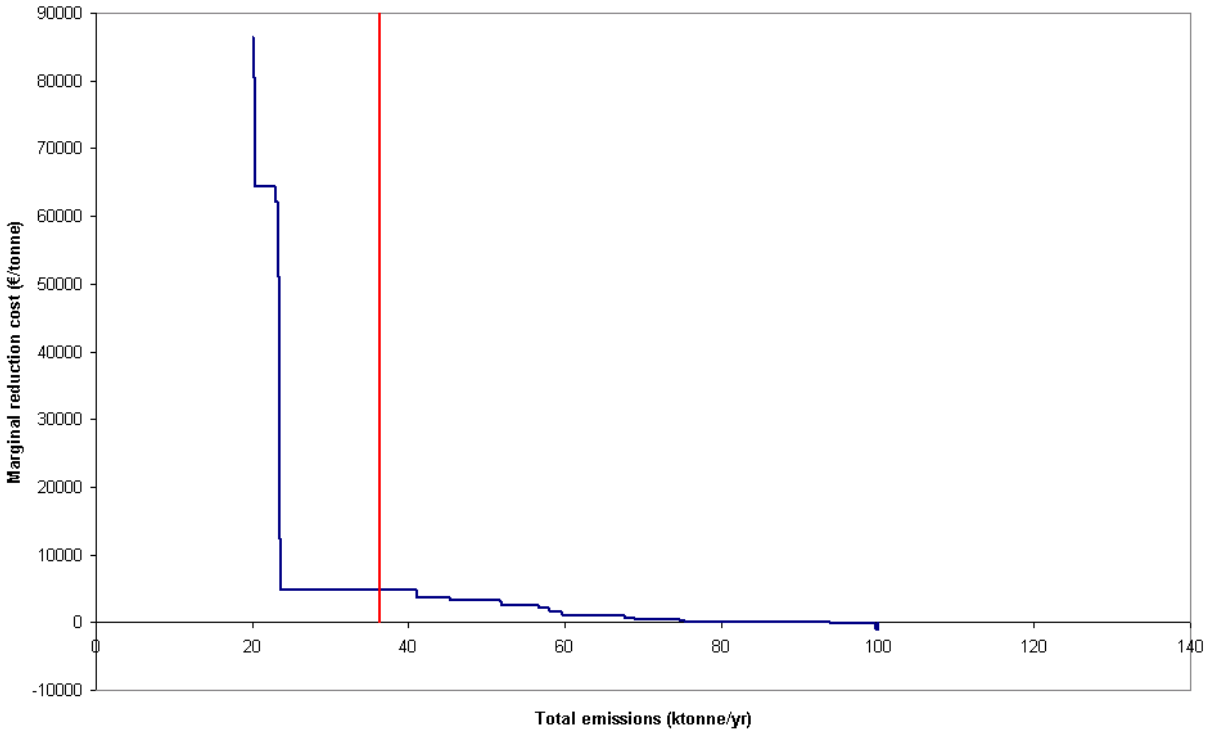

Figure 5.3.3: Marginal cost curve for VOC in 2020 for the maximum feasible reduction scenario (full curve)

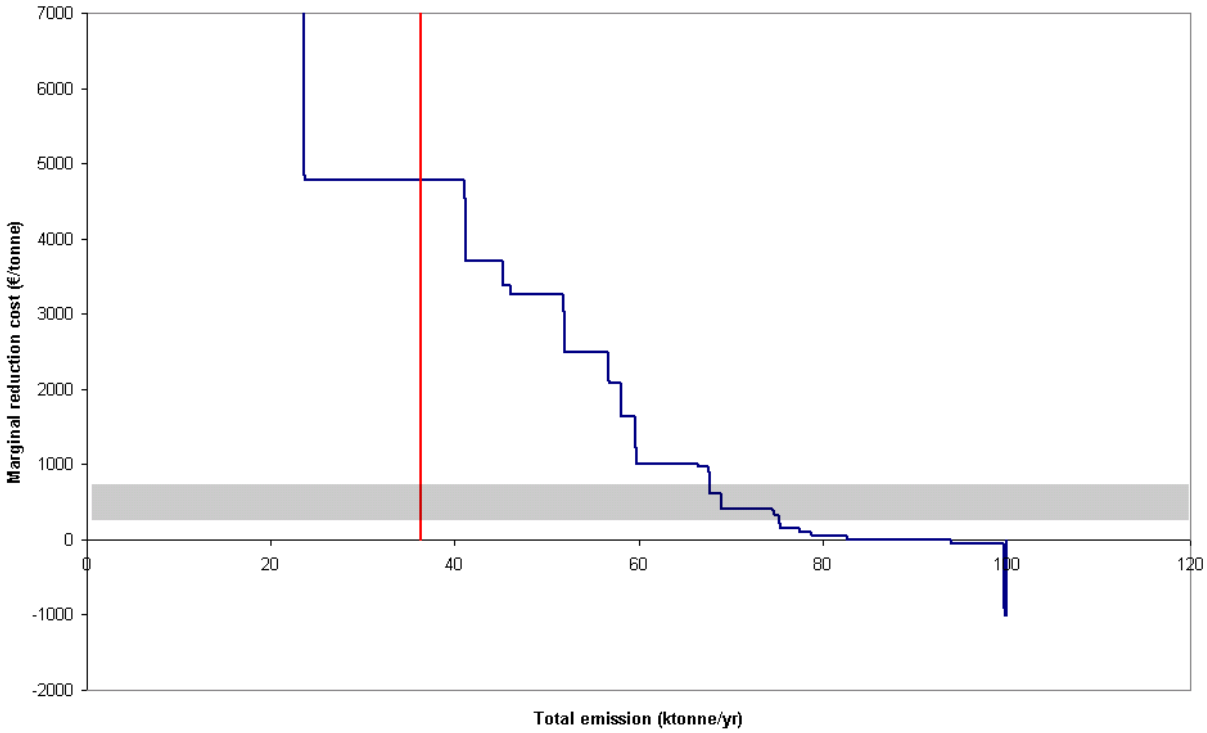

Figure 5.3.4: Marginal cost curve for VOC in 2020 for the maximum feasible reduction scenario (detail)

6 PRIMARY PM2.5

6.1 EVOLUTION OF EMISSIONS

6.1.1 Current legislation scenario

Full implementation of the current legislation regarding climate change policy and PM2.5 emission reduction in Lithuania will lead to a decrease of the yearly primary PM2.5 emissions from 17.485 ktonnes in 2000 to 11.730 ktonnes in 2020 (Figure 6.1.1); a decrease by 32.9%.

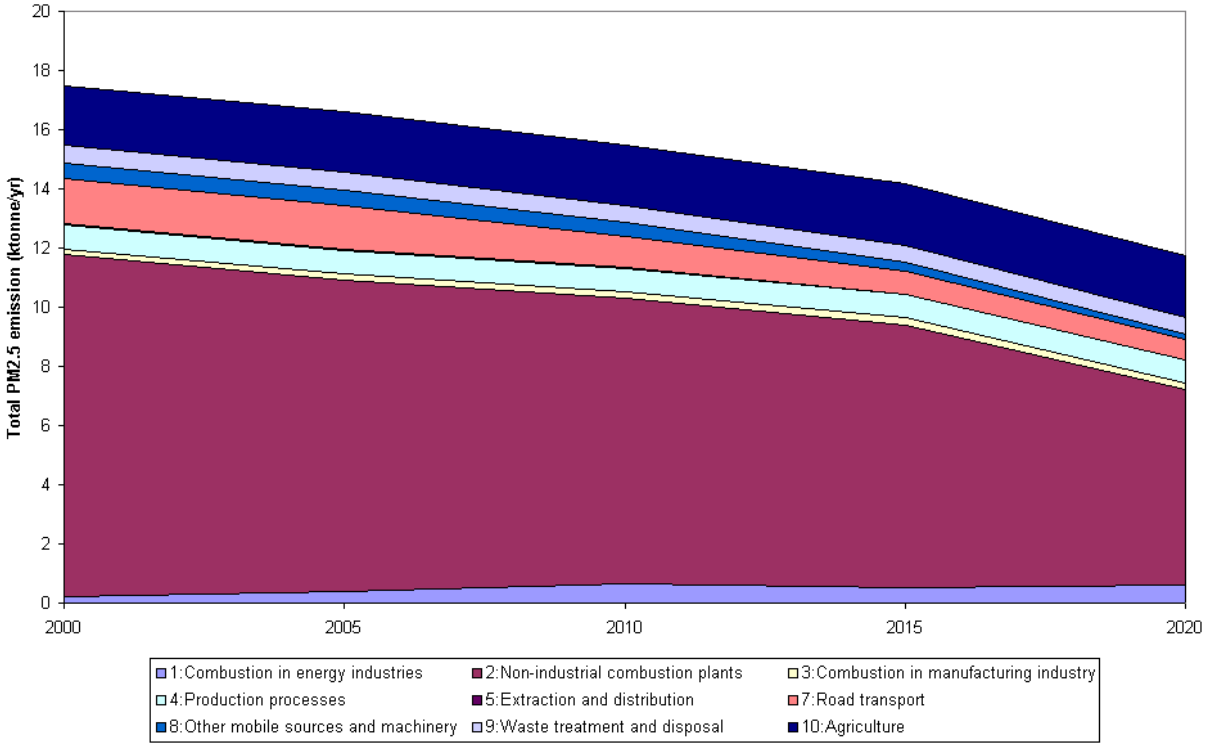

Figure 6.1.1: Evolution of the PM2.5 emissions under the current legislation scenario (IIASA, CP_CLE_Aug04 (Nov04))

The EU Thematic Strategy on air pollution (COM(2005) 446 final), however, sets a global reduction goal of the EU-25 PM2.5 emissions by 59% in 2020 relative to the 2000 level. Although no distribution of the effort over the various Member States has been proposed yet, it is likely that additional measures might be required.

6.1.2 Maximum feasible reduction scenario

The maximum feasible reduction scenario considers all possible additional measures that can be taken to further reduce primary PM2.5 emissions without changing the use of the various energy vectors. Full implementation of the maximum feasible reduction scenario would lead to a reduction of the total PM2.5 emissions from 17.485 ktonnes in 2000 to 3.689 ktonnes in 2020 (Figure 6.1.2); a decrease by 78.9%.

