Next phase of the European Climate Change Programme: Analysis of Member States actions to implement the Effort Sharing Decision and options for further community-wide measures

A report for DG Climate Action

Appendix 1: Greenhouse gas emissions projections, emissions limits and abatement potential in ESD sectors

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Executive Summary

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It is important to note that results presented in this report represent a snap shot of the policy gap at a given point in time. Additional greenhouse gas mitigation policies, introduced subsequently to the latest emissions modelling, will reduce the extent of the policy gap. For example, the most recent projections from Member States suggest further closure of the policy gap[1] than presented in the current report.

The Effort Sharing Decision (ESD) was agreed by the EU as part of the Climate and Energy package in December 2008. It sets national emission limits for greenhouse gas (GHG) emissions in the ESD sectors in the 27 EU Member States in 2020. The ESD covers emissions from all sources outside the EU's Emissions Trading System (ETS), except for international maritime emissions and emissions and removals from land use, land-use change and forestry (LULUCF)

This report is the second deliverable under the contract "*Next phase of the European Climate Change Programme: Analysis of Member States actions to implement the Effort Sharing Decision and options for further community-wide measures*". It has been prepared by AEA, in collaboration with Alterra, Ecofys and Fraunhofer ISI.

The overall objective of the project is to assist the European Commission and Member States in preparing and implementing successful policies and measures in order to fulfil their national commitments under the ESD. This report provides a summary of the work carried out under the project to date. It includes a description of the main tasks that have been completed, the methodologies that have been employed and the initial results.

Emissions projections – EU wide

Projections of future emissions within the scope of the ESD are available from EU wide modelling (such as the outputs from the PRIMES and GAINS models) and from modelling undertaken by Member States of emissions at a national level.

Current projections suggest that with measures in place mid 2009 the EU-27 will not meet its target reduction in emissions from the ESD sectors of about 10% by 2020 compared to 2005. This is the outcome from both the PRIMES/GAINS EU wide modeling, and Member States' own projections[2].

The PRIMES/GAINS analysis suggests a 'policy gap' equivalent to 5.8% of the 2005 emissions levels, with Member State projections suggesting a gap of 1.6% to 10.0% depending on the assumed take up of additional measures. This 'policy gap' represents the additional reduction in emissions required to meet the ESD target, across all of the relevant emissions sources.

Projected performance against target has also been assessed for those Member States with an emissions growth limit, as a group, and those Member States with an emissions reduction target, as a separate group. The projections suggest that the 'growth limit' group is on track to meet its overall target. The 'reduction target' group is projected to fall short of its target by between 2 and 11 percent.

[1] Eleven Member States are expected to meet their targets with existing policies and measures. A further seven Member States would meet their targets with planned additional policies and measures. Finally, nine Member States are unlikely to deliver on their commitments even with the additional measures foreseen for now. As regards EU-27, the estimates show that the overall non-ETS target would be delivered. (European Commission, Progress report toward meeting Kyoto Objectives, 2011).
[2] As Member States continually prepare updated projections, these conclusions may not represent the most up to date projections for all Member State. A cut off date of June 2010 was used when selecting the most recent projections.

Table ES1: Comparison of the relative policy gap in 2020 under different projections (negative policy gap indicates further reductions are needed to meet 2020 target)

POLICY GAP (% difference to target)	EU-27	Reduction Targets	Growth Limits
PRIMES / GAINS Baseline	-5.8%	-7.9%	4.2%
MS Projection (WEM)	-10.0%	-11.2%	-3.8%
MS Projection (WAM)	-1.6%	-2.1%	1.6%

(Note - assumed ESD 2020 targets represents to the sum of the individual Member State targets: EU-27: -9.4%; Reduction targets group: -14.0%; Growth targets group: +12.5%)

The projections represent a snap shot of the policy gap at a given point in time. Additional greenhouse gas mitigation policies, introduced subsequently to the latest emissions modelling, will reduce the extent of the policy gap. However, changes in other variables (such as economic growth projections) may increase the projected gap.

A number of uncertainties surround the estimated performance of the EU, with respect to the ESD target. These include uncertainties associated with the estimation of emissions within the scope of the Decision, and uncertainties associated within the modeling of the future projections (including economic growth rates, energy prices, policy impacts etc). These uncertainties, and their treatment in the projection methodologies, mean that it is difficult to compare projections from the different sources on an equivalent basis.

By far the largest greenhouse gas contributor to the ESD is carbon dioxide, accounting for almost 70% of the global warming potential from ESD-covered emissions in 2005 in the EU-27. CO_2 emissions do not contribute to the overall slight decrease in GHG emissions projected between 2005 and 2015, and significant reductions are only achieved beyond 2020.

Policy impacts – EU wide

A number of existing and planned EU wide policies and measures will deliver emissions reductions in the ESD sectors over the target period. The policies therefore have an important role in helping Member States meet their national targets.

The EU wide projections that have been made using the PRIMES and GAINS models already include the most important policies in the 2009 baseline projections, such as the CO2 and cars regulation and EU waste legislation. Therefore the estimated ‘policy gap’ (described above) already includes the effects of these policies.

However, a few key policies have been (or are planned to be) implemented subsequent to the PRIMES/GAINS baseline, which will act to reduce emissions (and the extent of the policy gap) further. In particular, the recast of the Energy Performance of Building Directive will deliver further emissions reductions in the buildings sector and the Renewable Energy Directive will deliver additional saving in the transport and heat sectors. Finally, the regulations on CO2 emissions from vans, once implemented, is likely to deliver additional emissions reductions from road transport.

Abatement potential – EU wide

In combination, the ESD sectors of agriculture, road transport, built environment, small industry and waste have an estimated technical abatement potential in 2020, that can be considered additional to any emission savings captured within the PRIMES/GAINS baseline, of 470 million tonnes of carbon dioxide equivalents ($MtCO_2$ eq), at an EU level.

Additional mitigation policies, introduced subsequently to the PRIMES/GAINS baseline will take up a proportion of the cost-effective abatement potential, reducing the remaining potential in 2020. After accounting for the impacts of the most important EU wide policies, the remaining abatement potential in 2020 is estimated to be 397 $MtCO_2$ eq.

Of the 397 $MtCO_2$ eq. of abatement potential remaining in 2020, an estimated 156 $MtCO_2$ eq is considered to be cost effective (i.e. below zero cost, using social discount rate), without the need for any further policy support e.g. a carbon price. In other words, the efficiency savings (e.g. reducing energy consumption) delivered by the measures over their lifetimes, is more than sufficient to offset the overall cost of their implementation and maintenance. These measures therefore offer a win-win option, by delivering both emissions reductions and financial savings.

The total cost effective abatement potential remaining in 2020 is estimated to be in excess of the policy gap in 2020. This suggests that the ESD target can be met, at an EU level, at no net cost to the European economy. In fact, delivery of the ESD targets using the cost-effective abatement potential will deliver net benefits to the economy through the efficiency savings.

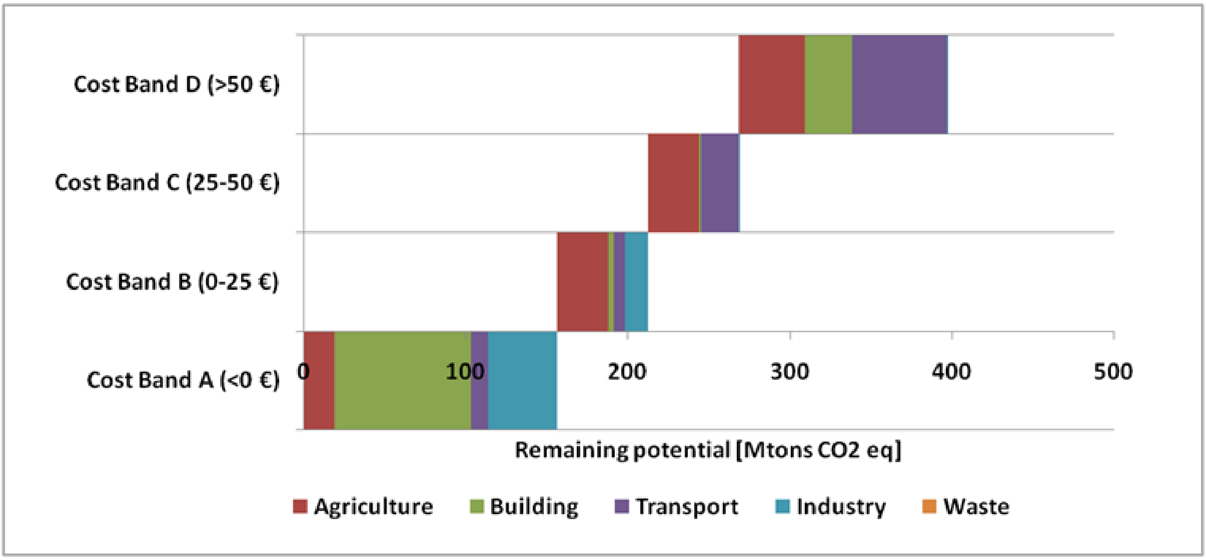
A further 56 $MtCO_2$ eq. of annual emissions reductions in 2020 is available at a cost less than €25/tCO_2 eq. Thus over 212 $MtCO_2$ eq. of abatement potential could be considered 'cost-effective' at a carbon price of €25/tCO_2 eq (see Table ES2). The take up of this cost-effective potential would represent an additional 8.5% reduction in the 2020 emission level, and a total reduction of 14% on the emission level in 2005.

Table ES2: Abatement potential in the EU per sector and per cost band

	EU 27	Agriculture	Building	Transport	Industry	Waste
Cost Band A (<0 €)	156	19	84	11	43	0
Cost Band B (0-25 €)	56	31	4	7	14	0
Cost Band C (25-50 €)	56	31	2	23	0	0
Cost Band D (>50 €)	129	41	29	58	0	0
EU wide per sector	397	122	118	100	57	0

Most of the abatement potential from the buildings and industry sectors can be realised at a negative cost. The majority of the abatement potential in the agriculture sector can be realised at a cost band <€25/tCO_2 eq. The remaining abatement potential in the transport sector is mostly at a cost >€25/tCO_2 eq. Thus each of these sectors might be expected to make a differential contribution to the overall target (see Figure ES1). Abatement potential remaining in the waste sector in 2020 is much more limited, largely as a result of the assumed effectiveness of existing policies in exhausting the potential.

Figure ES1: Abatement potential distributed over cost bands on EU level by sector.



There are uncertainties in the abatement cost analysis. The analysis, whilst based on bottom up technology estimates, has not been updated in detail to reflect new or emerging technologies, or account taken for changes in fuel prices. Furthermore, the cost estimates do not take into account certain hidden costs (e.g. time cost of installing measures) which may increase the cost estimates, or direct rebound effects (e.g. taking more heating comfort), which may reduce the emissions savings.

The estimated abatement potential is based, in most cases, upon technical measures. Therefore the potential savings do not take into account most behavioural measures (e.g. turning down the heating), which have the potential to delivery additional savings. On this basis the level of savings can be considered conservative.

Finally, the abatement potential estimates are largely based on EU wide assumptions, so may not reflect variations in technical potential or the cost of measures at a national level. Further work is required to provide a more detailed assessment of the abatement potential within specific Member States.

Agriculture sector

Emission projections

The agriculture sector in the EU-27 is responsible for emissions of 472 $MtCO_2$ eq[3] according to the latest UNFCCC submissions of 2008. This is about 9% of the total EU-wide GHG emissions and about 18% of the GHG emissions within the ESD.

The sector shows a historic trend of lower GHG emissions since 1990. This downward trend is mostly based on structural changes (less livestock) and management of nitrogen (less N mineral fertilizer use). However, as of 2006, emissions apparently stabilize.

The baseline emissions projections from PRIMES/GAINS for 2020 only show a very minor decline, from 471 $MtCO_2$ eq in 2005 to 463 $MtCO_2$ eq. in 2020. The WEM (with existing measures) projections from Member States results in almost the same projected GHG emission from agriculture for the EU-27, although among Member States larger differences occur between both projections.

The projections involve considerable uncertainty, especially in the activity data. The main drivers of GHG emission from agriculture, i.e. livestock numbers and fertilizer consumption, are difficult to predict and depend on global markets and bioenergy policies.

Policy impacts

Within the sector agriculture several EU and national policies have been identified that result in greenhouse gas emissions mitigation. However, most of these policies are not specifically aimed at climate mitigation action, but relate to actions to deal with concerns on other environmental issues. Nevertheless, these policies often have positive side-effects for climate mitigation, e.g. the Nitrates Directive and reduced nitrogen inputs.

The quantification of the mitigation potentials of these specific policies is limited. Most Member States do not provide detailed information on policy impacts, and when it is available it is typically highly aggregated, making it difficult to isolate specific policies.

The available quantified mitigation potentials reported by Member States for policies and measures (PAMs) in the agriculture sector are relatively low (i.e. 3.4 MtCO2-eq per year by 2020, less than 1% of the total emissions from agriculture). However, some Member States may have policies that deliver emission reduction but these savings are not estimated or reported.

Abatement potential

According to the projected technical mitigation potentials from the SERPEC study the total mitigation potential in agriculture could be as high as 122 $MtCO_2$-eq per year by 2020, which is in the same order of magnitude as the GAINS results. This is 26% of the projected 2020 baseline emissions from agriculture.

[3] Note, the Agriculture sector scope chosen does not include energy related emissions

The mitigation potential generally is the result of improving efficiency of nitrogen fertilizer use and lower nitrogen input, improved feed conversion in ruminants and prevention of emissions from manure storage and application.

About 25% of this projected mitigation potential comes from application of nitrification inhibitors. However, these are not yet part of any EU or national Member State policy. In Europe, the nitrification inhibitors are only applied at very small or experimental scale. In few other countries, e.g. New Zealand, their application is more widespread, and its use is also incentivized with policies and measures. The abatement potential and cost-effectiveness appear to be very country specific, which requires further research to improve the estimates of abatement potentials.

For certain measures there are some large difference in the projected emissions savings from Member State policies, and from the technical potentials in the SERPEC study. This may indicate that it might be difficult to deliver the potential emission reductions in practice. This is, in part, supported by evidence from those Member States who have examined the technical abatement potential in the agriculture sector at a national level. These estimates suggest that the savings identified using EU wide assumptions may not hold when taking into account the specific circumstances of the country.

Transport sector

Emission projections

Transport has the single largest contribution of any sector to emissions within the Effort Sharing Decision. Almost all of the greenhouse gas emissions associated with the transport sector, with the exception of emissions from aviation, are covered by the ESD. For the EU as a whole, emissions in 2020 are projected to differ by less than 1% from the level of emission seen in 2005.

While no sector specific target exists, if the transport sector were to make a proportionate contribution to the overall ESD target, in line with the emissions from the sector in 2005, then this would require further policies to be implemented – or abatement equivalent to 86 $MtCO_2$ in 2020 - based on the ESD targets for each Member States.

Member States' own projections suggest a lower level of emissions from the transport sector in 2020 than those from PRIMES/GAINS. However, on the basis of a proportionate contribution to the target, a policy gap is still projected.

Policy impacts

Existing policies will deliver important reductions in emissions from transport, and take up some of the lower cost abatement measures. In particular, the Regulation on CO2 from passenger cars and the Biofuels Directive will both have an important role.

Future policies will also deliver additional abatement. The proposed policy to limit CO2 emissions from vans and light vehicles is expected to reduce emissions from the transport sector by about 14 $MtCO_2$ eq by 2020. Also Member States' actions taken in response to the Renewable Energy Directive may deliver further reductions. These policies would reduce the overall policy gap, and take up a proportion of the abatement measures that may otherwise be available in 2020.

Abatement potential

Overall, on the basis of the updated SERPEC analysis, the sector has an estimated technical abatement potential of 100 $MtCO_2$ eq available in 2020. This is additional to any emissions reductions captured in the PRIMES/GAINS baseline, and also allows for the take up of certain measures by the proposed policy to limit CO2 emissions from vans and light vehicles.

While the transport sector has available abatement options in all of the cost bands examined, a large proportion of the abatement potential falls within the higher cost-bands. Specifically, only 11% (or 11 $MtCO_2$ eq) of the abatement potential is cost-effective without a carbon price. Around 7% (or 7 $MtCO_2$

eq) of the abatement potential can be realised at a carbon prices of €25/tCO_2 eq. Over 81% (or 81 MtCO_2 eq) of the abatement potential has a cost-effectiveness of >€25/tCO_2 eq.

This distribution may reflect the fact that there is less abatement potential in absolute terms from the low cost measures, or that a greater proportion of the low cost measures are likely be taken up in the baseline scenario – so the potential remaining in 2020 is less. Both of these explanations are plausible.

However, even with these existing policies the overall trend in emissions shows only a small decline on the level of emissions in 2005. In other words, the existing policies are expected to temper the increase in emissions, but are not sufficient to deliver significant absolute reductions in emissions from this sector. To deliver significant reductions would require the take up of more expensive technical measures, or the use of other abatement options (e.g. demand management). Alternatively, it might be more cost effective to deliver the overall ESD targets by abating emissions in other sectors.

The existing EU policy landscape (as captured in the PRIMES/GAINS baseline and the additional policies described above) targets energy performance of vehicles across most modes, and also the carbon intensity of energy used in the transport sector. Whilst the stringency of these measures could be increased (at greater cost) the policies already cover most emission sources within the scope of the ESD. One area where it could be argued that the current EU policy framework is less extensive is with respect to policies that influence activity levels (i.e. the total vehicle km). While certain instruments (e.g. fiscal policies) are largely the domain of national governments; this is potentially one area where the current policy landscape could be reinforced.

The take up of this full potential would reduce the absolute emissions from the sector, within the scope of the ESD, to 813 MtCO_2 eq. by 2020. This represents a 12% reduction in the 2005 emission level. The estimated reduction includes the impact of the proposed policy to limit CO2 emissions from vans and light vehicles.

Buildings sector

Emission projections

In the EU-27, the recent historical trend in buildings sector emissions has been a gradual decline that is partly masked by large annual fluctuations. From 1990 to 2008, the decline in emissions can be explained by the rehabilitation of existing buildings (and partly demolition) which more than compensates for the additional emissions from new (and more efficient) buildings. The fluctuations from year to year can be explained by annual ambient temperature fluctuations that lead to variations in heating demand.

According to PRIMES/GAINS the baseline emissions projections show a decline in emissions, from 690 MtCO_2 eq. to 626 MtCO_2 eq from 2005 to 2020, which is a decrease of about 9%. Thus, current projections suggest that the buildings sectors will make an important contribution to the overall ESD targets within Member States.

In the building sector the levels of future emissions are driven by new constructions, the retrofitting of the existing building stock and the demolition rate. For new construction the main drivers of emissions are the construction rate and the level of compliance with the respective building codes (i.e. under the EPBD recast). The main drivers for the existing building stock are the speed of the energy related retrofit rate, and the level of ambition of standards set by Member States.

Whilst no sector specific target exist, if the buildings sector were to make a proportionate contribution to the overall ESD target, in line with the emissions from the sector in 2005, then this would relate to an absolute emission in the EU 27 of 618 MtCO_2 eq in 2020, based on the ESD targets for each Member States. Compared to the current PRIMES baseline projection, the calculated emission reduction required to meet the ESD target is slightly lower (1%) than the current expectation.

Thus current policies are almost sufficient to reduce emissions from buildings proportionally to the ESD target. However, Member States own projections suggest higher baseline emissions in 2020, and a larger policy gap. This suggests further additional measures would be required to meet this illustrative target. This also assumes that all other sectors are able to deliver a proportionate share of the target.

Policy impacts

There have been significant policy developments in recent years for the building sector, for example the recast of the Energy Performance Building Directive (Directive 2010/31/EU). This means that a significant reduction in emissions within the buildings sector will already be delivered by current policy – assuming that the policy is effectively implemented and enforced at a national level.

A key action to unlock the remaining cost effective abatement potentials of the building stock is deep renovation (i.e., a high retrofit rate combined with high ambition level of the measures applied). This may require new policies at Member State level.

Abatement potential

The building sector has an estimated technical abatement potential equivalent to 118 $MtCO_2$ eq remaining in 2020. This is the potential after the policies included within the PRIMES/GAINS baseline are accounted for, and also additional policies such as the EPBD recast. Implementation of this full potential will reduce the baseline emissions in the sector to 466 $MtCO_2$ eq.

Of this potential 88 $MtCO_2$ eq, which corresponds to 75% of this remaining abatement potential, is cost-effective at a carbon price of <€25/tCO_2 eq. This estimate only includes emissions falling within the scope of the ESD. Further cost-effective emissions reductions are available for emissions outside the scope of the ESD (i.e. from measures that reduce electricity consumption).

Waste sector

Emission projections

Emissions from the waste sector have reduced significantly since 2005 (and before) and are projected to continue to decline to 2020. The rate of decline, however, is project to be much slower over the next 10 years than over the past 10 years.

Policy impacts

The emissions reductions have been strongly influenced by the requirements of the Landfill Directive and its controls on the disposal of biodegradable waste to land. This, and also increased landfill gas capture, have significantly reduced emissions of methane.

Assuming that the policy is effectively implemented and enforced at a national level, the Landfill Directive will continue to influence waste policy and emissions in the future, and Member States policies are often designed to meet the requirements of the Landfill Directive.

Abatement potential

Existing policies are projected to exhaust most of the technical abatement potential identified in the SERPEC (Sectoral Emission Reduction Potentials and Economic Costs for Climate Change Project) analysis. Other studies have identified some further opportunities for abatement, including emissions from wastewater treatment. These options may deliver further additional emissions reductions, but are likely to require additional policies interventions in order to be realised.

Industry sector

Emission projections

Industrial emissions covered by the ESD cannot be estimated as easily as emissions from other sectors, due to uncertainties about the split of those industrial emissions falling within the scope of the ESD, and those within the scope of the EU Emissions Trading Scheme (ETS).

An estimated 46 % of industrial GHG emissions are captured by the ESD with current definition of the EU ETS, and 37 % after 2012 due to the increased scope of the EU ETS. The PRIMES/GAINS baselines, when disaggregated at a sub-sector level, suggest a lower share of around 27 % after 2012, which may suggests the disaggregation approach applied here underestimates the ESD share.

The disaggregated PRIMES and GAINS baselines suggest emissions from non-ETS industry may increase from 290 $MtCO_2$ eq. in 2005 to 336 $MtCO_2$ eq. in 2020 (+15.9%). Member States' own projections, when disaggregated using the ETS/ESD split from PRIMES, suggest a higher level of emissions from the industrial sector in 2020 (416 $MtCO_2$ eq.). This difference occurs less with process-related emissions but more for the energy-related emissions (211 $MtCO_2$ eq. for the PRIMES/GAINS baseline projection and 286 $MtCO_2$ eq. for the Member State projections).

Policy impacts

At present there are few common EU polices to tackle direct emissions from non-ETS industry (while for indirect emissions, instruments like the Eco-design Directive exist).

At a national level, additional measures, i.e. policies planned but not implemented, may reduce emissions further by the relatively small number of 18 $MtCO_2$eq.

Whilst no sector specific target exists, if the non-traded industry sector were to make a proportionate contribution to the overall ESD target of 10 %, in line with the emissions from the sector in 2005, then this would require further policies to be implemented – or abatement equivalent to around 58 $MtCO_2$ eq. in 2020- - based on the ESD targets for each Member States.

Abatement potential

According to our analysis there is still at least a cost effective potential of close to 60 $MtCO_2$eq. remaining in the non-ETS industry. Most of the potentials in the non-ETS industries are cost-effective and rather equally split across Member States.

The gap to the target if applied uniformly across the sectors is comparatively high for the non-traded industries across most EU Member States including the new EU Member States. Energy efficiency options constitute the most important fields of action in those non-ETS industries. Actions to reduce emissions from non-ETS industries include reduction in space heating requirements (some non-ETS industries have 50 % space heat shares), industrial steam boilers (around 30% of industrial fuel use is for steam raising), improved furnaces and dryers, improved industrial processes.

There are large indirect abatement potentials in non-ETS industries due to electricity savings (164 $MtCO_2$ eq. by 2020). Although the issue of indirect emissions from electricity use is cross-cutting over all sectors, it is particularly relevant for the non-ETS industries. These potentials are economic but are frequently hampered by non-economic barriers; hence the price signal from the EU ETS is not sufficient and specific instruments may be required to address them.

Member State results

Emissions projections

Projections based on PRIMES and GAINS baselines predict that only 10 of the EU-27 Member States will meet or exceed their requirement under the ESD, with domestic actions alone. Furthermore, PRIMES and GAINS projections show nine Member States with a policy gap of over 10% (i.e. 10% further reduction between 2005 and 2020 is required under the ESD than is projected).

Member States' own projections paint a similar overall picture, though there are marked differences for some Member States. Overall, Member States' '*with existing measures'* projections agree with PRIMES and GAINS modelling in the direction of the policy gap (whether the Member State is projected to meet its ESD target or not) for all but 9 of the EU-27.

On the basis of the PRIMES/GAINS projections, only one of the Member States in the reduction targets group (Greece) is projected to meet its respective targets in 2020. In contrast, 9 of the 12 Member States in the growth limits group have projected emissions in 2020 within the required limits

It is encouraging to note that Member States' *with additional measures* projections indicate a considerable narrowing of the policy gap, which may indicate the impact of policies not included in the PRIMES/GAINS baseline, such as recent national policy measures, the implementation of the renewable energy directive or the implementation of the recast of the buildings directive.

Policy impacts

Under the EU Monitoring Mechanism Decision Member States are require to report information on their policies and measures to reduce greenhouse gas emissions. However reporting of information on policies is incomplete, and the policy information that is reported is not always consistent between Member States. These limitations make it difficult to draw firm conclusion on the impacts of individual policies and measures at a Member State level.

Abatement potential

The abatement potential has been assessed relative to the latest PRIMES/GAINS projections. It takes into account the potential take up and effectiveness of the individual abatement measures at a Member State level. The performance of certain measures has necessarily been based on EU wide assumptions. The results for individual Member States are therefore subject to a greater level of uncertainty than for the EU as a whole.

In terms of the relative share of the cost-effective abatement potential at a Member State level, 20 of the Member States have the most or second most share of cost-effective remaining abatement potential in the building sector, 16 in the agriculture, 13 in the industry and just five in the transport sector (see Table ES3).

The following table shows the cost-effective abatement potential at a carbon price of €25/tCO2 eq and the share of the remaining cost-effective abatement potential from each sector. The dark blue coloured cells indicate sectors with the most or the second most share of the cost-effective remaining abatement potential. The cost-effective potential is country specific; the percentage score reflects the distribution of abatement potential in the respective Member State.

Table ES3: Share of remaining cost-effective abatement potential in each sector by Member State

Member state	Total remaining cost effective potential [MtCO2 eq]	Share of cost-effective potential (Cost band A and B) per sector [%]				
		Building	Transport	Agriculture	Industry	Waste
AUSTRIA	5,066	18%	0%	17%	65%	0%
BELGIUM	7,785	70%	0%	30%	0%	0%
BULGARIA	957	59%	0%	41%	0%	0%
CYPRUS	131	56%	0%	14%	30%	0%
CZECH REPUBLIC	4,955	35%	0%	18%	47%	0%
DENMARK	4,287	6%	1%	65%	28%	0%
ESTONIA	487	4%	14%	19%	63%	0%
FINLAND	945	45%	0%	55%	0%	0%
FRANCE	30,072	34%	21%	28%	17%	0%
GERMANY	32,694	50%	1%	23%	26%	0%
GREECE	4,434	35%	29%	9%	27%	0%
HUNGARY	2,232	32%	26%	42%	0%	0%
IRELAND	4,757	48%	2%	46%	4%	0%
ITALY	14,889	61%	0%	21%	18%	0%
LATVIA	690	43%	28%	17%	12%	0%
LITHUANIA	1,108	37%	29%	34%	0%	0%
LUXEMBOURG	575	30%	0%	11%	59%	0%
MALTA	40	65%	0%	10%	25%	0%
NETHERLANDS	13,624	39%	6%	29%	27%	0%
POLAND	12,987	67%	5%	28%	0%	0%
PORTUGAL	5,405	6%	77%	6%	10%	0%
ROMANIA	1,725	0%	13%	87%	0%	0%
SLOVAKIA	1,022	30%	37%	34%	0%	0%
SLOVENIA	538	20%	0%	29%	51%	0%
SPAIN	25,599	36%	0%	15%	49%	0%
SWEDEN	2,717	0%	13%	25%	62%	0%
UNITED KINGDOM	32,696	39%	6%	15%	40%	0%

Considering the PRIMES 2009 projections and including additional policies implemented subsequent to the baseline projections, 16 Member State still have an apparent policy gap in terms of the annual emissions 2020 (and 11 Member States do not).

Of the 16 Member States with an apparent policy gap in 2020, 7 Member States have a cost-effective abatement potential (at a carbon price of €25/tCO_2 eq.) that is sufficient to close the policy gap. Taking into account all remaining abatement potential (also not cost-effective), 4 more Member States have sufficient potential to close the policy gap. Therefore, 5 Member States have an estimated technical abatement potential that is less than the estimated policy gap, when measured in terms of the annual emissions in 2020.

In practice, the extent of the policy gaps, and of the abatement potential is more uncertain. The estimated abatement potential at a country level is uncertain, and further work is required to improve the estimates. In addition, even if the estimated abatement potential were correct, Member States are able to utilise the flexibility provisions allowable under the Decision (e.g. transfer of allocations) to help them meet their targets. Furthermore, additional abatement potential is available from some abatement measures not captured in the analysis above (e.g. from behavioural measures). Therefore, the analysis of the policy gap is indicative of the situation in a given Member State, but by no means definitive,

Member States' preparedness and capacity to implement necessary measures for meeting their commitments under the ESD

A high level of preparedness is important for all Member States irrespective of whether they are projected to meet their ESD targets.

Out of the 27 Member States surveyed, 10 (37%) were assessed to be well prepared, 6 (22%) were assessed to have average preparation and 11 (41%) were assessed to have poor preparation and capacity to address their ESD targets.

Of the 10 Member States that are assessed to be well prepared, the majority are northern European countries with the exception of 2 southern European Member States. All of the 11 Member States assessed to be poorly prepared are either southern European or eastern European. Of the 6 Member States assessed as having average preparation, 3 are northern European and 2 are eastern European.

An assessment that a country is well prepared is not necessarily an indication that they will meet their ESD targets, more it is an indication that the government is aware that there is a gap and they are engaging in relevant policies and practices to try and close the gap. Likewise poor preparedness does not necessarily indicate that a country will not meet its targets.

Poor preparedness is more an indication of one of the following things: That the country is expected to meet its targets easily and does not recognise the potential value of transfers, that the country is expected not to meet it targets and is either not aware that further action is needed and/or there is little evidence that the country is actively preparing itself to meet the targets.

Table ES4: Number of Member States that are expected to meet/not meet their ESD targets and how well prepared they are to address any gaps.

Assessment	Number of Member States	%
Expected to meet ESD targets, good preparedness and capacity	2	7
Expected to meet ESD targets, average preparedness and capacity	2	7
Expected to meet ESD targets, poor preparedness and capacity	6	22
Not expected to meet ESD targets, good preparedness and capacity	8	30
Not expected to meet ESD targets, average preparedness and capacity	4	15
Not expected to meet ESD targets, poor preparedness and capacity	5	19
Total number of Member States assessed	**27**	**100**

The results presented above can be compared with the results from a questionnaire sent to Member States prior to the stakeholder conference that was held as part of the project in November 2010. Of the 9 Member States that returned the completed questionnaire 6 of these agreed with our initial analysis in terms of their overall level of preparedness. Of the 3 that did not agree 2 of these reported themselves as good but were as assessed on the basis of our methodology as poor. This difference might be explained by the fact that certain activities may be underway, but not captured by our simple indicators. Our results therefore represent the worst case scenario in most cases. In the one remaining case our scoring suggested a more favorable level of preparedness than the Member States own scoring.

It is also important to note that the evaluation represents a 'snap shot' based on the published evidence available at a given point in time (i.e 2010). Member States' relative preparedness and capacity will change (and hopefully improve) over time. In particular, activities that are 'in preparation' but not published may not be captured in this initial assessment.

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Appendices

Glossary

Term	Definition
Baseline scenario	This is an emissions projection scenario. The baseline usually represent the 'business as usual' situation, and is used assess the relative impacts of new policies of measures, or alternative modelling assumptions. The baseline will include the impacts of socio-economic drivers on emissions, as well as the impacts of policies already in place.
Without Measures scenario	In relation to Member States reporting of emission under the EU Monitoring Mechanism, the Without Measures scenario represents the Member States baseline emissions projection prior to the introduction of climate policies. This is not necessarily consistent with the baseline scenario used in other models.
With Existing Measures (WEM) scenario	In relation to Member States reporting of emission under the EU Monitoring Mechanism, the With Existing Measures scenario includes the effect of adopted and implemented policies
With Additional Measures (WAM) scenario	In relation to Member States reporting of emission under the EU Monitoring Mechanism, the With Additional Measures scenario includes the effect of planned policies
ESD policy gap	For a given Member State, this is the estimated difference between the projected change in emissions between 2005 and 2020 under the baseline scenario, and the Member States' target under the Effort Sharing Decision
Frozen technology reference level (FTRL) scenario	When assessing abatement potential, the FTRL scenario allows 'bottom up' estimates of the abatement potential from individual measures to be compared with the emissions projections derived from 'top down' models. In the FTRL all the characteristics of the baseline emission scenario from the top down model are assumed, with the exception of technology characteristics which remain 'frozen' at the 2005-level. As a result, autonomous and policy-driven efficiency improvements are not taken into account in the FTRL.
Abatement potential (FTRL)	This is the overall abatement potential of abatement technologies, when expressed relative to the FTRL scenario i.e. the emissions abatement potential of new technologies is compared with the average performance of comparable technologies in 2005.
New abatement potential	When analysing the abatement potential of measures, the new abatement potential represents the total abatement potential (FTRL) minus the potential already taken up in the baseline (i.e. it represents the difference between the FTRL scenario and the Baseline scenario)

1 Introduction

This report is the second deliverable under the contract "*Next phase of the European Climate Change Programme: Analysis of Member States actions to implement the Effort Sharing Decision and options for further community-wide measures*". It has been prepared by AEA, in collaboration with Alterra, Ecofys and Fraunhofer ISI.

1.1 Overview of the ESD

The Effort Sharing Decision (ESD) was agreed by the EU as part of the Climate and Energy package in December 2008. It sets national emission limits for greenhouse gas (GHG) emissions in the ESD sectors in the 27 EU Member States in 2020. The ESD covers emissions from all sources outside the EU's Emissions Trading Scheme (ETS), except for international maritime emissions and emissions and removals from land use, land-use change and forestry (LULUCF). The ESD covers a number of sectors and sources. In order of importance, the three largest sectors are:

- Energy use in road transport,
- Energy use in the built environment and
- Emissions from agriculture.

Other sources include emissions from less energy intensive businesses in the industry sector; methane emissions from waste; industrial process emissions (including F-gases) and fugitive emissions from the energy sectors (leakage of gas pipelines, coal mining).

Table 1-1: Total GHG emissions within the scope of the ESD, by sector, in 2005

Sector	Mt CO_2 eq.
Energy sector	101.8
Energy use in industry	167.4
Energy use in households	498.6
Energy use in services and other	262.2
Energy use in transport	924.4
Industrial processes	122.6
Waste	146.6
Agriculture	471.0
Total emissions	**2,688**

Source: PRIMES and GAINS (see section 2.2.1 for a definition of the scope)

The Decision defines linear legally binding emissions trajectories in Member States for the period 2013-2020 with annual monitoring and compliance checks. It also provides flexibility for Member States in reaching their targets by allowing transfers of annual emissions allocations between years, between Member States and the use of external credits through the Clean Development Mechanism. From a national perspective, the ESD can be regarded as a (flexible) emissions ceiling, which can be achieved via multiple sectors, comprising both national and Community wide instruments.

Under the ESD, all Member States have individual 2020 emissions targets, which, based on the original estimates, average out at -10% for the EU as a whole compared to 2005. In Member States where GDP/capita exceeds the EU average, a deeper emissions reduction than the EU average is required, up to -20% below 2005. Countries with a low GDP per capita will be allowed to increase their emissions in ESD sectors by up to 20% above 2005 levels. This approach reflects projections that their relatively higher economic growth in the next decade will be accompanied by increased emissions in, for instance, the transportation sector. Nevertheless, these targets still represent a limit on their total emissions and will require a reduction effort also in these Member States.

Delivery of these targets will be challenging, and will require additional policy interventions. Typically, in the early phase of a policy development cycle, 'getting the data right' is a key issue. This will involve important analytical work such as agreeing emissions baselines, quantifying future impacts of policies, improving monitoring of emission sources and clarifying unclear sector definition. Furthermore, in order to deliver cost-effective policies, evidence is required on the technical and behavioural measures and the policies options that can be used to implement the abatement activities. Finally, the ‘multiple sector’ character of the ESD will require Member States to build upon and bring together sectoral governance structures. This is also likely to require greater engagement with regional and local delivery agencies.

1.2 Study objectives

The overall objective of the project is to assist the European Commission and Member States in preparing and implementing successful policies and measures in order to fulfil their national commitments under the ESD. The specific objectives of the project are to:

1. Examine and assess Member States' preparedness, capacity and performance in implementing emission reduction policies and measures in the ESD sectors in order to achieve their national targets under the ESD;
2. Support the European Commission in preparing for further community-wide policies and measures to support Member States in achieving their national targets under the ESD;
3. Facilitate an exchange of information between the European Commission and relevant authorities in the Member States in order to ensure that they define and implement timely and adequate measures to comply with their national emission limits in the ESD.

This report contributes directly to each of these objectives.

1.2.1 Scope of this report

This report provides a summary of the work carried out under the project to data. In includes a descriptions of the main tasks that have been completed, the methodologies that have been employed and the initial results. More specifically the report includes, in accordance with the project specification:

- A detailed analysis of the emissions in each country;
- A detailed analysis of Member State projections and a comparison with other EU wide projections;
- An analysis of the expected gaps within each Member State for meeting their commitments under the ESD;
- An assessment of the cost-effective abatement potentials in the various sectors and sub-sectors;
- An analysis of Member States preparedness and capacity to implement necessary measures for meeting their commitments under the ESD;
- An identification of best practice mitigation policies at national level;
- An assessment of existing community-wide policies and measures in sectors covered by the ESD and their expected effects in terms of quantitative emissions reductions in each Member State by 2020 and 2030.

1.2.2 Report structure

In addition to this introduction, the report is structured as follows:

- **Section 2** describes the methodology that has been followed for each of the individual tasks, including the key challenges that have been overcomes.
- **Section 3** provides a summary of the main results from the analysis performed to date
- **Section 4** provides some discussion of the results to date, and draws conclusions

The appendices provide supplementary information relating to the work carried to date.

- **Appendix 1** summarises the policies included within the PRIMES and GAINS baseline scenarios

- **Appendix 2** and **Appendix 3** provide further details on the approach has been followed to update the abatement cost estimates from previous research (SERPEC)
- **Appendix 4** illustrates a results matrix for comparing performance across Member States

2 Methodology

This section describes the methodology that has been followed. For each of the main tasks a brief description is provided on the approach that has been implemented, the data sources that have been drawn upon and the analysis that has been carried out. Key assumptions and sensitivities with the approach used are highlighted where relevant.

2.1 Emissions in the base year

The starting point for the analysis is an assessment of the scope and scale of emissions that are captured by the Effort Sharing Decision. From this it is possible to project the trend in these emissions in the future, and then compare this trend with the emissions limits that have been agreed by each of the individual Member States under the Decision. This will identify those countries that are expected to meet their targets, and those that have an apparent ‘policy gap’.

2.1.1 Emissions targets

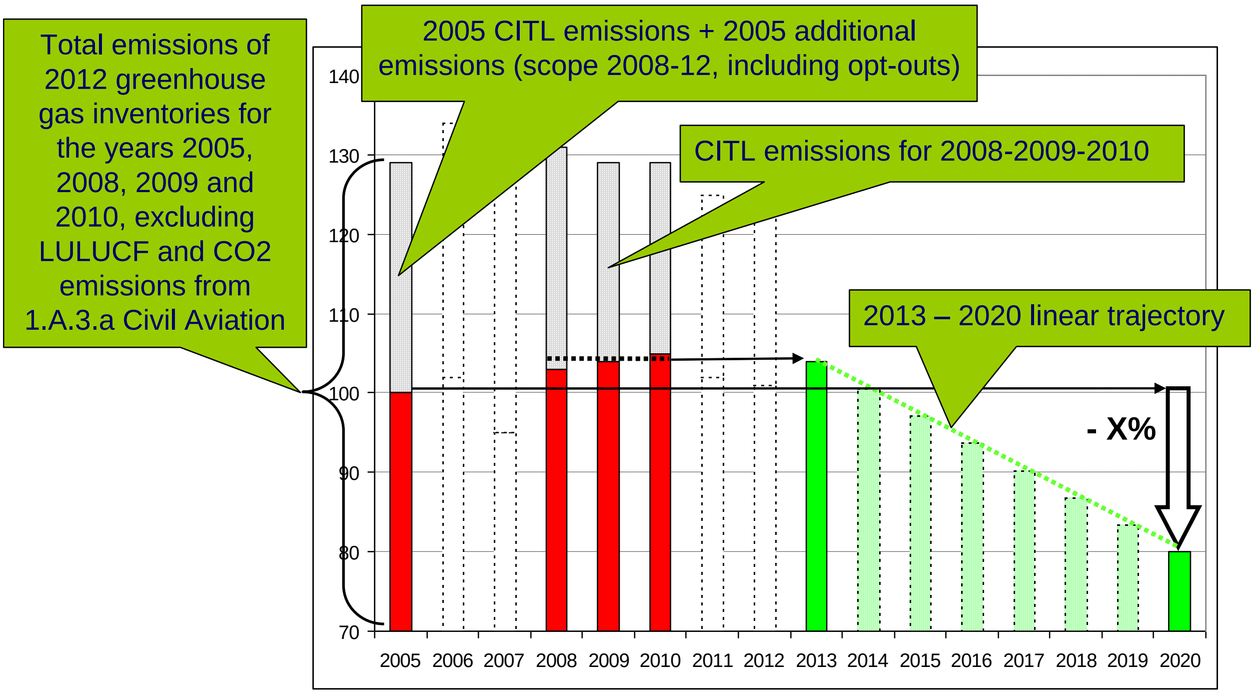
Under the Decision, the 2020 level of effort that has been agreed by Member States has been determined in relation to the level of its 2005 greenhouse gas emissions covered by the Decision. Emissions from installations and sources that existed in 2005 but which were brought into the EU Emission Trading System in the period from 2006 to 2012, or were temporarily excluded from the EU ETS in 2005, should be taken into account.

Member States have annual binding emission limits in accordance with a linear trajectory and they must report their emissions to the Commission each year in the period 2013-2020. This will ensure a gradual move towards their 2020 targets in sectors where change takes time, such as buildings, infrastructure, and transportation. An illustration of how this calculation could be applied is shown in the figure below.

The figure describes the situation for Member States with a negative emission limit. In this case the Member State is required to ensure that its GHG emissions in 2013 do not exceed its average annual GHG emissions during 2008, 2009 and 2010, and from 2013, the linear trajectory to the 2020 target. A Member State with a positive emission limit must ensure its GHG emissions in 2013 do not exceed a level defined by a linear trajectory starting in 2009. The percentage reduction or increase for each Member State is defined in Annex II of the Decision. The intention is that absolute emissions targets will be set for Member States by October 2012 once the 2010 reviewed emissions inventories become available.

The Decision allows a further adjustment to the annual targets to take into account changes in the scope of the Emissions Trading System (ETS) from 2013. For example, annual target may be reduced to take out emissions from installations that are part of the ETS for the first time in Phase III.

Figure 2-1: Setting absolute emissions targets under the Decision



Source: EU Commission, Climate Change Committee Working Group II, 28th September 2010

An initial estimate has been made of the scope of emissions covered by the Decision in each Member State, for use in this study. This represents an indicative estimate based on the emissions data available to date. This estimate will differ from the emissions used to assess the compliance against the final agreed targets. However, we consider the estimate provides a reasonable indication of the magnitude of the target that each Member State will be expected to achieve under the Decision.

It is also important to recognise that as part of the delivery of their target Member States are able to utilise certain flexibility provisions. These include measures within the Member State itself. Specifically, overachievement during 2013-2019 can be carried over to subsequent years, up to 2020. Flexibility provisions can also be used between Member States. Member States may transfer up to 5% of their annual emission allocation to other Member States, which may use this emission allocation until 2020 (ex-ante). Also overachievement in 2013-2020 may be transferred to other Member States, which may use this emission allocation until 2020 (ex-post). Finally, Member States can utilise project based (i.e. JI/CDM) credits to help meet their targets. Partly as a result of these flexibility provisions, the actual trajectory of emissions within a Member State, over the commitment period, may be different to a simple linear trend.

For each Member State, the emissions within the scope of the Decision have been estimated based upon the emissions data reported by Member States in their National Inventory Report (NIR). In most cases, the latest NIR reports submitted by Member States did not specifically differentiate between the emissions that are within the scope of the Decision and those outside. It was therefore necessary to approximate the extent of emissions covered by the Decision using additional data, as described below.

For each Member State, its estimated 2020 emissions target was calculated using the following two-step calculation. This is consistent with the approach that will be used to set the actual target:

Step 1: Calculate the initial 2020 ESD emissions limit

The following equation was used for estimating 2020 emissions target:

$$\textbf{ESD 2020}_{\text{initial}} = (\textbf{Total 2005}_{\text{Annex I}} - \textbf{ETS 2005}_{\text{Scope 08 – 12}}) * (1 +/- X\%)_{\text{Annex II}}$$

Where:

- **2005** $_{\textbf{Annex I}}$ is the total emissions from all sectors listed in Annex I of the Decision in year 2005.
- **ETS 2005** $_{\textbf{Scope 08 – 12}}$ is the total emissions covered by the EU ETS in 2005, assuming the EU-ETS scope in the 2008-2012 period including opt-outs. This will be derived from the Community International Transaction Log (CITL). The CITL records the issuance, transfer, cancellation, retirement and banking of allowances that take place in the EU registry.
- **(1 +/- X%)** $_{\textbf{Annex II}}$ is the increase or decrease in emissions compared with 2005 permitted under Annex II of the Decision, where X% is the respective Member States' limit.

In order to provide a current estimate of the 2020 target, we estimated each element of the above formula as follows:

- **2005** $_{\textbf{Annex I}}$ was estimated by taking the total GHG emissions (excluding LULUCF) from the 2008 national emissions inventory[4], noting that this value includes domestic but not international aviation. Domestic aviation was then subtracted from this total, using estimates from the UNFCCC data viewer (1.A.3.A. Civil Aviation), as this will be captured within the EU ETS from 2012.
- **ETS 2005** $_{\textbf{Scope 08 – 12}}$ was estimated based on CITL data, together with the European Commission's review of Member States National Allocation Plans (NAPs) for Phase II of the ETS (European Commission, 2007). The latter document included Member States' initial estimates of installations that will come under the scope of the EU ETS in 2008 to 2012 due to, for example, an extended scope applied by Member States.
- **(1 +/- X%)** $_{\textbf{Annex II}}$ was taken directly from Annex II of the Decision.

Step 2: Calculate the adjusted ESD emissions limit after accounting for allowances from 2013

Article 10 of the Decision allows an adjustment to the emissions limits for Member States to take into account emissions from installations within the scope of the EU ETS from 2013 onwards (i.e. Phase III), that were not part of the ETS in previous years. The adjustment will be made on the basis of allocated allowances from 2013.

The quantity of emissions in 2005 arising from installations that are expected fall within the extended scope of the ETS from 2013 is still uncertain. In the absence of a better estimate, an approximation has been made on the basis of reported emissions from certain source categories that reflect key sectors falling within the phase 3 scope. Specifically, emissions from the following activities were subtracted from the 2005 base year emissions, based on estimates taken from UNFCCC data viewer for emissions in 2005:

- CO_2 from Ammonia Production (2.B.1) and Aluminium Production (2.C.3);
- N2O from Nitric Acid Production (2.B.2) and Adipic Acid Production (2.B.3);
- PFCs from Aluminium Production (2.C.3).

The above approach allows an initial approximation of the emissions limit (in absolute terms) in each Member State, based on currently available data.

2.2 Projected emissions to 2020

It is important to understand, for each individual Member State, the extent to which emissions within the scope of the ESD are likely to change in future years. This will provide an indication, based on current expectations, of the likelihood of each individual Member States meeting its emissions target. This will also show the expected situation for the EU as a whole.

2.2.1 EU wide projections from PRIMES and GAINS

Multi-sectoral EU wide projections are available from a range of modeling assignments. Specifically, the Commission has funded recent model runs from the PRIMES (Capros et al, 2010) and GAINS

[4] Annex 1 of the Decision defines the following categories within the scope of the Decision: Energy (Fuel combustion, Fugitive emissions from fuels), Industrial processes, Solvent and other product use, Agriculture, Waste. This effectively covers the full scope of Member States national GHG inventories, with the exception of the Land Use Land Use Change and Forestry.

supported by CAPRI (Höglund-Isaksson et al, 2010) models. These models provide multi-sectoral projections for GHG emissions across the EU 27 Member States, based upon a consistent set of assumptions which in particular include the effects of the economic crisis.

On this basis, the baseline scenarios from the PRIMES/GAINS analysis have been applied in this current study (see Section 3.3.1). This baseline scenarios modelled in PRIMES/GAINS provide projections of GHG gas emissions to 2030 based on harmonised assumptions, current trends and enacted policies by EU and Member States. The baseline also accounts for the overall ETS cap (including use of CDM) but does not assume full achievement of the ESD targets, by including only policy measures implemented by mid 2009. The same principle holds for the renewables targets, for which the heat and transport sub-sectors are also highly relevant for ESD. Also here, the PRIMES/GAINS baseline does not assume full achievement.

Within these latest projections an estimate has been made of the proportion of emissions that falls within the EU ETS, and the proportion outside of the EU ETS (i.e. within the scope of the ESD). In the GAINS projections this has been made at a sub-sectoral level, accounting for those industrial activities whose non CO_2 greenhouse gas emissions will fall under the ETS from 2013. However, for the PRIMES analysis the split has only been made on an aggregate basis i.e. across all energy sectors. No estimate has been provided of the split at a sub-sectoral level, with the exception of emissions from aviation – which will become part of the EU ETS in 2012. It is therefore necessary to approximate the scope of the emissions within each of the sub-sector that could be covered by the ESD. It should also be noted that the split reported in PRIMES is based on ETS scope relevant for the ESD decision, i.e. the ETS scope valid from 2013 including aviation and additional CO_2 and non-CO_2 process emissions.

Approximating the allocation of emissions to the EU ETS and ESD sectors, at a sub-sectoral level, is far from straightforward. Differences in the reporting of emissions data, in the definitions of process and sectors and in the consistency of assumptions can all create major challenges for allocating emissions in this way. This is further complicated by the fact that the tools and models used to project future emissions typically have less potential to disaggregate emissions in this way.

Given these complexities, and the limited resources available to this task, it has been necessary to adopt a simplified approach to allocation of emissions in the current analysis. This approach has then been compared with the results from a more refined approach, to assess the overall reliability. Further comparisons have been made with the approximations that have been made by a small number of Member States.

Based upon an understanding of the current coverage of the EU ETS, and how this relates to the sub-sectors in the PRIMES and GAINS models, the following allocation approach has been applied:

- All of the non-CO_2 emissions were assumed to be part of the ESD with the exception of emissions from the production of primary aluminium (PFC), nitric acid (N_2O), and adipic acid, (N_2O) which will be part of the EU ETS from 2013[5]. These sub-sectors could all be identified separately from the GAINS analysis.
- All of the CO_2 emissions from energy use in transport are assumed to be part of the ESD with the exception of CO_2 emissions associated with aviation, as these emissions will become part of the ETS from 2012. Aviation could be identified separately from the PRIMES analysis.
- All of the CO_2 emissions from energy use in the agriculture, household and service sectors are assumed to be part of the ESD[6], with no overlaps with the EU ETS. Each of these sub-sectors is defined separately in the PRIMES analysis.

After correcting for those emissions covered by domestic aviation, the following allocation was assumed for the remaining CO_2 emissions that were estimated in the PRIMES modelling to fall within the EU ETS sector:

- All emissions from the power and distribution sector were assumed to be covered by the EU ETS. This is identified as a separate sub-sector in the PRIMES modelling.

[55] Commission Decision 2009/73/EC of 17 December 2008 amending Decision 2007/589/EC as regards the inclusion of monitoring and reporting guidelines for emissions of nitrous oxide, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:024:0018:0029:EN:PDF
[6] The PRIMES projections are made on a production basis, so energy use includes direct fuel consumption only.

- All emissions from the ‘energy branch’ were assumed to be covered by the EU ETS. This is also identified as a separate sub-sector in the PRIMES modelling
- All of the CO2 process emissions from ammonia production and aluminium production were assumed to be part of the ETS, as they will be captured within Phase III of the EU ETS. The PRIMES analysis included an estimate of the non energy related CO2 emissions within the scope of the ETS.

Once these adjustments have been made the residual EU ETS emissions can be calculated e.g. total EU ETS emissions – power and distribution emissions – energy branch emissions – process emissions within scope III of ETS - aviation emissions – non CO_2 emissions within scope III of the ETS = residual. All of this EU ETS residual is assumed to apply to energy use in the industry sector. In other words, the ETS emissions that are not covered by any of the above sub-sector sectors are assumed to relate to emissions from the industry sector. This residual therefore defines the proportion of the emissions from the industry sector that are assumed to be covered by the EU ETS, and therefore the proportion falling within the ESD.

As noted above, the methodology that has been followed includes a number of limitations. For some of the sectors whose emissions have been allocated to the ESD (e.g. energy use in service sector) a proportion of these emissions might be captured under the EU ETS[7]. In contrast, a proportion of the emissions within the energy branch that were allocated to the EU ETS might actually fall within the scope of the ESD. In the approach followed, both of these potential errors would influence the ‘residual’ EU ETS emissions, and therefore the estimated split of emissions within the industry sector. Hence in our analysis the industry sub-sector is subject to uncertainty in terms of the split of emissions between the ETS and ESD.

2.2.2 Member State projections

Submissions of the Member States (under Article 3.1 of the Council Decision 280/2004/EC on a Mechanism for Monitoring Community Greenhouse Gas Emissions and for implementing the Kyoto Protocol, henceforth 'Monitoring Mechanism Decision') provide Member States own projections on the expected evolution of their greenhouse gas emissions to 2020. Member States are required to submit updated projections on a biennial basis. In accordance with these requirements most, but not all, Member States provided new submissions in March 2009.

Member States report their emission projections for three different scenarios: Without Measures, With Existing Measures (WEM, includes the effect of adopted and implemented policies) and With Additional Measures[8] (WAM, includes the effect of planned policies). Under the EC Monitoring Mechanism Decision, Member States are required to report quantitative estimates of the effect of policies and measures on emissions accounted for in their projection scenarios. These estimates are also compiled in the European Environment Agency’s database of climate change policies and measures.

Ideally, the quantitative estimates for the individual policies would explain the difference, for a given Member State, between the emissions projections associated with the ‘without measures’ scenario, and the ‘with existing measures’ scenario. However, this is seldom the case. Not all Member States quantify impacts of all policies. Also projections may have been made ‘top down’ and policy estimates ‘bottom up’ which can also explain the difference.

The timeliness of Member State projections is also important to consider. As described below, more recent projections are available for certain Member State than for others. This means the treatment of key emissions drivers – in particular the extent to which the projections take into account the recent economic crisis – will differ between projections prepared for different Member States, and also between Member State projections and the PRIMES/GAINS projections.

[7] For example, in the emissions projections produced for the UK (DECC, 2009) approximately 7% of service sector emission were assumed to fall within the ETS, and 3% of emissions from refineries (Energy branch) were assumed to be outside of the EU ETS.
[8] Not all Member States (Denmark, Netherlands, United Kingdom, Germany, Spain, Poland) reported WAM projections so for these countries the WAM have been set equal to the WEM projections.

In most cases, Member State projections are only available up to 2020, since this represents the current requirements under the Monitoring Mechanism. Therefore, unlike the PRIMES/GAINS analysis, it is not possible to use these projections to derive emissions estimates beyond 2020.

Selected Member States have made available updated projections more recently than the formal requirements of the Monitoring Mechanism Decision, for example, as part of a 'progress report' in relation to the MM. Likewise, for certain Member States the projections data in Member States 5th National Communications is more recent that the projections within the submission under the Monitoring Mechanism Decision. Therefore, for these Member States more recent information is available on policies introduced, or planned to be introduced. This may include policies that were not captured within the EU wide projections produced using PRIMES/GAINS. The source of the latest Member State projections used in this report is shown below. In the current analysis, for a given Member State, the most recent projections published before the 30th June 2010 has been considered.

Table 2-1: Data sources for Member State projections

Member State	Source
Austria	2009 Submission under Article 3.1 of the Council Decision 280/2004/EC on a Mechanism for Monitoring Community Greenhouse Gas Emissions and for implementing the Kyoto Protocol
Belgium	2009 Submission under Article 3.1 of the Council Decision 280/2004/EC on a Mechanism for Monitoring Community Greenhouse Gas Emissions and for implementing the Kyoto Protocol
Denmark	2010 Submission in relation to the MM Decision as requested by the EC through WG2 meeting 31st March 2010
Finland	2009 Submission under Article 3.1 of the Council Decision 280/2004/EC on a Mechanism for Monitoring Community Greenhouse Gas Emissions and for implementing the Kyoto Protocol)
France	2009 Submission under Article 3.1 of the Council Decision 280/2004/EC on a Mechanism for Monitoring Community Greenhouse Gas Emissions and for implementing the Kyoto Protocol)
Germany	5th National Communication submission under Article 4.1 and 1.2 under the UNFCCC
Greece	2009 Submission under Article 3.1 of the Council Decision 280/2004/EC on a Mechanism for Monitoring Community Greenhouse Gas Emissions and for implementing the Kyoto Protocol)
Ireland	2010 Submission in relation to the MM Decision as requested by the EC through WG2 meeting 31st March 2010
Italy	2009 Submission under Article 3.1 of the Council Decision 280/2004/EC on a Mechanism for Monitoring Community Greenhouse Gas Emissions and for implementing the Kyoto Protocol)
Luxembourg	2010 Submission in relation to the MM Decision as requested by the EC through WG2 meeting 31st March 2010
Netherlands	2009 Submission under Article 3.1 of the Council Decision 280/2004/EC on a Mechanism for Monitoring Community Greenhouse Gas Emissions and for implementing the Kyoto Protocol)
Portugal	2009 Submission under Article 3.1 of the Council Decision 280/2004/EC on a Mechanism for Monitoring Community Greenhouse Gas Emissions and for implementing the Kyoto Protocol)
Spain	2010 Submission in relation to the MM Decision as requested by the EC through WG2 meeting 31st March 2010
Sweden	2009 Submission under Article 3.1 of the Council Decision 280/2004/EC on a Mechanism for Monitoring Community Greenhouse Gas Emissions and for implementing the Kyoto Protocol)
United Kingdom	June 2010 update of GHG projections published by Department of Energy and Climate Change
Bulgaria	5th National Communication submission under Article 4.1 and 1.2 under the UNFCCC
Cyprus	2009 Submission under Article 3.1 of the Council Decision 280/2004/EC on a Mechanism for Monitoring Community Greenhouse Gas Emissions and for implementing the Kyoto Protocol)
Czech Republic	2009 Submission under Article 3.1 of the Council Decision 280/2004/EC on a Mechanism for Monitoring Community Greenhouse Gas Emissions and for implementing the Kyoto Protocol)
Estonia	2009 Submission under Article 3.1 of the Council Decision 280/2004/EC on a Mechanism for Monitoring Community Greenhouse Gas Emissions and for implementing the Kyoto Protocol)
Hungary	5th National Communication submission under Article 4.1 and 1.2 under the UNFCCC
Latvia	2009 Submission under Article 3.1 of the Council Decision 280/2004/EC on a Mechanism for Monitoring Community Greenhouse Gas Emissions and for implementing the Kyoto Protocol)
Lithuania	5th National Communication submission under Article 4.1 and 1.2 under the UNFCCC
Malta	2009 Submission under Article 3.1 of the Council Decision 280/2004/EC on a Mechanism for Monitoring Community Greenhouse Gas Emissions and for implementing the Kyoto Protocol)
Poland	5th National Communication submission under Article 4.1 and 1.2 under the UNFCCC
Romania	2009 Submission under Article 3.1 of the Council Decision 280/2004/EC on a Mechanism for Monitoring Community Greenhouse Gas Emissions and for implementing the Kyoto Protocol)
Slovakia	2010 Submission in relation to the MM Decision as requested by the EC through WG2 meeting 31st March 2010
Slovenia	2009 Submission under Article 3.1 of the Council Decision 280/2004/EC on a Mechanism for Monitoring Community Greenhouse Gas Emissions and for implementing the Kyoto Protocol)

To date, the reporting template used under the EC Monitoring Mechanism does not differentiate between EU ETS sectors and ESD sectors, although the European Commission is currently working on a new reporting template that would require this in the future. This would enable, in the future, the likely compliance under the ESD to be monitored using Member States own reported projections. However, only six Member States have to date submitted updated projections that explicitly identify the scope of emissions within the EU ETS.

Therefore, in order to estimate the split of emissions within the scope of the Decision, using Member States projections, an approximation is required on the allocation of emissions to the ETS and ESD sectors. In the absence of more detailed data, a simplistic approach was taken that drew upon the estimated splits used in the PRIMES/GAINS baseline projections. It was assumed that the same proportion of emissions in a given sub-sector fall under the EU-ETS in all sets of projections. Hence, the emissions covered by the ESD from a given sub-sector could be estimated for a Member State projection by multiplying the total emissions from the sub-sector by the percentage of emissions from the same sub-sector in the PRIMES/GAINS baseline projection that are assumed to be covered by the ESD. These estimates can be found in Section 3.1.2.

This approach allows for the fact that some Member State projections predict different levels of growth within sub-sectors than the PRIMES/GAINS baseline. However, it will lead to inaccuracies where the Member State projections assume changes in the structure of the sector, so that a different proportion of emissions fall under the ESD than are predicted by PRIMES/GAINS.

Similar uncertainties relate to the allocation of emissions between the ESD and EU ETS sectors, as for the PRIMES/GAINS projections above. The relative uncertainty in the approach has been examined by comparing the results from this approach from the estimates derived by Member States themselves. However, as noted above, only a few Member States have made this estimate to date, and for those that have provided the split, it is not always clear what assumptions have been made e.g. whether the change in scope of the ETS in phase III has been taken into account.

2.2.3 Identification of the policy gap

Using the projections described in the section above, and the estimated target emissions for each Member State in 2020, the difference between the baseline emissions and the target under the ESD can be estimated. This effectively represents the policy gap (see Glossary).

One complication is that the current Member States targets are defined on a relative basis i.e. % change in 2005 emissions, rather than an absolute basis. However, for the purposes of the current analysis an absolute target has been estimated for each Member State.

The policy gap has also been estimated on the basis of both the PRIMES/GAINS analysis, and on the basis of Member States own projections. As discussed, the different projections are not fully consistent, and therefore cannot be compared directly. However, it is still useful to examine how Member States perceptions of the policy gap (based on their own modeling) may differ from the results derived using PRIMES/GAINS.

Allowing for the main uncertainties associated with emissions projections in general (e.g. GDP, energy prices, policy impacts) the main sensitivity associated with this specific analysis is related to the allocation of emissions between the ESD and EU ETS sectors. A comparison has been made with Member States own estimates of the split, where available. This gives an indication of the relative accuracy of the approach.

2.3 Review of policy impacts

Both the PRIMES/GAINS projections and Member State projections take into account the projected impact of policies and measures (PAMs) in place to reduce GHG emission levels in future years. These include both EU wide PAMs but also policies and measures implemented in response to specific national policy objectives. Understanding the impact of these policies in useful for determine the contribution of the existing policy framework to the ESD targets, and the need for future policies interventions.

2.3.1 Community-wide policies and measures

EU-wide Common and Coordinated Policies and Measures (CCPMs) are policies and measures developed by the European Union that apply across Europe. These CCPMs are often closely linked to national PAMs, since European Directives require Member States to enact legislation to implement them. Based on information provided by 26 Member States on the consequence of the implementation of CCPMs at National level, over 56% of PAMs implemented at national level were introduced in response to the adoption of CCPMs and 24% more have been reinforced by them (EEA 2009). This suggest over three-quarters of the national policies in place within Member States are directly linked to EU Wide policies and measures.

These community-wide policies and measures will act upon emissions with the ESD sectors, and therefore drive action in Member States that will help to meet their targets. In the emissions projections described in the section above, certain **existing** Community-wide polices and measures were included in the baseline scenario. Specifically, the baseline scenario used in the PRIMES projections includes policies and measures implemented in the Member States by April 2009 and EU legislative provisions adopted by April 2009 that are defined in such a way that there is almost no uncertainty how they should be implemented in the future (such as revised ETS directive, CO_2 and cars regulation, implementing measures of eco-design directives). Likewise the GAINS modelling includes the impact of the main EU policies acting upon non-CO_2 greenhouse gases (including e.g. the Common Agriculture Policy health check). Therefore, the impacts of these policies and measures can be assumed to have been accounted for in the projections provided above[9]. The full list of policies included within the baseline projections are summarised in the Appendix 1.

Whilst the PRIMES and GAINS analysis included an assessment for the most important EU-wide policies and measures that will act upon the ESD sectors, the analysis only accounted for policies implemented, or adopted legal provisions, up to April 2009. It did not include the impacts associated with **new** policies that have been implement since 2009, or proposed. In assessing both the projected emissions in Member States, and the abatement potential, it is important that these impacts are accounted for.

For each of the main ESD sectors, we have carried out a review of those EU policies, or policy proposals that were not captured within the PRIMES baseline. Where quantitative estimates of the policy impacts were available these were collated and analysed at a sectoral, and Member State level. In some cases this drew upon preparatory work carried out at an EU level to inform future policy proposals.

2.3.2 National policies and measures

In addition to the community wide policies and measure described above, national policies and measures will also act to limit emissions in the ESD sectors. Whilst a large proportion of these policies will be linked to EU wide policies, other will be separate stand-alone policies. Understanding the impacts of these national policies is important for both ensuring that the emissions projections reflect the impact of all potential policies, but also to identify example policies that can be considered ‘good practice’.

Information on national policies has been collected, collated and analysed at both a sectoral level (i.e. to understand the mix and type of measures in each of the main ESD sectors) and at a Member State level (i.e. to understand the main policies and measures relevant to the ESD in each Member State).

A key challenge is collating policy estimates on a consistent and comparable basis. A number of source of information are available on national policies and measures, which have attempted to overcome some of these challenges. Our approach involved a review of existing published reports on policy impacts. This drew upon a number of core datasets, as described below.