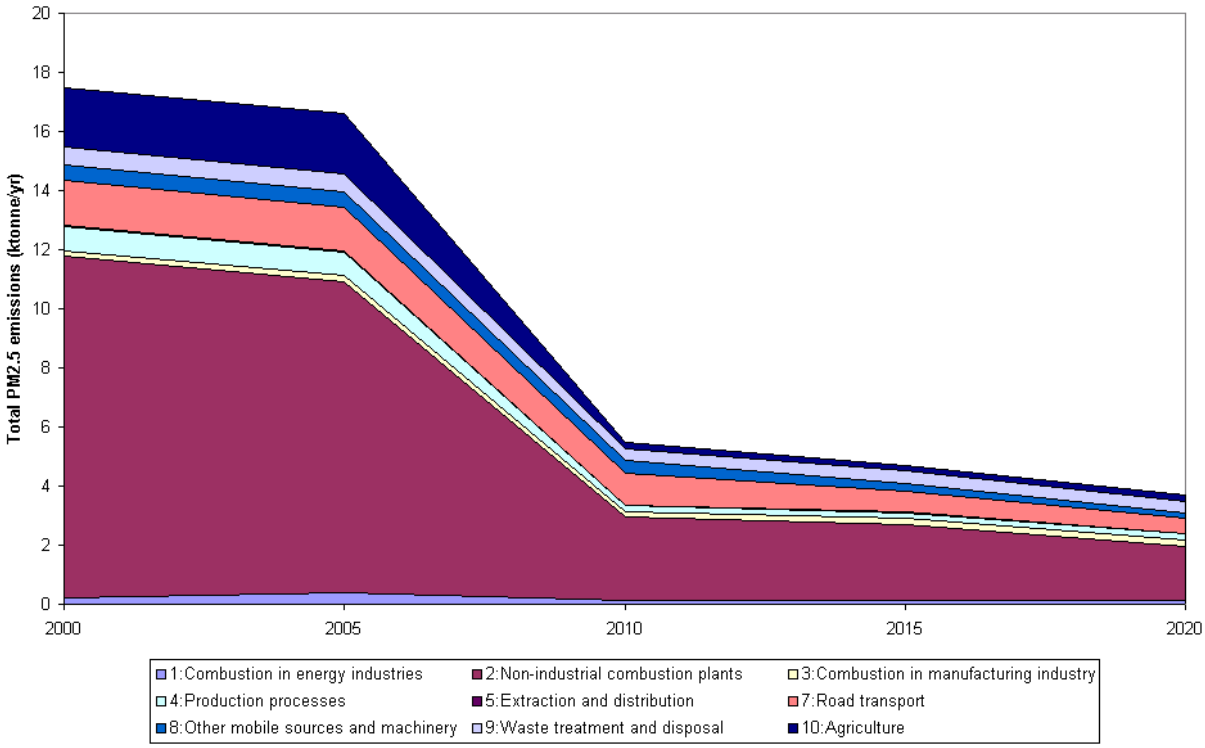

Figure 6.1.2: Evolution of the PM2.5 emissions under the maximum feasible reduction scenario (IIASA, CP_MFR_Nov04 (Nov04))

6.2 MEASURES TAKEN

In order to reach the reduction in the current legislation scenario, Lithuanian policy considers installation of mainly 1 field and 2 field electrostatic precipitators on solid fuelled combustion plants and on process emissions, next to the introduction of cleaner engines for road and non-road transport (Annex 8). Good housekeeping measures are foreseen for the storage and handling of dusty materials.

The reduction in the maximum feasible reduction scenario considers installation of electrostatic precipitators with 3 fields or more on solid fuelled combustion plants and on process emissions, installation of fabric filters on heavy fuel oil and gasoil fired combustion plants and the enhanced introduction of cleaner engines for road and non-road transport (Annex 9). Improved feeding practices are introduced in the agricultural sector.

6.3 ASSOCIATED COSTS

Finally, it should be assessed whether the envisaged measures are cost efficient, meaning that these costs should not exceed the benefits associated with the emission reduction. Therefore, a comparison is made between the unit reduction costs and the external costs of air pollution. External costs of air pollution by PM2.5 for Lithuania have been calculated to vary between 8400 and 24000 €/tonne of PM2.5 emitted (*); the variation resulting from uncertainties in the estimation method.

The marginal cost curve for VOC for the current legislation scenario is shown in Figure 6.3.1 (full curve) and Figure 6.3.2 (detail) and presented in a tabulated form in Annex 8. The current legislation scenario already contains measures that can be regarded as not being cost efficient. In spite of these cost inefficient measures, the EU global reduction goal on the national level can not be reached.

The marginal cost curve for VOC in the maximum feasible reduction scenario is shown in Figure 6.3.3 (full curve) and Figure 6.3.4 (detail) and presented in a tabulated form in Annex 9. From this cost curve it is clear that the EU global reduction goal on the national level can be reached but requires that some measures that can not be considered as being cost efficient are taken.

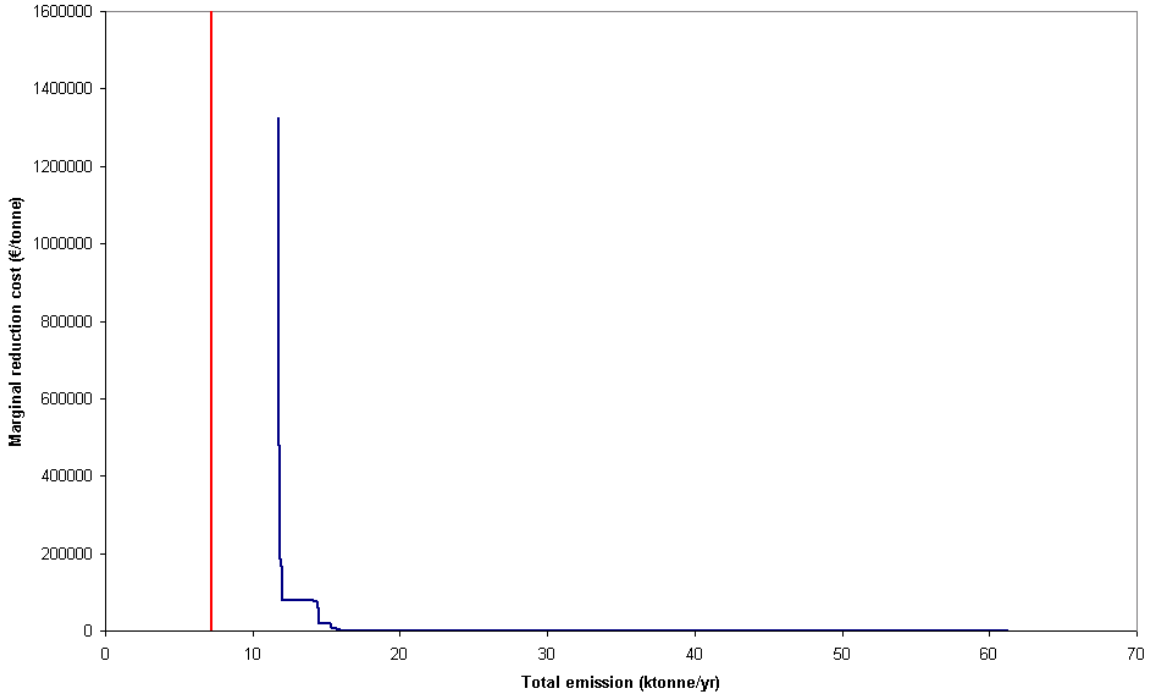

Figure 6.3.1: Marginal cost curve for primary PM2.5 in 2020 for the current legislation scenario (full curve)

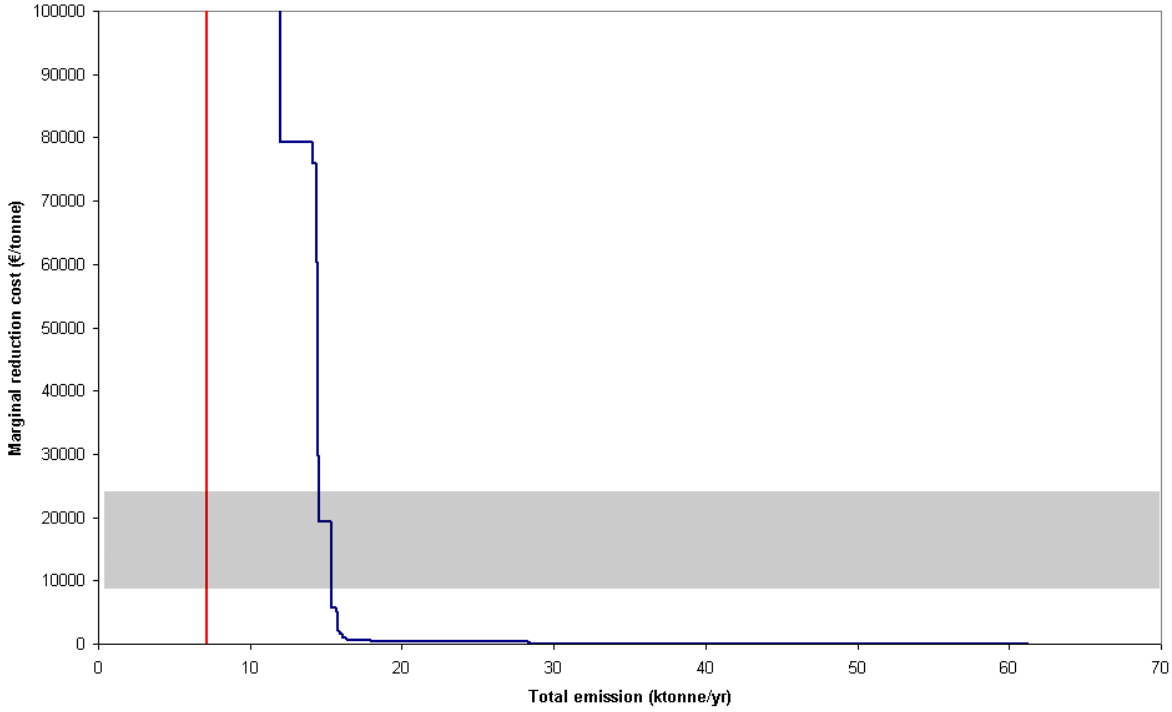

Figure 6.3.2: Marginal cost curve for primary PM2.5 in 2020 for the current legislation scenario (detail)