[9] As with the emissions projections themselves, the assumed impact of the policies is based upon PRIMES modelling and is likely to differ, for a given Member State, with the policy impacts assessed at Member State level. In particular, variations in how the policy requirements are met within individual Member States may result in a larger variation in policy impacts than assumed within the PRIMES modelling.

- The **EEA' climate change policies and measures database** is compiled by the European Environment Agency (EEA) using information submitted to the Commission by Member States in accordance with the EU Monitoring Mechanism Decision. Data is reported for existing measures and additional measures, in line with the reporting of projections (see above). It contains information on the carbon savings from a range of policies, both common and coordinated policies and measures (CCPMs) and national policies. The policies have also been categorised by instrument type and sector. The data is reported in a consistent way for each of the Member States, so it is possible to identify the savings from a given CCPM across different Member States. However, the coverage is incomplete and not all Member States report data for all policies. Furthermore, not all data will be current, with some policy estimate more recent than others. Therefore one Member State may report a CCPM as 'existing' whereas another may report it as 'additional'. No distinction is made between policy impacts on emissions in the ESD and non-ESD sectors.

- **Member States reports submitted in accordance with UN and EC reporting requirements** The EEA's climate change polices and measures database draws upon reported by Member States in accordance with their international reporting commitments. This includes Member States 5th National Communications to the UNFCCC, as well as Member States reporting in accordance with the EU Monitoring Mechanism. The former is submit by Annex I Parties to the UNFCCC every 4-5 years (most recent submission deadline 31st December 2009) and the latter has bi-annual reporting requirements, with 15th March 2009 the last reporting deadline. Consequently, Member States were not required to provide updated projections in 2010. However, a few Member States have provided updated projections and submitted them to the Commission following a request from the Commission Member States in March 2010. Whilst the reports submitted under the Monitoring Mechanism Decision provide the latest projections, they may not include updated estimates of the policy impacts. We have reviewed and collated information on national policies reported in the most recent projections reports prepared by Member States. Since these were prepared subsequent to the PRIMES modelling they are more likely to include 'additional policies' that were not captured within either the PRIMES/GAINS baseline or the EEA climate policies database.

- The **MURE database** provides information on energy efficiency policies and measures that have been carried out in the Member States of the European Union and enables the simulation and comparison at a national level of the potential impact of such measures. It includes information on the measures type, by end use sector. It also includes a description of the measures, and a semi-quantitative assessment of the measures impact. The data is compiled by energy efficiency agencies representing each of the EU Member States. No distinction is made between the impacts arising in the ETS and ESD sectors.

- The **IEA Energy Efficiency Policies and Measures database** provides information on policies and measures taken or planned to improve energy efficiency within IEA member countries. It provides information on policies by type, and by target audience. It also includes a description of the individual policies. However, information on the quantitative savings from individual policies and measures is limited.

One of the challenges associated with each of the data sources is the assessment of the policy impacts relevant to the ESD targets. With very few exceptions policy impacts are not disaggregated into emissions arising in the sources covered by the ESD and source outside of the ESD scope. Whilst for some sectors (e.g. agriculture, waste, and to a lesser extent transport) this is not a major issues, for other sectors (e.g. energy efficiency policies in the industry, commercial and residential sectors) this issue is much more important.

To deal with this, in the building sector we have taken out the indirect emissions, i.e. emissions that originate from electricity and district heating which are covered by the ETS. This has been done at a country level.

2.3.3 Best practice policy examples

The review of national policies and measures has been used to identify good practice policy examples that can be used as case studies. These represent policies which have either been particularly novel or innovative in their approach, or particularly effective. Inevitably the selection of the best practice examples has involved a degree of expert judgement.

2.4 Cost-effective emissions abatement potentials

The aim of this part of the project is to help prioritise sectors in which the EC and Member States can take action to reduce emissions further to meet the effort sharing decision targets. This is done by assessing the remaining emissions abatement potentials in all sectors and of the costs associated with delivering that potential.

The analysis draws largely on the results of the Sectoral Emission Reduction Potentials and Economic Costs for Climate Change (SERPEC 2009a) (SERPEC-CC, hereafter named SERPEC) project[10]. The SERPEC analysis has been used in the current study since it provides the most comprehensive and complete dataset available, covering each of the main ESD sectors in a consistent and comparable basis. However due to some differences in the scope of the current project the SERPEC data had to be adapted.

2.4.1 Background: The Sectoral Emission Reduction Potentials and Economic Costs for Climate Change (SERPEC) Project

Reference case – baselines in SERPEC

In SERPEC, the CO_2 abatement potentials of new technologies are compared with the average performance of comparable technologies in 2005.

The reference for the development of energy related CO_2 emissions over time was modelled by a so-called *frozen technology reference level scenario* (FTRL). The FTRL scenario holds all the characteristics of the PRIMES 2007-baseline scenario (EC, 2008; Capros et al., 2008), such as an average economic growth rate of 2.2% per year until 2030, with the exception of technology characteristics of sectors which remain ‘frozen’ at the 2005-level.

The rationale for using a FTRL scenario (see Glossary) is that it allows the bottom-up identification of abatement potentials using 2005 technologies as a reference. Thus, the overall bottom-up identified abatement potential should be compared with this macro-economic FTRL scenario. The calculated feasible abatement potential is bounded by the inertia of capital replacement rates and maximum market growth rates of new technologies. Other reductions in energy use can be achieved through structural changes in the economy (e.g. increasing material efficiency, or modal changes in transport) and behavioural changes, but these were not considered in the SERPEC study.

Energy prices

In SERPEC, energy prices from the PRIMES baseline scenario (EC, 2008; Capros et al., 2008), were used to calculate revenues from energy savings. These prices are time and energy carrier specific. The cost calculations are sensitive to the energy price assumptions (see chapter 3.3.3). When comparing the SERPEC results with other studies, two factors are very important, the baseline comparison and the energy price scenarios used.[11]

Potential of low carbon technologies

SERPEC assumes that low-carbon technologies are applied in each cycle of renewal or renovation of industrial plants, power production plants, buildings, cars, trucks and electric appliances. Renewal rates - at the end of an installation’s technical lifetime – range from 10 to 15 years, for e.g.

[10] Summary and sector specific reports can be downloaded from: http://www.ecofys.com/com/publications/brochures_newsletters/ambitious_emission_reductions_costneutral_for_the_EU.htm
[11] For further information see: Summary report Ambitious emission reductions cost-neutral for the EU, p. 40ff

refrigerators and cars, up to 50 years for industrial plants. At the same time SERPEC assumes, the rate of improvement of existing installations (retrofitting industrial plants or renovating houses) to double to 2-3% per year. Some limitations are also assumed, for instance there is a practical maximum to the market growth rates of new technologies because new factories for producing wind turbines or solar panels cannot be built straightaway.

The abatement potential was identified via a bottom-up approach in which the maximum deployment and associated cost of around 650 individual low-carbon technologies, in different sectors of the economy, were analysed. All of the identified technologies were either already in commercial application, or likely to become commercially viable in the near future. To identify their abatement potentials the maximally feasible implementation rates were estimated, often governed by the turnover rate of existing technology stock (i.e. how frequently the building stock is refurbished, or vehicle stock if replaced).

Specific abatement costs

Both the CO_2 savings and the abatement costs are expressed relative to a reference situation. The cost of deploying the abatement options was assessed from a social, i.e. policy makers perspective. Capital costs were annualised over the technical lifetime of the measure using a discount rate of 4%. This value is similar to government bond rates. The annual operation and maintenance costs were assumed to remain fixed over the depreciation period. Energy savings were calculated against energy prices before taxation. The cost calculation assumes an existing and regulatory framework and does not take into account costs of developing a regulatory framework etc. so it does only consider the cost price of CO_2. All prices and costs are expressed in 2005 €, unless otherwise stated.

This cost calculation method used is also referred to as the ‘social cost method’. The method allows for comparison of the ‘bare’ costs of technologies, across measures, sectors and countries. A negative cost indicates that from a social perspective there will be a net economic gain from taking these measures, while a positive cost indicates a net economic loss. Note, that the so-called private ‘end-user’ perceives higher energy prices and discount rates (9% or higher). As a result, the cost-curve looks different from a private end-user perspective (see chapter 3.3.3).

Deployment potentials and scenarios

The maximum rate of replacement of industrial plants (2–4%/yr), power plants (2–3%/yr), buildings (1%/yr) and renovation of the building shell (2.5%/yr) determine to a large extent the deployment rate and abatement potential of new technologies in 2020. Most technologies in SERPEC are already available today. The deployment rate of many technologies, determined by the replacement rate of, for instance, power plants or cars were assessed and described in the SERPEC report.

Retirement and renewal of stock

Table 2-2 shows stock turnover, retrofit and maximum market growth rates (in % per year) for different market segments applied in SERPEC. The table shows that the maximum market growth rate of renewables is large (between 8% and 20% per year). The stock turnover of passenger cars is also large, with 8% per year. The renewal of the buildings stock occurs at a much slower pace of 1% per year.

In industry, the sensitivity of the total abatement potential to the assumptions on the stock turnover rate was tested in the SERPEC project by applying a turnover rate of zero. This resulted in an overall 10% lower abatement potential in 2030. This fairly small difference is explained by the fact that the bundle of retrofit measures in industry has a large abatement potential as well (see below). Under the assumption of no stock turnover, these measures apply to a larger volume of ‘old’ stock that remains in production. The increased potential from retrofitting compensates a large amount of the potential ‘lost’ due to lack of stock turnover into more efficient new stock

Table 2-2: Stock turnover, retrofit and maximum market growth rates used in abatement cost assessment

Segment	Metric	%/yr
Industrial plants	Stock turnover	2 – 4
Power plants	Stock turnover	2.8 – 3.3
Passenger cars	Stock turnover	8
Freight trucks	Stock turnover	5
Airplanes	Stock turnover	2.5
New buildings	Stock turnover	1
Renovation of buildings	Retrofit	2.5
Growth different renewable electricity technologies	Market growth	8 - 23

Source: SERPEC 2009

Retrofit measures

For so-called retrofit measures the rate of implementation is not, or to a lesser extent, limited by the inertia of stock renewal. Other factors play a role in the deployment rate of technologies such as limited knowledge, lack of polices etc. in most cases, we chose to present the full technical potential of retrofits in 2020 and 2030, thus implicitly assuming that a period of 15 to 25 years ahead is potentially sufficient to reach full implementation of these technologies. The renovation rate of buildings was assumed to occur at a maximum rate of 2.5% per year (current rate is around 1% per year, see Table 2-2). Insulation measures (roof, wall, floor, windows) and implementation of advanced heating systems were assumed to be implemented as part of a bigger project of buildings renovation. As a consequence, of this 'coupled renovation', the maximum implementation rate of these measures follows the rate of renovation.

Deployment scenarios

A set of technologies on a cost-curve, sorted on increasing unit costs (€/t CO_2), suggests a straightforward ranking of technologies, in which 'society' deploys the full potential of the cheapest option first, then moves on to the next option, etc. in several sectors. However, the definition of such an order is not straightforward and there were defined a deployment scenario in SERPEC.

2.4.2 Limitations of SERPEC analysis in the context of this study

The SERPEC analysis does have some limitations in the context of this study:

- The SERPEC project was focused on the EU-level potential. This potential was derived bottom-up from individual Member State estimates but these estimates were necessarily based on broad assumptions about each Member State. The results for individual Member States are therefore subject to a greater level of uncertainty than for the EU as a whole. Where they have been able to reflect country specific circumstances, Member States' own estimates may provide a more accurate representation of the abatement potential. However, country specific estimates are only available for a few Member States, and selected sectors.
- The calculation of the abatement potential in SERPEC only considered technological measures[12] that were available in the regular market, but no prototypes or earlier. Actual emissions reductions can go beyond this level through structural changes in the economy and through behavioural changes. Examples of structural changes are increasing material efficiency or modal changes in transport; behavioural changes include e.g. the acceptance of one degree lower temperature as comfort temperature in homes or making less car journeys. The effect of structural changes and behavioural changes and possible rebound effects were not considered in the analysis in SERPEC. The calculated remaining potential in this study only derives from the abatement potential calculated in SERPEC and does not consider reductions that could be achieved by these non-technological measures. **Therefore a Member State may have a higher remaining abatement potential than given in this study**.

[12] The one exception is that in the transport sector ecodriving was included as an option.

- As described, the cost calculations are sensitive to the energy price assumptions. The SERPEC baseline emissions have been adapted for use in this study, but fuel prices, investment costs and discount rates remain unchanged (find the discount rate sensitivity analysis in chapter 3.3.3). The results of the study should therefore be carefully interpreted, taking closely into account the energy price scenarios used.
- The abatement options have been assessed against a so-called frozen technology (2005) reference. The extent to which the abatement potential of individual measures will be delivered by current (climate) policies in the 'business as usual' baseline, was not assessed[13]. Moreover, the reference of the project did not yet include the economic crisis and the reference year was 2005 instead of 2010.

It was therefore necessary to make some adjustments and corrections to the SERPEC data to address the above limitations and make the results more applicable to the current study.

2.4.3 Principal adjustments to SERPEC data

The outcome from the analysis, for each of the ESD sectors, is a broad estimate of the abatement potentials by 2020 in four different cost bands. These cost bands have been chosen so that the PRIMES/GAINS baseline carbon prices, both ETS and non ETS, are set as limits. For 2020, these cost bands are: <=0€, 0-25€, 25-50€ and >50€ intervals. The use of these costs bands provides a flexible framework that enables the priority sectors to be identified, whilst accepting that there are uncertainties in the precise values for specific measures.

For certain Member States, country specific estimates of the abatement potential are available for certain ESD sectors. Our approach has drawn upon these estimates to validate and refine the initial SERPEC based estimates. The aim has not been to provide a concrete comparison and explanation of any discrepancies of the data from different sources, due to differences in methodologies and models. However, it has been possible to qualitatively assess if the results from Member State studies change the overall findings from the SERPEC analysis.

In summary, the assessment of the cost-effective abatement potential has followed three sequential steps:

- **Step 1:** Using the original SERPEC data, assess of the cost effective potential for each Member State, in each ESD sector, in terms of the chosen cost bands.
- **Step 2**: Update the SERPEC analysis of the cost effective potential, where appropriate, in terms of the chosen cost bands.
- **Step 3:** Cross check results with Member State specific estimates of the cost effective potential where possible

Each of these steps is described in more detail below. It is important to stress that this approach is not without uncertainties. The approach to combine bottom up calculations on individual emission saving measures (SERPEC) with emission scenarios based on energy system modelling with more detail on energy supply than for energy demand (PRIMES) has its limitations, as the methodologies are not fully compatible and adaptations and simplifications need to be made to apply the above mentioned steps. This becomes especially evident for the savings at the level of individual countries (instead of EU level). Due to such uncertainties, remaining potentials may occur for some sectors and countries that need further explanation, e.g. in the case of a zero remaining potential, which would mean that current policies seem to deliver the full potential identified in the SERPEC study.

[13] In general the comparison of baseline calculations from top-down models, such as PRIMES, and bottom-up technology assessments, such as SERPEC, is a delicate –if not impossible- task

2.4.4 Step 1: Using the original SERPEC data, assess of the cost effective potential for each Member State, in each ESD sector, in terms of the chosen cost bands.

In the SERPEC project the abatement potential of the individual abatement measures were assessed 'bottom up' relative to the performance of current (2005) technologies and with 2007 projections for GDP, population and fuel prices. Further details on the approach used are provided in Appendix 1.

For the energy-related CO_2 emissions, the overall potential for these measures to deliver real reduction in emissions was then assessed relative to a so-called Frozen Technology Reference Level scenario (FTRL). The FTRL scenario was based upon the PRIMES 2007-baseline scenario (EC, 2008; Capros et al., 2008). The FTRL exhibits all the characteristics of the PRIMES 2007 baseline, such as the economic growth rate, with the exception of the technology characteristics of sectors which remain 'frozen' at the 2005-level. As a result, autonomous and policy-driven energy and carbon efficiency improvements (which are included in the baseline scenario) are not taken into account in the FTRL.

For each of the abatement measures a maximum feasible implementation rate was estimated. This was defined on an annual basis, to reflect the potential uptake of measures over time, and provides a limit on the amount of abatement that can be delivered by a given technology at a specified point in the future. Technology learning rates were also estimated for measures that had not yet reached market penetration.

For *process emissions* of CO_2, nitrous oxide (N_2O), methane (CH_4) and fluorinated gases (F-gases) new baselines were calculated, which include the impact of existing policies[14].

The abatement from individual measures were integrated and ranked at a sectoral level in a marginal abatement cost curve (MACC). This was prepared for the main emissions sources covered by the scope of the ESD. An important consideration was that some abatement measures may result in a net increase in emissions within the scope of the ESD. For example, a measure leads to higher **direct** emissions when it replaces a measure with **indirect** emissions (e.g. replacing an electric heating system or district heating with a more efficient boiler). According to ESD logic this measure does not mitigate emissions in the ESD sector and therefore has not been taken into account for this study. It is though important to understand that these measures will still deliver gross reductions in emissions; however they shift the net emissions from the ETS sector to the ESD sector.

The marginal abatement cost curves (MACCs) were derived at a Member State and sector level. However, the focus of SERPEC was to get broad estimates across the EC and the individual conditions within each country could only be taken into account in a simplified manner. The meant, for example, that EU wide assumptions were used to derive the abatement potential for certain measures (e.g. average energy consumption of new diesel passenger cars). Where conditions within a Member State deviate greatly from the EU average (e.g. a preference for smaller or larger vehicles than the average) the results will be less accurate. The Member State results should therefore be regarded as indicative of the overall level of abatement potential, and not precise estimates of the situation in a given Member State.

In this current study, the results from the SERPEC analysis have been reclassified, for each sector and each Member States, into each of the cost bands described above. This indicates (based on the assumptions used within the SERPEC study) the sectors within a given Member State where the most cost-effective opportunities exist, as well as the overall abatement potential across all cost bands.

2.4.5 Step 2: Update the SERPEC analysis of the cost effective potential for the chosen cost bands

As described above, the SERPEC emission abatement potential was assessed relative to a FTRL baseline constructed with the 'PRIMES-2007' (and GAINS 2007 for non-CO_2 gases) model version with a base year of 2005. However, this current study requires an assessment of the abatement

[14] Baselines are comparable to the baselines included in the Commissions 2008 Climate Package, see IIASA (2008)

potential remaining in 2020 after account has been made for the effects of existing policies. This has been assessed by assuming that the difference between the (constructed) FTRL scenario (2009) and the PRIMES and GAINS baseline scenario (2009) is the reduction delivered by the policy. Therefore, the remaining potential that could be delivered by new policies is the full SERPEC potential minus this difference[15].

However, since the SERPEC study was completed, new PRIMES and GAINS baseline projections have been prepared reflecting changes in underlying assumptions such as economic activity factors and the effect of the recession, but also policies and price scenarios. Within the scope of this study, it is not possible to update completely the SERPEC analysis. Instead, three main factors have been taken into account to make the SERPEC analysis more consistent with the latest PRIMES and GAINS scenarios:

1. The impact of the recession in the period between 2005 and 2010.

The effect of the recession was calculated by comparing the PRIMES 2009 and 2007 emissions for two periods, 2005 to 2010 and 2010 to 2020. In the period 2005-2010, the new policies accounted for in the 2009 PRIMES projections would be expected to have a very small effect and the recession a larger one. From 2010 to 2020, the effect of policies would be expected to be much larger. By looking at the relative differences in the periods separately it is possible to estimate how much of the difference in 2020 results from the recession. This approach is a simplification because in practice these differences are also due to changes in fuel prices and the influence of policies, moderated by counterbalancing changes in population assumptions. More details on how this adjustment was done in each sector can be found in Appendix 3.

2. The change in reference year, and assessment period (2010-2020 instead of 2005-2020)

In the SERPEC analysis, the abatement potential for a given year was based on maximum feasible annual implementation rates for each of the new clean technologies and fuels. Between 2005 and 2020 the annual rates were assumed to be constant. Assuming that these rates cannot be increased, the potential that could be implemented in the period 2010 to 2020 is 10/15 (0.66) of the original potential. More details on how this was done in each sector can be found in Appendix 3.

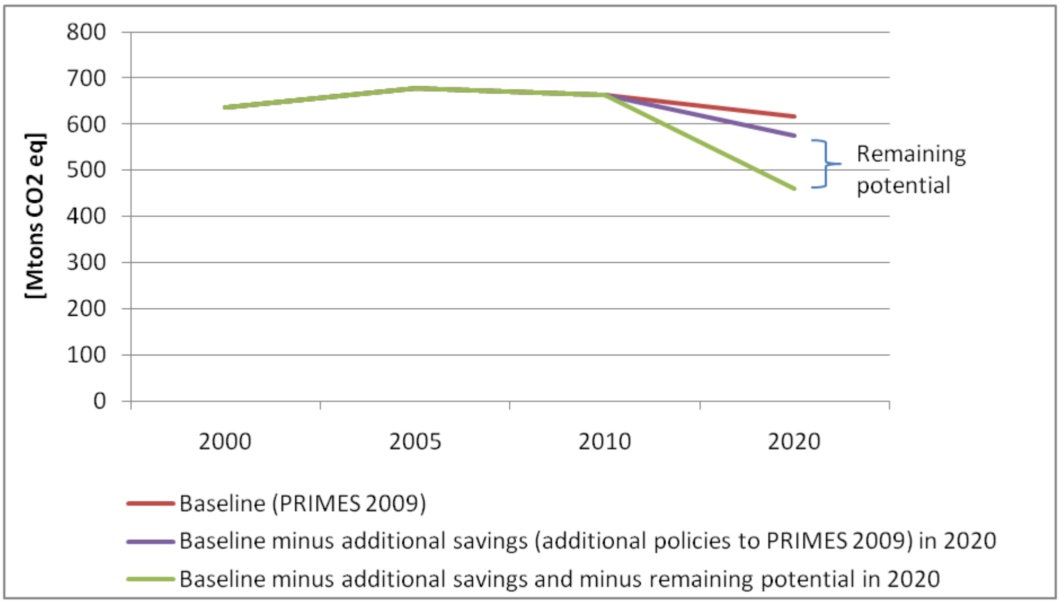
Combining the effect of the new base year and the recession, the remaining potential is calculated by: (1- x)*0.66 * the original SERPEC potential; where x = effect of the recession. The effect of the recession was calculated at the individual country level.

3. Calculation of the remaining abatement potential

The factor to account for the effect of the recession is applied to the original FTRL emissions in 2020. This gives a new FTRL, which takes into account the recession but not policy delivery. The difference between the PRIMES 2009 baseline emissions at 2020 and this new FTRL is the reduction delivered by policies included in the PRIMES model. Taking this value from the abatement potential in 2020 gives a **new abatement potential.** A further correction is required to adjust for policies implemented subsequent to PRIMES 2009. Policies that have been implemented until June 2010 have been taken into account. Thereto additional policies, i.e. policies that have not been included in the PRIMES and GAINS 2009 model version have been identified. The mitigation potential of these policies have been estimated (additional savings) and subtracted from the 'new abatement potential', resulting in the **remaining potential** (see Figure 2-2).

[15] For agriculture, no major mitigation policies were introduced across member states in the period 2007 (FTLR) and 2009 (PRIMES-GAINS). Given the high uncertainties with respect to the emissions of the sector agriculture, which we consider are mainly due to activity data, this difference to 2007-2009 we do not consider to be delivered by policy, but due to data uncertainties and differences in model parameterisation. Therefore only the technical abatement potentials of the SERPEC study were considered.

Figure 2-2: Illustration of the effect of additional policies (implemented subsequent to PRIMES 2009) on the remaining potential using the example of the building sector (EU level).



4. The determination of the cost bands

The following section describes the approach that was followed to determine the distribution of the remaining abatement potential to the cost bands. We decided to follow a simplified approach that applied a consistent methodology across sectors and Member States.

We assumed the same unit costs for individual technologies as calculated in the SERPEC project. This approach is based on the assumption that additional savings from the new baseline realise part of the abatement potential, but the measures in themselves and the framework parameters (investment costs/ energy prices) do not differ from the assumption made in the SERPEC project. This means that (additional) investment costs are the same, and fuel prices (to calculated revenues from energy savings) are also the same.

In the SERPEC project, the abatement options were ranked by cost efficiency (€/t CO_2), which leads to a marginal abatement cost curve for the European Union in 2020. The cost curves showed what abatement options are cheapest per tonne of CO_2 abated in 2020. In the actual project, the data on costs are broad estimates of the cost-effective remaining abatement potentials assigned to four ranges. Cost band A includes measures with costs below 0 €/t CO_2, cost band B includes measures in the range between 0 and 25 €/t CO_2, cost band C includes measures in the range between 25 and 50 €/t CO_2 and cost band D includes all measure that are more expensive than 50 €/t CO_2 (see Table 2-3). This flexible framework enables the priority sectors to be identified, but does not give a false impression about the accuracy of the results.

Table 2-3: Overview of the cost bands used in the abatement cost analysis

Cost Band	Cost range in €/tCO_2
Cost band A	< 0
Cost Band B	0< B< 25
Cost Band C	25< C< 50
Cost Band D	> 50

For policy decisions it is important to know what share of the cost-curve (as assessed against the FTRL) is already implemented in the business as usual (baseline) development. It could be argued that typically the most cost-effective options are taken up first. However, the non-cost barriers to uptake of certain technologies may be higher than for more expensive ones, so that some of the more expensive ones are implemented first. Also certain policies may drive the uptake of some of the more expensive technologies for other reasons e.g. to stimulate new markets.

To determine how the recession, the shorter time period and the implementation resulting from policies might alter the cost distribution of the potential, we assumed:

a) that the potential reduction caused by the recession and the changed reference year (shorter time period) has the same effect on every cost band because effects of recession and shorter time period uses up potential without changing the overall objective (as policies). Therefore we multiplied each cost band with the same correction factor.
b) that the potential used up by policies (PRIMES 2009 baseline and additional policies implemented until June 2010) has different effects on every cost band. We assumed a gradual decrease in implementation from cost band A to cost band D. We estimated that the most reduction in the potential took place in cost band A and the least in cost band D. To calculate the exact distribution of the cost bands we made simplifying assumptions: First, the total savings realised by the policies (baseline PRIMES 2009) and additional policies to PRIMES 2009 were divided by four. Secondly, half of the savings from the most expensive cost band D was reallocated to cost band A, based on the above described assumption that more potential is used up from cost band A than cost band D. The remaining abatement potential is then the initial estimate minus the savings. If this results in a negative potential, then the savings are taken into the adjacent cost band.

The following two figures illustrate the effect on the abatement potential in the case of the building sector in a specific Member State. On the left side we see the abatement potential calculated in SERPEC, already corrected for indirect emissions (Figure 2-3) in the middle we see the cost bands corrected with a sector specific factor (for sector specific details, see appendix 3) taking into account the effects of the recession and the shorter time period (Figure 2-4) and on the right side we see the further adaptation, taking into account the baseline (PRIMES 2009) and additional policies implemented until June 2010 (Figure 2-5).

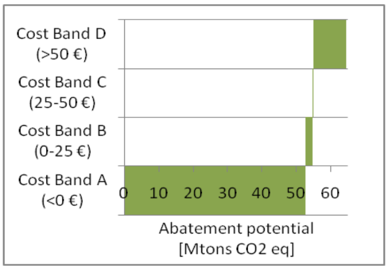


Figure 2-3: Abatement potential calculated in SERPEC (only direct emissions)

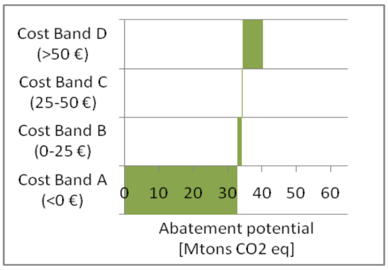


Figure 2-4: Abatement potential corrected by effects for recession and different time period

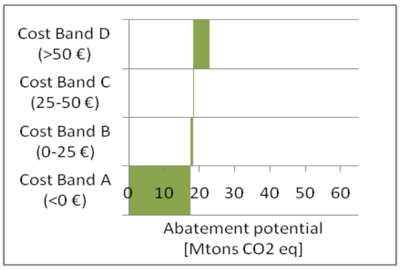


Figure 2-5: Abatement potential taking into account effect of policies

An example of the detailed calculation steps for the case of the building sector in the United Kingdom is given below (see Table 2-4). In the SERPEC study the direct emissions abatement potential in 2020 was estimated to be 64.4 MtCO_2 eq. The effect of the recession and the 1/3 shorter time period to implement saving measures reduces the potential by the factor 0.628[16] to 40.2 MtCO_2 eq. Policies already captured in the baseline scenario exhausts another 15.2 MtCO_2 eq and the effect of additional policies (in this case the EPBD recast) was estimated to be 8.4 MtCO_2 eq. in 2020. Altogether these changes lead to a remaining abatement potential of 16.6 MtCO_2 eq in 2020.

It is important to note that effective implementation of existing and additional policies is expected reduce the remaining abatement potential by 59% in 2020 (reducing it from 40.2 MtCO_2 eq. to 16.6 MtCO_2 eq). This highlights the important contribution of the existing policy framework to the delivery of the ESD targets.

[16] Further information on how this factor was calculated is found in appendix 3.

Table 2-4: Methodology for calculation of remaining cost bands, exemplary for the UK

	A_<0	B_0-25	C_25-50	D_>50	Commentary
Step 1: Cost bands calculated in SERPEC (only direct emission savings)	52,679	2,100	153	9,485	Cost bands from SERPEC (only direct emission savings)
Step 2: Cost bands reduced by effect of recession and shorter time period	33,331	1329	97	6,007	All cost bands equally corrected by a sector specific factor (0.624 in the building sector) (further details on this factor see Appendix 3)
Step 3a: Determination of effect of policies (used up potential) by cost band	19,312	770	56	3481	Every cost band is reduced by the same percentage in the case of United Kingdom 41%.
Step 3b: Reallocation of the reductions from Cost band D to A (50%)	21,052	770	56	1,740	50% of the potential that should be taken out from cost band D is shifted to cost band A (and will be taken out there).
Step 4: Remaining potential per cost band	12,278	559	41	4,267	The amount of potential used up in every cost band (Step 3b) is subtracted from the cost bands determined in step 2. The result is the remaining potential.

Further details for each sector are described in Appendix 2 and Appendix 3.

2.4.6 Step 3: Cross check results with Member State specific estimates of the cost effective potential where possible

The estimated remaining potential has been cross checked with Member State data, where available. Due to differences in methodologies and assumptions (base year, policies included), this comparison has been made on a more general level i.e. the order of magnitude and distribution over sectors. Further examination of the precise difference has not been possible, in most cases, within the scope of the current study.

2.5 Preparedness, capacity and performance

In addition to understanding the policy gap for each Member State and the cost-effective abatement potentials in ESD sectors, this project has also looked at the preparedness and capacity of Member States to implement necessary measures for meeting their commitments under the ESD. Understanding Member States' preparedness, capacity and performance is important for the European Commission so that any need for additional assistance by Member States in meeting their requirements can be effectively assessed. It will also help with targeting of any assistance that is already planned.

2.5.1 Overview

Whilst the value in assessing preparedness, capacity and performance is clear, performing the assessment is more challenging. There are no standard criteria that define each of the characteristics, and whilst there are potentially a wide number of criteria that could be used, all require a degree of subjective judgement. A further challenge relates to data availability and consistency. Certain criteria, for example availability of sectoral emissions projections, can be assessed on a uniform basis across Member States using existing published reports, other criteria – such as staff resources working on ESD, will be difficult to assess based on published documents and might be more Member State specific.

On this basis a pragmatic approach was adopted. A desk based review was used, drawing upon existing data and reports. This allowed a high-level assessment to be carried out of all Member States using a consistent and comparable approach. However, it required certain simplifying assumptions to hold true. In particular, it assumed that the selected criteria were suitable indicators of the overall preparedness, capacity and performance of the respective Member State.

Reflecting the above issues, the review of preparedness, capacity and performance involved the following sequential steps:

Step	Description
Step 1: Develop, test and agree the assessment criteria	Draft criteria were sent to the European Commission for comment and approval. The final criteria agreed are listed in Box 1 below. The agreed criteria were then tested by applying the criteria and scoring to the information collated for the United Kingdom. The results of this assessment were reviewed and it was agreed that the assessment produced sensible results.
Step 2: Collate data from existing data sources to inform the assessment against each criteria	Information has been collated for each Member State using the data sources listed in Table 2-5 below.
Step 3: : Evaluate the overall preparedness and capacity	Using the evidence collated in step 2 the overall preparedness and capacity was evaluated.

2.5.2 Step 1: Develop, test and agree the assessment criteria

A standardised template was developed and tested for use in assessing each of the criteria. The template covers two complementary dimensions of preparedness, capacity and performance. These are:

1. Member States' preparedness, capacity and performance in relation to the planning and implementation of **climate change mitigation policies in general**
2. Member States' preparedness, capacity and performance in relation to the implementation of the **ESD decision**

For each dimension a series of criteria were defined to assess the relative performance of each Member State. The criteria have been designed to enable an assessment based on readily available data sources. In each case a clear and transparent scoring mechanism has been applied. Where possible the criteria draw upon existing performance indicators (e.g. those used by the EEA), or survey results.

The template, and associated criteria, is provided in the Box 1 below. A semi-quantitative scoring mechanism was used (0, + and ++).

Box 1: Criteria for the assessment of Member States' preparedness, capacity and performance

1. <u>Member States' preparedness, capacity and performance in relation to the planning and implementation of climate change mitigation policies in general</u>

A first set of criteria were used to assess Member States' preparedness, capacity and performance in relation to climate change policies in general (and not the ESD in particular). These criteria provide an understanding of the capacity and experience that each Member State has built from past activities, which can be drawn upon to meet the future requirements of the ESD.

Criterion 1.1: Preparedness, capacity and performance in relation to climate change mitigation strategies

To assess this criterion we considered the following indicator and used the scoring shown in brackets to assess the Member States' performance:

- **Status of Member States' national climate change strategy documentation.** To assess this indicator we reviewed the national documentation to identify if a climate change strategy or action plan has been adopted (by government or parliament) or not, and if it has been adopted whether it has already been (at least partially) implemented.
    - CC strategy documentation not adopted (0)
    - CC strategy documentation adopted but not implemented (+)

- CC strategy documentation adopted and partially or fully implemented (++)

Criterion 1.2: Preparedness, capacity and performance in relation to the monitoring and reporting of progress on climate change mitigation activities

Monitoring and reporting is an important activity that Member States will need to perform under the ESD. Three indicators have been used to assess Member States' performance and capacity in this area.

- **Quality of Member State reporting under the Monitoring Mechanism Decision** as analysed by the EEA in 2009. The EEA analysed the quality and completeness of the Member State submissions based on the following categories of information: information on PAMs, information on projection scenarios, information on projections and information on modelling. For each category of information the Member States' performance was assessed in comparison to examples of good practices. The following scores are presented for each Member State in relation to the above categories of information:
    - Information not reported in 2009 (0)
    - Information reported but not clear and/or not to the level of detail expected from good practice (+)
    - Information reported with clarity and to the level of detail expected from good practice (++)

- **Timeliness of Member States' reporting of their 5th National Communication to the UNFCCC**.
    - Not submitted (0)
    - Submitted but late (+)
    - Submitted on time (++)

- **Completeness of reporting of indicators and projection parameters.** To assess this indicator we identified if Member States provide details on parameters and indicators for projections alongside their projections. We assume that completeness of reporting of the mandatory (under the MM Decision) parameters and indicators can provide a measure of the Member States' capacity to develop emission projections. The analysis of this indicator was validated by looking at the EU study "assessment and improvement of methodologies used for Greenhouse Gas projections".
    - No projection indicators reported (0)
    - Half or less than half of the projection indicators reported (+)
    - More than half of the projection indicators reported (++)

Criterion 1.3: Preparedness, capacity and performance in relation to climate change mitigation policies and measures

To assess this criterion we looked at one indicator: whether the Member State has planned additional policies and measures that could be adopted in the future to mitigate climate change beyond the existing policies and measures. In assessing performance, we also considered whether the impact of the additional policies had been quantified.

- **Status of planned policies and measures**.
    - No additional policies and measures are planned (0)
    - Additional policies and measures are planned but their expected effect is not quantified (+)
    - Additional policies and measures are planned and their expected effect is partially or fully quantified (++)

2. <u>Member States' preparedness, capacity and performance in relation to the implementation of the ESD decision</u>

A second set of criterion were used to assess each Member States' preparedness and capacity in relation to the requirements of the ESD.

Criterion 2.1: Understanding of the ESD targets and institutional arrangements

This criterion examines the extent to which Member States have carried out analysis and put in place targets related to the requirements of the ESD.

- **Assessment of the ESD target.** On the basis of published data, this indicator seeks to understand if the Member State has carried out any of their own analysis of the implication of the ESD target in terms of the required levels of emission reduction.
    - No national assessment of the ESD target (0)
    - National assessment of ESD target for national emissions but no sectoral assessment (+)
    - National assessment of the ESD target, with further assessment of sectoral contributions (++)

Criterion 2.2: Understanding of the contribution of different sources and sectors to the ESD target

The sectoral disaggregation of emissions projections is important for understanding the level of future emissions within the scope of the ESD, and the contribution from different sources. To assess this criterion we developed an indicator that reflected the level of detail provided by Member States in the GHG emission projections reported under the MM Decision and/or as presented in national documents.

- **Sectoral disaggregation of Member States' GHG emission projections**.
  - No sectoral disaggregation of projections (residential, commercial, industry , transport, agriculture, waste), only total estimates (0)
  - Projections disaggregated for some, but not all, of the main sectors (+)
  - Projections disaggregated for all of the main sectors (++)

Criterion 2.3: Understanding of the abatement potential within the ESD sectors

This criterion aims to answer the following question: Has the Member State assessed the abatement potential and within the different sectors covered by the ESD. This understanding will help to ensure that the emissions reductions are delivered at least cost.

- **Assessment of cost effective abatement potential across ESD sector**
  - No assessment of cost-effective abatement potential for ESD sector (0)
  - Assessment of cost-effective abatement potential for certain ESD sector (+)
  - Assessment of cost-effective abatement potential for all sectors (++)

Criterion 2.4: Understanding of the impacts of policies and measures on the ESD target

This criterion aims to reflect the extent to which a differentiation is made by Member States between policy impacts arising from non ESD sources and from ESD sources. This information is important so that Member States can understand the expected contribution of their policies to their ESD target.

- **Reporting of policy impacts in accordance with ESD targets.**
  - No accounting for ESD/non ESD split in emission reporting (0)
  - Accounting for ESD/non ESD split for certain policies or sector (+)
  - Accounting for ESD/non ESD split for all policies or sector (++)

In addition to the assessment of preparedness and capacity, a separate assessment was carried out of the **political and public support for climate change mitigation policies** within the Member State. While this attribute does not reflect the relative preparedness or capacity of a given Member State for implementing measures under the ESD, it does provide an indication of the level of support for further measures. A low level of public support might indicate a barrier to the effective implementation of the ESD. Likewise, it could be assumed that if the population of the country believes that climate change is a serious issue, the capacity of the Member State to address the ESD is reinforced because of the public support.

The template, and associated criteria, is provided in the Box 2 below. A semi-quantitative scoring mechanism was used (0, + and ++).

Box 2. Criteria for the assessment of public and political support to climate change policies

To review the Member State public support to CC policies we used the following two criteria: public perception of the seriousness of CC in Member State; and public perception of the actions taken by the national governments.

Criterion 3.1: Public perception of the seriousness of CC

This criterion looks at the perception of climate change by the population of the Member State to identify if the population believes that climate change is a serious problem or not. The special Eurobarometer on "European's attitudes towards climate change" carried on in 2009 gives us an interesting data to assess this criterion in the Member State.

We used the answers to the following question to analyse this criteria in the Member State: "How serious a problem do you think climate change is at the moment?"."

- CC is thought not to be a serious problem (0)
- CC is thought to be a fairly serious problem (+)
- CC is thought to be a very serious problem (++)

Criterion 3.2: Public perception of the actions taken by the national government

This criterion looks at the perception of the population on the actions taken by their national government until 2009. The special Eurobarometer on "European's attitudes towards climate change" carried on in 2009 gives us an interesting data to assess this criterion in the Member State.

We used the answers to the following question to analyse this criteria in the Member State: "In your opinion is the national government currently doing too much, doing about the right amount, or not doing enough to fight climate change?"

- Doing too much (0)
- Doing about the right amount (+)
- Not doing enough (++)

2.5.3 Step 2: Collate data from existing data sources to inform the assessment against each criteria

As described in Step 1 above, our approach aimed to gather as much data from existing established data sources and Member State reviews, as this will help to ensure the consistency of the data. Table 2-5 below lists the main sources of information used in this analysis. Primary surveying and data collection will be restricted to those criteria and those Member States where alternative evidence is not available. Furthermore, given the large amount of potential data required there is an argument for targeting the primary data collection on those Member States where an understanding of preparedness and capacity is most important, for example, those Member States with the biggest policy gap.

Table 2-5: Data sources used to assess preparedness against each criteria

Sources of Information	Links
Member States UNFCCC 5th national communication.	http://unfccc.int/national_reports/annex_i_natcom/submitted_natcom/items/4903.php
European Environment Agency – Member States national adaptation strategies.	http://www.eea.europa.eu/themes/climate/national-adaptation-strategies
European Environment Agency – Member States climate change policies and measures.	http://www.eea.europa.eu/themes/climate/pam
European Commission – Annual environmental policy review for each member state. (2009)	http://ec.europa.eu/environment/policyreview.htm
European Environment Agency – Greenhouse gas emission trends and projections in Europe 2009, tracking progress toward Kyoto targets.	http://www.eea.europa.eu/publications/eea_report_2009_9/annex-additional-information-on-greenhouse-gas-emission-trends-and-projections.pdf
Eurobarometer – Europeans' attitudes towards climate change. (2009)	http://ec.europa.eu/public_opinion/archives/ebs/ebs_322_en.pdf
European Commission - "Progress towards achieving the Kyoto objectives" required under Article 5 of decision 280/2004/EC of the European Parliament and of the Council concerning a mechanism for monitoring community greenhouse gas emissions and for implementing the Kyoto Protocol.	Reporting Under Decision 280/2004/EC
Member States environmental/climate change websites.	

2.5.4 Step 3: Evaluate the overall preparedness and capacity

In this step we evaluated the overall preparedness and capacity based on the available evidence. This included a review of examples of good practice in terms of institutional capacity. The assessment represents an initial evaluation based on published literature. The results have not, so far, been presented to Member States for cross-checking, although they have been compared to the results from a questionnaire issued to Member States in preparation for the first project conference in November 2010.

It is also important to note that the evaluation represents a ‘snap shot’ based on the published evidence available at a given point in time. Member States’ relative preparedness and capacity will change (and hopefully improve) over time. In particular, activities that are ‘in preparation’ but not published may not be captured in this initial assessment.

3 Results

The section presents the results of the analysis, in accordance with the methodology described in the previous section.

3.1 Emissions projections and policy gap

The results from the analysis of the emissions within the scope of the ESD, and the extent of any policy gap are shown below. The results are presented at three levels of resolution. Firstly, the results are presented for the EU-27 as a whole. This shows the expected trend in emissions across all Member States. Results are then presented at the individual Member States level. Finally, the emission trends are demonstrated for each of the main sectors that are within the scope of the ESD.

3.1.1 EU-wide

None of the projections analysed for this study appear to show that the EU-27 is on track to meet a target of 10% reduction in emissions covered under the ESD between 2005 and 2020. Figure 3-1 illustrates the trajectory of each projection, and Table 3-1 gives the policy gap (the difference between projected emissions in 2020 and the ESD target), The three sets of projections analysed (PRIMES/GAINS baseline, and Member State 'With Existing Measures' (WEM) and 'With Additional Measures' (WAM) projections)[17] all show the EU-27 as a whole falling short of this target at present. This indicates that more policies and measures are required across the EU in general to comply with the ESD (though not necessarily in every Member State).

Member States can be split into two groups: those that have targets under the ESD which are lower than their 2005 emissions (here denoted 'reduction targets'), and those with targets higher than their 2005 emissions (here denoted 'growth limits'). All of the EU-15 Member States except Portugal have reduction targets, and all of the EU-12 Member States except Cyprus have growth limits. Figure 3-1 and Table 3-1 show how the overall trends split between these two groups. By multiplying each Member State's relative target by an estimate of their 2005 emissions that are within the scope of the ESD, it is possible to estimate the overall targets for each group of Member States. This estimation method results in an overall EU-27 target of -9.3%. In other words, if each Member State were to meet its target exactly, using domestic actions only, this would result in a reduction in EU emissions within the scope of the Decision by 9.3%[18], from 2005 levels.

Summing all the Member States with reduction targets indicates that collectively, they are required to reduce their emissions by 14.0% under the ESD. Member States with growth limits, meanwhile, have an overall target to limit emissions growth to 12.5%. These implied emissions reductions do not reflect the use of any flexibility provisions.

In two of the three projections analysed (the PRIMES/GAINS projections and Member States' WAM projections) the 'growth limits' group is projected to meet its implied percentage emissions change target under the ESD. In the WEM projections, it is mainly due to projections of very high emission growth from four Member States (Latvia, Lithuania, Romania and Bulgaria), as can be seen from analysis at the Member State level in section 3.1.2, that these projections indicate an overall exceedance of the ESD target for the 'growth limits' group.

Overall, as shown in Figure 3-1, the PRIMES/GAINS projections track the broad trend in the Member State projections reasonably well. However, it is also notable that under the PRIMES/GAINS baseline, the emissions trajectory for the 'growth limits' group changes significantly between 2005-2015 and 2015-2020, from a steady increase to virtually no increase in the latter period. A similar trend is not, however, reflected in either set of Member State projections. One possible explanation for the flattening out of the emissions between 2015-2020, in the PRIMES/GAINS projections, is the role of recently introduced EU policies, such as the Regulation on CO_2 from cars, which will have an

[17] As described in Section 2.2.1, Member States own projections have been apportioned to the ETS and ESD sectors, on the basis of the split used in PRIMES and GAINS, and not based on Member States own estimates (which are generally not available).
[18] This differs from the 10% reduction estimated previously due to different values for the 2005 base year emissions used in this current study. The current estimate is based on Member States latest inventories. See Section 2.1.1

increasing influence over time (e.g. as existing vehicle stocks are replaced). The effects of the recession, which are captured in PRIMES/GAINS but may not be fully captured in the Member State projections, could be another explanatory factor. These issues are discussed in more detail, at a sectoral level, in the next section.

The 'reduction targets' group is projected to fall short of its implied percentage emissions change target by between 2 and 11 percent. This overall result is indicative of many of the EU-15 Member State projections; the PRIMES/GAINS baseline only shows two of the EU-15 (Portugal and Greece) meeting their respective targets in 2020 through purely domestic measures. However, it is encouraging to note that the WAM projections indicate a considerable narrowing of the policy gap, which may indicate, for some Member States, the impact of policies not included in the PRIMES/GAINS baseline. This is despite the fact that, in some cases, the WAM projections include assumptions on economic growth that do not take into account the impacts of the global recession (as the projections were finalised before the effects of the recession became clear).

Table 3-1: Comparison of the relative policy gap in 2020 under different projections (negative policy gap indicates further reductions are needed to meet 2020 target)

POLICY GAP (% difference to target)	EU-27	Reduction Targets	Growth limits
PRIMES / GAINS Baseline	-5.8%	-7.9%	4.2%
MS Projection (WEM)	-10.0%	-11.2%	-3.8%
MS Projection (WAM)	-1.6%	-2.1%	1.6%

(Note - assumed ESD 2020 targets: EU-27: -9.4%; Reduction targets group: -14.0%; Growth limits group: +12.5%)

It is also important to note that these results do not factor in the use of any flexibility provisions (Articles 3.2, 3.4, 3.5 and 5 of the Decision) by Member States in meeting their targets in 2013-2020. Individual Member State are able to transfer allocations (up to 5% of its annual emission allocation for a given year) to other Member States, which may use this emission allocation for the given year or any subsequent years until 2020. The use of these internal flexibilities will not influence the overall emissions reductions within the EU, but will influence the level of emissions reductions within individual Member States. Member States are also able to make use of external Joint Implementation / Clean Development Mechanism (JI/CDM) credits, to meet part of the ESD targets. Whilst the use of these credits is capped (on a yearly basis up to 3% of 2005 non-ETS emissions in Member States), their use will not reduce the absolute emissions within the EU to the same extent, with some of the necessary reductions being delivered outside of the EU.

One of the implications of the transfers is that the policy gap in 2020 only provides a static measure of the actual efforts required by Member States. In practice, Members States can use the flexibility provisions to manage the effort required over the whole compliance period. For example, gains relative to the target trajectory in early years can be used to balance out losses in later years. In practice, expectation for what targets may be in place post-2020 may have an important influence on Member States strategy up to 2020.

Figure 3-1: Projected progress of the EU-27, Member States with targets to reduce emissions (reduction targets) and Member States with targets to limit growth in emissions (growth limits) against their estimated ESD targets (each projection is indexed relative to its 2005 value)

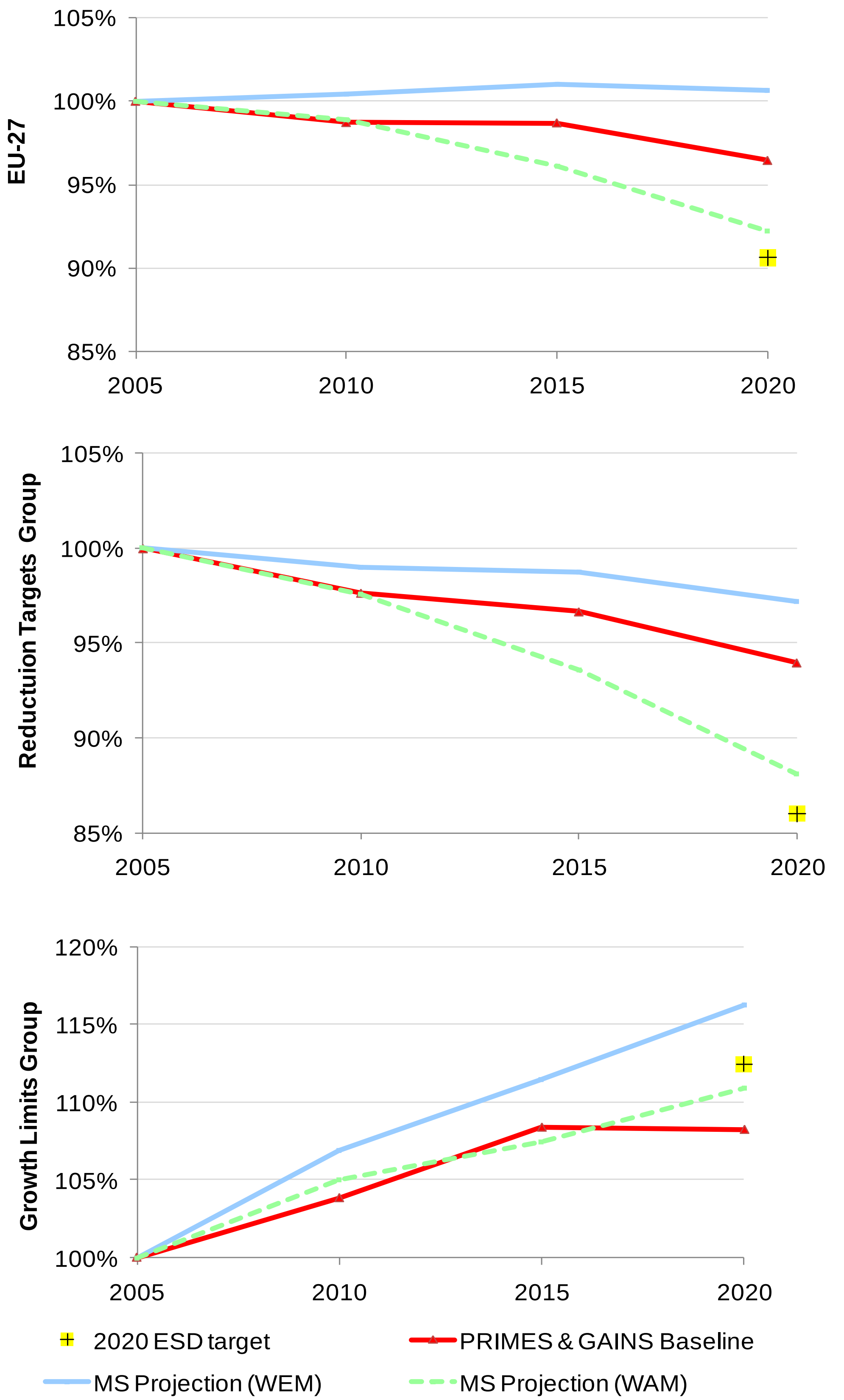


Figure 3-2 and Figure 3-3 both show the progression of EU-27 emissions from the ESD sector from 2005 to 2030 as projected by the PRIMES/GAINS baseline, split by sub-sector and greenhouse gas respectively. The sub-sector split in Figure 3-2 has been estimated from the overall sectoral split given by PRIMES and GAINS; see Section 2.2.1 for details of the methodology used.

In the EU-27 in 2005, transport provided the largest contribution to emissions under the ESD by sector (just over a third). The other two large contributors are household energy consumption (19%) and agriculture (17%). The remaining sectors account for less than 10% each. However, by far the largest reductions between 2005 and 2020 under this projection are in the waste sector, where emissions reduce by over 40%. Energy use in the service and agriculture sectors provides the next largest cuts, of around 11%. Based on the sectoral split used in this study, energy use in the industry and construction sector is the only activity to see significant growth in emissions over this period, of 26%. This may reflect the fact that this sub-sector is subject to less policy influence than other sectors (allowing for the fact that this excludes industry covered by the ETS). However, it is important to note that the estimation method is subject to the most uncertainty for this sector, and at least part of this growth may be a statistical artefact. Detailed discussion on the trends in emissions in each of these individual sectors is provided in Section 3.1.4 below.

By far the largest greenhouse gas contributor to the ESD is carbon dioxide, accounting for almost 70% of the global warming potential from ESD-covered emissions in 2005 in the EU-27. CO_2 emissions do not contribute to the overall slight decrease in GHG emissions between 2005 and 2015, and significant reductions are only achieved beyond 2020. In contrast, emissions from methane drop by 20% between 2005 and 2020, mainly in municipal and industrial solid waste; this is likely to be a result of the national implementation of the Landfill Directive. Emissions of nitrous oxide change little over the 25-year period to 2030, whilst emissions from F-gases rise by over 20%. Large increases in emissions from refrigeration in the industrial and commercial sectors in virtually every Member State account for the majority of this rise.

Figure 3-2: Projected emissions within the ESD for the EU-27, split by sub-sector (based on PRIMES & GAINS baseline)

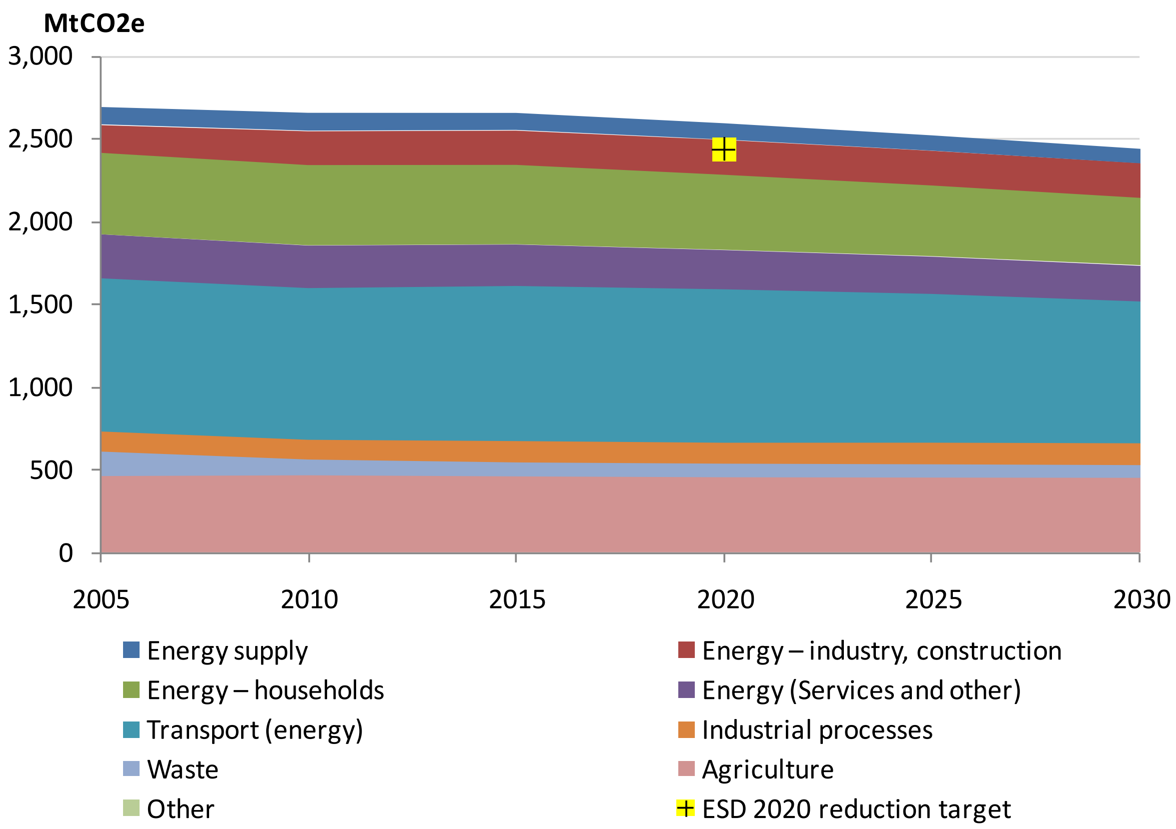
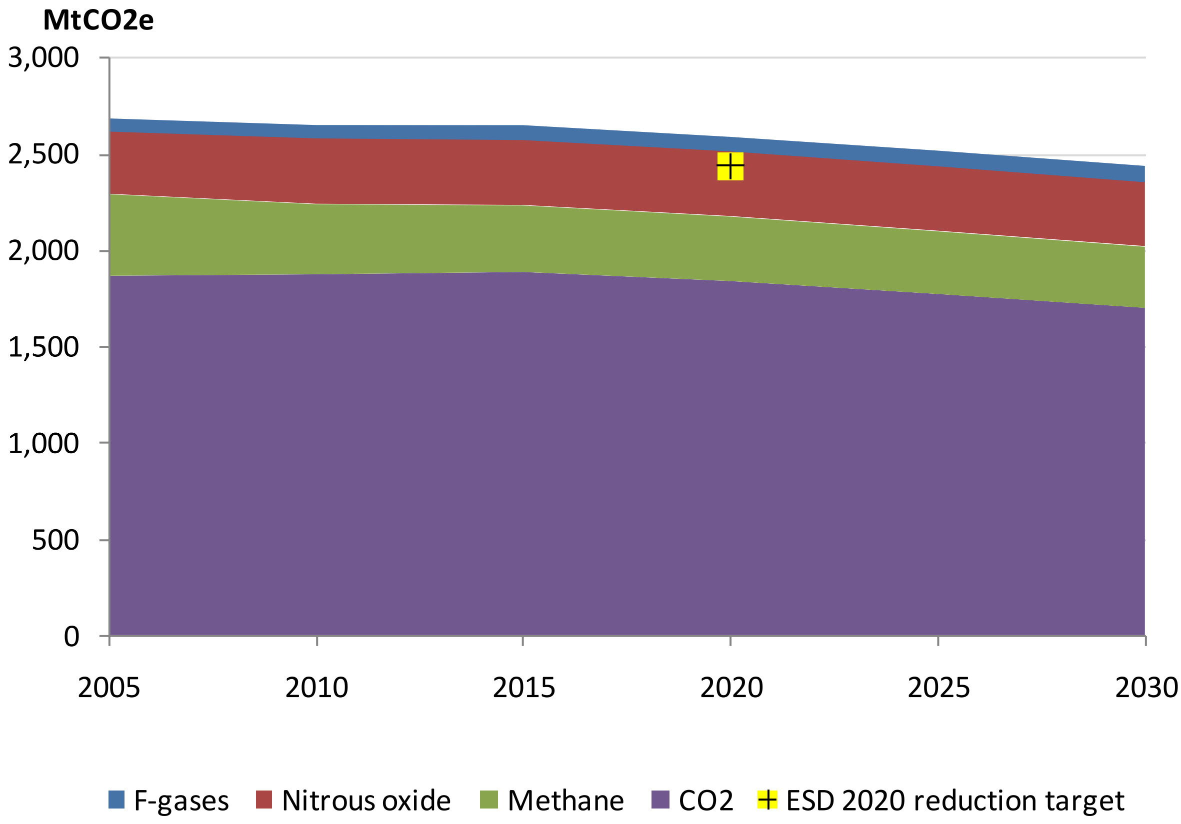


Figure 3-3: Projected emissions within the ESD for the EU-27, split by greenhouse gas (based on PRIMES & GAINS baseline)



3.1.2 Member States

The results can also be shown for individual Member State.

Two sources of projections are compared: the PRIMES/GAINS 2009 baseline results, and projections submitted by Member States as part of the Monitoring Mechanism (see Table 2-2 for details of the source for each Member State). It can be seen that these two sources do not always agree, but in most cases the overall result (whether a Member State is projected to meet or fail to meet its reduction target domestically) is the same.

This apparent agreement is not unexpected given the methodology that has been used. Member States are not currently required in their projections to include an estimate of the split of emissions into those that fall under the EU-ETS and ESD respectively. Very few do, and none include this split by sub-sector. Therefore, for the purposes of this study the split between emissions that would be traded under the EU-ETS and those that would fall under the ESD have been estimated based on the proportions in each Member State and sub-sector in the PRIMES/GAINS baseline (see section 2.2.2 for details). Therefore, the overall estimates for the split of emissions between those covered under the ESD and EU-ETS are likely to follow similar trends (including potential inaccuracies). The figures below should be considered in this context.

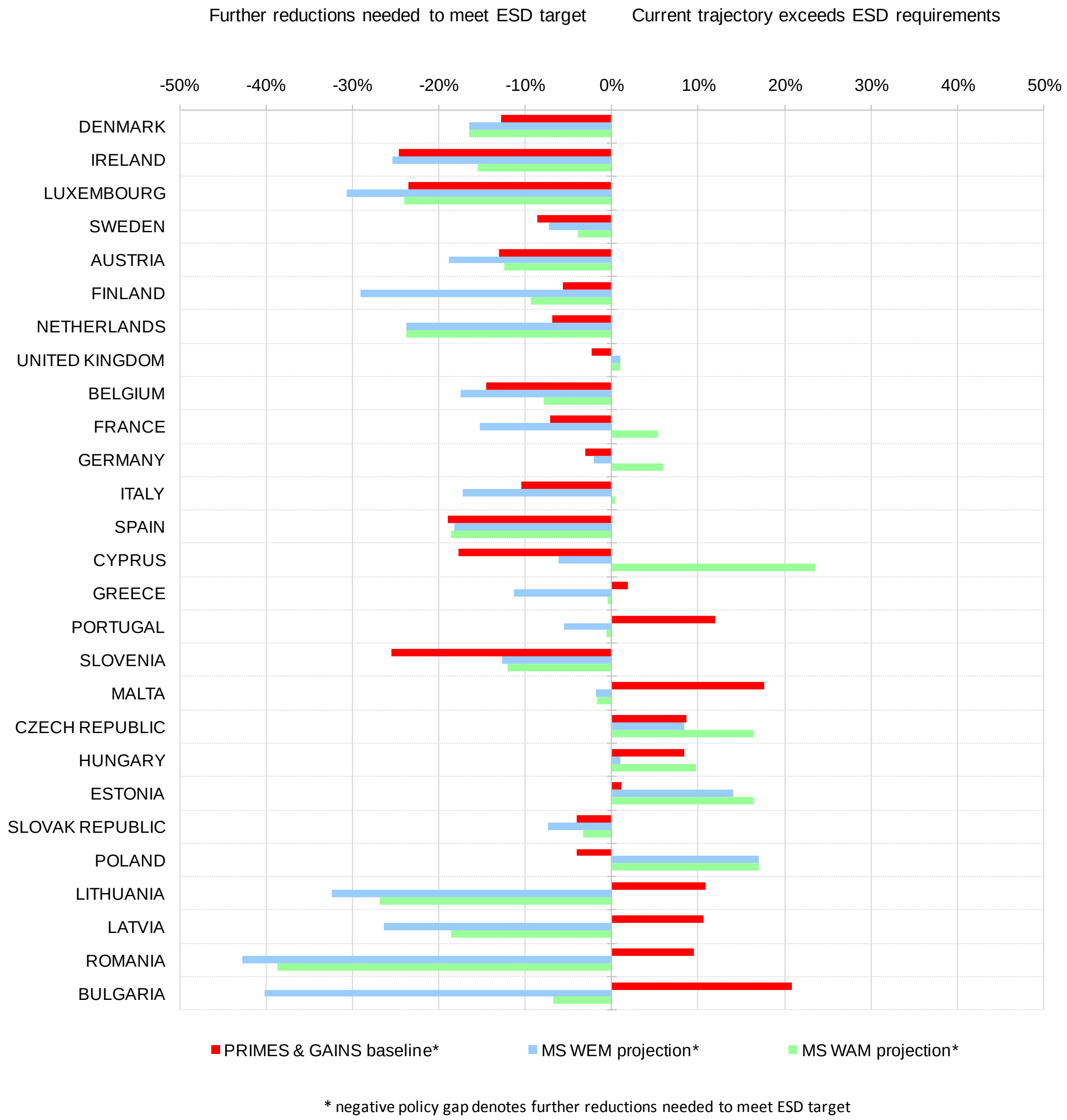
Figure 3-4 shows a comparison of the change in emissions, between 2005 and 2020, from all sources covered by the ESD according to a range of projections. This can be compared with the relative target set for each Member State under the ESD to evaluate the current projected gap, referred to as the “policy gap”. If current projections for a Member State show emissions exceeding the ESD target in 2020, then further policies and measures will be needed in order to close this gap. In the chart the gap is represented as the percentage change in emissions 2005-2020, between the projections and the

ESD target for each Member State. Projections based on PRIMES and GAINS baselines indicate that only 10 of the EU-27 Member States will meet or exceed their requirement under the ESD. Furthermore, PRIMES and GAINS projections show nine Member States with a policy gap of over 10% (i.e. 10% further reduction between 2005 and 2020 is required under the ESD than is projected).