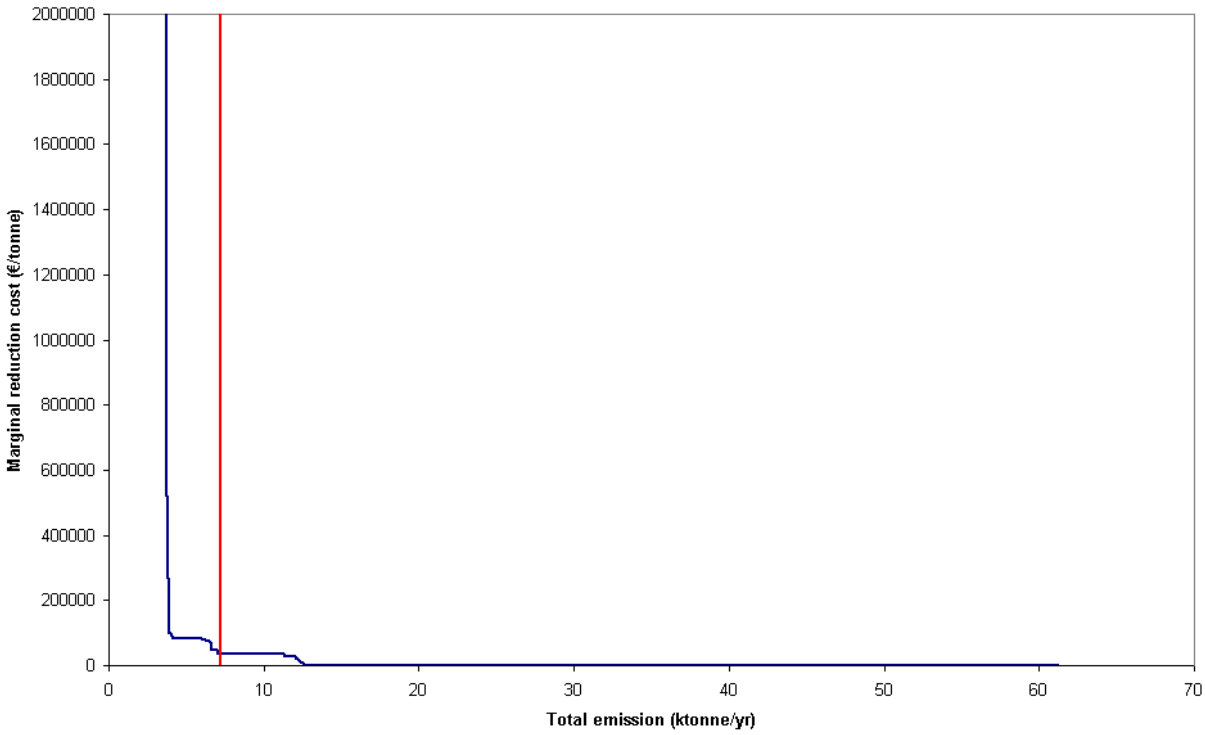

Figure 6.3.3: Marginal cost curve for primary PM2.5 in 2020 for the maximum feasible reduction scenario (full curve)

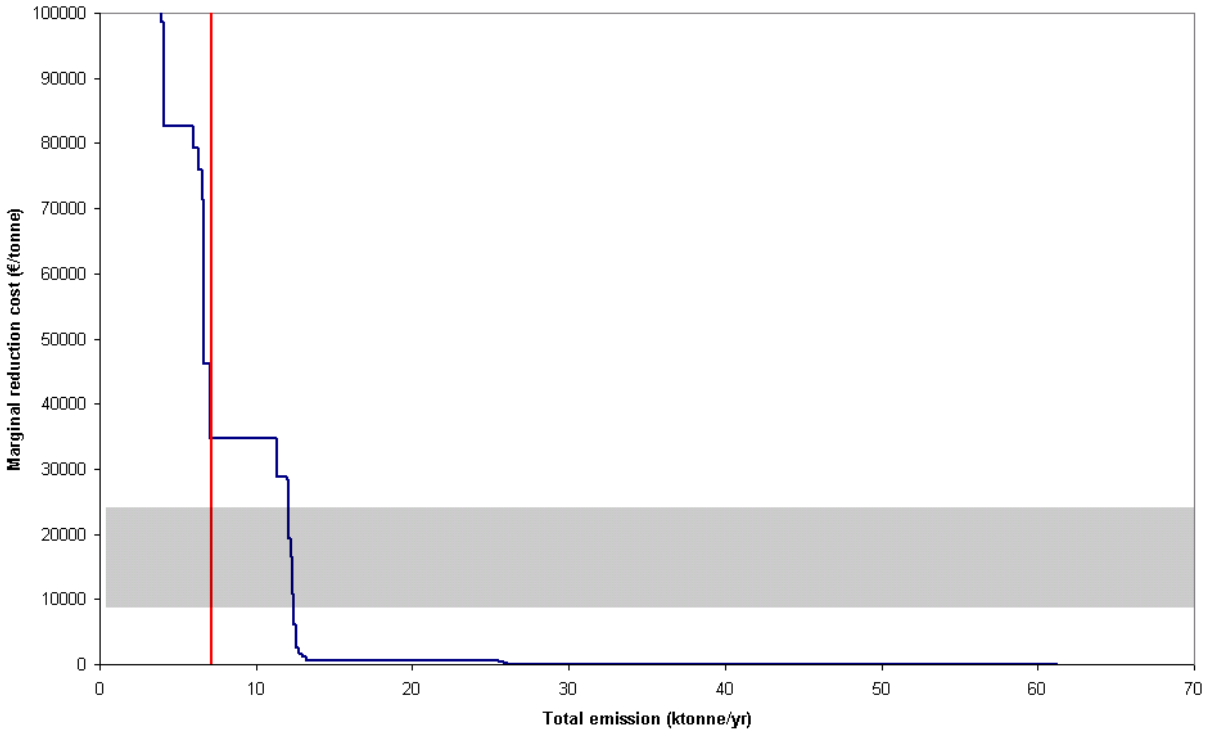

Figure 6.3.4: Marginal cost curve for primary PM2.5 in 2020 for the maximum feasible reduction scenario (detail)

7 CONCLUSIONS

The implementation of the current legislation with effect on emissions of SO_2, NO_x, NH_3 and VOC; including measures taken within the framework of climate change policy; allows Lithuania to meet the emission ceilings set for 2010 for these pollutants.

The EU Thematic Strategy on air pollution (COM(2005) 446 final) foresees a review of the NEC Directive. The ceilings for SO_2, NO_x, VOC and NH_3 will not only be reviewed, but also a new ceiling for primary PM2.5 will be introduced. For the moment, it is not clear at what level the ceilings for the individual Member States will be set, but the following global reduction targets have been put forth for the EU25 for 2020 relative to the base year 2000:

- SO_2 : -82%
- NO_x : -60%
- NH_3 : -27%
- VOC : -51%
- PM2.5 : -59%

The implementation of the current legislation with effect on emissions of SO_2, NO_x, NH_3, VOC and PM2.5; including measures taken within the framework of climate change policy; does not allow to reach the global reduction targets of the Thematic Strategy on Air Pollution applied to the national emissions for either of the pollutants. So it is clear that additional measures will have to be proposed because it is highly unlikely that national emission ceilings for Lithuania will remain unaltered in the future.

The selection of which measures to implement additionally will depend on the height of the ceilings for the individual pollutants and on the marginal cost of the individual measures.

The maximum feasible reduction scenario, as calculated by the RAINS model, provides the emission reduction that is technically feasible without changes in the energy vectors (compared to the current legislation scenario) and without accounting for the marginal cost of the individual measures. Implementation of this maximum feasible reduction scenario allows to reach the global EU25 reduction targets on the national level (even distribution of these targets over the various Member States) for all pollutants except NH_3. For all pollutants, except SO_2, this implies that a number of additional measures are implemented that can not be considered as cost efficient when compared to the external cost of air pollution on the national level.

The most likely outcome of the review of the National Emissions Ceilings Directive is that ceilings will be set in between the currently set ceilings and the ceilings derived from the maximum feasible reduction scenario. The measures that are most cost efficient to take in order to meet these ceilings are the measures of the beginning of the marginal cost curve for the maximum feasible reduction scenario.

LITERATURE

AEA Technology Environment (2005); *Damages per tonne of emission of PM2.5, NH_3, SO_2, NO_x and VOCs from each EU25 Member State (excluding Cyprus) and surrounding seas*, Study on behalf of DG ENV

EU; *Thematic Strategy on Air Pollution (COM(2005) 446final)*

IIASA; *RAINS online – scenarios CP_CLE_Aug04(Nov04) and CP_MFR_Nov04(Nov04)*

ANNEXES

Annex 1: Reduction measures for SO_2 considered in the current legislation scenario for 2020

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
-	None	-	67.227	-	-
Power and district heating plants	Wet flue gas desulphurisation on new hard coal fired plants	100	37.956	29.271	267
Power and district heating plants	Wet flue gas desulphurisation on new brown coal fired plants	100	37.941	0.015	478
Power and district heating plants	Low sulphur heavy fuel oil for existing plants	70	37.661	0.280	560
Power and district heating plants	Low sulphur heavy fuel oil for new plants	70	36.839	0.822	562
Power and district heating plants	Low sulphur gasoil (0.2% S) for new plants	35	36.821	0.018	1737
Combustion in domestic and commercial sector	Low sulphur gasoil (0.2% S)	35	36.602	0.218	1753
Other combustion in industry	Low sulphur gasoil (0.2% S)	35	36.539	0.063	1757
Other combustion in industry	Low sulphur gasoil (0.045% S)	65	36.376	0.163	2726
Combustion in domestic and commercial sector	Low sulphur gasoil (0.045% S)	65	35.813	0.563	2727
Traffic (non-road)	Low sulphur diesel (0.045% S)	100	34.772	1.041	2727
Power and district heating plants	Low sulphur gasoil (0.045% S) for new plants	65	34.724	0.048	2737
Traffic (road)	Low sulphur diesel (0.001% S)	100	21.721	13.003	3476