Member State's own projections paint a similar overall picture, though there are marked differences for some Member States. Overall, Member State 'with existing measures' (WEM) projections agree with PRIMES and GAINS modelling in the direction of the policy gap (whether the Member State is projected to meet its ESD target or not) for all but 9 of the EU-27. The most marked differences are in projections for Lithuania, Latvia, Romania and Bulgaria, where the Member State projections show much higher growth in emissions than PRIMES/GAINS – with a consequential impact on the policy gap. This may relate to different expectations for the levels of economic growth within these Member States, particularly if their latest projections do not yet account for the impacts of the recent recession. Five Member States (the UK, France, Germany, Cyprus and Poland) estimate that, with additional planned measures ('with additional measures' projection), they will meet their ESD target where they are not expected to under the PRIMES and GAINS baseline projection. This may, in part, be explained by new national policies included in the Member State projections that were not captured in the PRIMES/GAINS analysis. This would include, for example, national policies stimulating renewable heat and the use of renewable energy in the transport sector. Additionally, where these projections were made prior to the full impact of the recession being known to Member States, a re-evaluation may lead to even lower projected emissions.

There is a general trend, particularly in the PRIMES and GAINS projections but largely supported by Member States' own projections, that Member States with targets to reduce emissions between 2005 and 2020 are not projected to achieve their ESD targets. In contrast, Member States with targets where their emissions are allowed to grow under the ESD are projected to meet their targets.

Figure 3-4: Estimation of the policy gap in 2020 between current projected emissions from sectors covered by the ESD and the national target under the Effort Sharing Decision (negative policy gap denotes further reductions needed to meet target)



3.1.3 Uncertainty analysis – scope of ESD emissions

The above conclusions are drawn on a relative basis for each projection, i.e. by considering the percentage change in emissions in 2020 relative to the emissions in 2005, for each projection separately. Whilst this is consistent with the targets that have been set for each of the Member States under the Decision, in practice it is absolute changes in emissions that are important (i.e. the $MtCO_2$ eq). It is therefore necessary to estimate the absolute emissions target for a given Member State, and for the EU as a whole.

However, calculation of an absolute emissions target raises issues associated with methodological differences in the different sources of projections. For example, the level of emissions of greenhouse gases ($MtCO_2$ eq.) in 2005, as reported in PRIMES, differs from the reported emissions in Member State inventory submissions to the UNFCCC. This discrepancy results from the use of slightly different statistical data, with the PRIMES estimates drawing on energy statistics reported to Eurostat rather than emissions data reported in UNFCCC submissions[19]. Consequently, the absolute emissions in PRIMES are not directly comparable to those reported in Member States' inventories[20]. Therefore, an estimate of the ESD emissions limit for a given Member State in 2020 using PRIMES 2005 emissions data may result in a different value than one estimated using data reported in Member States' inventories.

This discrepancy in the 2005 base year emissions also results in a slightly different relative (i.e. % change) emissions target, for the EU as a whole, when derived using PRIMES data, to the relative emissions target derived using Member State inventory data. This is because the EU target is a composite of Member States' targets, so any discrepancy in the targets at Member State level results in a discrepancy in the EU wide target. For the EU as a whole, the 2020 emissions target calculated from Member States' latest inventory data equates to a 9.3% reduction compared with 2005 emissions. However, the target based on the PRIMES/GAINS baseline would equate to an overall reduction of 9.4%. Since the former calculation more closely follows the methodology that will be used to calculate Member States' absolute emissions targets under the ESD, it is likely that this is the more accurate estimate. Furthermore, the inventory based estimate also closely match submissions from four Member States (Denmark, Ireland, Sweden, and France) that have separately estimated the size of their 2005 emissions covered under the ESD (average difference was 1%).

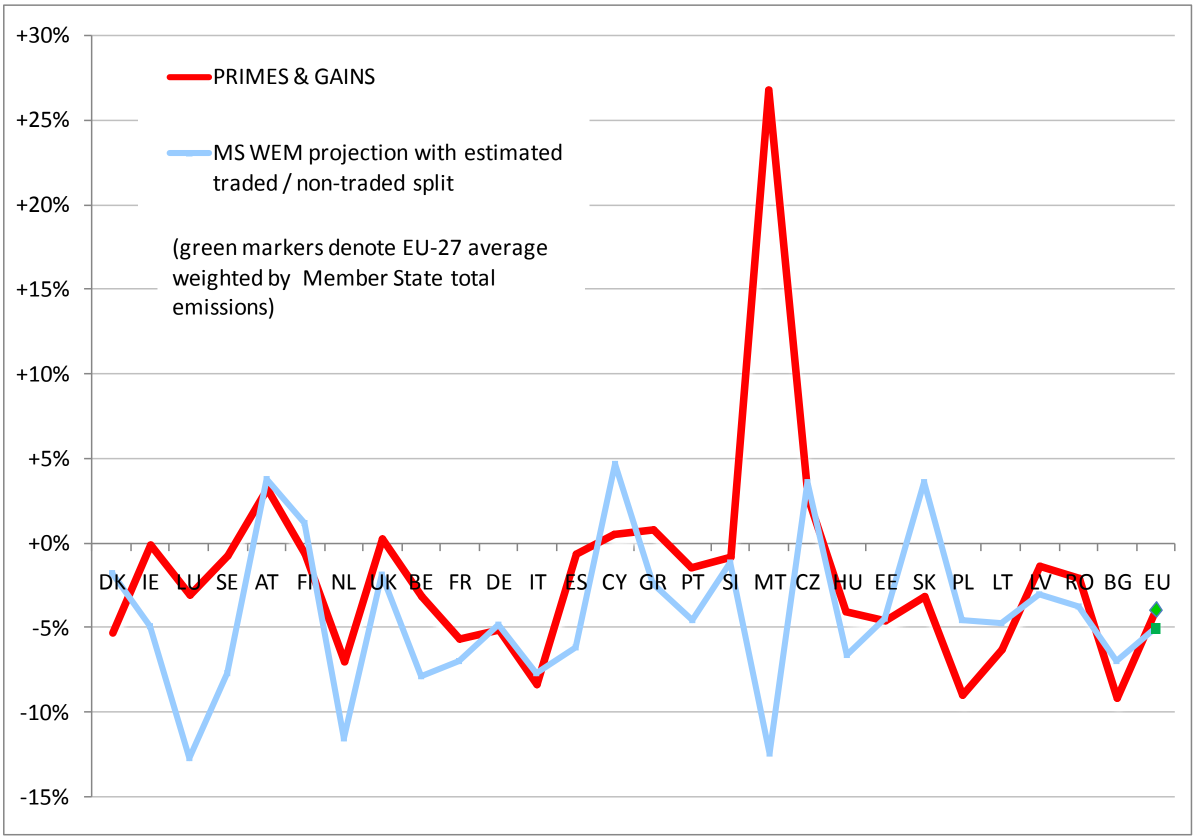
Figure 3-5 below compares the different estimates of emissions covered under the ESD, in 2005, for each Member State. It therefore provides an indication of the potential uncertainty in the ESD emissions limits (when expressed as an absolute emissions value). Since the emissions in 2005 are the starting point when estimating the limits to be applied in 2020, then uncertainties in these emissions will also be reflected in the estimates of future limits. In the figure the estimates (from the different sources) are shown as the difference to the values calculated from the latest inventory data for each Member State. Therefore a positive value indicates an estimate of the scope of ESD emissions that is greater than the inventory estimate, and a negative value an estimate that is lower than the inventory estimate. This comparison shows that the inventory estimates frequently differ from the estimates based on data in PRIMES/GAINS, and therefore the data used to 'split' the Member States' WEM and WAM projections.

It can be seen from Figure 3-5 that, across the EU-27, the PRIMES/GAINS baseline generally gives a lower estimate of the 2005 emissions under the ESD than that estimated from the latest inventory; only six Member States[21] contradict this trend. The same result is observed when comparing the PRIMES/GAINS baseline with data from the seven Member States (Denmark, Ireland, Sweden, Finland, the UK, France and Romania) that provided an estimate for the proportion of emissions in 2020, from their projections, that fall under the ESD: the PRIMES/GAINS baseline gives a consistently lower estimate for both absolute ($MtCO_2$eq) and relative (% of total emissions) emissions covered by the ESD. As discussed above, this may in part be explained by the different statistical basis for the PRIMES analysis, which draws upon the energy statistics reported to Eurostat.

The chart also shows the difference in emissions between the inventory-based split and the estimate used in the analysis of Member States (WEM/WAD) projections, as shown above. Since our estimates for the ESD proportion of the Member State projections are based on PRIMES/GAINS baseline data, these projections also broadly follow the same trend (i.e. discrepancies in the PRIMES/GAINS data are also reflected in the WED/WAD projections).

[19] Whilst these energy statistics are also used by Member State inventory compilers the classification of energy to sectors may differs slightly from those used in PRIMES. Hence there are some differences in scope and allocation. In addition, the emissions factor used to report the emissions arising from energy use may also differ between PRIMES and Member state inventories.
[20] PRIMES does provide an output that is consistent with the reporting to the UNFCCC. However, this output could not be reconciled with the latest MS inventories in all cases, so was not examined further.
[21] Austria, the UK, Cyprus, Greece, Malta and the Czech Republic.

Figure 3-5 Comparison of different estimates of 2005 emissions covered under the ESD for each Member State, showing the percentage difference between projection estimates and estimate calculated from Member State inventory data



The above analysis highlights two important points:

- The way in which the emissions within the scope of the ESD are calculated can have an important influence on the estimated policy gap, particularly at a Member State level.
- A robust assessment of the performance at an EU level requires a consistent and harmonised approach to be applied for all Member States.

The approach used in the current analysis (using the split of emissions between ESD and ETS sectors as reported in PRIMES/GAINS) is considered to be a pragmatic approach that treats all Member States on a consistent basis. However, it is clear that it is not without limitations. As more Member State report updated projections, including the split of emissions captured within the ESD, the analysis of the policy gap at a Member State level can be assessed with greater accuracy. This can also be used to improve the coverage of ESD emissions within PRIMES and GAINS.

3.1.4 Sectors

While the ESD targets apply to all emissions within the scope of the Decision, it is useful to understand the projected trends in emission from each of the sub-sectors, and relative influence of the different sources over time. For the main sub-sectors, representing around 93%[22] of the emissions within the scope of the ESD, the emissions trends are described in the sections below.

A summary of the headline results for each sector is provided in the table below, these values are further explained in the text that follows.

[22] Sources that have not been examined in detail include emissions from energy use in the agriculture sector. Some of the difference also relates to the 'other' emissions category in GAINS, which cover systematic differences between GAINS and the emissions reported to UNFCCC. The other category is effectively a balancing mechanism to ensure that the GAINS model matches MS inventories.

Table 3-2: Emissions from the main ESD sectors in 2005 and 2020, for EU27

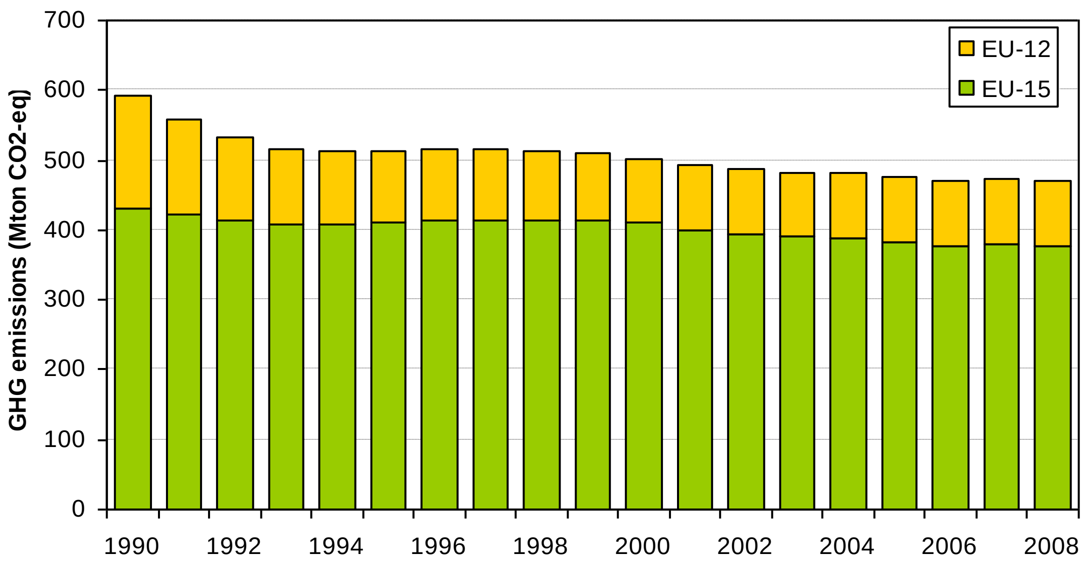
	Agriculture	Building	Industry	Transport	Waste	Other
Emissions in 2005 (PRIMES/GAINS	471	690	290	924	147	170
Emission in 2020 (PRIMES/GAINS)	464	626	336	927	83	160
Emissions in 2020 (MS WEM)	465	638	416	844	128	186
Indicative emissions target in 2020[1]	*431*	*618*	*261*	*826*	*138*	*164*

[1] No sectoral emissions targets exist. The emission targets used here are illustrative and assume a pro-rata allocation of the ESD target as a whole, based on the sum of Member States individual targets, and the relative emissions from the sectors in 2005.

Agriculture

In the EU-27, the agriculture sector (IPCC category 4)[23] has an emission of 472 MtCO_2 eq according to the latest UNFCCC submissions of 2008. This is about 9% of the total EU-wide GHG emissions and about 18% of the GHG emissions within the ESD. Emissions of greenhouse gases have been in gradual decline over the past two decades (Figure 3-6). From 1990 to 2008, emissions fell by one-fifth. However, reductions in the agriculture sector so far were mostly due to reductions in number of livestock, which decreased especially in the beginning of the nineties in the new member states. However, also in most EU-15 countries the number of livestock reduced partly due to implementation of animal welfare regulations and the Nitrates Directive, which puts a limit to the amount of animal manure that is allowed to be applied.

Figure 3-6: GHG emissions arising from agriculture across the EU-27 (source: EEA Greenhouse gas data viewer)



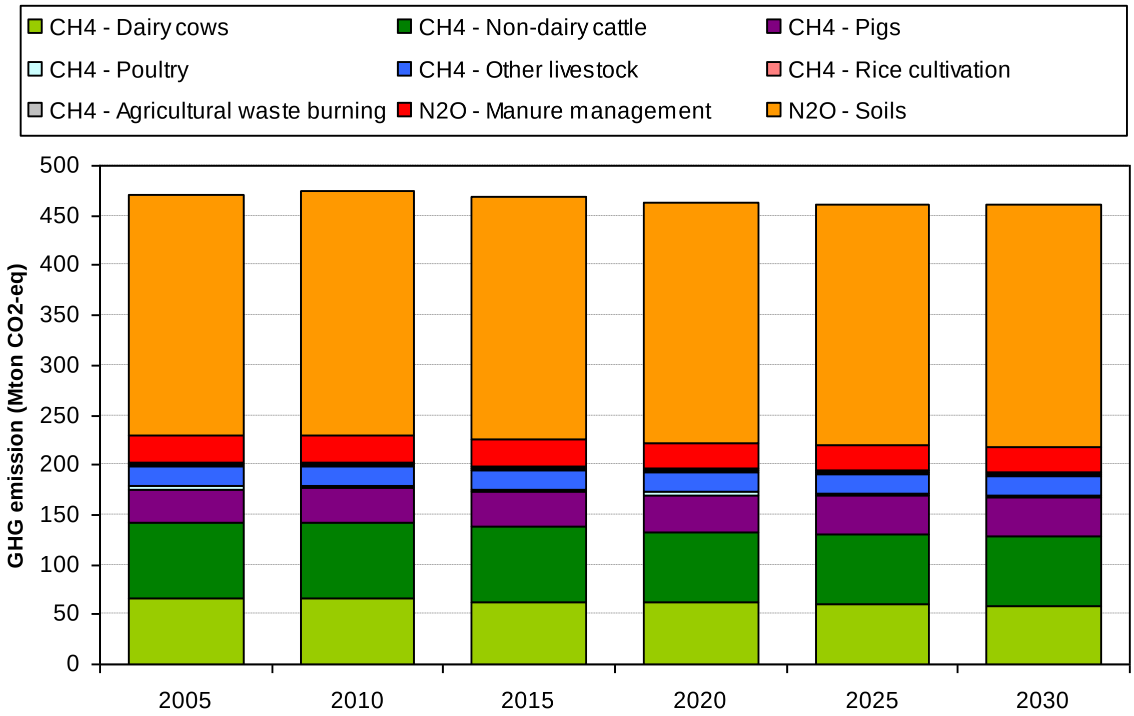
In Figure 3-7 the baseline emission projections for agriculture are shown. These emissions are based on the most recent projections from the GAINS model (Höglund-Isaksson et al., 2010). All emissions are expressed in CO_2-equivalents using the IPCC 1997 GWP values (310 for N_2O and 21 for CH_4). The baseline emissions projections only show a very minor decline, from 471 MtCO_2 eq. in 2005 to 464 MtCO_2 eq. in 2020, which is a decrease of about 1.6%. The figure also shows the different sources of emissions. When comparing the projected emissions for 2005 and 2020, the methane emissions from dairy cattle are projected to decrease by about 7%, whereas for pigs and poultry

[23] All anthropogenic emissions from agriculture except for fuel combustion and sewage emissions. It includes methane (CH_4) and nitrous oxide (N_2O) from enteric fermentation, manure management, rice cultivation, agricultural soils, prescribed burning of savannas, field burning of agricultural residues and other.

increases in methane emissions are projected. For N_2O a decrease by 8% is projected for emissions from manure management while emissions from soils is estimated to increase by 1%.

The main drivers for GHG emissions from agriculture are livestock numbers and fertilizer consumption. The number and type of livestock affect CH_4 emissions through enteric fermentation and from manure storage and N_2O emissions from manure storage and manure application. The total number of livestock is projected to remain more or less constant, with a slight decrease in cattle number, but increases in pigs and poultry (Höglund-Isaksson et al., 2010). N fertilizer application is the main driver for N_2O soil emissions. The N fertilizer consumption in the 2020 baseline scenario is projected to slightly increase from 10.8 MtN in 2005 to 11.2 MtN in 2020 (Höglund-Isaksson et al., 2010). Fertilizer consumption decreases in most West-European Member States (especially the Netherlands and UK) and is projected to increase in most East and Central European Member States (especially Poland and Romania). However, projections are uncertain, and changes in market prices and human diets have their impact on the amount and distribution of livestock and crops. Furthermore, the potential of agricultural intensification in central and eastern Europe depends on the uptake of biomass cultivation for bio-energy and food prices.

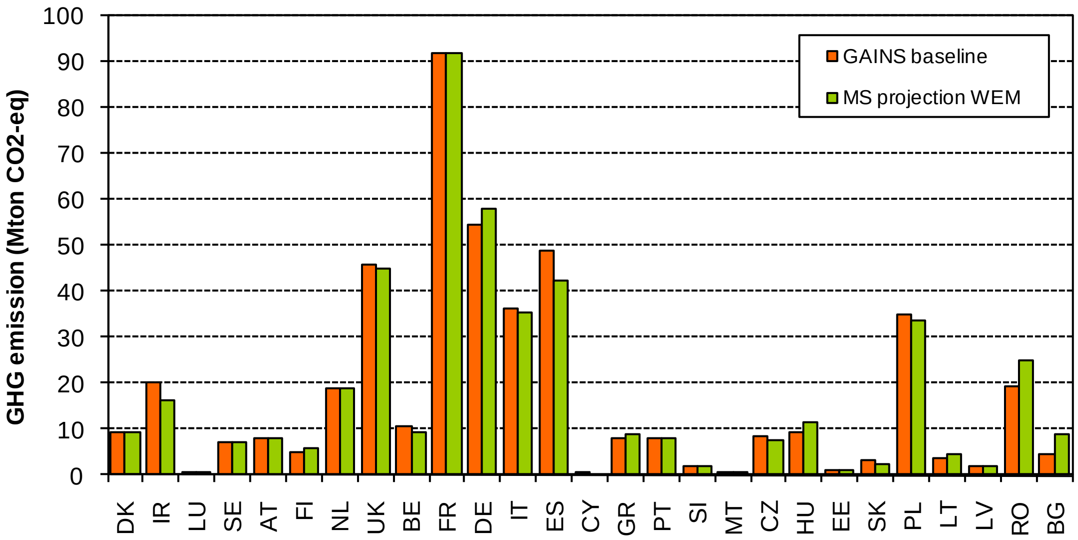
Figure 3-7: Baseline GHG emissions and composition from agriculture (emissions from fuel use in agriculture are not included, since these are not part of the UNFCCC category 4 Agriculture)



Source: projections by GAINS (Höglund-Isaksson et al., 2010

In Figure 3-8 the projected annual emissions in 2020 from GAINS are compared with the projections provided by the member states in accordance with the EU Monitoring Mechanism. The total projected GHG emission for 2020 from the sector Agriculture in the EU-27 is 463.5 $MtCO_2$ eq. for the GAINS baseline projection and 465.3 $MtCO_2$ eq. for the projections provided by the individual member states, which agrees well. However, for individual countries the projections differ more. The member state projections for Ireland (-18%), Spain (-13%) and Slovakia (-34%) are much lower compared to the GAINS projections, whereas for Finland (+15%), Slovenia (+17%), Hungary (+21%), Lithuania (+34%), Romania (+29%) and Bulgaria (+90%) the member states projections are higher. Some of the differences can be explained by differences in methodology, e.g. Germany and Poland apply the revised IPCC methodology from 2006 for their N_2O soil emissions, whereas most countries and the GAINS analysis use the IPCC guidelines of 1997. Other differences are likely to relate to underlying assumptions from the projections, e.g. different livestock populations.

Figure 3-8: GHG projections for Agriculture for 2020 for the GAINS Baseline projection and Member States' projections with existing measures



Whilst no sector specific target exist, if the agriculture sector were to make a proportionate contribution to the overall ESD target, in line with the emissions from the sector in 2005, then this would relate to an absolute emission in the EU 27 of 431 $MtCO_2$ eq in 2020, based on the ESD targets for each Member State. Compared to the current GAINS baseline projection and the WEM projections by the Member State, the calculated emission reaching the ESD target is much lower. This shows that there is still a large policy gap if Member States want to reduce emissions from agriculture proportionally to the ESD target. This all assumes that all other sectors are able to deliver a proportionate share.

A similar analysis can be carried out at a Member State level. Table 3-3 provides an overview of the historical trend in emissions[24], the projected future trend in emissions, and the hypothetical 'policy gap' for each Member State. The analysis is based on the PRIMES/GAINS projections. As with the EU wide analysis, the policy gap assessment assumes Member States would reduce their emissions proportionately to their respective ESD target e.g. for Denmark, emission would need to reduce by 20%. The table shows that for most Member States the trend is downwards with lower GHG emission from agriculture. However, in most new Member States, especially Bulgaria and Romania, emissions from agriculture are projected to increase. Assuming a proportionate share in the ESD target most EU-15 Member States have a policy gap for 2020, especially the Netherlands, Luxembourg, Austria and Spain have a large policy gap (> 15%). For most new Member States no policy gap exists, since their emissions are allowed to increase according to the ESD target.

Table 3-3: Summary matrix: Results from the emissions analysis, by Member State, for the agriculture sector

	Trend (2005 - 2008)	Trend (2010-2020)			Policy gap (2020)		
	Historic	PRIMES & GAINS	MS WEM	MS WAM	PRIMES & GAINS	MS WEM	MS WAM
DENMARK	→	↓	↓	↓	☹	😐	😐
IRELAND	→	→	↓	↓	☹	😐	😐
LUXEMBOURG	→	↓	→	→	😐	☹	☹
SWEDEN	→	↓	↓	↓	😐	☺	☺
AUSTRIA	→	→	→	→	😐	☹	☹
FINLAND	→	↓	→	↓	😐	😐	😐

[24] The trend analysis is based on the data reported for the respective projections. It also represents the relative trend and not the absolute emissions. This explains why for certain Member States e.g. Spain the trend in emissions in the WAM shows a greater increase than in the WEM.

NETHERLANDS	→	→	↑	↑	☹	☹	☹
UNITED KINGDOM	→	↓	→	→	😐	😐	😐
BELGIUM	→	→	→	→	☹	😐	😐
FRANCE	→	↓	↓	↓	😐	😐	😐
GERMANY	↓	↓	↓	↓	😐	😐	😐
ITALY	→	→	↓	↓	😐	😐	😐
SPAIN	↑	↑	→	↑	☹	😐	☹
CYPRUS	→	↑	↑	↓	😐	☹	☺
GREECE	↓	→	↓	↓	☺	☺	☺
PORTUGAL	→	→	↓	↓	☺	☺	☺
SLOVENIA	→	↓	↑	↑	☺	😐	😐
MALTA	↑	↓	→	→	☺	☺	☺
CZECH REPUBLIC	↑	↓	↓	↓	☺	☺	☺
HUNGARY	→	→	↑	↑	☺	😐	☺
ESTONIA	↓	↓	→	→	☺	☺	☺
SLOVAK REPUBLIC	→	↓	↓	↓	☺	☺	☺
POLAND	↑	→	→	→	☺	☺	☺
LITHUANIA	↑	↓	→	→	☺	☺	☺
LATVIA	↑	↓	→	→	☺	☺	☺
ROMANIA	→	→	↑	↑	☺	😐	☺
BULGARIA	↓	→	↑	↑	☺	☹	☹
EU27	→	↓	→	→	😐	😐	😐

Key

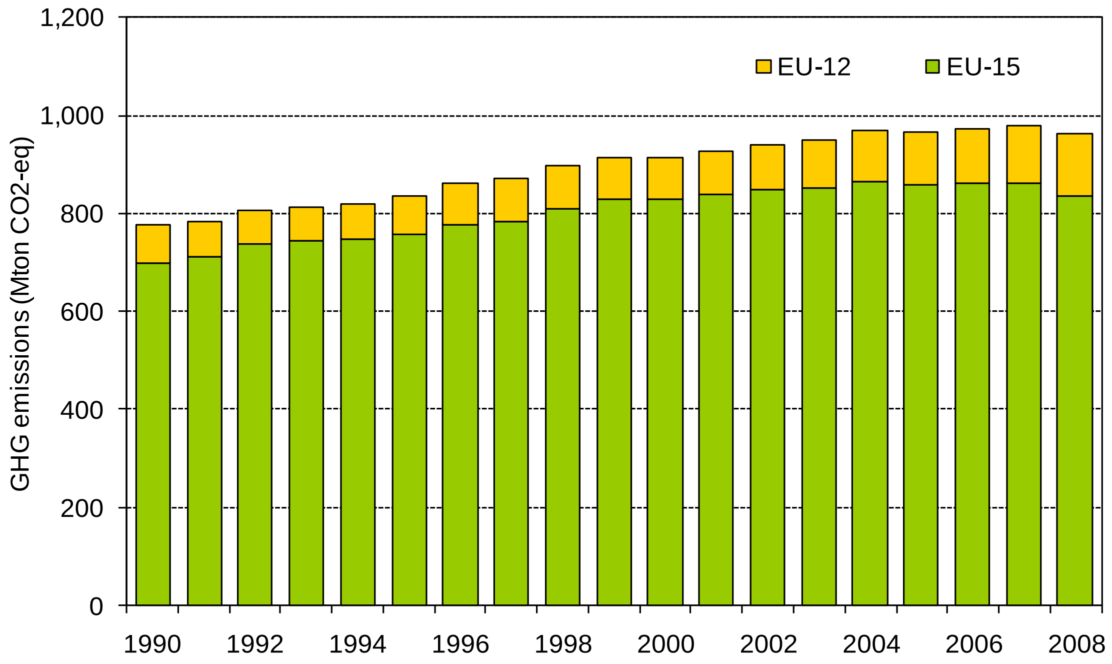
Emissions		Policy gap	
Trend criteria	**Symbol**	**Gap criteria**	**Symbol**
< -2%	↓	>-15%	☹
-2% to 2%	→	0% to -15%%	😐
>2%	↑	>0%	☺

Transport

In the EU-27, the transport sector emissions (IPCC sector 1A3) have increased by 24% between 1990 and 2008 (Figure 3-9). The transport sector is the only sector where GHG emissions have increased over this period. The main driver of the increase in CO_2 emissions has been the increase in passenger and freight tonne kilometers (EEA 2009). The increase has been relatively consistent over the period, with the biggest increase seen between 1997 and 1998 where emissions increased by 3.2%. In contrast, the most recent inventory year has seen the biggest decrease in emissions (-1.8%) which can be explained by the very high international oil price over this period, as well as the influence of the economic recession. CO_2 emissions (99%) dominate the emissions from the transport sector.

The figure includes emissions from aviation. In future years, these emissions will form part of the EU ETS, so these emissions will be outside of the scope of the ESD. Also outside the scope of the ESD, as currently defined, are emissions from international maritime shipping (which are also excluded from the chart below).

Figure 3-9: GHG emissions arising from transport across the EU-27 (source: EEA Greenhouse gas data viewer)

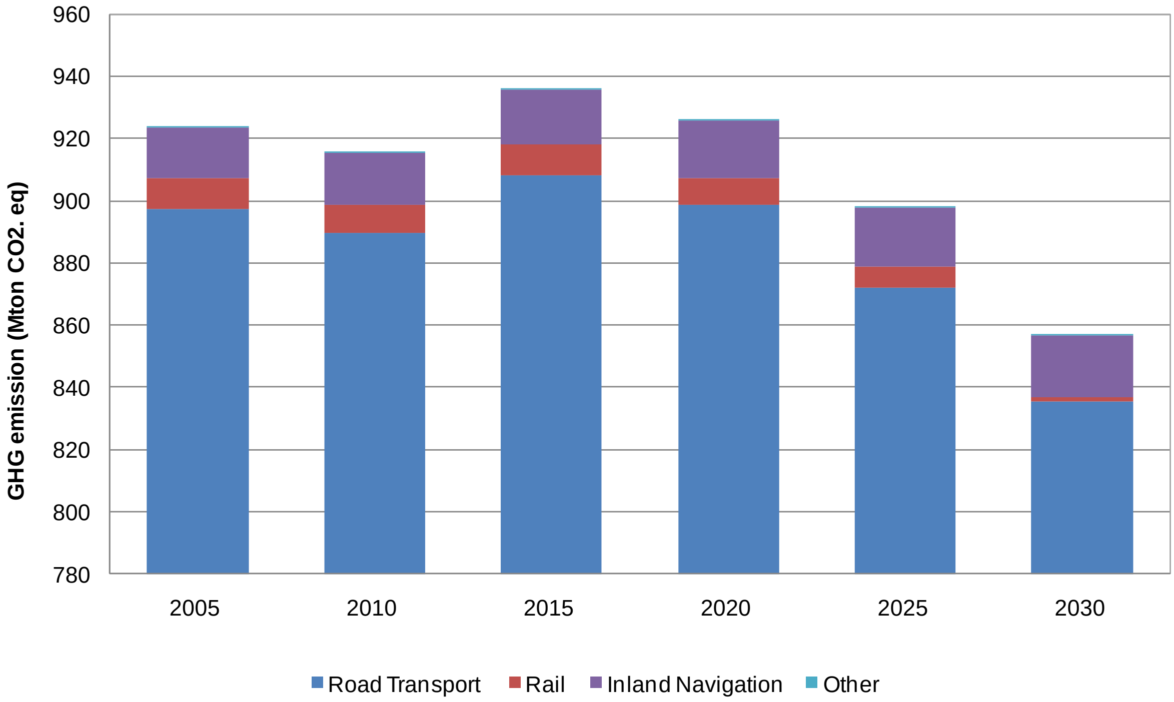


In Figure 3-10 the baseline emissions projections for the transport sector are shown. These include only those emissions that form part of the ESD i.e. emissions from aviation are excluded. These emissions are based on the most recent modeling using the GAINS (Höglund-Isaksson et al., 2010) and PRIMES (Capros et al 2010) models. The baseline emissions projections only show a small increase in emissions from 924 $MtCO_2$ eq. in 2005 to 927 $MtCO_2$ eq. in 2020. GHG emissions are projected to decrease slightly from 2005 to 2010, however, they are then projected to increase again, rising above the 2005 levels by 2015, before declining once again to 2030

Over the period examined, the emissions of greenhouse gases continue to be driven by increasing level of road transport activity (passenger and vehicle km). However, the latest 2009 projections assume a much less pronounced growth of transport activity than previous projections as a result of lower GDP growth and the effects of new policy measures included in the 2009 Baseline. The emissions from the increasing level of transport activity are increasingly offset by the impacts of existing policies. These include policies that reduce the carbon intensity of the energy consumed. For example, the PRIMES baseline assumes the uptake of biofuels in accordance with currently implemented policies (however not delivering the 10% target for RES in transport from the RES Directive). Likewise, hybrid vehicles are assumed to make significant in-roads into the stock over the period, although grid electricity is not assumed to penetrate the transport market strongly. Other policies, in particular the CO_2 from Cars Regulation will continue to improve the energy efficiency of new vehicles and deliver considerable emissions savings, particularly by 2030. Further details on the baseline assumptions can be found in the original modeling reports (Capros et al 2010, Höglund-Isaksson et al., 2010). Further discussion on the policy impacts can be found in the next section.

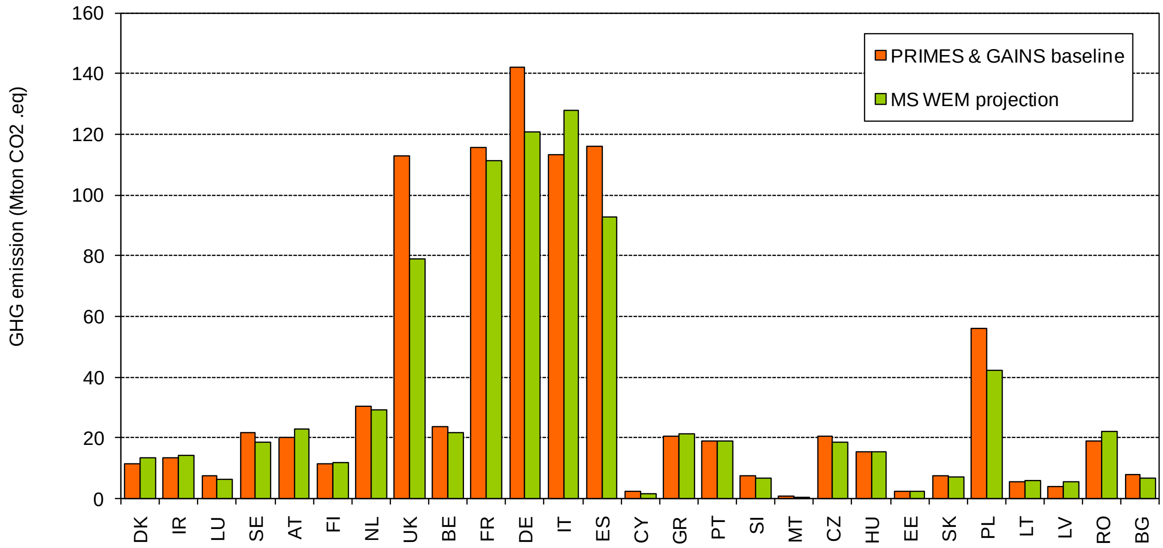
The figure also shows the different sources of emissions. Emissions from road transport continue dominate the overall emissions (97% in 2020). Looking into the change in emissions by source, between 2005 and 2020, road transport emissions stay constant whereas emissions from rail are projected to fall by 7%. This suggest, therefore, that the policy induced improvements in the energy efficiency of new vehicles and the reductions in the carbon intensity of transport fuels are not sufficient to deliver absolute reductions in road transport emissions, in the face of increasing levels of activity. However, some emissions reductions will be achieved in other transport modes.

Figure 3-10: Baseline GHG emissions and composition from transport, as projected by PRIMES-GAINS



For individual countries the projections often show a much greater variation. The member state projections for Malta (46%), Cyprus (33%) and UK (30%) are much lower compared to the PRIMES and GAINS projections, whereas for Latvia (31%), and Romania (15.7%) the member states projections are higher. The large variation in the transport projections can be in part attributed to the different assumptions with respect to the effects of the economic recession on transport activity levels. Different assumptions on the impacts of policies are also likely to be an important factor.

Figure 3-11: Baseline GHG emissions and composition from transport, as projected by PRIMES-GAINS and Member States



Whilst no sector specific target exist, if the transport sector were to make a proportionate contribution to the overall ESD target, in line with the emissions from the sector in 2005, then this would relate to an absolute emission in the EU 27 of 826 $MtCO_2$-eq in 2020, based on the ESD targets for each Member State. Compared to the current PRIMES/GAINS baseline projection, the calculated emission reduction required to meet the ESD target is much lower than the projected emissions in 2020. This shows that there is still a large policy gap if Member States want to reduce emissions from transport proportionally to the ESD target. However, Member States own projections suggest the policy gap is smaller so less additional effort may be required. In both cases, the implied targets assume that all other sectors are able to deliver a proportionate share.

A similar analysis can be carried out at a Member State level. Table 3-4 provides an overview of the historical trend in emissions, the projected future trend in emissions[25], and the hypothetical 'policy gap' for each Member State. As with the EU wide analysis, the policy gap assessment assumes Member States would reduce their emissions proportionately to their respective ESD target e.g. for Denmark, emission would need to reduce by 20%. Almost all Member States are projected to miss the illustrative pro-rata target for the transport sector, several by a significant margin (>15%). The overall conclusion i.e. whether a Member State is likely to meet or miss the illustrative pro-rata target, is consistent for 20 of the Member States in both the PRIMES/GAINS projections and the Member States' (WEM, WAM) projections – although the distance from target varies more greatly. It is notable that the challenges associated with meeting the illustrative target appears equally applicable to those Member States with a 'growth limit' (largely the EU-12 Member States) as to those with a 'reduction target'. This reinforces the argument that the growth limits still represent real limits on emissions, particularly for a sector such as transport where emissions are closely correlated with GDP.

Table 3-4 Summary matrix: Results from the emissions analysis, by Member State, for the transport sector

	Trend (2005 - 2008)	Trend (2010-2020)			Policy gap (2020)		
	Historic	PRIMES & GAINS	MS WEM	MS WAM	PRIMES & GAINS	MS WEM	MS WAM
DENMARK	↓	↓	→	→	😐	☹	☹
IRELAND	↓	↑	↑	↑	☹	☹	☹
LUXEMBOURG	→	↑	↑	↑	☹	☹	☹
SWEDEN	↓	→	→	↓	😐	☹	😐
AUSTRIA	↓	↓	↑	→	😐	☹	😐
FINLAND	↓	↓	→	↓	😐	😐	😐
NETHERLANDS	↓	↓	↑	↑	😐	☹	☹
UNITED KINGDOM	↓	↓	↓	↓	😐	☺	☺
BELGIUM	↓	↓	↓	↓	😐	😐	😐
FRANCE	↓	↓	↓	↓	😐	😐	☺
GERMANY	↓	↓	↓	↓	😐	☺	☺
ITALY	↓	↑	↑	↓	😐	☹	😐
SPAIN	→	↑	↑	↑	☹	😐	😐
CYPRUS	↑	↑	→	↓	☹	😐	☺
GREECE	→	→	↑	↑	😐	☹	😐
PORTUGAL	→	→	→	→	☺	😐	😐
SLOVENIA	↑	↑	↑	↑	☹	☹	☹
MALTA	↓	↓	↓	↓	☺	☺	☺
CZECH REPUBLIC	↑	↑	↑	↓	😐	☺	☺
HUNGARY	↑	↑	↑	↑	☹	☹	😐
ESTONIA	→	↑	↑	↑	☺	😐	😐
SLOVAK REPUBLIC	↑	↑	↓	→	☹	😐	😐
POLAND	↑	↑	↑	↑	☹	😐	😐

[25] The trend analysis is based on the data reported for the respective projections. It also represents the relative trend and not the absolute emissions. This explains why for certain Member States e.g. Slovak Republic the trend in emissions in the WEM shows a greater decrease than in the WAM

LITHUANIA	↑	↑	↑	↑	☹	☹	☹
LATVIA	↑	↑	↑	↑	☹	☹	☹
ROMANIA	↑	↑	↑	↑	☹	☹	☹
BULGARIA	→	↑	↑	↑	☺	☺	☺
EU27	→	→	→	↓	😐	😐	😐

Key

Emissions		Policy gap	
Trend criteria	**Symbol**	**Gap criteria**	**Symbol**
< -2%	↓	<-15%	☹
-2% to 2%	→	0% to -15%%	😐
>2%	↑	>0%	☺

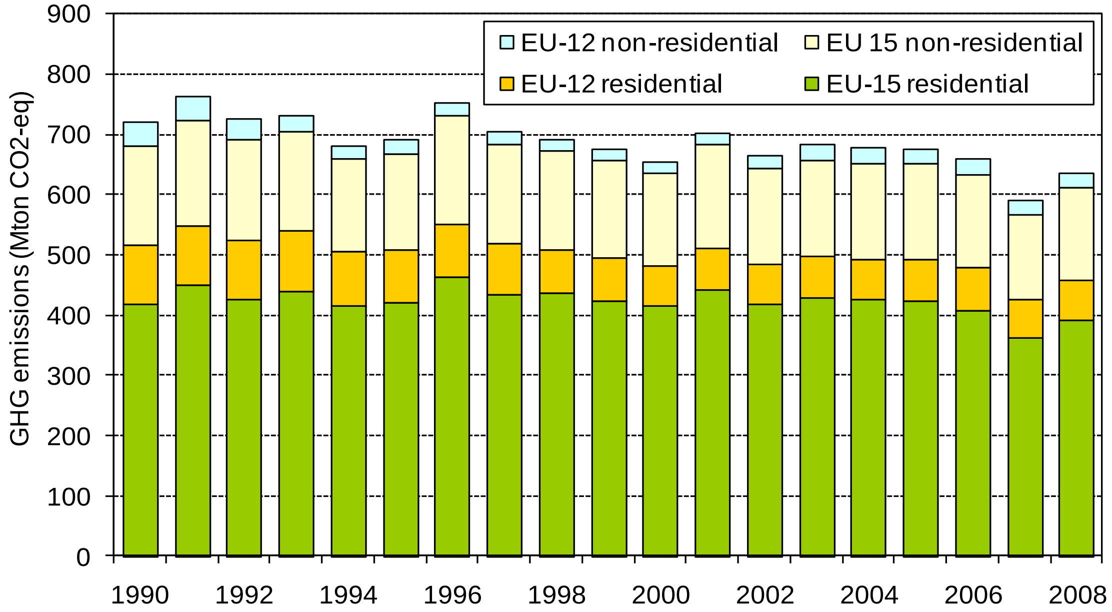
Buildings

The 'buildings' sector includes emissions from energy consumption within commercial/institutional buildings and also from the residential sector (IPCC category 1 A 4a respective 1 A 4b). The resolution of the reported data does not allow further disaggregation by sub sectors (office, schools, hospital e.g.). Only direct emissions are included, i.e. all emissions from fuel combustion in households, commercial and institutional buildings[26]. The 'indirect' emissions from electricity use arise within the electricity generation sector and are assumed to be captured as part of the EU Emissions Trading Scheme. These emissions are therefore outside the scope of the ESD and have not been considered further below.

In the EU-27, the buildings sector emissions have shown a gradual decline that is partly masked by large annual fluctuations. From 1990 to 2008, emissions fell about 13%. The decline can be largely explained by rehabilitation activities on existing buildings (and partly demolition) which more than compensate additional emissions from new (and more efficient) buildings. The fluctuations from year to year can be explained by ambient temperature fluctuations that lead to different heating degree days (HDD).

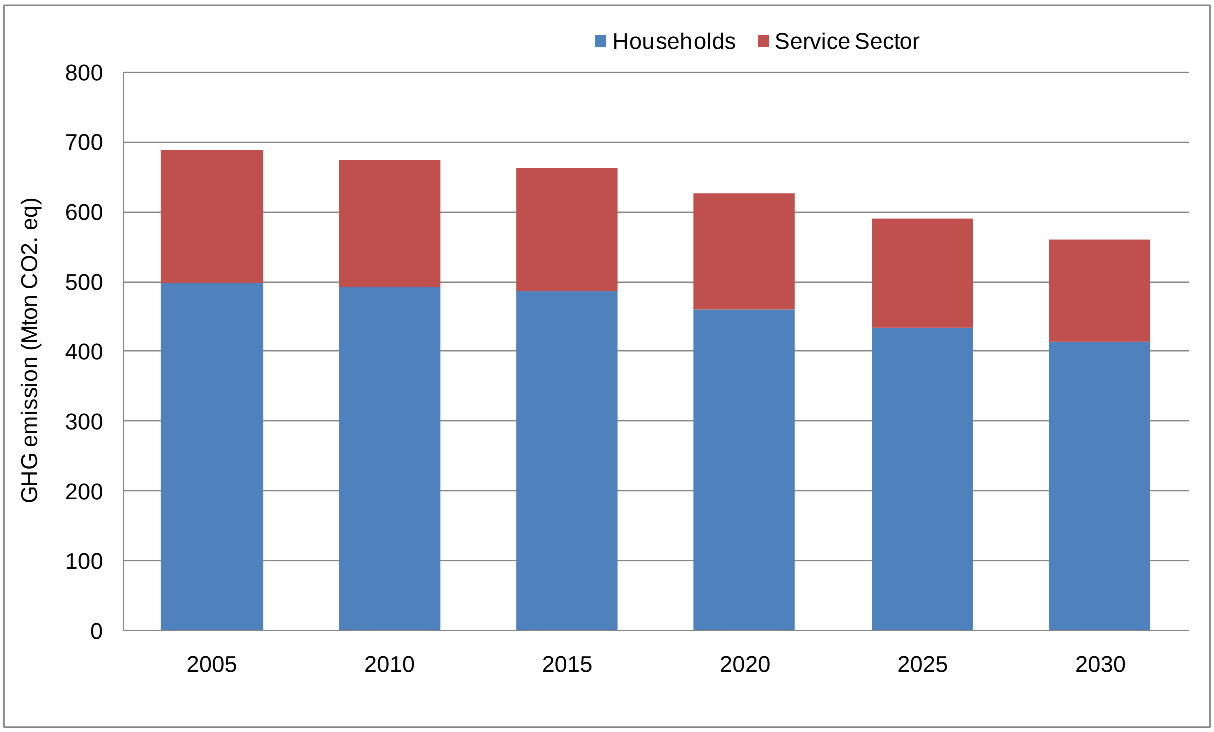
[26] Source: http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ri.pdf).

Figure 3-12: GHG emissions arising from building sector across the EU-27 (source: EEA Greenhouse gas data viewer).



In Figure 3-13 the baseline emissions for buildings based on the most recent projections from PRIMES are shown. The baseline emissions show a decline, from 689 $MtCO_2$ eq. in 2005 to 626 $MtCO_2$ eq. in 2020, which is a decrease of about 9%.

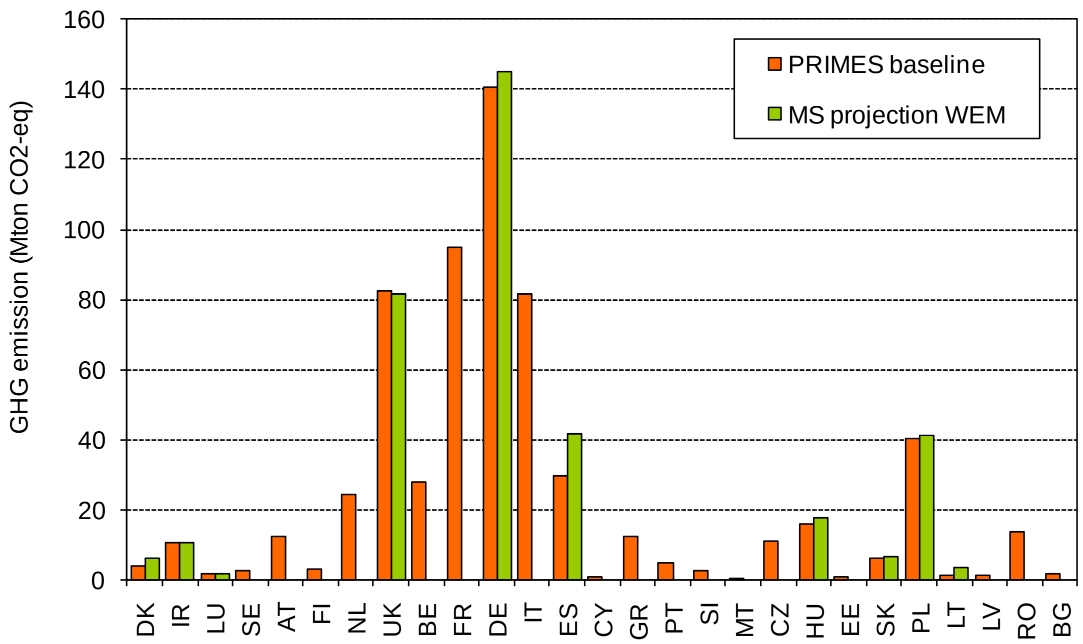
Figure 3-13: Baseline GHG emissions from buildings, as projected by PRIMES



In Figure 3-14 the 2020 projections from PRIMES and GAINS are compared with the latest projections provided by the Member States in accordance with the EU Monitoring Mechanism. For several Member States no data were provided for the WEM projections. In general the WEM projections from the Member States do not differ much from the PRIMES baseline projection. The difference might be explained by a different approach, different modeling parameters and inclusion/ exclusion of national measures

In the building sector the levels of future emissions are driven by new constructions, the retrofitting of the existing building stock and the demolition rate. For new construction the main drivers of emissions are a) the speed (construction rate), which is dependent from the market development and b) the level of compliance with the respective building codes (i.e. under the EPBD recast). The main drivers for the existing building stock are a) the speed of the energy related retrofit rate, which is connected to the market development (and the compliance with the EPBD recast when undertaking mayor renovation) and b) the quality of the renovation. The strength of these drivers is strongly influenced by Member States' level of ambition. The major uncertainties associated with future emissions projections therefore lie in the assumed market development and in the compliance with the relevant buildings codes (under the EPBD recast).

Figure 3-14: GHG projections for Building sector for 2020 from the PRIMES Baseline projection and Member States' projections with existing measures (WEM)



Whilst no sector specific target exist, if the buildings sector were to make a proportionate contribution to the overall ESD target, in line with the emissions from the sector in 2005, then this would relate to an absolute emission in the EU 27 of 618 $MtCO_2$-eq in 2020, based on the ESD targets for each Member State. Compared to the current PRIMES baseline projection, the calculated emission reduction required to meet the ESD target is slightly lower (1%) than the current expectation. This shows that current policies are almost sufficient to reduce emissions from buildings proportionally to the ESD target. However, Member States own projections suggest higher baseline emissions in 2020, and a larger policy gap. This suggests further additional measures would be required to meet this illustrative target. This all assumes that all other sectors are able to deliver a proportionate share.

A similar analysis can be carried out at a Member State level. Table 3-5 provides an overview of the historical trend in emissions, the projected future trend in emissions, and the hypothetical 'policy gap' for each Member State. As with the EU wide analysis, the policy gap assessment assumes Member States would reduce their emissions proportionately to their respective ESD target.

Table 3-5: Summary matrix: Results from the emissions analysis, by Member State, for the buildings sector

	Trend (2005 - 2008)	Trend (2010-2020)			Policy gap (2020)		
	Historic	PRIMES & GAINS	MS WEM	MS WAM	PRIMES & GAINS	MS WEM	MS WAM
DENMARK	↓	↓	↓	↓	😐	☺	☺
IRELAND	↑	↑	→	↓	☹	☹	☺
LUXEMBOURG	→	↓	↑	↑	☹	☹	☹
SWEDEN	↓	↓	↓	↓	☺	☺	☺
AUSTRIA	→	↓	↓	↓	😐	😐	☺
FINLAND	↓	↓	→	↓	😐	😐	☺
NETHERLANDS	↓	↓	↓	↓	😐	😐	😐
UNITED KINGDOM	↓	↓	↓	↓	☺	☺	☺
BELGIUM	→	→	→	↓	😐	☹	☺
FRANCE	→	↓	↑	↓	😐	☹	☺
GERMANY	↓	↓	↓	↓	☺	☺	☺
ITALY	→	→	↑	↓	😐	😐	☺
SPAIN	→	↓	↑	↑	😐	☹	☹
CYPRUS	↑	↑	↑	↓	☹	☹	😐
GREECE	↑	↑	↑	↓	😐	☹	☺
PORTUGAL	↓	↓	↓	↓	☺	☺	☺
SLOVENIA	→	↑	↓	↓	☺	☺	☺
MALTA	↓	↑	↑	↑	☺	☹	☹
CZECH REPUBLIC	↓	↓	↓	↓	☺	☺	☺
HUNGARY	→	→	↓	↓	☺	☺	☺
ESTONIA	↓	→	↑	↑	☺	☺	☺
SLOVAK REPUBLIC	→	↑	↑	↑	☺	☺	☺
POLAND	↑	↓	→	→	☺	☺	☺
LITHUANIA	↓	↑	↑	→	☺	☹	☹
LATVIA	→	↑	↓	↓	☺	☺	☺
ROMANIA	↑	↑	↑	↑	☺	☹	☹
BULGARIA	↑	→	↑	↑	☺	☹	😐
EU27	↓	↓	↓	↓	😐	😐	☺

Key

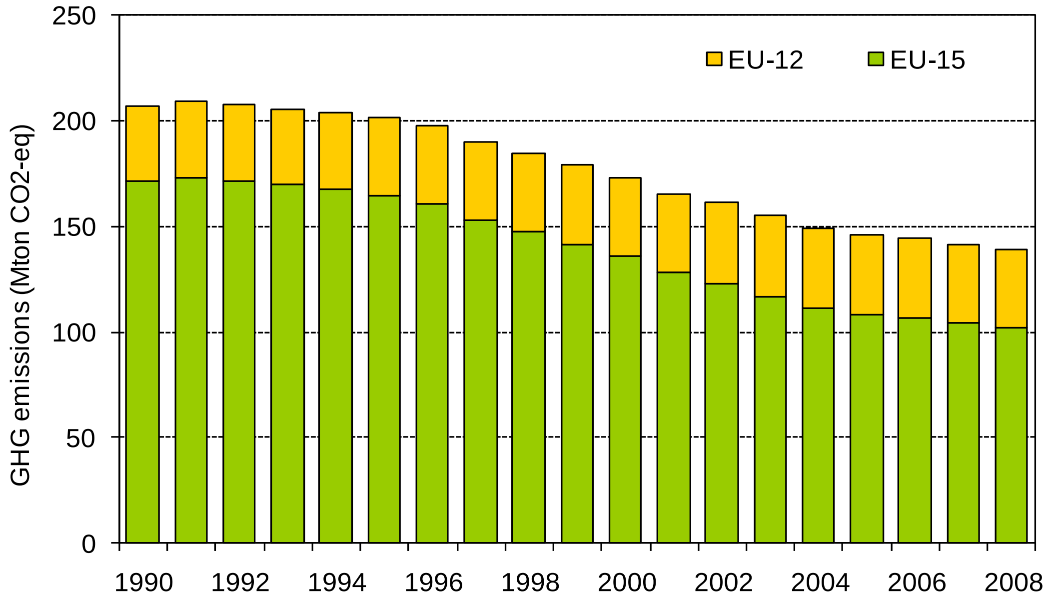
Emissions		Policy gap	
Trend criteria	Symbol	Gap criteria	Symbol
< -2%	↓	<-15%	☹
-2% to 2%	→	0% to -15%%	😐
>2%	↑	>0%	☺

Waste

In the EU-27, the waste sector emissions (IPCC category 6[27]) have declined by 40% between 1990 and 2008 (Figure 3-15). The decline has not been consistent over this period, emissions decreased relatively slowly between 1990 and 1995, accelerated between 1996 and 2004 and since then the decline has slowed down again. CH_4 emissions account for the majority of the emissions from the waste sector (88%) therefore the emission reductions in the waste sector so far have been from the managed waste disposal on land sector (IPCC category 6A1). The main driver for CH4 emission reduction from this sector is the amount of biodegradable waste going to landfills, total municipal waste disposal on land declined by 37% between 1990 and 2008. The second major determining factor for the decrease is from the increasing methane recovery rate from landfills (EU NIR 2010). These changes have been strongly driven by the landfill Directive (1999/31/EC) which sets reduction targets of the total amount of biodegradable municipal waste going to land fill against 1995 levels and introduces encourages CH_4 recovery technology at landfill sites.

All emissions from the waste sector are considered to be in the non-traded sector.

Figure 3-15: GHG emissions arising from waste across the EU-27 (source: EEA Greenhouse gas data viewer)



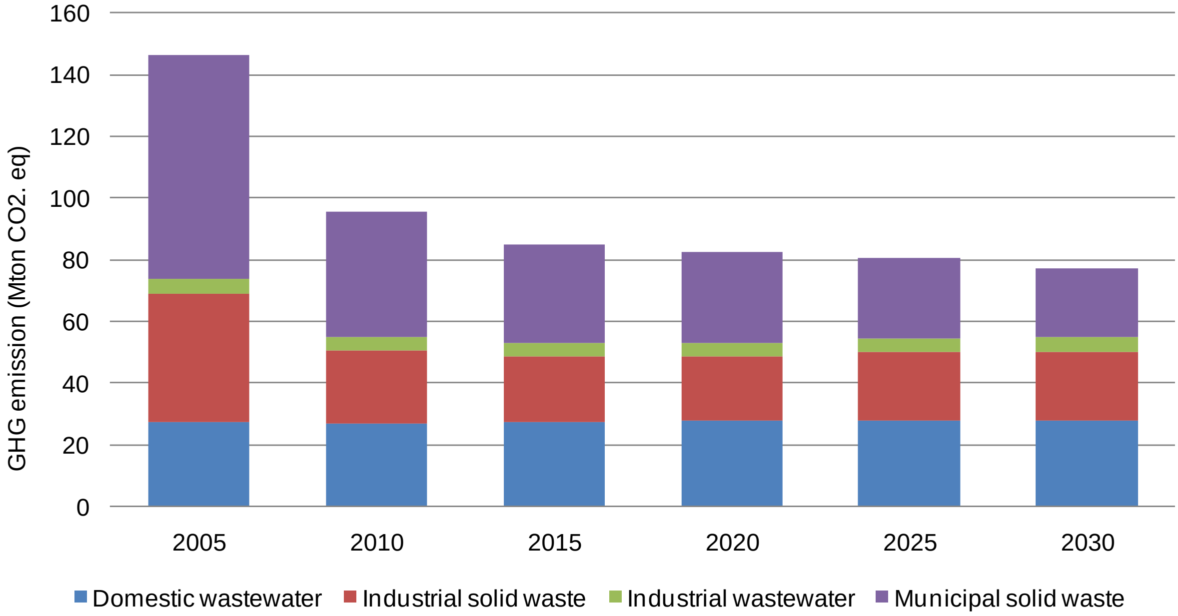
In Figure 3-16 the baseline emissions for waste are shown. These emissions are based on the most recent projections from the GAINS model (Höglund-Isaksson et al., 2010) therefore CO_2 emissions from the waste sector have not been accounted for[28]. This is considered as a reasonable assumption, since based on the EU-27 inventory in 2008, CO_2 emissions accounted for just 2% of the total GHG emissions from the waste sector. All emissions are expressed in CO_2-equivalents using the IPCC 1997 GWP values (310 for N_2O and 21 for CH_4). The baseline emissions projections show a significant decline, from 147 $MtCO_2$ eq in 2005 to 83 $MtCO_2$ eq. in 2020, which is a decrease of about 44%. The figure also shows the different sources of emissions. When comparing the projected emissions for 2005 and 2020, the methane emissions from municipal solid waste and industrial solid waste are projected to decrease about 59% and 50% respectively. Emissions from the other two sources also decline slightly. For N_2O an increase by 5% is projected for emissions from domestic wastewater.

Emissions from municipal solid waste are driven by the production of waste, and its subsequent treatment. The former is driven by population growth, income, urbanization and consumption trends. The latter is strongly influenced by existing policies, in particular the Landfill Directive. Over the period to 2030, the major reduction in methane emissions that is projected for the sector will arise from

[27] Intergovernmental Panel on Climate Change
[28] CO_2 emissions is not reported separately for the waste sector in PRIMES 2009.

extended diversion of biodegradable waste away from landfills into different waste treatment options e.g., recycling, incineration, composting and anaerobic digestion (Höglund-Isaksson et al., 2010).

Figure 3-16: Baseline GHG emissions and composition from waste, as projected by GAINS (the CO_2 emissions from waste incineration not included, however it is considered to only contribute ~ 2% of the overall emissions from the waste sector)



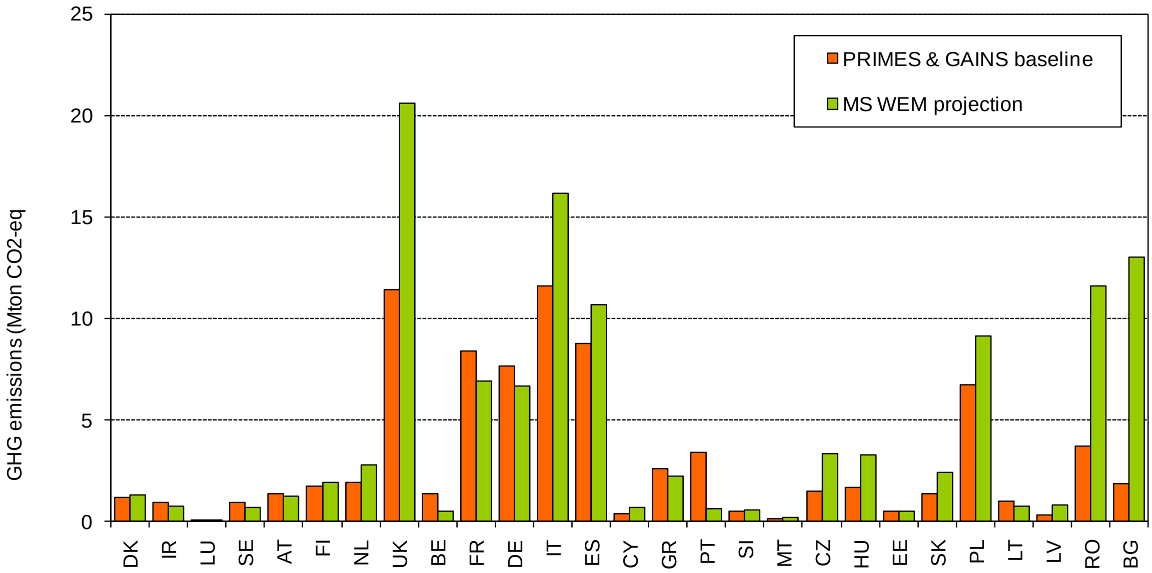
In Figure 3-17 the projected annual emissions in 2020 from GAINS are compared with the projections provided by the member states in accordance with the EU Monitoring Mechanism. The total projected GHG emissions in 2020 from the sector waste in the EU-27 is estimated to be 82.7 $MtCO_2$ eq based on the GAINS baseline projection and 128.4 $MtCO_2$-eq[29] for the with existing measures projections provided by the individual Member States. Therefore, the Member State projections are anticipating a much smaller decline in emissions (by around 70%) than the projections from GAINS.

It is not obvious whys such a variation existing between the projections estimates. However, it could relate to assumptions with respect to underlying drivers (e.g. the levels and mix of waste), to policy responses (e.g. timescales for compliance with Landfill directive) as well as to the methodological assumptions that underpin the modelling (e.g. methane capture rates). It may also be a consequence of overly optimistic assumptions concerning the rate at which new facilities offering an alternative to landfill are coming on stream. For example, waste incineration remains deeply unpopular with the public in many Member States and in some (eg the UK), numerous incineration projects have often failed to receive approval or have suffered protracted delays, largely as a result of entrenched opposition.

The variation in emissions is even larger when viewed from the perspective of individual Member States. The member state projections for Bulgaria (605%), Romania (213%) and Slovakia (76%) are much higher compared to the GAINS projections, whereas for Portugal (-82%), Belgium (-62%), Lithuania (-28%) and Sweden (-28%) the member states projections are lower. For the former group this may be explained by the assumptions with respect to deadlines for meeting targets for waste disposal in some non-compliant sites[30].

[29] Sum of MS WEM projections minus projected CO_2 emissions in order to make the sources included consistent
[30] In July 2009, Bulgaria, Romania and Poland were given extended deadlines with annual decreasing targets for the amount of waste disposed in some non-compliant sites.

Figure 3-17: Baseline GHG emissions and composition from waste, as projected by GAINS (the emissions from waste incineration are not included however it is considered to only contribute ~ 2% of the overall emissions from the waste sector)



Whilst no sector specific target exist, if the waste sector were to make a proportionate contribution to the overall ESD target, in line with the emissions from the sector in 2005, then this would relate to an absolute emission in the EU 27 of 138 $MtCO_2$-eq in 2020, based on the ESD targets for each Member State. Compared to the current IIASA baseline projection, no further emissions reductions would be required to meet this illustrative target. Current projections are much lower than this level. This is supported by Member States own projections. This all assumes that all other sectors are able to deliver a proportionate share.

A similar analysis can be carried out at a Member State level. Table 3-6 provides an overview of the historical trend in emissions, the projected future trend in emissions, and the hypothetical 'policy gap' for each Member State. As with the EU wide analysis, the policy gap assessment assumes Member States would reduce their emissions proportionately to their respective ESD target. In the waste sector, almost all Member States are expected to reduce their emissions by 2020, by a greater proportional amount than the illustrative pro rata limits. This conclusion is consistent, for most Member States, between the PRIMES/GAINS projections and the Member States' projections.