Annex 2: Reduction measures for SO_2 considered in the maximum feasible reduction scenario for 2020

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
-	None	-	67.226	-	-
Power and district heating plants	Wet flue gas desulphurisation on new hard coal fired plants	10	64.299	2.927	268
Power and district heating plants	High efficiency flue gas desulphurisation on new hard coal fired plants	90	37.117	27.182	385
Power and district heating plants	Wet flue gas desulphurisation on existing hard coal fired plants	100	36.725	0.392	421
Power and district heating plants	High efficiency flue gas desulphurisation on new heavy fuel oil fired plants	100	35.177	1.548	441
Refineries	Stage 3 SO_2 emission reduction for process emissions	100	32.688	2.488	459
Combustion in domestic and commercial sector	Use of low sulphur coal	100	31.746	0.942	463
Power and district heating plants	Wet flue gas desulphurisation on existing heavy fuel oil fired plants	100	31.235	0.511	464
Waste	Ban on burning of agricultural wastes	100	30.961	0.274	547
Other combustion in industry	Low sulphur heavy fuel oil	10	30.938	0.024	549
Other combustion in industry	Wet flue gas desulphurisation for hard coal fired plants	90	30.752	0.185	551
Industrial boilers	Low sulphur heavy fuel oil	10	30.747	0.005	575
Combustion in domestic and commercial sector	Low sulphur heavy fuel oil	100	30.487	0.260	584
Other combustion in industry	Wet flue gas desulphurisation for heavy fuel oil fired plants	90	30.243	0.243	608

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
Sulphuric acid production	Stage 3 SO_2 emission reduction for process emissions	100	27.899	2.344	621
Power and district heating plants	Wet flue gas desulphurisation on new brown coal fired plants	10	27.898	0.001	683
Combustion in fuel production and conversion	Wet flue gas desulphurisation for heavy fuel oil fired plants	99.90	21.698	6.200	741
Other combustion in industry	Lime injection in hard coal fired plants	10	21.684	0.015	758
Combustion in domestic and commercial sector	Low sulphur coke	100	21.683	0.001	769
Power and district heating plants	Wet flue gas desulphurisation on existing brown coal fired plants	100	21.675	0.007	820
Power and district heating plants	High efficiency flue gas desulphurisation on new brown coal fired plants	90	21.662	0.014	882
Industrial boilers	Wet flue gas desulphurisation for heavy fuel oil fired plants	90	21.608	0.054	913
Waste	Ban on residential burning of waste	100	21.592	0.016	1154
Combustion in fuel production and conversion	High efficiency flue gas desulphurisation on heavy fuel oil fired plants	0.10	21.585	0.007	1397
Lime production	Stage 3 SO_2 emission reduction for process emissions	100	21.497	0.088	1645
Cement production	Stage 3 SO_2 emission reduction for process emissions	100	20.846	0.651	2210
Power and district heating plants	Low sulphur gasoil (0.045% S)	100	20.773	0.073	2723
Other combustion in industry	Low sulphur gasoil (0.045% S)	100	20.523	0.251	2726
Combustion in domestic and commercial sector	Low sulphur gasoil (0.045% S)	100	19.656	0.867	2727

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
Power and district heating plants	Lime injection in new plants on high sulphur other fuels	30	19.584	0.072	3333
Traffic (non-road)	Low sulphur diesel (0.001% S)	100	18.459	1.125	3476
Traffic (road)	Low sulphur diesel (0.001% S)	100	5.456	13.003	3476
Power and district heating plants	Wet flue gas desulphurisation for new high sulphur other fuels fired plants	70	5.190	0.267	4416
Industrial boilers	Lime injection in plants on high sulphur other fuels	30	5.179	0.010	6519
Industrial boilers	Wet flue gas desulphurisation for high sulphur other fuels fired plants	70	5.146	0.033	9194

Annex 3: Reduction measures for NO_x considered in the current legislation scenario for 2020

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
-	None	-	94.111	-	-
Combustion in fuel production and conversion	Combustion modification for gas fired plants	32	94.106	0.005	0
Industrial boilers	Combustion modification for heavy fuel oil fired plants	32	94.104	0.002	0
Other industrial combustion	Combustion modification for hard coal fired plants	32	94.098	0.006	0
Other industrial combustion	Combustion modification for heavy fuel oil fired plants	32	94.091	0.007	0
Power and district heating plants	Combustion modification for existing brown coal fired plants	25	94.090	0.000	0
Power and district heating plants	Combustion modification for existing hard coal fired plants	80	94.056	0.035	0
Power and district heating plants	Combustion modification for existing heavy fuel oil fired plants	65	94.017	0.039	0
Power and district heating plants	Selective catalytic reduction for new brown coal fired plants	40	94.016	0.001	0
Traffic (non road) - rail	Euro II for diesel engines	28.75	93.776	0.240	208
Traffic (non road) - rail	Euro III for diesel engines	33.75	93.388	0.388	232
Power and district heating plants	Combustion modification for existing gas fired plants	60	93.201	0.187	321
Combustion in fuel production and conversion	Combustion modification for heavy fuel oil fired plants	32	92.992	0.209	335
Nitric acid production	Stage 1 NOx emission reduction for process emissions	100	92.272	0.720	514

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
Traffic (non road) - inland waterways	Euro I for diesel engines	83.33	92.210	0.062	641
Other industrial combustion	Combustion modification for gas fired plants	32	92.067	0.143	770
Traffic (non road) - agriculture	Euro I for diesel engines	4.07	92.045	0.022	901
Power and district heating plants	Selective catalytic reduction for new hard coal fired plants	65	90.356	1.689	1131
Traffic (road)	Stage II for heavy duty LPG fueled direct injection vehicles	100	90.145	0.211	1330
Power and district heating plants	Selective catalytic reduction for new heavy fuel oil fired plants	55	90.086	0.059	1347
Traffic (road)	Euro IV for light duty vehicles on LPG	100	82.926	7.160	1423
Industrial boilers	Combustion modification for gas fired plants	32	82.858	0.068	1626
Traffic (non road) - construction machinery	Euro II for diesel engines	8	82.833	0.025	1627
Traffic (road)	Stage II for heavy duty gas engines	100	82.810	0.023	1709
Traffic (non road) - construction machinery	Euro III for diesel engines	24	82.707	0.103	1743
Traffic (road)	Euro IV for light duty vehicles on ethanol	100	82.698	0.008	2421
Traffic (road)	Euro IV for light duty vehicles on methanol	100	82.682	0.017	2421
Traffic (road)	Euro IV for light duty vehicles on gasoline	100	56.506	26.176	2844
Traffic (non road) - agriculture	Euro II for diesel engines	11.47	56.414	0.092	3155
Traffic (road)	Euro IV for light duty vehicles on gas	100	56.402	0.012	3205
Traffic (non road) - agriculture	Euro III for diesel engines	17.13	56.209	0.192	3642
Traffic (non road) - construction	Euro IV for diesel engines	46.34	55.968	0.241	4813

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
machinery					
Traffic (road)	Euro V for heavy duty diesel engines	90	31.033	24.935	6720
Power and district heating plants	Selective catalytic reduction for new gas fired plants	100	30.582	0.451	7230
Traffic (road)	Euro IV for heavy duty diesel engines	10	28.324	2.259	7907
Traffic (non road) - agriculture	Euro IV for diesel engines	46.34	27.804	0.520	10250
Traffic (road)	Euro IV for light duty vehicles on diesel	100	26.949	0.855	18079
Traffic (road)	Stage III for 4-stroke motorcycles on gasoline	100	26.947	0.002	196078

Annex 4: Reduction measures for NO_x considered in the maximum feasible reduction scenario for 2020

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
-	None		94.116	-	-
Industrial boilers	Combustion modification + selective non-catalytic reduction for heavy fuel oil fired plants	20	94.114	0.001	0
Other industrial combustion	Combustion modification for gasoline fired plants	100	94.111	0.004	0
Other industrial combustion	Combustion modification + selective non-catalytic reduction for hard coal fired plants	20	94.105	0.005	0
Power and district heating plants	Combustion modification + selective catalytic reduction for existing brown coal fired plants	100	94.103	0.002	0
Power and district heating plants	Selective catalytic reduction for new brown coal fired plants	40	94.101	0.002	0
Traffic (non road) - rail	Euro II for diesel engines	28.75	93.861	0.240	208
Traffic (non road) - rail	Euro III for diesel engines	33.75	93.473	0.388	232
Waste	Ban on burning of agricultural wastes	100	92.847	0.626	240
Waste	Ban on residential burning of waste	100	92.811	0.036	561
Cement production	Stage 3 NOx emission reduction for process emissions	100	91.613	1.198	718
Lime production	Stage 3 NOx emission reduction for process emissions	100	91.450	0.162	739
Other industrial combustion	Combustion modification for gasoil fired plants	100	91.412	0.038	781
Industrial boilers	Combustion modfication for other low sulphur solid fuel plants	100	91.323	0.089	786
Traffic (non road) - inland waterways	Euro I for diesel engines	16.67	91.311	0.012	801
Combustion in domestic and commercial sector	Combustion modification for heavy fuel oil fired plants	100	91.287	0.024	833

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
Power and district heating plants	Combustion modification + selective catalytic reduction for existing hard coal fired plants	100	91.217	0.070	862
Combustion in fuel production and conversion	Combustion modification + selective non-catalytic reduction for heavy fuel oil fired plants	20	91.034	0.183	874
Traffic (non road) - agriculture	Euro I for diesel engines	4.07	91.012	0.022	901
Power and district heating plants	Combustion modification + selective catalytic reduction for existing heavy fuel oil fired plants	100	90.938	0.074	951
Power and district heating plants	Selective catalytic reduction for new hard coal fired plants	100	88.340	2.598	1132
Traffic (road)	Stage III for heavy duty vehicles on ethanol	100	88.332	0.008	1250
Power and district heating plants	Selective catalytic reduction for new heavy fuel oil fired plants	100	88.224	0.108	1296
Traffic (road)	Stage II for heavy duty LPG fueled direct injection vehicles	17	88.188	0.036	1397
Traffic (road)	Euro IV for light duty vehicles on LPG	25.2	86.384	1.804	1424
Combustion in fuel production and conversion	Combustion modification + selective catalytic reduction for heavy fuel oil fired plants	80	85.547	0.837	1530
Other industrial combustion	Combustion modification + selective non-catalytic reduction for heavy fuel oil fired plants	20	85.541	0.006	1545
Other industrial combustion	Combustion modification + selective catalytic reduction for hard coal fired plants	80	85.516	0.025	1598
Traffic (non road) - construction machinery	Euro II for diesel engines	8	85.491	0.025	1627
Traffic (road)	Stage III for heavy duty vehicles on LPG	17	85.311	0.181	1661
Other industrial combustion	Combustion modification + selective catalytic reduction for heavy fuel oil fired plants	80	85.281	0.030	1690

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
Traffic (non road) - construction machinery	Euro III for diesel engines	24	85.178	0.103	1743
Traffic (road)	Stage III for heavy duty vehicles on methanol	100	85.138	0.040	1750
Traffic (non road) - inland waterways	Euro VI for diesel engines	66.67	85.013	0.125	1761
Traffic (road)	Stage III for heavy duty vehicles on gas	83	84.993	0.020	1995
Other industrial combustion	Combustion modification + selective non-catalytic reduction for gas fired plants	20	84.868	0.125	1999
Traffic (road)	Euro VI for light duty vehicles on LPG	74.8	79.405	5.463	2175
Combustion in fuel production and conversion	Combustion modification + selective non-catalytic reduction for gas fired plants	20	79.401	0.004	2319
Traffic (non road) - rail	Euro VI for methanol engines	100	79.392	0.008	2372
Traffic (road)	Euro IV for light duty vehicles on methanol	25.2	79.388	0.004	2402
Industrial boilers	Combustion modification + selective non-catalytic reduction for other solid high sulphur fuel fired plants	20	79.380	0.008	2442
Traffic (road)	Stage II for heavy duty gas engines	17	79.376	0.004	2514
Nitric acid production	Stage 3 NOx emission reduction for process emissions	100	77.937	1.439	2592
Traffic (road)	Euro IV for light duty vehicles on gasoline	25.2	71.340	6.596	2844
Industrial boilers	Combustion modification + selective catalytic reduction for heavy fuel oil fired plants	80	71.334	0.007	3064
Traffic (non road) - agriculture	Euro II for diesel engines	11.47	71.242	0.092	3155
Traffic (road)	Euro VI for light duty vehicles on ethanol	74.8	71.236	0.006	3172
Power and district heating plants	Combustion modification + selective catalytic reduction for existing gas fired plants	100	70.850	0.385	3453

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
Combustion in fuel production and conversion	Combustion modification + selective catalytic reduction for gas fired plants	80	70.831	0.020	3551
Traffic (non road) - agriculture	Euro III for diesel engines	17.13	70.638	0.192	3642
Other industrial combustion	Combustion modification + selective catalytic reduction for gas fired plants	80	70.067	0.572	3709
Industrial boilers	Combustion modification + selective non-catalytic reduction for gas fired plants	20	70.008	0.059	3717
Refineries	Stage 3 NOx emission reduction for process emissions	100	69.455	0.553	3743
Traffic (road)	Euro VI for light duty vehicles on methanol	74.8	69.442	0.013	3965
Industrial boilers	Combustion modification + selective catalytic reduction for other high sulphur solid fuel fired plants	80	69.405	0.037	4006
Traffic (road)	Euro IV for light duty vehicles on gas	20	69.402	0.002	4006
Traffic (road)	Euro VI for light duty vehicles on gasoline	74.8	49.419	19.983	4169
Power and district heating plants	Combustion modification + selective catalytic reduction for new high sulphur solid fuel fired plants	100	49.253	0.166	4387
Traffic (non road) - construction machinery	Euro VI for diesel engines	46.1	49.012	0.241	4691
Traffic (non road) - construction machinery	Euro IV for diesel engines	9.9	48.970	0.043	4694
Traffic (road)	Euro IV for light duty vehicles on ethanol	25.2	48.967	0.002	4804
Traffic (road)	Euro VI for light duty vehicles on gas	80	48.957	0.010	4906
Traffic (road)	Euro V for heavy duty diesel engines	12	45.633	3.325	6719
Traffic (road)	Euro VI for heavy duty diesel engines	78	22.942	22.691	6947
Industrial boilers	Combustion modification + selective catalytic reduction for	80	22.671	0.271	7169

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
	gas fired plants				
Power and district heating plants	Selective catalytic reduction for new gas fired plants	100	20.417	2.255	7225
Traffic (road)	Euro IV for heavy duty diesel engines	10	18.158	2.259	7907
Combustion in domestic and commercial sector	Combustion modification for gas fired plants	100	17.638	0.520	8932
Combustion in domestic and commercial sector	Combustion modification for LPG fired plants	100	17.541	0.098	9123
Combustion in domestic and commercial sector	Combustion modification for gasoil fired plants	100	17.481	0.060	9203
Combustion in domestic and commercial sector	Combustion modification for gasoline fired plants	100	17.478	0.003	9259
Traffic (non road) - agriculture	Euro VI for diesel engines	37.58	16.966	0.512	10006
Traffic (non road) - agriculture	Euro IV for diesel engines	8.77	16.868	0.098	10265
Traffic (road)	Euro VI for light duty vehicles on diesel	74.8	15.469	1.398	14189
Traffic (road)	Euro IV for light duty vehicles on diesel	25.2	15.254	0.215	18064
Traffic (road)	Stage III for 4-stroke motorcycles on gasoline	100	15.252	0.002	196078

Annex 5: Reduction measures for NH_3 considered in the maximum feasible reduction scenario for 2020

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
-	None	-	57.765	-	-
Livestock - Other poultry	Low nitrogen feed + low emission stables + low ammonia application (average efficiency)	100	56.634	1.131	2724
Livestock - Other cattle (solid manure)	Low ammonia application (high efficiency)	100	55.955	0.679	5360
Livestock - Laying hens	Low nitrogen feed + biofiltration + covered outdoor storage + low ammonia application (average efficiency)	100	55.152	0.803	5924
Fertiliser production	Strip	100	49.927	5.225	7001
Livestock - sheep and goats	Low ammonia application (high efficiency)	100	49.915	0.011	11307
Livestock - pigs (liquid manure)	Low nitrogen feed + biofiltration + covered outdoor storage + low ammonia application (average efficiency)	100	46.318	3.598	13392
Livestock - pigs (solid manure)	Low nitrogen feed + biofiltration + low ammonia application (high efficiency)	100	44.850	1.467	13529
Livestock - diary cows (solid manure)	Low nitrogen feed + low ammonia application (high efficiency)	100	42.799	2.052	13724
Livestock - pigs (liquid manure)	Low emission stables	44.21	42.343	0.455	17547
Livestock - diary cows (liquid manure)	Low nitrogen feed + low emission stables + low ammonia application (high efficiency)	100	39.530	2.813	18141
Livestock - Other cattle (liquid manure)	Low emission stables + low ammonia application (average efficiency)	100	38.490	1.040	19024

Annex 6: Reduction measures for VOC considered in the current legislation scenario for 2020

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
-	None	-	100.034	-	-
Vehicle refinishing - new plants	Primary measures + 25% high solids & water based paints	100	99.867	0.167	-2759
Vehicle refinishing - existing plants	Primary measures + 25% high solids & water based paints	100	99.812	0.055	-2525
Industrial use of paints	Standard solvent based paint (60% solvent) + 65% application efficiency	15	98.797	1.015	-1222
Industrial use of paints	Improved solvend based paint (55% solvent) + 65% application efficiency	25	96.303	2.494	-862
Wood impregnation	Vacuum impregnation system + process optimisation	15	96.165	0.138	-72
Industrial use of paints	Water based paints	10	94.882	1.283	-47
Solvent degreasing - existing plants	Cold cleaning	1	94.876	0.006	0
Solvent degreasing - existing plants	Water based degreasing	55	94.490	0.386	0
Solvent degreasing - new plants	Water based degreasing	60	93.543	0.947	0
Dry cleaning - existing plants	Conventional closed circuit machines	100	93.397	0.146	0
Industial application of high performance solvent based adhesives	Activated carbon adsorption	35	93.386	0.011	0
Industial application of high performance solvent based adhesives	Incineration	35	93.375	0.011	0
Industial application of traditional solvent based adhesives	Emulsions (water based)	19	93.344	0.031	0
Industial application of traditional solvent based adhesives	Hotmelts	13	93.323	0.021	0

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
Industial application of traditional solvent based adhesives	Incineration	11	93.309	0.014	0
Industrial use of paints	Powder coating	17	87.957	5.353	0
Organic chemical industry - downstream units	Lead detection and repair - stage I	50	87.921	0.035	0
Products incorporating solvents	Basic emission management techniques	100	87.921	0.000	0
Offset printing	Primary measures + incineration	90	87.913	0.008	0
Offset printing	Primary measures	10	87.913	0.000	0
Rotogravure in publication	Low solvent inks + enclosure + activated carbon adsorption	100	87.891	0.022	0
Shoe manufacturing	Good housekeeping + substitution (60% solvent based / 40% water based)	100	87.814	0.077	0
Wood impregnation	Vacuum impregnation system	5	87.798	0.017	0
Wood impregnation	Water based preservatives	70	86.361	1.437	0
Solvent degreasing - existing plants	Closed degreaser - chlorinated solvents	19	86.234	0.127	79
Solvent degreasing - new plants	Closed degreaser - chlorinated solvents	25	85.866	0.368	81
Combustion in domestic and commercial sector	New. improved small boiler with accumulation tank for other low sulphur solid fuels	30	84.215	1.651	85
Gasoline distribution - transport and depots	Internal floating covers + stage IA (single stage) controls	100	83.041	1.174	102
Evaporation emissions from cars	Small carbon canisters	100	80.867	2.174	152
Combustion in domestic and commercial sector	New. improved small boiler with accumulation tank for hard coal	30	80.830	0.037	273
Solvent degreasing - existing plants	Closed degreaser - A3 solvents	5	80.797	0.034	296