Table 3-6: Summary matrix: Results from the emissions analysis, by Member State, for the waste sector

	Trend (2005 - 2008)	Trend (2010-2020)			Policy gap (2020)		
	Historic	PRIMES & GAINS	MS WEM	MS WAM	PRIMES & GAINS	MS WEM	MS WAM
DENMARK	↓	→	→	→	☺	☹	☹
IRELAND	↓	↑	↓	↓	☺	😐	😐
LUXEMBOURG	↓	↑	↑	↑	☹	☹	☹
SWEDEN	↓	↓	↓	↓	☺	☺	☺
AUSTRIA	↓	↓	↓	↓	☺	☺	☺
FINLAND	↓	↓	↓	↓	☺	☺	☺
NETHERLANDS	↓	↓	↓	↓	☺	☺	☺
UNITED KINGDOM	↓	↓	↓	↓	☺	😐	😐

BELGIUM	↓	→	↓	↓	😐	☺	☺
FRANCE	↓	→	↓	↓	☺	☺	☺
GERMANY	→	↓	↓	↓	☺	☺	☺
ITALY	↓	↓	↓	↓	☺	😐	☺
SPAIN	↓	↓	↓	↓	☺	☺	☺
CYPRUS	↓	→	↑	↓	☺	😐	☺
GREECE	↓	↓	↓	↓	☺	☺	☺
PORTUGAL	↓	↓	↓	↓	☺	☺	☺
SLOVENIA	↓	↓	↓	↓	☺	☺	☺
MALTA	↓	→	↑	↑	☺	😐	😐
CZECH REPUBLIC	↓	↓	↑	↑	☺	😐	😐
HUNGARY	↓	↓	↑	↑	☺	☺	☺
ESTONIA	↓	↓	↓	↓	☺	☺	☺
SLOVAK REPUBLIC	↓	↓	→	→	☺	☺	☺
POLAND	↓	→	↑	↑	☺	☺	☺
LITHUANIA	↓	↓	↓	↓	☺	☺	☺
LATVIA	↓	↓	→	→	☺	☺	☺
ROMANIA	↓	↓	↑	↑	☺	☹	☹
BULGARIA	↓	↓	↑	↑	☺	☹	😐
EU27	↓	↓	↓	↓	☺	☺	☺

Key

Emissions		Policy gap	
Trend criteria	**Symbol**	**Gap criteria**	**Symbol**
< -2%	↓ (green)	<-15%	☹ (red)
-2% to 2%	→ (yellow)	0% to -15%%	😐 (yellow)
>2%	↑ (red)	>0%	☺ (green)

Industry

In the EU-27, the industry sector emissions (IPCC categories 1.A.2[31] and 2[32]) have been declining over the past two decades (Figure 3-18) but have been fairly stable since 2001 except for 2008 where the international financial and economic crisis had already affected the industrial sector. From 1990 to 2008, emissions fell by 21 % in the EU-27. These emissions include both emissions from the industries under the EU ETS and from industries under the Effort Sharing Directive (ESD). A strict separation of both parts of the industry is rather difficult but possible with some efforts (based on, for example, the Community Independent Transaction Log CITL registers). For the following we have used a simplified approach taking the following assumptions:

- The definition of the sectors under the ETS is those relevant in 2013. However, today the situation is still different as starting from 2013 new sectors will be included in the ETS, in particular from the non-ferrous industry and the chemical industry. We therefore show both values in Figure 3-18). In the further analysis we consider the ETS in the form of 2013 as relevant.
- Direct energy-related CO_2-emissions of ETS industries are determined by a sectoral approach based on data from the ODYSSEE-MURE project (www.odyssee-indicators.org) and the Community Independent Transaction Log CITL (http://ec.europa.eu/environment/ets/). This approach calculates the fractions of industrial sectors such as the iron/steel sector which are

[31] 1.A.2. Manufacturing Industries and Construction
[32] 2. Industrial Processes

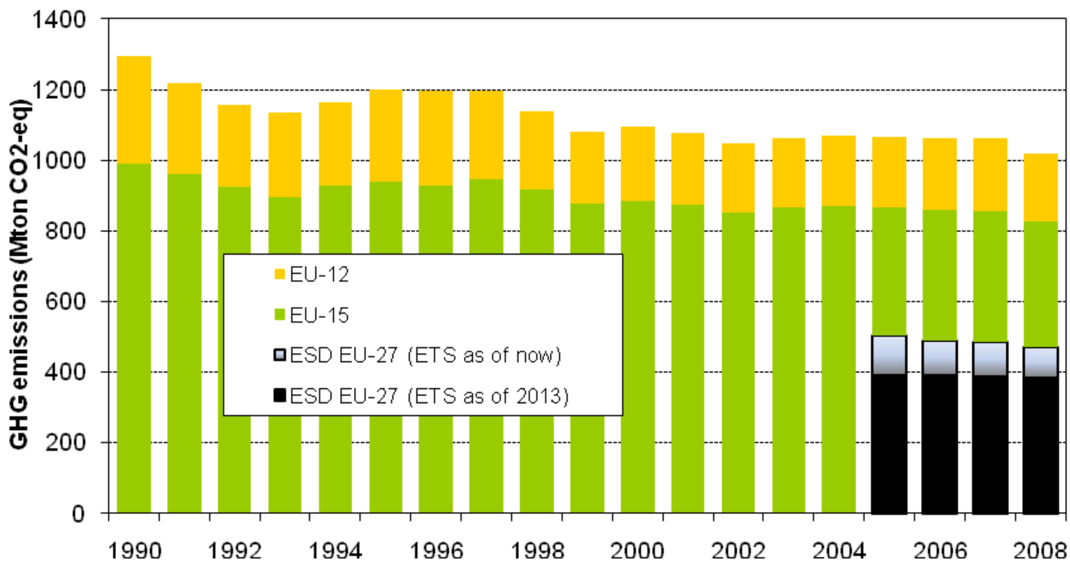
part of the ETS. These fractions are based on estimates (e.g. sectors such as cement are supposed to be to 100 % in the ETS) or are derived from comparison with the CITL data. In a more refined approach, carried out for Germany, also the emissions from the general category of combustion installations in the CITL are distributed among the industrial sector. This implies, however, a careful in-depth analysis of those installations and the separation from installations in the energy sector. Direct process emissions are, according to PRIMES 2009 around 82% part of the ETS.

- Indirect CO_2-emissions from industrial electricity use and (to less a degree) district heat use are in principle to be associated with the ESD. These emissions are accounted for in the ETS as being associated to energy supply companies. Energy supply companies, so far, however, do mainly take influence on the electricity supply mix and the supply efficiency but do not take a role in the improvement of demand side electricity efficiency so far, although in the future this may be enforced as an outcome of the present discussions around the 20 % energy efficiency target and the European energy efficiency action plan. However, as Figure 3-18 shows the direct emissions only, they are not included either in the figures for the ESD industry.
- The N_2O-emissions from process emissions such as the production of adipic or nitric acid are fully associated with the ETS. Again, they are associated to the ETS only starting from 2013. The same holds for F-gas emissions from primary aluminium.
- The CH_4 and F-gas-emissions (except the F-gas emissions from primary aluminum production) are excluded from the ETS as these gases are not covered by the ETS even after 2013.

Figure 3-18 shows the part of the industrial GHG missions that can be associated with the ESD. Today this is on average roughly 46 % of all industrial GHG emissions (out of this around 73 % are CO_2-related, and around 62 % due to energy-related CO_2). After 2013 this fraction will fall to 37 %[33] (with around 77 % CO_2-related, and around 63 % due to energy-related CO_2).

Reductions in the industry sector so far were due to the reduction of process emissions (especially N_2O-emissions and F-gases from primary aluminum), the fuel shift towards natural gas and electricity, the restructuring of industries in Eastern Germany and the Eastern European Member States as well as energy efficiency measures.

Figure 3-18 GHG emissions arising from industry across the EU-27 and part of the emissions under the Effort Sharing Decision (source: EEA Greenhouse gas data viewer, own calculations)

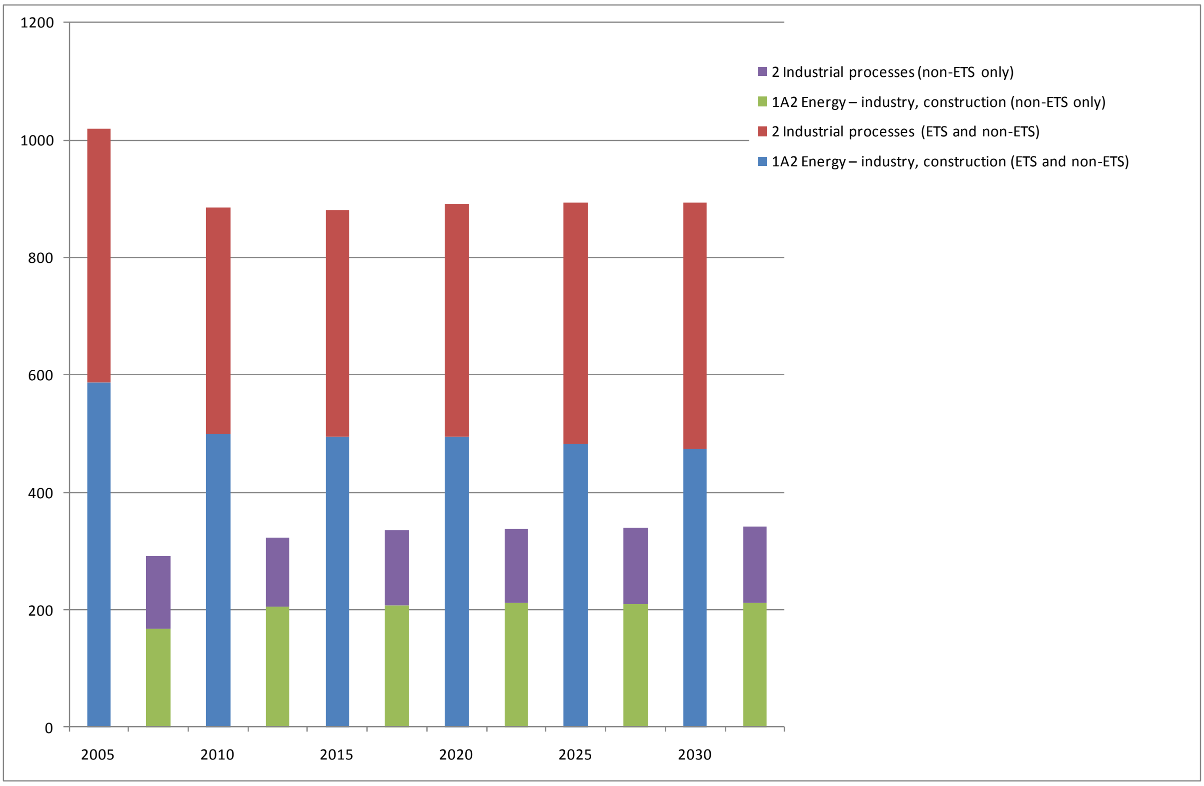


In Figure 3-19 the baseline emission projections for industry are shown based on the most recent projections from the PRIMES model (Capros et al., 2010) and the GAINS model (Höglund-Isaksson et

[33] In a more formal approach based on the PRIMES and GAINS baselines used in the following this share is estimated to be 27 %. The reason may be that for some Member States there are deviations. We will investigate this discrepancy further in this work.

al., 2010)[34]. All emissions are expressed in CO_2-equivalents using the IPCC 1997 GWP values (310 for N_2O and 21 for CH_4). The baseline emissions projections for the sum of ETS and non-ETS industry shows first a quite strong decrease from 2005 levels from 1,018 $MtCO_2$-eq in 2005 to 890 $MtCO_2$ eq in 2020 (mainly due to the reduction of process emissions, in particular N_2O), which is a decrease of about 12.6%. The baseline emissions projections for non-ETS industry only shows on the other hand an increase of 2005 levels from 290 $MtCO_2$ eq to 336 Mt CO_2 eq in 2020 (+15.9%). The strongest increase comes from energy-related emissions of non-ETS industries which are expected to increase by 26% in 2020.

Figure 3-19: Baseline GHG emissions and composition from the sum of ETS and non-ETS industry as well as from non-ETS industry alone, as projected by GAINS



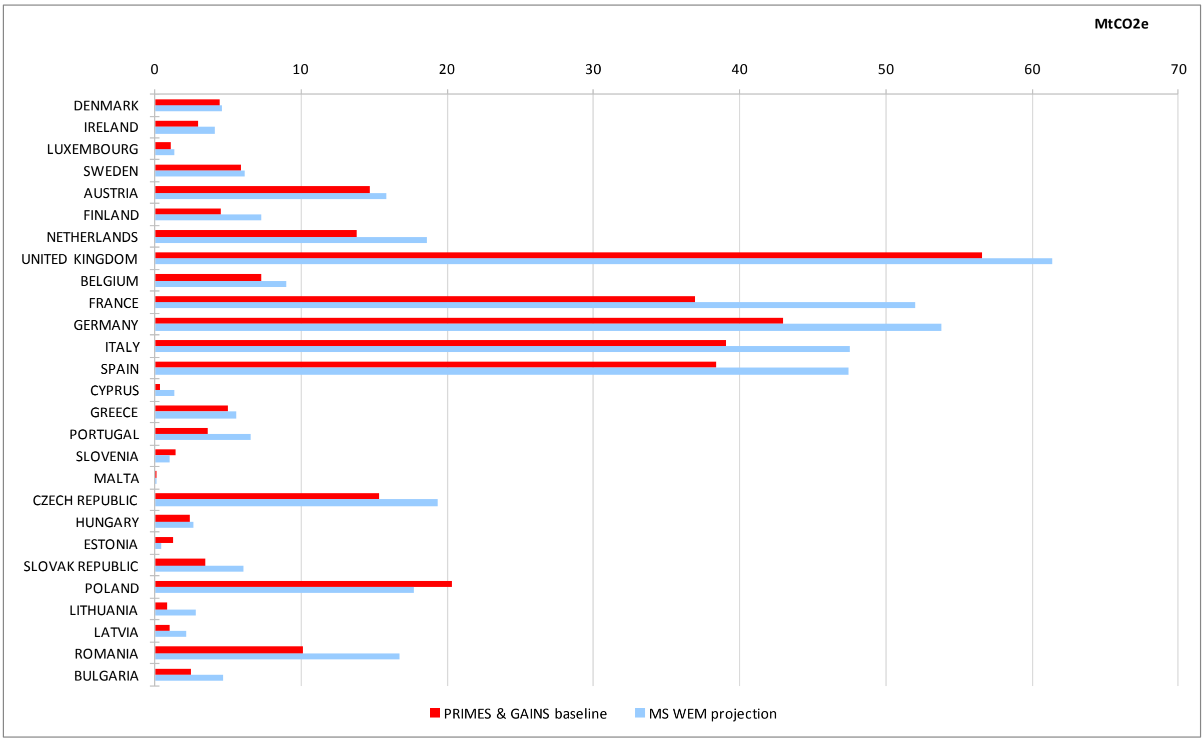
In Figure 3-20 the projected annual emissions from non-traded industries in 2020 from PRIMES/GAINS are compared with the projections provided by the member states in accordance with the EU Monitoring Mechanism. Some of the differences among the Member States may be explained by the different shares of heavy industry. This is why the UK has for example higher values that Germany despite the smaller size of the industry. However, heavy industries in the UK have a comparatively small share of energy consumption and of CO_2 emissions. For example the five most energy-intensive industries (iron/steel, non-ferrous metals, chemicals, non-metallic minerals, pulp/paper) which are mostly under the ETS represent 46 % of the UK industrial energy related CO_2 emissions while they are 77 % in Germany.

The total projected GHG emission for 2020 from the sector Industry in the EU-27 is 336 $MtCO_2$ eq for the PRIMES/GAINS baseline projection and 416 $MtCO_2$ eq. for the projections provided by the individual member states. The difference occurs less with process-related emissions (125 $MtCO_2$ eq. for the GAINS baseline projection and 131 $MtCO_2$ eq. for the projections provided by the individual member states) but in particular for the energy-related emissions (211 $MtCO_2$ eq. for the GAINS

[34] It is important to note that there are differences between the inventory emissions from energy consumption in industry (1:A.2) and the PRIMES/GAINS emissions, when comparing historic years, e.g. 2005. These differences stem mainly from two reasons:
(i) PRIMES draws upon Eurostat energy statistics. Whilst these statistics are also used in the compilation of emissions inventories they may not applied in the same way as in PRIMES.
(ii) The inventory data for industry (1.A.2) includes the combustion of fuels for the self-generation of electricity while the PRIMES data excludes these fuels according to the conventions of Eurostat (and includes them in the transformation sector which is not part of the ESD).
In the frame of this project it was not possible to harmonise inventories and Eurostat conventions. However, the calcluation of industrial emissions wihtin the scope of the ESD did adjust for the estimated emissions within the scope of the ETS – which includes emissions from self generation to a large degree. Therefore the impact on the results concerning the ESD should be more limited.

baseline projection and 286 $MtCO_2$ eq. for the projections provided by the individual member states). There are some differences across the member states but for all countries except for Estonia, Poland and Slovenia the member state projections are higher than the GAINS/PRIMES projections. This difference could be due to the lower estimate of the ESD from the GAINS/PRIMES figures as mentioned earlier.

Figure 3-20: GHG projections for non-ETS industry for 2020 for the PRIMES/GAINS Baseline projection and Member States' projections with existing measures



Whilst no sector specific target exists, if the non-traded industry sector were to make a proportionate contribution to the overall ESD target, in line with the emissions from the sector in 2005, then this would require further policies to be implemented – or abatement equivalent to around 75 $MtCO_2$-eq. in 2020. This is a significant gap reflecting the projected increase in energy-related emissions from the sector over the period.

A similar analysis can be carried out at a Member State level. Table 3-7 provides an overview of the historical trend in emissions, the projected future trend in emissions, and the hypothetical 'policy gap' for each Member State. As with the EU wide analysis, the policy gap assessment assumes Member States would reduce their emissions proportionately to their respective ESD target. It is clear from the results presented below that for a large number of the Member States (23) the illustrative pro-rata target will not be met, based on current projections. It is also notable that both the historical trend, and the projected future trend in emissions, is an increase for a number of Member States. Whilst the results for this section should be treated with greater caution, due to the limitations in the allocation methodology, these results do suggest that this sector is potential a priority area for further mitigation.

Table 3-7: Summary matrix: Results from the emissions analysis, by Member State, for the industry sector

	Trend (2005 - 2008)	Trend (2010-2020)			Policy gap (2020)		
	Historic	PRIMES & GAINS	MS WEM	MS WAM	PRIMES & GAINS	MS WEM	MS WAM
DENMARK	↑	↓	↓	↓	☹	☹	☹
IRELAND	↑	↑	↑	↑	☹	☹	☹
LUXEMBOURG	→	↑	↑	↑	☹	☹	☹
SWEDEN	↓	↑	→	→	😐	☹	☹
AUSTRIA	↑	→	↑	↑	☹	☹	☹
FINLAND	↓	↑	↑	→	😐	☹	☹
NETHERLANDS	↑	↓	↑	↑	☹	☹	☹
UNITED KINGDOM	↑	↓	↑	↑	☹	☹	☹
BELGIUM	↑	↑	↑	↑	☹	☹	☹
FRANCE	↑	→	↑	↑	☹	☹	☹
GERMANY	↑	↓	→	→	☹	☹	☹
ITALY	↑	↑	↑	↑	☹	☹	☹
SPAIN	↑	↑	↑	↑	☹	☹	☹
CYPRUS	↓	↑	↑	↓	😐	☺	☺
GREECE	↓	↑	↑	↑	☺	☺	☺
PORTUGAL	→	↓	↑	↑	☺	☹	☹
SLOVENIA	↑	↑	↓	↓	☹	😐	😐
MALTA	↓	↑	→	→	☺	☺	☺
CZECH REPUBLIC	↓	↑	↓	↓	☺	☹	☹
HUNGARY	↑	↓	↑	↓	☹	😐	☺
ESTONIA	↑	↑	↑	↑	☹	😐	😐
SLOVAK REPUBLIC	↑	↑	↑	↑	☹	☹	☹
POLAND	↑	↑	↑	↑	☹	☹	☹
LITHUANIA	↑	↑	↑	↑	😐	☹	☹
LATVIA	↑	→	↑	↑	😐	☹	☹
ROMANIA	↑	↑	↑	↑	☹	☹	☹
BULGARIA	↑	↑	↑	↑	☹	☹	☹
EU27	↑	↑	↑	↑	☹	☹	☹

Key

Emissions		Policy gap	
Trend criteria	**Symbol**	**Gap criteria**	**Symbol**
< -2%	↓	<-15%	☹
-2% to 2%	→	0% to -15%%	😐
>2%	↑	>0%	☺

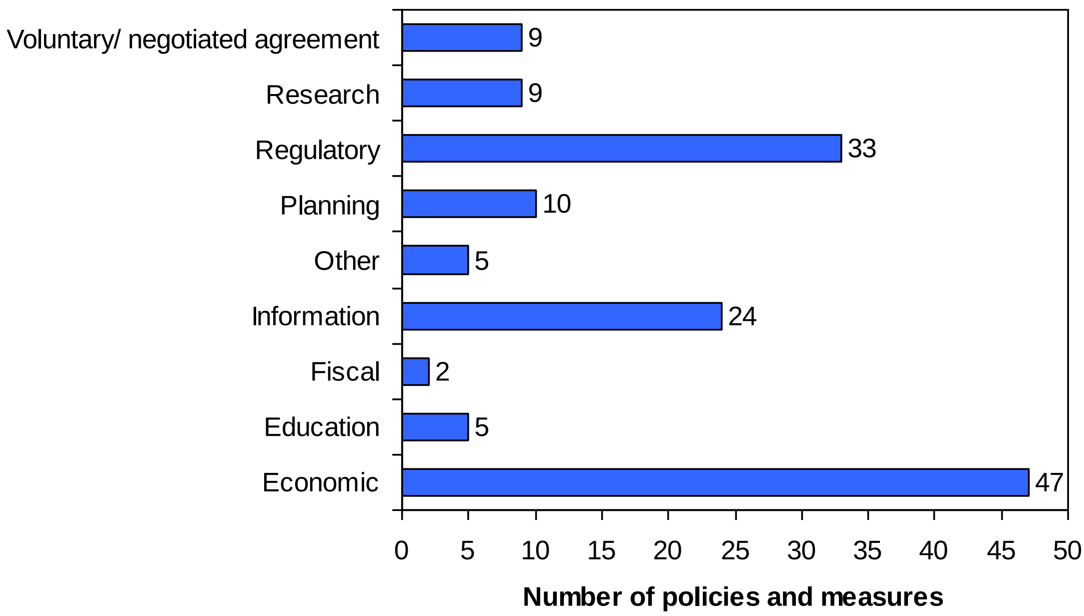
3.2 Policy impacts

The emissions projections described above took into account the impact of certain EU wide policies[35] This section examines the policy landscape in more detail, analysing the extent to which existing and planned policies will help Member States to meet their targets under the ESD.

3.2.1 Agriculture

This analysis of the agriculture sector is based on the policies and measures that are included in the EEA's database on climate change policies and measures. This database contains 92 policies or measures related to the sector agriculture. Almost all EU countries have some policies defined and reported, except Cyprus, Luxembourg and surprisingly Ireland, since Ireland has a relatively large fraction of total emissions from agriculture. Most of the policies and measures focus on nitrous oxide (77) and methane (66), but also CO_2 is included in 43 of the policies and measures. Most of the measures have already been implemented (71) or are adopted (12) and only 8 policies and measures are planned. The database also provides information about the type of policy and measure (Figure 3-21). Most policies and measures are of economic or regulatory type, with policies relating to information provision also important. Some policies fall within more than one category so are represented more than once in the chart below.

Figure 3-21 Classification to type of policy and measure (policies and measures can be classified to more than one category)



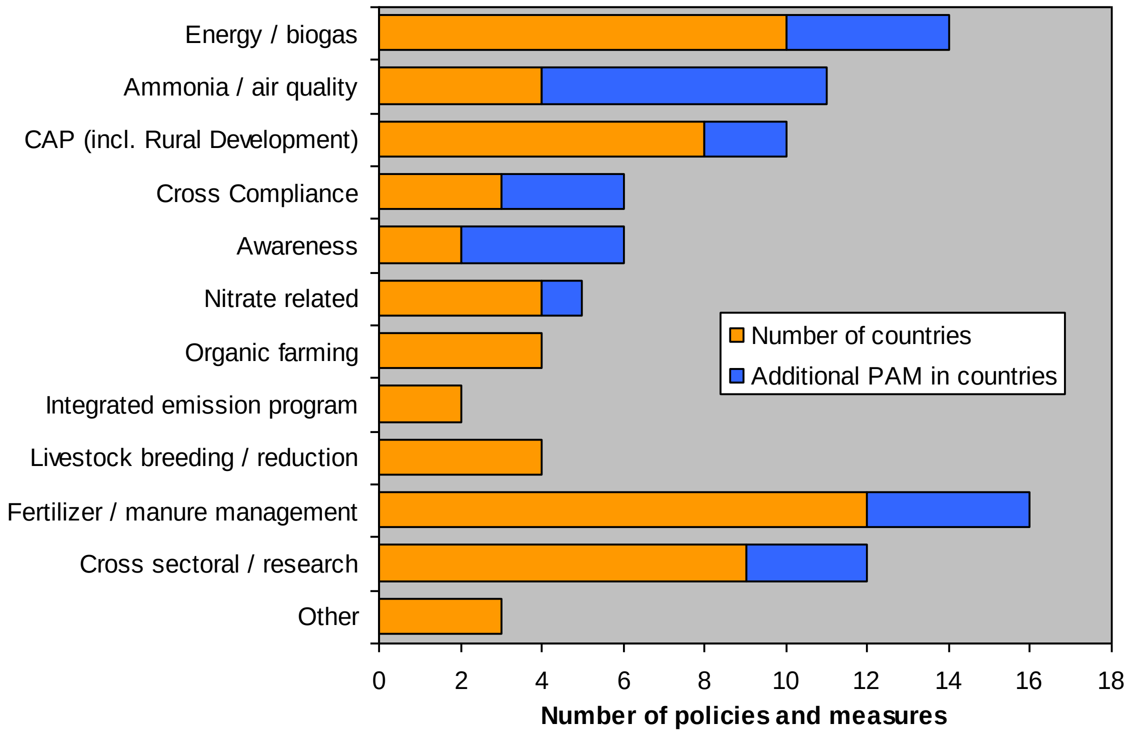
Additional analysis of the policies has allowed a further categorization of the policies and measures, in terms of the subject of the measure (Figure 3-22). Most countries have policies and measures related to production and use of biomass for bioenergy and fertilizer and manure use and management. Policies and measures related to air quality / ammonia, nitrate and the CAP are part of existing EU policies and are generally not specifically aimed at climate change mitigation, but most do have positive effects on GHG emissions as well, since they lead to reduction of the amount of nitrogen inputs. Only few countries have reported specific policies or measures aiming at awareness raising related to climate change mitigation (categories education and information).

The bioenergy / biogas measures aim to reduce methane emission from manure storage and management in the agriculture sector. However, by replacing fossil fuels these measures will also deliver emissions reductions from the energy sector. About 16 policies and measures (PAMs) are specifically aimed at reducing GHG emissions from manure storage and management, and 6 are mainly aimed at increasing use of bio-energy. The ammonia / air quality, cross compliance, nitrate

[35] Appendix 1 lists the policies and measures captured within the PRIMES/GAINS baseline projections.

related, organic farming and fertilizer / manure management measures mainly reduce the nitrous oxide emissions from soils following application of fertilizers and manures. Together, these measures total about 34 PAMs, of which 10 operate indirectly via ammonia. Most of these measures are not specifically aimed at reduction of N_2O emissions, but reduce nitrogen inputs because of concerns relating to other environmental impacts (i.e. water pollution via nitrate and air pollution via ammonia). Only 2 PAMs are specifically targeted at reducing methane emissions from enteric fermentation, despite this being the second largest emission source. The remaining PAMs (about 34) are defined general and cannot easily be related to a specific IPCC emission category.

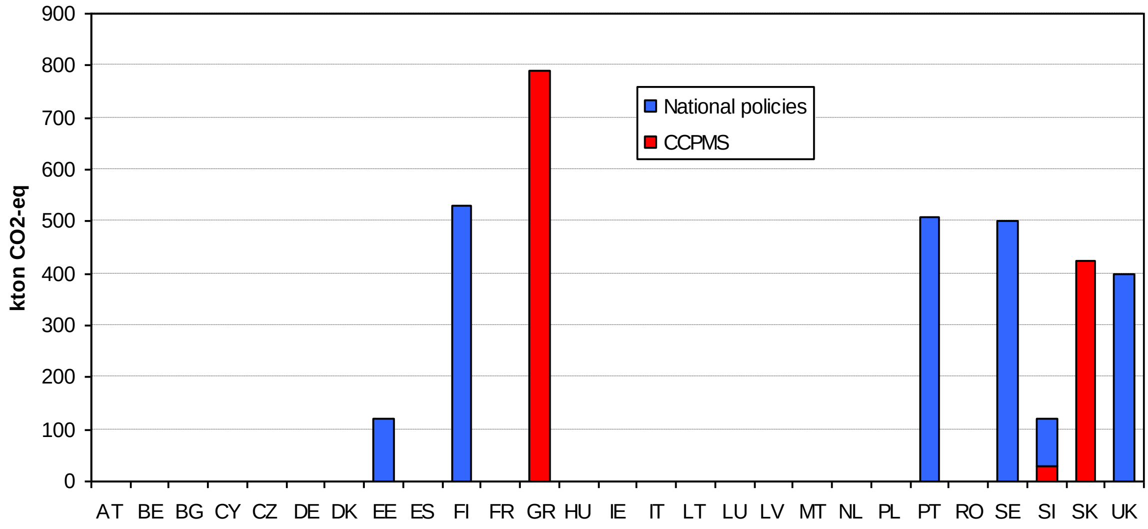
Figure 3-22 Categorization of policies and measures



Most policies and measures (62) are related to EU policies, e.g. the Common Agricultural Policy, the Nitrates Directive and the IPPC directive. About 30 policies and measures can be considered as national policies that are not directly related to EU policies, most of these policies and measures focus on stimulation of biogas from manure or on projects that have to increase awareness amongst farmers on climate mitigation measures. However, the distinction between EU or national policy is not always clear from the policy description.

The database contains some information about the mitigation potential of the policies and measures. However, for only a few policies and measures was the mitigation potential (absolute reduction in kton CO_2-eq per year) estimated. In 2010 this was the case for 20 policies and measures, with a total mitigation potential of 6.2 $MtCO_2$ eq. per year. For 2020, quantitative estimates are only available for 13 policies and measures with a total mitigation potential of 3.4 $MtCO_2$ eq. per year (Figure 3-23). The database also contains a column for costs, however, only for one policy (non food crops in the United Kingdom) was any estimate provided.

Figure 3-23 Policy impacts of measures estimated for 2020 by the Member States in the EEA's climate change policies and measures database for the agriculture sector



The EEA's policies and measures database also gives some information on whether the PAM is part of the Member States projection scenario with existing measures (WEM) or the scenario with additional measures (WAM). For agriculture most policies and measures are WEM + WAM (84) and only 8 PAMs are indicated as only additional measures. Of these PAMs only two had a quantified mitigation potential, which taken together totaled 518 ktCO_2-eq per year. The lack of policies relating to the WAM scenario might indicate a lack of new policies in preparation within Member States.

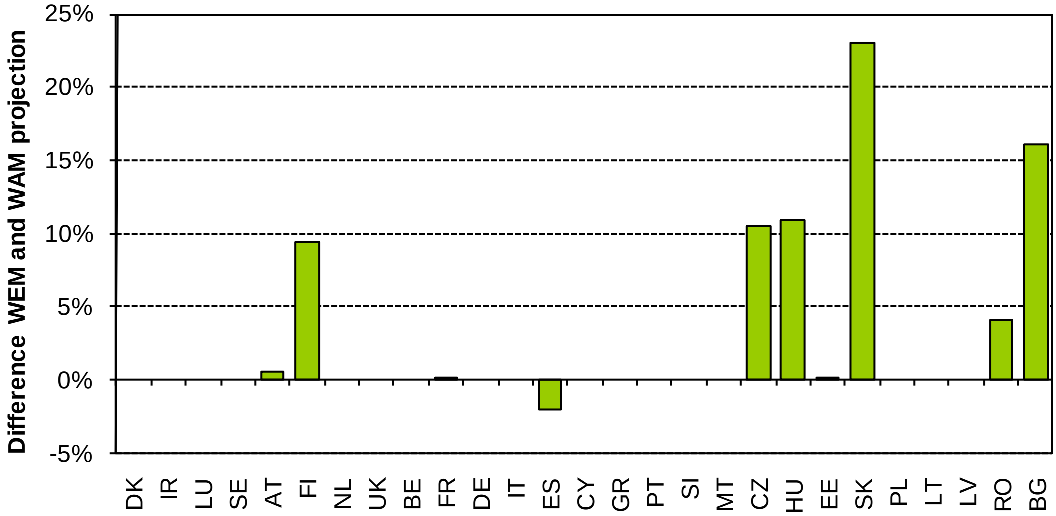
Most of the policies and measures from the PAMs database are likely to be already included in the GAINS baseline projection, which comprises the Nitrates Directive (1991/676/EEC), Common Agricultural Policy (CAP) Reform (2006/144/EC), the CAP "Health Check" and the "Set aside" regulation (73/2009). Furthermore the effect of the Biofuels Directive (2009/28/EC) is included based on the projections by PRIMES and national legislation controlling emissions of nitrogen compounds (NO_X, NH_3), which indirectly affect non-CO_2 GHG emissions, are included. We estimate that about 69 of the policies and measures from the database are covered in the GAINS baseline, whereas 23 policies and measures may not be included. Most of these latter policies and measures focus on biogas, some on climate awareness and information for farmers and few on specific measures that reduce N_2O emissions from soils. However, only 9 of these PAMs included a quantitative estimate of the mitigation potential. In total this represents an annual emissions reduction of 1.65 MtCO_2 eq. in 2020. Table 3-8 shows the additional mitigation potential due to the policies and measures that are not included in the GAINS baseline, and have reported a quantitative estimate. This is likely to represent an underestimate of the total impacts, as not all additional policies have a quantified emissions saving

Table 3-8 Mitigation potential of additional policies and measures that are not included in the GAINS 2020 baseline projection

Country	Mitigation potential (ktCO_2-eq / year)
Estonia	120
Finland	529
Portugal	507
Slovenia	92
United Kingdom	400

In Figure 3-24 the difference between the with existing and with additional measures scenarios are shown for agriculture. For several Member States no data were provided for the WAM projections, i.e. Cyprus, Denmark, Germany, Netherlands and United Kingdom. The sum of the additional mitigation potential for the other Member States is 4.8 MtCO_2 eq, this is only about 1% of the total emissions of the sector Agriculture. For some eastern European countries (Czech Republic, Hungary, Slovakia and Bulgaria) a mitigation potential of more than 10% can be reached with the additional measures. The reason for the negative result for Spain is unknown, it might be related to cross-sectoral impacts, e.g. cultivation of more biomass for energy, which results in more N_2O soil emissions in agriculture.

Figure 3-24 Additional mitigation potential in WAM projection compared to WEM projection. For some Member States no data were provided and for others the emissions were similar in both projections.