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
Traffic (non-road) - 2-stroke off road	Stage II controls for gasoline engines	100	80.449	0.348	316
Gasoline distribution - service stations	Stage IB controls	100	79.781	0.668	449
Wood impregnation	Activated carbon adsorption	5	79.715	0.065	458
Solvent degreasing - existing plants	Basic emission management techniques	20	79.680	0.035	855
Decorative paints	Changes in paint formulation and application patterns	100	76.535	3.145	897
Traffic (road)	Stage II controls for gasoline engines on 2-stroke gasoline engines	80	76.479	0.056	898
Traffic (non road) - rail	Euro II for diesel engines	28.75	76.431	0.049	1025
Traffic (non road) - rail	Euro III for diesel engines	33.75	76.357	0.073	1231
Traffic (road)	Stage III controls for gasoline engines on 2-stroke gasoline engines	20	76.343	0.014	1420
Traffic (road)	Euro IV for light duty vehicles on LPG	100	70.101	6.242	1632
Wood impregnation	Incineration	5	70.035	0.065	1680
Traffic (road)	Stage II for heavy duty LPG fueled direct injection vehicles	100	69.873	0.163	1721
Traffic (road)	Stage II for heavy duty gas engines	100	69.852	0.021	1941
Traffic (road)	Euro IV for light duty vehicles on ethanol	100	69.845	0.007	2778
Traffic (road)	Euro IV for light duty vehicles on methanol	100	69.831	0.014	2778
Traffic (road)	Euro IV for light duty vehicles on gas	100	69.818	0.012	3205
Traffic (road)	Euro IV for light duty vehicles on gasoline	100	47.001	22.817	3263
Domestic use of solvents	Product reformulation	75	46.468	0.533	3377
Dry cleaning - new plants	New generation closed circuit machine	50	46.454	0.015	3398

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
Traffic (non road) - inland waterways	Euro I for diesel engines	83.33	46.443	0.011	3799
Traffic (road)	Stage III for 4-stroke motorcycles on gasoline	100	46.361	0.082	4850
Traffic (non road) - agriculture	Euro I for diesel engines	4.07	46.357	0.004	5390
Traffic (non road) - construction machinery	Euro II for diesel engines	8	46.354	0.003	11822
Traffic (non road) - construction machinery	Euro III for diesel engines	24	46.339	0.015	12413
Traffic (non road) - agriculture	Euro II for diesel engines	11.47	46.326	0.013	23129
Traffic (non road) - agriculture	Euro III for diesel engines	17.13	46.300	0.027	26166
Traffic (non road) - construction machinery	Euro IV for diesel engines	46.34	46.266	0.034	34284
Traffic (road)	Euro IV for light duty vehicles on diesel	100	45.964	0.302	51134
Traffic (road)	Euro V for heavy duty diesel engines	90	43.262	2.701	62033
Traffic (road)	Euro IV for heavy duty diesel engines	10	42.985	0.277	64464
Traffic (non road) - agriculture	Euro IV for diesel engines	46.34	42.913	0.072	73639

Annex 7: Reduction measures for VOC considered in the maximum feasible reduction scenario for 2020

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
-	None	-	98.827	-	-
Vehicle refinishing - new plants	Primary measures + 40% high solids & 60% water based paints	100	98.629	0.198	-1009
Vehicle refinishing - existing plants	Primary measures + 40% high solids & 60% water based paints	100	98.563	0.066	-910
Industrial use of paints	Water based paints	45	92.789	5.774	-47
Solvent degreasing - existing plants	Water based degreasing	55	92.403	0.386	0
Solvent degreasing - new plants	Water based degreasing	70	91.298	1.105	0
Dry cleaning - existing plants	Conventional closed circuit machines + activated carbon adsorption	100	91.149	0.149	0
Industrial application of high performance solvent based adhesives	Activated carbon adsorption	40	91.137	0.013	0
Industrial application of high performance solvent based adhesives	Incineration	50	91.121	0.016	0
Industrial application of traditional solvent based adhesives	Emulsions (water based)	40	91.056	0.065	0
Industrial application of traditional solvent based adhesives	Hotmelts	60	90.958	0.099	0
Other industrial sources	Good housekeeping in steel industry + switch to emulsion bitumen	100	90.609	0.349	0
Industrial use of paints	Powder coating	35	85.926	4.684	0
Organic chemical industry - storage	Internal floating covers + VRU Stage II	100	85.915	0.011	0

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
Organic chemical industry - downstream units	Leak detection and repair - Stage IV	100	85.817	0.097	0
Products incorporating solvents	Upgrade condensation units/carbon adsorption + solvent recovery	100	85.817	0.001	0
Offset printing - existing plants	Primary measures + solvent free inks + incineration	100	85.807	0.010	0
Rotogravure in publication - existing plants	Low solvent water based inks + enclosure + activated carbon adsorption	100	85.785	0.023	0
Rotogravure in publication - new plants	Water based inks	100	85.783	0.001	0
Refineries	Leak detection and repair - Stage II + Covers on water separators	100	83.554	2.229	0
Shoe manufacturing	Good housekeeping + substitution (60% solvent based / 40% water based) + automatic application	10	83.544	0.010	0
Wood impregnation	Water based preservatives + vacuum impregnation system	80	81.894	1.651	0
Wood impregnation	Water based preservatives	20	81.483	0.411	0
Waste	Ban on burning of agricultural wastes	100	78.003	3.480	43
Solvent degreasing - existing plants	Closed degreaser - chlorinated solvents	32	77.790	0.213	47
Solvent degreasing - new plants	Closed degreaser - chlorinated solvents	10	77.643	0.147	68
Shoe manufacturing	Good housekeeping + substitution (60% solvent based / 40% water based) + biofilter	70	77.548	0.095	105
Evaporation emissions from cars	Small carbon canisters	100	75.374	2.174	152
Solvent degreasing - existing plants	Closed degreaser - A3 solvent - activated carbon adsorption	13	75.285	0.089	226
Traffic (non-road) - 2-stroke off road	Stage II controls for gasoline engines	100	74.937	0.348	316

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
Solvent degreasing - new plants	Closed degreaser - A3 solvent	10	74.787	0.150	332
Waste treatment and disposal	Improved landfills	100	74.760	0.027	375
Solvent degreasing - new plants	Closed degreaser - A3 solvent - activated carbon adsorption	10	74.608	0.152	395
Decorative paints	Changes in paint formulation and application patterns - possible developments beyond legal requirements	100	69.015	5.593	415
Shoe manufacturing	Biofilter	20	68.993	0.023	440
Industrial use of paints	Improved solvent based paints (55% solvent) + incineration	10	67.736	1.256	621
Offset printing - new plants	Incineration	100	67.721	0.015	649
Traffic (road)	Stage II controls for gasoline engines on 2-stroke gasoline engines	80	67.665	0.056	898
Gasoline distribution - service stations	Stage II + IB controls	100	66.513	1.152	963
Combustion in domestic and commercial sector	New boiler and oxidation catalyst for other low sulphur solid fuels	100	59.830	6.683	1001
Traffic (non road) - rail	Euro II for diesel engines	28.75	59.781	0.049	1025
Traffic (non road) - rail	Euro III for diesel engines	33.75	59.708	0.073	1231
Traffic (road)	Stage III controls for gasoline engines on 2-stroke gasoline engines	80	59.694	0.014	1420
Traffic (road)	Stage III for heavy duty vehicles on ethanol	100	59.688	0.006	1586
Traffic (road)	Euro IV for light duty vehicles on LPG	25.2	58.114	1.573	1634
Traffic (road)	Stage II for heavy duty LPG fueled direct injection vehicles	17	58.087	0.028	1808
Industrial use of paints	Standard solvent based paint (60% solvent) + 65%	10	56.907	1.179	2077

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
	application efficiency + incineration				
Traffic (road)	Stage III for heavy duty vehicles on LPG	17	56.765	0.142	2108
Traffic (road)	Stage III for heavy duty vehicles on gas	83	56.747	0.018	2218
Traffic (road)	Stage III for heavy duty vehicles on methanol	100	56.716	0.032	2220
Traffic (road)	Euro VI for light duty vehicles on LPG	74.8	51.949	4.767	2492
Traffic (non road) - rail	Euro VI for methanol engines	100	51.941	0.008	2551
Traffic (road)	Euro IV for light duty vehicles on methanol	25.2	51.937	0.004	2756
Traffic (road)	Stage II for heavy duty gas engines	17	51.934	0.004	2854
Combustion in domestic and commercial sector	New boiler and oxidation catalyst for hard coal	100	51.786	0.148	3036
Traffic (road)	Euro IV for light duty vehicles on gasoline	25.2	46.036	5.750	3263
Domestic use of solvents	Product reformulation	100	45.325	0.711	3377
Dry cleaning - new plants	New generation closed circuit machine	40	45.313	0.012	3398
Traffic (road)	Euro VI for light duty vehicles on ethanol	74.8	45.308	0.005	3638
Food and drink industry	Incineration	100	41.151	4.157	3700
Traffic (road)	Euro IV for light duty vehicles on gas	20	41.149	0.002	4006
Traffic (road)	Euro VI for light duty vehicles on methanol	74.8	41.138	0.011	4547
Traffic (non road) - inland waterways	Euro I for diesel engines	16.67	41.136	0.002	4749
Traffic (road)	Euro VI for light duty vehicles on gasoline	74.8	23.713	17.423	4781
Traffic (road)	Stage III for 4-stroke motorcycles on gasoline	100	23.631	0.082	4850
Traffic (road)	Euro VI for light duty vehicles on gas	80	23.620	0.010	4906
Traffic (non road) - agriculture	Euro I for diesel engines	4.07	23.617	0.004	5390

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
Traffic (road)	Euro IV for light duty vehicles on ethanol	25.2	23.615	0.002	5511
Dry cleaning - new plants	Hydrocarbon machine	60	23.597	0.018	6230
Traffic (non road) - construction machinery	Euro II for diesel engines	8	23.594	0.003	11822
Traffic (non road) - construction machinery	Euro III for diesel engines	24	23.579	0.015	12413
Traffic (non road) - inland waterways	Euro VI for diesel engines	66.67	23.564	0.016	14063
Traffic (non road) - agriculture	Euro II for diesel engines	11.47	23.551	0.013	23129
Traffic (non road) - agriculture	Euro III for diesel engines	17.13	23.524	0.027	26166
Traffic (non road) - construction machinery	Euro IV for diesel engines	9.9	23.518	0.006	33436
Traffic (non road) - construction machinery	Euro VI for diesel engines	46.1	23.488	0.030	37449
Traffic (road)	Euro IV for light duty vehicles on diesel	25.2	23.412	0.076	51089
Traffic (road)	Euro V for heavy duty diesel engines	12	23.052	0.360	62026
Traffic (road)	Euro VI for heavy duty diesel engines	78	20.603	2.449	64365
Traffic (road)	Euro IV for heavy duty diesel engines	10	20.326	0.277	64464
Traffic (non road) - agriculture	Euro IV for diesel engines	8.77	20.312	0.014	73747
Traffic (non road) - agriculture	Euro VI for diesel engines	37.58	20.248	0.064	80535
Traffic (road)	Euro VI for light duty vehicles on diesel	74.8	20.019	0.229	86475

Annex 8: Reduction measures for primary PM2.5 considered in the current legislation scenario for 2020

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
-	None	-	61.269	-	-
Industrial boilers	Good housekeeping for heavy fuel oil fired boilers	50	61.269	0.00009	0
Other combustion in industry	Good housekeeping for heavy fuel oil fired plants	50	61.268	0.00042	0
Other combustion in industry	Electrostatic precipitator (1 field) - hard coal fired fluidised bed plants	50	61.262	0.00627	0
Other combustion in industry	Electrostatic precipitator (2 fields) - hard coal fired fluidised bed plants	50	61.255	0.00647	0
Brown coal mining	Good practice	100	61.255	0.00001	0
Power and district heating plants	Good housekeeping for existing heavy fuel oil fired plants	50	61.255	0.00064	0
Power and district heating plants	Electrostatic precipitator (2 fields) - existing brown coal grate fired plants	100	61.253	0.00137	0
Power and district heating plants	Electrostatic precipitator (2 fields) - existing hard coal grate fired plants	100	61.245	0.00817	0
Power and district heating plants	Electrostatic precipitator (2 fields) - existing brown coal fluidised bed plants	100	61.243	0.00220	0
Power and district heating plants	Electrostatic precipitator (2 fields) - existing brown coal pulverised fired plants	100	61.226	0.01665	0
Power and district heating plants	Good housekeeping for new gasoil fired plants	50	61.226	0.00002	0
Power and district heating plants	Electrostatic precipitator (2 fields) - new brown coal fluidised bed plants	100	61.223	0.00331	0
Electric arc furnaces	Fabric filter for process emissions	50	61.156	0.06724	0
Fertiliser production	Cyclone for process emissions	5	60.955	0.20115	0

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
Fertiliser production	Fabric filter for process emissions	95	48.343	12.61211	0
Cement production	Electrostatic precipitator (3 fields or more) for process emissions	100	28.512	19.83010	35
Electric arc furnaces	Wet scrubber for process emissions	49	28.449	0.06390	157
Glass production	Fabric filter for process emissions	50	28.397	0.05124	195
Glass production	Electrostatic precipitator (2 fields) for process emissions	49	28.349	0.04869	205
Power and district heating plants	Electrostatic precipitator (2 fields) - new brown coal pulverised fired plants	100	28.313	0.03539	283
Refineries	Electrostatic precipitator (1 field) for process emissions	40	28.190	0.12342	324
Refineries	Electrostatic precipitator (2 fields) for process emissions	59	28.002	0.18792	373
Power and district heating plants	Electrostatic precipitator (2 fields) - new low sulphur solid fuel fired plants	100	26.602	1.39975	450
Power and district heating plants	Electrostatic precipitator (2 fields) - new hard coal pulverised fired plants	100	18.010	8.59218	491
Power and district heating plants	Electrostatic precipitator (2 fields) - existing hard coal fluidised bed plants	100	17.991	0.01926	519
Power and district heating plants	Electrostatic precipitator (2 fields) - existing hard coal pulverised fired plants	100	17.882	0.10832	554
Other combustion in industry	Electrostatic precipitator (2 fields) - hard coal pulverised fired plants	50	17.865	0.01725	580
Power and district heating plants	Electrostatic precipitator (2 fields) - new hard coal fluidised bed plants	50	16.443	1.42168	598
Other combustion in industry	Electrostatic precipitator (1 field) - hard coal	50	16.427	0.01672	598

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
	pulverised fired plants				
Combustion in domestic and commercial sector	Cyclone on hard coal fired automatic medium sized boilers	60	16.365	0.06126	816
Industrial boilers	Electrostatic precipitator (1 field) - low sulphur solid fuel fired plants	50	16.248	0.11773	934
Industrial boilers	Electrostatic precipitator (2 fields) - low sulphur solid fuel fired plants	50	16.126	0.12152	1070
Lime production	Electrostatic precipitator (3 fields or more) for process emissions	100	15.965	0.16078	1493
Other combustion in industry	Electrostatic precipitator (2 fields) - hard coal grate fired plants	50	15.959	0.00604	1656
Other combustion in industry	Electrostatic precipitator (1 field) - hard coal grate fired plants	50	15.954	0.00585	1709
Traffic (non road) - rail	Euro III for diesel engines	33.75	15.901	0.05256	1712
Traffic (non road) - rail	Euro II for diesel engines	28.75	15.875	0.02634	1899
Power and district heating plants	Electrostatic precipitator (2 fields) - new solid high sulphur fuel fired plants	100	15.761	0.11342	2204
Power and district heating plants	Good housekeeping for new heavy fuel oil fired plants	100	15.757	0.00377	2655
Combustion in fuel production and conversion	Good housekeeping for heavy fuel oil fired plants	50	15.744	0.01350	3705
Industrial boilers	Electrostatic precipitator (2 fields) - high sulphur solid fuel fired plants	50	15.736	0.00797	5016
Industrial boilers	Electrostatic precipitator (1 field) - high sulphur solid fuel fired plants	50	15.728	0.00773	5178
Other combustion in industry	Electrostatic precipitator (1 field) - derived coal fired	50	15.726	0.00189	5295

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
	plants				
Combustion in domestic and commercial sector	Non catalytic new wood stoves	10	15.391	0.33590	5746
Traffic (non road) - agriculture	Euro I for diesel engines	4.07	15.387	0.00342	5839
Traffic (non road) - inland waterways	Euro I for diesel engines	83.33	15.382	0.00554	7225
Traffic (non road) - construction machinery	Euro II for diesel engines	8	15.377	0.00423	9461
Traffic (non-road) - 2-stroke off road	Stage II controls for gasoline engines	100	15.366	0.01122	9805
Other combustion in industry	Electrostatic precipitator (2 fields) - derived coal fired plants	50	15.364	0.00195	10260
Traffic (non road) - construction machinery	Euro III for diesel engines	24	15.351	0.01268	14192
Traffic (non road) - agriculture	Euro II for diesel engines	11.47	15.335	0.01654	17529
Combustion in domestic and commercial sector	Non catalytic new coal stoves	10	15.332	0.00262	19113
Traffic (road)	Euro IV for light duty vehicles on diesel	100	14.534	0.79794	19362
Traffic (non road) - agriculture	Euro III for diesel engines	17.13	14.510	0.02471	28330
Traffic (non road) - construction machinery	Euro IV for diesel engines	46.34	14.471	0.03903	29717
Traffic (road)	Stage II controls for gasoline engines on 2-stroke gasoline engines	80	14.470	0.00109	45956
Traffic (non road) - agriculture	Euro IV for diesel engines	46.34	14.381	0.08818	60447
Traffic (road)	Stage III controls for gasoline engines on 2-stroke gasoline engines	20	14.381	0.00031	65359

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
Traffic (road)	Euro IV for heavy duty diesel engines	10	14.146	0.23500	76001
Traffic (road)	Euro V for heavy duty diesel engines	90	12.031	2.11498	79230
Fugitive process emissions in small industry	Good practice - Stage 2	20	11.999	0.03167	98515
Fugitive process emissions in small industry	Good practice - Stage 1	50	11.960	0.03959	168485
Traffic (road)	Euro IV for gasoline direct injection light duty vehicles	100	11.830	0.13013	186883
Other combustion in industry	Good housekeeping for gasoil fired plants	50	11.830	0.00004	263713
Traffic (road)	Euro IV for light duty vehicles on ethanol	100	11.830	0.00005	408831
Traffic (road)	Euro IV for light duty vehicles on methanol	100	11.829	0.00010	408831
Traffic (road)	Euro IV for light duty vehicles on gasoline	100	11.752	0.07751	480173
Storage and handling: other industrial products	Good practice	100	11.751	0.00113	497778
Storage and handling: coal	Good practice	100	11.748	0.00271	515996
Storage and handling: fertilisers	Good practice	100	11.748	0.00044	547445
Storage and handling: agricultural products	Good practice	100	11.746	0.00149	576562
Traffic (road)	Stage II for heavy duty LPG fueled direct injection vehicles	100	11.746	0.00048	579854
Traffic (road)	Euro IV for light duty vehicles on LPG	100	11.730	0.01539	662041
Traffic (road)	Stage II for heavy duty gas engines	100	11.730	0.00006	662691
Traffic (road)	Euro IV for light duty vehicles on gas	100	11.730	0.00003	1325381
Traffic (road)	Stage III for 4-stroke motorcycles on gasoline	100	11.730	0.00025	1596424

Annex 9: Reduction measures for primary PM2.5 considered in the maximum feasible reduction scenario for 2020

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
-	None	-	61.270	-	-
Combustion in domestic and commercial sector	New derived coal manual single house boilers	100	61.270	0.00003	0
Brown coal mining	Good practice	100	61.270	0.00001	0
Power and district heating plants	Electrostatic precipitator (3 fields or more) - existing brown coal grate fired plants	100	61.269	0.00141	0
Power and district heating plants	Electrostatic precipitator (3 fields or more) - existing hard coal grate fired plants	100	61.260	0.00843	0
Power and district heating plants	Electrostatic precipitator (3 fields or more) - existing brown coal fluidised bed plants	100	61.258	0.00227	0
Power and district heating plants	Electrostatic precipitator (3 fields or more) - existing brown coal pulverised fired plants	100	61.241	0.01717	0
Power and district heating plants	Electrostatic precipitator (3 fields or more) - new brown coal fluidised bed plants	100	61.237	0.00341	0
Briquettes production	Electrostatic precipitator (3 fields or more) for process emissions	100	61.237	0.00004	0
Livestock - other cattle	Feed modification	100	61.236	0.00170	0
Livestock - diary cattle	Feed modification	100	61.233	0.00232	0
Livestock - pigs	Feed modification	100	61.224	0.00891	0
Livestock - poultry	Feed modification	100	61.215	0.00906	0
Fertiliser production	Fabric filter for process emissions	100	47.939	13.27590	0
Cement production	Electrostatic precipitator (3 fields or more) for process emissions	100	28.109	19.83010	35

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
Electric arc furnaces	Fabric filter for process emissions	100	27.975	0.13448	74
Waste	Ban on burning of agricultural wastes	100	26.147	1.82800	82
Waste	Ban on residential burning of waste	100	25.991	0.15600	128
Glass production	Electrostatic precipitator (3 fields or more) for process emissions	99	25.889	0.10145	197
Power and district heating plants	Electrostatic precipitator (3 fields or more) - new brown coal pulverised fired plants	100	25.853	0.03649	274
Refineries	Electrostatic precipitator (3 fields or more) for process emissions	99	25.528	0.32517	431
Power and district heating plants	Electrostatic precipitator (3 fields or more) - new hard coal pulverised fired plants	100	16.667	8.86069	495
Power and district heating plants	Electrostatic precipitator (3 fields or more) - existing hard coal fluidised bed plants	100	16.647	0.01986	503
Power and district heating plants	Electrostatic precipitator (3 fields or more) - new solid low sulphur fuel fired plants	100	15.204	1.44349	506
Power and district heating plants	Electrostatic precipitator (3 fields or more) - existing hard coal pulverised fired plants	100	15.092	0.11170	537
Other combustion in industry	Electrostatic precipitator (3 fields or more) - hard coal pulverised fired plants	100	15.056	0.03559	562
Combustion in domestic and commercial sector	Baghouse for automatic medium sized hard coal fired boilers	100	14.719	0.33692	594
Power and district heating plants	Electrostatic precipitator (3 fields or more) - new hard coal fluidised bed plants	100	13.253	1.46611	600
Other combustion in industry	Electrostatic precipitator (3 fields or more) - hard coal fluidised bed plants	100	13.240	0.01335	749
Other combustion in industry	Electrostatic precipitator (3 fields or more) - hard coal	100	13.228	0.01246	803

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
	grate fired plants				
Residential food preparation	Filter in kitchen	100	13.203	0.02474	1212
Industrial boilers	Electrostatic precipitator (3 fields or more) - solid low sulphur fuel fired plants	100	12.952	0.25064	1237
Lime production	Electrostatic precipitator (3 fields or more) for process emissions	100	12.791	0.16078	1493
Traffic (non road) - rail	Euro III for diesel engines	33.75	12.739	0.05256	1712
Traffic (non road) - rail	Euro II for diesel engines	28.75	12.712	0.02634	1899
Power and district heating plants	Electrostatic precipitator (3 fields or more) - new solid high sulphur fuel fired plants	100	12.595	0.11696	2479
Combustion in domestic and commercial sector	Cyclone for manual medium sized hard coal fired boilers	100	12.584	0.01181	2541
Combustion in domestic and commercial sector	New hard coal manual single house boilers	100	12.576	0.00729	2742
Traffic (non road) - agriculture	Euro I for diesel engines	4.07	12.573	0.00342	5839
Industrial boilers	Electrostatic precipitator (3 fields or more) - solid high sulphur fuel fired plants	100	12.557	0.01645	6080
Combustion in domestic and commercial sector	Baghouse for automatic medium sized solid low sulphur fuel fired boilers	100	12.432	0.12486	6167
Power and district heating plants	Fabric filter for heavy fuel oil fired plants	100	12.419	0.01243	7241
Traffic (non road) - inland waterways	Euro I for diesel engines	16.67	12.418	0.00111	9031
Power and district heating plants	Fabric filter for heavy fuel oil fired plants	100	12.414	0.00424	9445
Traffic (non road) - construction	Euro II for diesel engines	8	12.410	0.00423	9461

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
machinery					
Traffic (non-road) - 2-stroke off road	Stage II controls for gasoline engines	100	12.398	0.01122	9805
Other combustion in industry	Electrostatic precipitator (3 fields or more) - derived coal fired plants	100	12.394	0.00402	9948
Other combustion in industry	Fabric filter for heavy fuel oil fired plants	100	12.392	0.00280	10733
Combustion in fuel production and conversion	Fabric filter for heavy fuel oil fired plants	100	12.303	0.08907	10778
Traffic (non road) - construction machinery	Euro III for diesel engines	24	12.290	0.01268	14192
Industrial boilers	Fabric filter for heavy fuel oil fired plants	100	12.289	0.00062	16219
Traffic (non road) - inland waterways	Euro VI for diesel engines	66.67	12.276	0.01327	16574
Traffic (non road) - agriculture	Euro II for diesel engines	11.47	12.259	0.01654	17529
Traffic (road)	Euro IV for light duty vehicles on diesel	25.2	12.058	0.20108	19346
Traffic (non road) - agriculture	Euro III for diesel engines	17.13	12.034	0.02471	28330
Traffic (road)	Euro VI for light duty vehicles on diesel	74.8	11.347	0.68708	28876
Traffic (non road) - construction machinery	Euro IV for diesel engines	9.9	11.340	0.00690	28982
Combustion in domestic and commercial sector	New catalytic domestic wood stoves	100	7.074	4.26535	34799
Traffic (non road) - construction machinery	Euro VI for diesel engines	46.1	7.042	0.03220	35094
Traffic (road)	Stage II controls for gasoline engines on 2-stroke gasoline engines	100	7.041	0.00109	45956

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
Combustion in domestic and commercial sector	Catalytic insert for fireplaces	100	6.641	0.39988	46089
Traffic (road)	Stage III for heavy duty vehicles on ethanol	100	6.641	0.00020	50294
Combustion in domestic and commercial sector	Good housekeeping for heavy fuel oil fired installations	100	6.640	0.00086	58480
Traffic (non road) - agriculture	Euro IV for diesel engines	8.77	6.623	0.01668	60536
Traffic (road)	Stage III controls for gasoline engines on 2-stroke gasoline engines	100	6.623	0.00031	65359
Traffic (road)	Stage III for heavy duty vehicles on methanol	100	6.622	0.00099	70412
Traffic (non road) - agriculture	Euro VI for diesel engines	37.58	6.550	0.07164	71470
Traffic (road)	Euro IV for heavy duty diesel engines	10	6.315	0.23500	76001
Traffic (road)	Euro V for heavy duty diesel engines	12	6.033	0.28200	79221
Traffic (road)	Euro VI for heavy duty diesel engines	78	4.128	1.90555	82727
Traffic (non road) - rail	Euro VI for methanol engines	100	4.128	0.00024	85077
Combustion in domestic and commercial sector	New catalytic domestic hard coal stoves	100	4.084	0.04360	90596
Fugitive process emissions in small industry	Good practice - Stage 2	100	3.926	0.15835	98641
Traffic (road)	Euro IV for gasoline direct injection light duty vehicles	15	3.906	0.01952	186985
Power and district heating plants	Fabric filter for gasoil fired plants	100	3.906	0.00012	245740
Traffic (road)	Euro VI for gasoline direct injection light duty vehicles	85	3.793	0.11331	268030
Traffic (road)	Euro IV for light duty vehicles on methanol	25.2	3.793	0.00002	405586
Traffic (road)	Euro IV for light duty vehicles on gasoline	25.2	3.773	0.01953	480202

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
Storage and handling: other industrial products	Good practice	100	3.772	0.00113	497778
Storage and handling: coal	Good practice	100	3.769	0.00271	515996
Other combustion in industry	Fabric filter for gasoil fired plants	100	3.769	0.00025	518838
Traffic (road)	Euro VI for light duty vehicles on ethanol	74.8	3.769	0.00004	533585
Storage and handling: fertilisers	Good practice	100	3.769	0.00044	547445
Storage and handling: agricultural products	Good practice	100	3.767	0.00149	576562
Traffic (road)	Stage II for heavy duty LPG fueled direct injection vehicles	17	3.767	0.00008	609091
Traffic (road)	Euro IV for light duty vehicles on LPG	25.2	3.763	0.00388	662587
Traffic (road)	Euro VI for light duty vehicles on methanol	74.8	3.763	0.00007	666982
Traffic (road)	Euro VI for light duty vehicles on gasoline	74.8	3.704	0.05939	701289
Combustion in domestic and commercial sector	Good housekeeping for gasoil fired installations	100	3.703	0.00074	729375
Traffic (road)	Stage III for heavy duty vehicles on LPG	17	3.703	0.00041	739697
Construction activities	Spraying water at construction sites	100	3.702	0.00108	762436
Traffic (road)	Stage III for heavy duty vehicles on gas	83	3.701	0.00005	789011
Combustion in domestic and commercial sector	New catalytic domestic derived coal stoves	100	3.701	0.00036	805556
Traffic (road)	Euro IV for light duty vehicles on ethanol	25.2	3.701	0.00001	811172
Traffic (road)	Stage II for heavy duty gas engines	17	3.701	0.00001	974545
Traffic (road)	Euro VI for light duty vehicles on LPG	74.8	3.689	0.01180	1007176
Traffic (road)	Stage III for 4-stroke motorcycles on gasoline	100	3.689	0.00025	1596424

Sector	*Measure*	*Degree of implementation* *%*	*Total emission* *ktonne/yr*	*Reduction by measure* *ktonne/yr*	*Marginal cost* *€/tonne*
Traffic (road)	Euro IV for light duty vehicles on gas	20	3.689	0.00001	1656726
Traffic (road)	Euro VI for light duty vehicles on gas	80	3.689	0.00002	2021345