In the following section the additional policies and projections for agriculture are presented for Member States that updated their projections since the latest submission requirement under the MM in 2009.

Denmark
The updated projections from 2010[36] show that emissions are projected to decrease slightly from 9.61 $MtCO_2$ eq. in 2006 to 9.36 $MtCO_2$ eq. in 2020. No projection for WAM is provided.

Ireland
Ireland submitted an updated set of projections in 2010 including an analysis of their policies and measures. This information is based on information submit in April 2010. For the WEM projection updated forecasts of animal numbers, fertilizer use and crop areas were used. These estimates take into account the agreed increases in the national milk quota prior to quota removal in 2015, the expansion of the dairy herd thereafter. For the WAM projection no further measures were included. The projected emissions for 2020 for agriculture are the same in the WEM and WAM projection (17.8 $MtCO_2$ eq.). This is somewhat higher compared to their previous projection of 16.5 $MtCO_2$ eq.

United Kingdom
The UK published updated projections in June 2010. For agriculture an additional mitigation potential of 3.0 $MtCO_2$ eq. per year was projected. Emission reductions come from crop management and fertiliser use, enteric fermentation and manure management.

Netherlands
In April 2010 the Netherlands published new GHG projections (Daniels et al., 2010)[37]. In the WEM projection the GHG emission from agriculture is 17.5 $MtCO_2$ eq. in 2020, which is lower compared to the previous projection (19.1 $MtCO_2$ eq.). The WAM projection is 17.2 $MtCO_2$ eq., the additional mitigation potential is obtained by a higher percentage of manure that will be digested, as stimulated in the 'Schoon en Zuinig' policy.

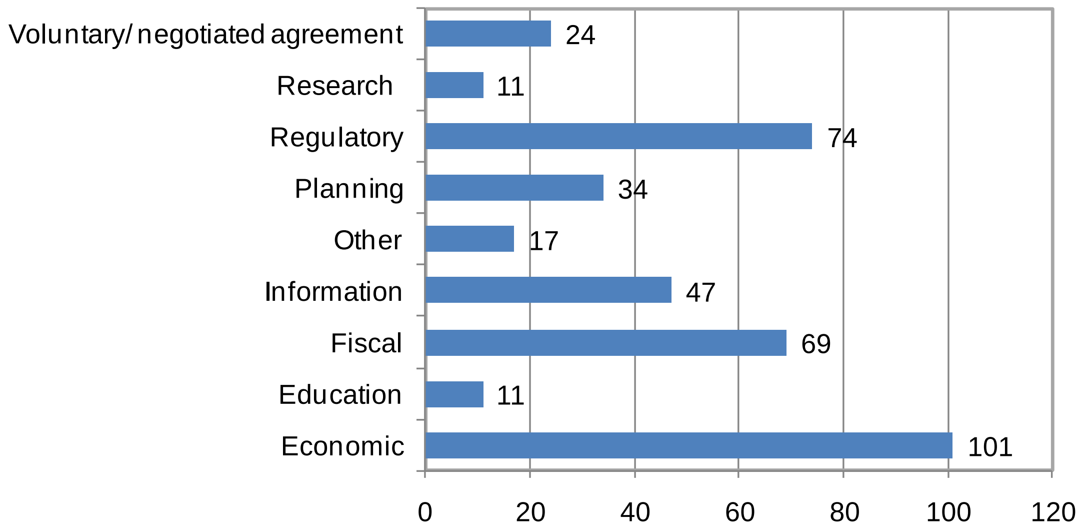
Poland
No additional measures reported in Poland's projections for the agriculture sector. WEM=WAM.

[36] http://www2.dmu.dk/Pub/FR793.pdf
[37] http://www.rivm.nl/bibliotheek/digitaaldepot/E10004.pdf

3.2.2 Transport

The EEA's climate change policies and measures database contains 262 policies or measures related to the sector transport. All EU Member States have some policies defined and reported. Most of the policies and measures focus on carbon dioxide (259) and a considerably less number of policies reportedly target nitrous oxide (95) and methane (82) emissions. Most of the measures have already been implemented (166) or are adopted (38) and 50 policies and measures are planned. The database also provides information about the type of policy and measure (Figure 3-25). Most policies and measures are economic instruments or of a regulatory type, but also fiscal policies and information-based instruments are important. Some policies fall within more than one category so are represented more than once in the chart below.

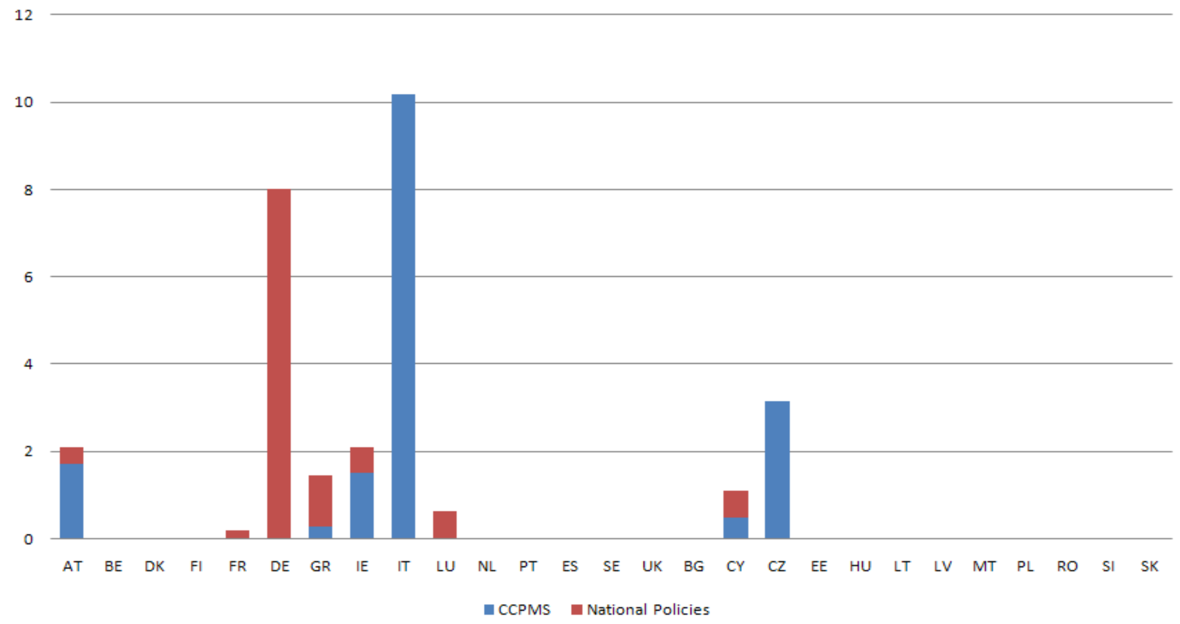
Figure 3-25 Classification to type of policy and measure (policies and measures can be classified to more than one category)



The PAMs database also contains information about the mitigation potential of the policies and measures. However, only for a few policies and measures the mitigation potential (absolute reduction in $ktCO_2$-eq per year) was estimated. In 2010 this was the case for 98 policies and measures, with a total mitigation potential of 59.4 $MtCO_2$ eq. per year. For 2020 it is indicated for 81 policies and measures with a total mitigation potential of 177.5 $MtCO_2$ eq. per year. The database also contains a column for costs per tonne of carbon mitigated, however, the number of policies that have information on this aspect is very limited.

The analysis above provides an overview of the policies and measures reported by the Member States contained in the EEA's climate change policy database. Figure 3-26 shows the quantified impact of **additional measures** only in the database by each Member State in 2020 in the transport sector. These policies are split into CCPMs (i.e. EU wide) and national policies. The total quantified impact of national policies in the WAM 2020 scenario is 11.6 $MtCO_2$ eq. This represents just 1.5% of the WAM scenario emissions in 2020.

Figure 3-26 Policy impacts of additional measures estimated by the Member States in the EEA's climate change policies and measures database for the transport sector



The PAMs that are marked as additional measures in the EEA's climate policies database give an indication of the policies at a Member State level that are not yet implemented. These may on the face of it be considered additional to those in the PRIMES/GAINS baseline. However, some (in fact most) of the policies will already be captured in the PRIMES baseline. Therefore, whilst the data in the EEA's climate policies database provides a useful understanding of Member States expectations of the savings that will be delivered by existing policies, it provides limited information on policies that may be additional to the PRIMES/GAINS baseline.

The review of the PAMs database was supplemented by an examination of Member States most recent submission under the MM, focusing on updated projection reports submitted in 2010. Almost all of the policies were found to relate to EU wide policies already captured within the PRIMES/GAINS baseline. The one exemption to this is the estimated 1.9 $MtCO_2$ eq./year savings estimated in 2020 from the implementation of the Limit Values for Vans Directive (see below) in the UK.

The 2009 PRIMES/GAINS baseline includes a range of EU wide policies that are expected to deliver emission savings in the transport sector. These include policies that[38]:

- Reduce the level of activity – such as developments in the Trans-European Transport Network[39]
- Improve the energy efficiency of transport – specifically, the Regulation on CO_2 from cars
- Reduce the GHG intensity of transport fuels - including the Biofuels Directive and Fuel Quality Directive.

As described previously, by 2020 these policies will act to offset some of emissions arising from the increased level of activity, but are not projected to deliver absolute reductions in emissions by this date.

Some further reduction may, however, be delivered by policies that are not captured fully in the PRIMES/GAINS baseline. These include policies introduced subsequent to the PRIMES baseline, and policies planned but not yet implemented. Specifically:

[38] PRIMES also includes certain policies that target other environmental objectives but may also influence emissions of greenhouse gases, to a lesser extent. These include Regulation EURO 5 and 6 and the Implementation of MARPOL Convention VI.
[39] Whilst not explicitly referenced the PRIMES baseline projection are assumed to include 2007/58/EC Development of the Community's railway for which the MS estimate (in the EEA's climate change polices and measures database) an emission saving of 37.3 $MtCO_2$ eq for all MS.

- **Clean and energy efficient road transport Directive (2009/33/EC).** This Direction aims to support a broad market introduction of environmentally-friendly vehicles[40]. The Directive requires that energy and environmental impacts linked to the operation of vehicles over their whole lifetime are taken into account in purchase decisions. These lifetime impacts of vehicles shall include at least energy consumption, CO_2 emissions and emissions of the regulated pollutants of NO_x, NMHC and particulate matter. Purchasers may also consider other environmental impacts. An impact assessment of the Directive indicated an annual emissions saving between 974 to1,974 $ktCO_2$ eq/year depending on the scenario[41].

- **Limit values for Vans Directive**. The Directive adopted on 28th October 2009 is a new legislative proposal to reduce CO2 emissions from light commercial vehicles (vans). The proposal is modelled on the CO2 emissions legislation for Europe's passenger cars. A two-year phase-in period will start in 2014 requiring 75% of each manufacturer's newly registered vans to emit no more than 175g/km of CO2. The percentage will rise to 80% in 2015 and 100% from 2016 onwards. The current proposal suggests that the efficiency target will reduce to 135g/km by 2020, but this is still subject to review. The impact assessment for the proposed CO2 limits for vans "Setting Emissions performance standards for new light commercial vehicles as part of the Community's integrated approach to reduce CO2 emissions from light-duty vehicles[42]", estimated that the reduction in the GHG emissions from LDVs in year 2020 for targets from 2012 to 2015 targets corresponds roughly to 5% of the total reduction effort (estimated to be.13.5 $MtCO_2$) required under the Effort Sharing Decision.

- **Regulation (EC) No 661/2009** introduces a number of measures aimed at passenger cars and light vehicles that mandate the uptake of certain energy efficiency measures. Specifically, the regulations require the mandatory equipping of new passenger cars with tyre pressure monitoring systems (TPMS), and also set requirements for all new cars to be equipped with low rolling resistance tyres (LRRT). Article 11 of Regulation requires new cars to be equipped with gear shift indicators.

- **Renewable Energy Directive**. The Renewable Energy Directive (RED) imposes stretching renewables targets for 2020 across the EU. This requires 10% of energy used in the transport sector to be from renewable sources by 2020. The requirement of the RED work alongside the Fuel Quality Directive which requires which will require a 6% reduction in the greenhouse gas intensity of transport fuels by 2020. The PRIMES baseline assumes a certain level of renewable energy in transport (according to the policies current at the time of the analysis) but did not however assume delivery of the 10% target for RES in transport. National policies implemented in response to the renewable energy and fuel quality directives may deliver further emissions savings beyond the PRIMES baseline.

It is not straightforward to assess the 'additional' impact of these policies over and above the PRIMES/GAINS baseline, due to potential inconsistencies in assumptions. The impact assessment results described above provide a bottom up estimate of the impacts of the policies on emissions within the transport sector which can be used as an initial approximation. In particular, the introduction of Limit value for Vans has the potential to reduce emissions within the transport sector by 13.5 $MtCO_2$ by 2020. This would therefore reduce the policy gap identified in the previous section. It would also reduce the 'remaining' abatement potential that could be targeted by new policies.

Actions at a national level to implement the requirements of Renewable Energy Directive as also likely to deliver further emissions reduction in both the transport sector and other sectors relevant to the ESD (e.g. heat). No further assessment has been carried out of national renewable energy policeis for the current report. This is an area for further examination.

More generally, the current EU policy landscape (as captured in the PRIMES/GAINS baseline and the additional policies described above) provides a good coverage of the energy performance of vehicles across most modes, and also targets carbon intensity of energy used in the transport sector. Some small gaps in coverage may remain, for example, similar regulations for the energy performance of heavy goods vehicles, which may warrant further policy attention. In addition, whilst the policy

[40] http://ec.europa.eu/transport/urban/vehicles/doc/synopsis.pdf
[41] http://ec.europa.eu/transport/urban/studies/doc/2007_ia_dir_clean_efficient_vehicles.pdf
[42] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SEC:2009:1454:FIN:EN:PDF

coverage may be broad this does not necessary mean that current policies are sufficiently stringent to meet the emission targets (particularly over the longer term), or that all relevant market failures are overcome.

One area where it could be argued that the current EU policy framework is less extensive is with respect to policies that influence activity levels (i.e. the total vehicle km). While certain key policies (e.g. fiscal instruments) are largely the domain of national governments; this is potentially one area where the current policy landscape could potential be reinforced. This would include policies relating to be behavioural change.

3.2.3 Buildings

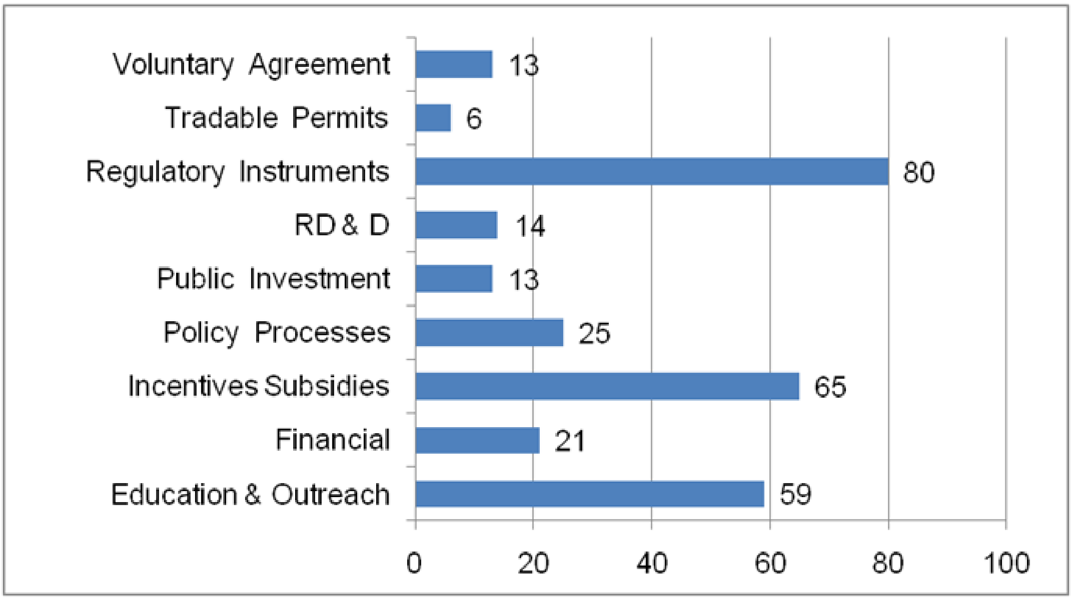
This analysis is based on the policies and measures that are included in the IEA database on energy efficiency and on global renewable energy and on the MURE database.[43]

The IEA databases provide information on policies and measures taken or planned to improve energy efficiency and use of global renewable energy. The database on energy efficiency covers appliances, buildings, framework policy, industry, multi sectoral policies and transport. The data base on renewable energy covers all relevant sources of renewable energy.

The database contains 165 policies or measures related to the building sector. Almost all EU countries have some policies defined, except Bulgaria, Cyprus, Estonia, Latvia, Lithuania, Luxembourg, Malta, Romania and Slovenia.

The database also provides information about the type of policy and measure (Figure 5). Most policies and measures are of economic or regulatory type, but also education is an important one. 163 measures are already in force, only two are planned.

Figure 3-27: Classification to type of policy and measure (policies and measures can be classified to more than one category)



Most of the regulatory instruments are related to the EPBD and its recast, other policies and measures can be considered as national policies that are not directly related to EU policies, most of these policies and measures focus on education and outreach and incentives and subsidies. However, the distinction between EU and national policy is not always clear from the description in the database.

The IEA database contains in some cases information about the mitigation potential of the policies and measures. However, only for few policies and measures the mitigation potential (absolute reduction in

[43] http://www.iea.org/textbase/pm/index.html; http://www.isisrome.com/mure/

ktCO_2-eq per year) was estimated. The IEA database contains no additional policies to the PRIMES baseline.

The MURE II database seems to contain also more recent policies that are not (yet) included in the IEA database. Also the database permits to analyse more in detail financing instruments. The financing policies can be differentiated by soft loans and by grants/ subsidies. Only 13% of the financing policies address soft loans the remaining 87% address grants and subsidies. Soft loans are only found in Germany, France, Greece, Slovenia and Slovakia.

The MURE II database informs about policies implemented in addition to PRIMES 2009 baseline (policies implemented by latest April 2009 are taken into account) are few:

- 1 policy in Finland regarding thermal insulation
- 10 policies proposed (France, Ireland, Italy, Luxembourg and Hungary). Most of them are of legislative/normative and financial type, 2 are of the information/education type
- Quantification of mitigation potential is not available

Table 3-9: Overview of Member State policies

Country	Code	Title	Status	Type	Starting Year	Ending Year	Semi-quantitative Impact
FI	FIN7 (ex A1FIN9)	Thermal insulation ordinance	Ongoing	Legislative/Normative	1/2010		High
FR	FRA47	Carbon tax	Proposed (advanced)				Unknown
IR	IRL27	Energy Efficient Lighting	Proposed (advanced)	Legislative/Normative	9/2009	Medium	
IT	ITA29	Standard for efficient lighting and electrical appliances	Proposed (advanced)	Information/Education, Legislative/Normative	2011	Medium	
LU	LUX16	Expansion of the upgrading programme for old buildings	Proposed (advanced)	Financial	2010	Medium	
LU	LUX17	Renewal of oldest heating systems	Proposed (advanced)	Financial, Legislative/Normative	2010	Medium	
LU	LUX18	Increase in promotion of efficient new building (new buildings, as against WD2008)	Proposed (advanced)	Financial	2010	Medium	
LU	LUX19	Electricity savings in electrical appliances	Proposed (advanced)	Financial	2010	Low	
HU	HUN21	HU73 Application of individual measurements with miniature heat centers in district heating supply	Proposed (advanced)	Legislative/Normative	Unknown		
HU	HUN23	HU74 Development of the operation of an energy efficiency consultant network	Proposed (advanced)	Information/Education	Unknown		
HU	HUN24	HU75 Periodic inspection of household boilers	Proposed (advanced)	Legislative/Normative	Unknown		

Source: http://www.isisrome.com/mure/selection1.asp: accessed: 28.09.2010

EPBD recast

The mitigation potential of the recast of the EPBD is not included in the PRIMES baseline. The impact of this additional policy was estimated based on the impact assessment done for the EPBD recast (2008).
In that assessment, the impact had been calculated with savings of 139 Mt CO_2 in 2020 compared to a baseline for a case where:

- the threshold of 1.000 m² for renovation requirements was removed
- higher retrofit rates would be achieved via improved regulations on building certificates and compliance checks and
- more ambitious standards would be applied, due to implementation of a methodology to design national standards with a view to cost optimal requirements.

Looking at the final version of the EPBD recast as adopted in May 2010, such measures have in fact been implemented with the new EPBD.

However the impact assessment assumed a theoretical start of the measures in 2010, whereas the EPBD recast was only adopted in 2010. This leaves time for the Member States until 2012 to adapt their national regulations. After that there will be also some response time until the new regulations are visible in the market.

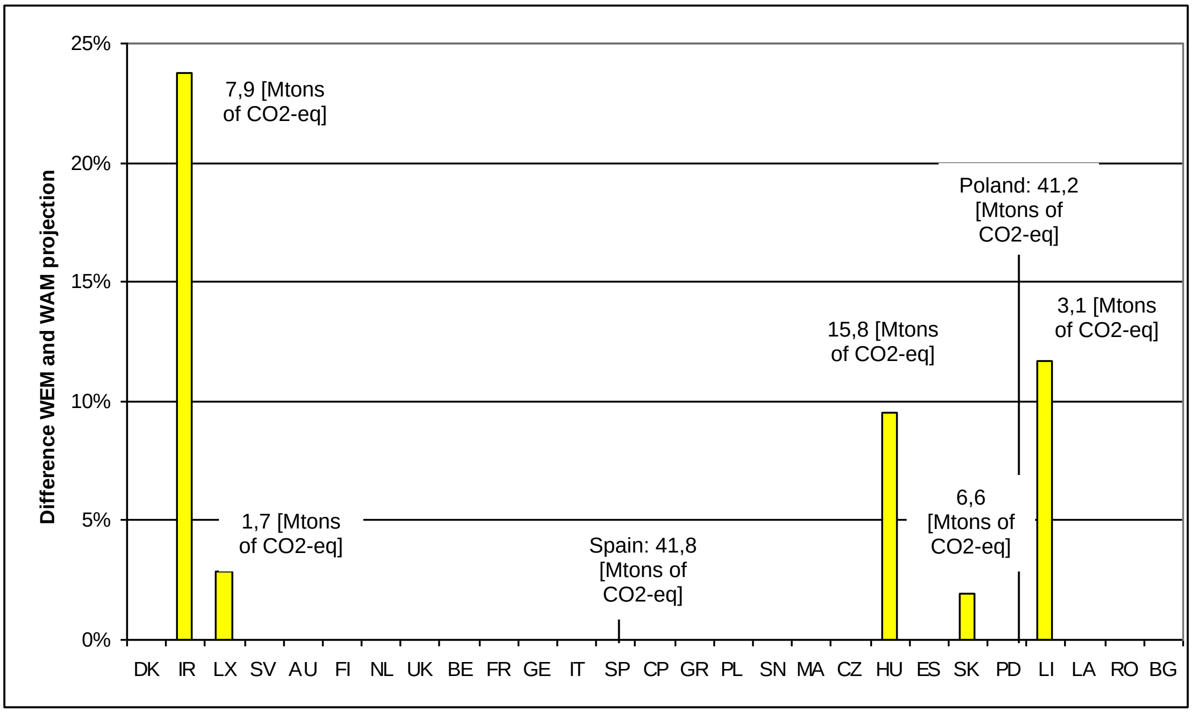
Additionally the impact assessment of the energy savings action plan (draft, 2010) revealed that a scheme consisting of financial support, information campaigns and capacity building (the European building initiative) is necessary to harvest the full effect of the EPBD recast.

As a result, the net effect of the EPBD recast beyond the PRIMES baseline was estimated with 42.5 Mt CO_2 in the time period until 2020. In a second step this additional saving potential is allocated to the different Member States, taking into account the different climate conditions and building stocks of the Member States.

In Figure 3-28 the difference between the *with existing* (WEM) and *with additional measures* (WAM) scenarios are shown for the building sector. For several Member States no data were provided for the WAM projections. Only for some Member States data were provided and for some the emissions were similar in both projections.

For most of the Member States no data were provided for the WAM projections.

Figure 3-28: Additional mitigation potential in WAM projection compared to WEM projection. For some Member States no data were provided and for others the emissions were similar in both projections



The most recent Member State submission under the MM, for those Member States that did submit updated projections in 2010, and 5th National Communication shows that the following additional measures are planned for implementation by Member States in the building sector.

Table 3-10: Emission savings from policies reported by Member States in updated projections after the 2009 MM

Country	Mitigation potential in 2020 (Mt CO_2.eq/year)
Ireland	2.5
UK	21.7
Germany	28.0[1]
Luxembourg	0.1
Bulgaria	2.6
Hungary	4.5

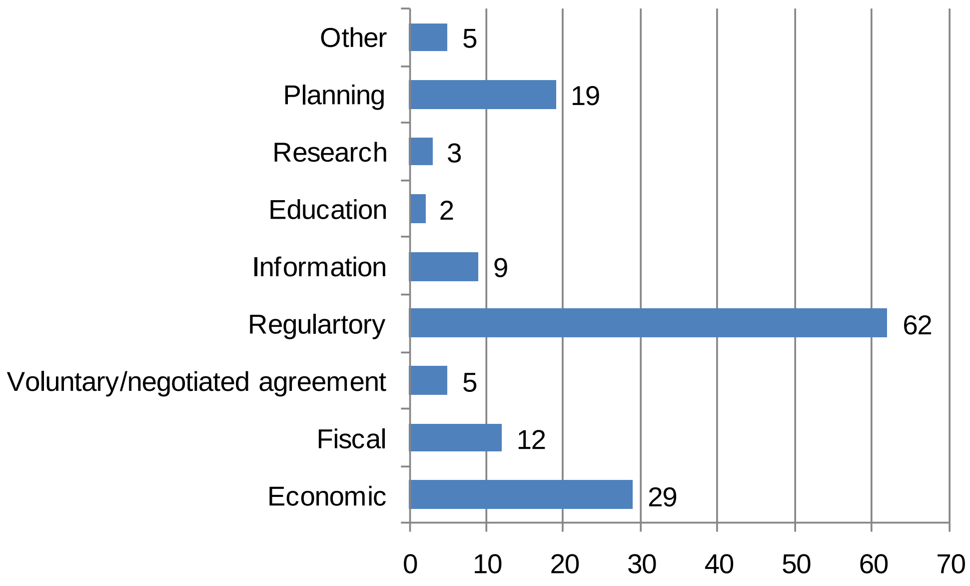
[1] **no difference made between WEM and WAM projections**

The policies in the above table show the total GHG mitigation from all additional measures by Member States reported supporting the updated projections after the 2009 MM submission. A closer look at the individual policies shows that many of the quantified savings are already accounted for in PRIMES. In a few countries this is not clear if there are additional to PRIMES or not. Reports from Denmark, Lithuania, Poland and Spain did not have specific data on building sector

3.2.4 Waste

The EEA's climate change policies and measures database contains 103 policies or measures related to the sector waste. Twenty five EU Member States have some policies defined and reported (none reported for Austria and Luxembourg). This includes cross cutting policies which affects the waste sector. When considering policies that only impact the waste sector this number decreases to 80. Most of the policies and measures focus on methane emissions (93) and a considerably less number of policies target carbon dioxide (52) and nitrous oxide (40) emissions. Most of the measures have already been implemented (72) or are adopted (12) and 15 policies and measures are still in the 'planned' status. The database also provides information about the type of policy and measure (Figure 3-29). Most policies and measures are of regulatory in nature or associated with economic instruments. Some policies fall within more than one category so are represented more than once in the chart below.

Figure 3-29 Classification to type of policy and measure (policies and measures can be classified to more than one category)

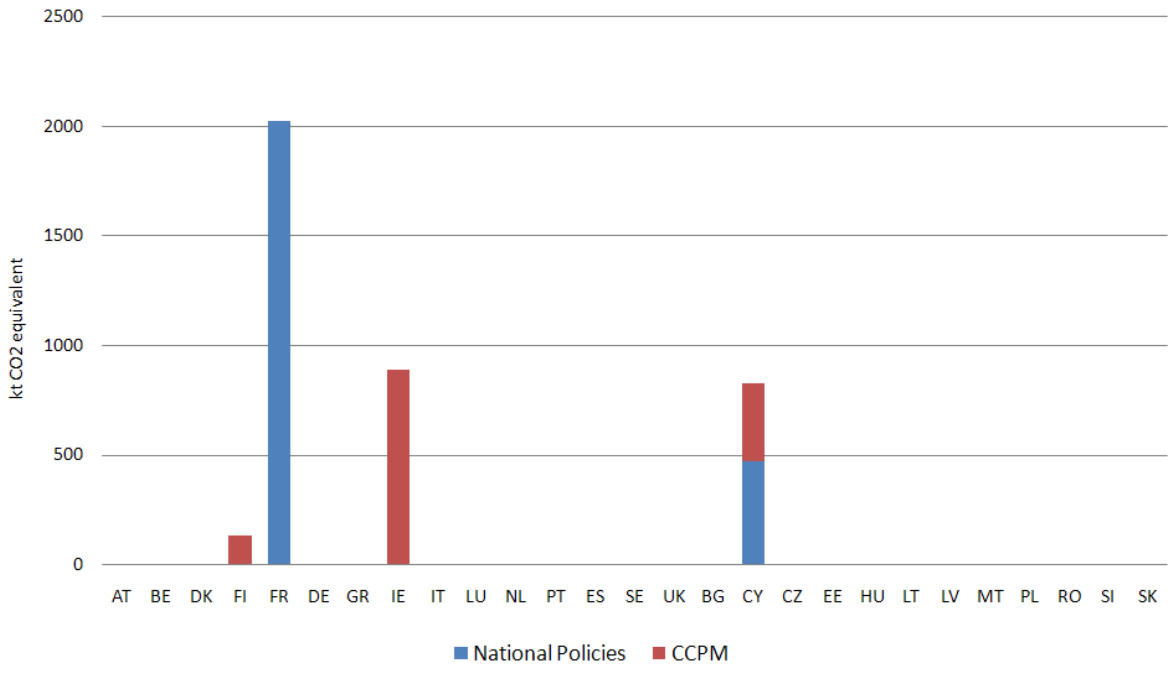


The database also contains information about the mitigation potential of the policies and measures. However, only for few policies and measures the mitigation potential (absolute reduction in ktCO_2-eq per year) was estimated.

For policies that solely impact the waste sector, in 2010 impacts were estimated for 31 policies and measures, with a total mitigation potential of 11.6 MtCO_2 eq. per year. For 2020, impacts of 26 policies and measures have been estimated with a total mitigation potential of 19.1 MtCO_2 eq. per year.

The analysis above provides an overview of the policies and measures reported by the Member States contained in the EEA's climate change policies and measures database. Figure 3-30 shows the quantified impact of **additional measures** only in the database by each Member State in 2020 in the waste sector. This is split by CCPM (i.e. EU wide) and national policies. The total quantified impact of national policies in the WAM 2020 scenario is 11.6 MtCO_2 eq.

Figure 3-30: Policy impacts of additional measures estimated by the Member States in the EEA's climate change policies and measures database for the waste sector



The PAMs that are marked as additional measures in the database give an indication of the policies at a Member State level that are not yet implemented. However, closer examination reveals that most of these PAMs are already be in the PRIMES/GAINS baseline, which comprises of Directive on waste (Directive 2006/12/EC), Waste Management Framework Directive (2008/98/EC), Landfill Directive (1999/31/EC) and the Packaging and packaging waste Directive (2005/20/EC). PRIMES/GAINS does not specify that the Packaging and Packaging Waste Directive is included in their modeling, however the objective of the policy does not directly impact GHG emissions (to reduce the packaging waste weight and volume and to develop packaging reuse and recycling system to reduce their impact on the environment) and the policy is not new.

A review was also carried out of recent Member State submission under the MM, for those Member States that submitted an updated in early 2010. The review identified only one additional policy measures in Bulgaria: the 'utilisation of the captured methane for production of electricity' relevant to the waste sector. Since this policy is strongly related to the Landfill Directive, and the emissions savings are associated with offset emissions in the electricity generation sector, the savings are not considered additional.

With regards to the Landfill Directive, which is responsible for large projected saving over the compliance period, GAINS assumes that all EU-27 Member State will meet the required diversion of biodegradable waste away from landfills, i.e. 25% in 2006, 50% in 2009 and 65% in 2016 of the 1995 amounts land-filled. All landfill sites receiving biodegradable waste should by 2009 be equipped with gas recovery equipment. Countries with a heavy reliance on landfills have been granted a four years grace period for compliance (i.e., Greece, Ireland, Italy, Spain, Portugal, United Kingdom, Cyprus, Estonia, Hungary, Slovenia, Poland, and Slovakia) to meet their targets. Also, under the Landfill Directive, all EU Member States that have not been granted extensions must ensure that sub-standard landfills that existed before the introduction of the Directive now comply with its requirements by July 2009.

However, in July 2009, Bulgaria, Romania and Poland were given extended deadlines with annual decreasing targets for the amount of waste disposed in some non-compliant sites. The deadlines are: Bulgaria (14 landfill sites) 31st December 2014; Poland (305 landfill sites) 31st December 2011; Romania (101 landfill sites) 16th July 2017. This would mean that CH_4 emission projections for those Member States may be higher than previously estimated in GAINS and Member States projections since emissions from landfills continue for a significant period following the closure of a site and the projections and emissions from unmanaged sites currently share a high proportion of the CH_4 emissions in Bulgaria for example (BG NIR).

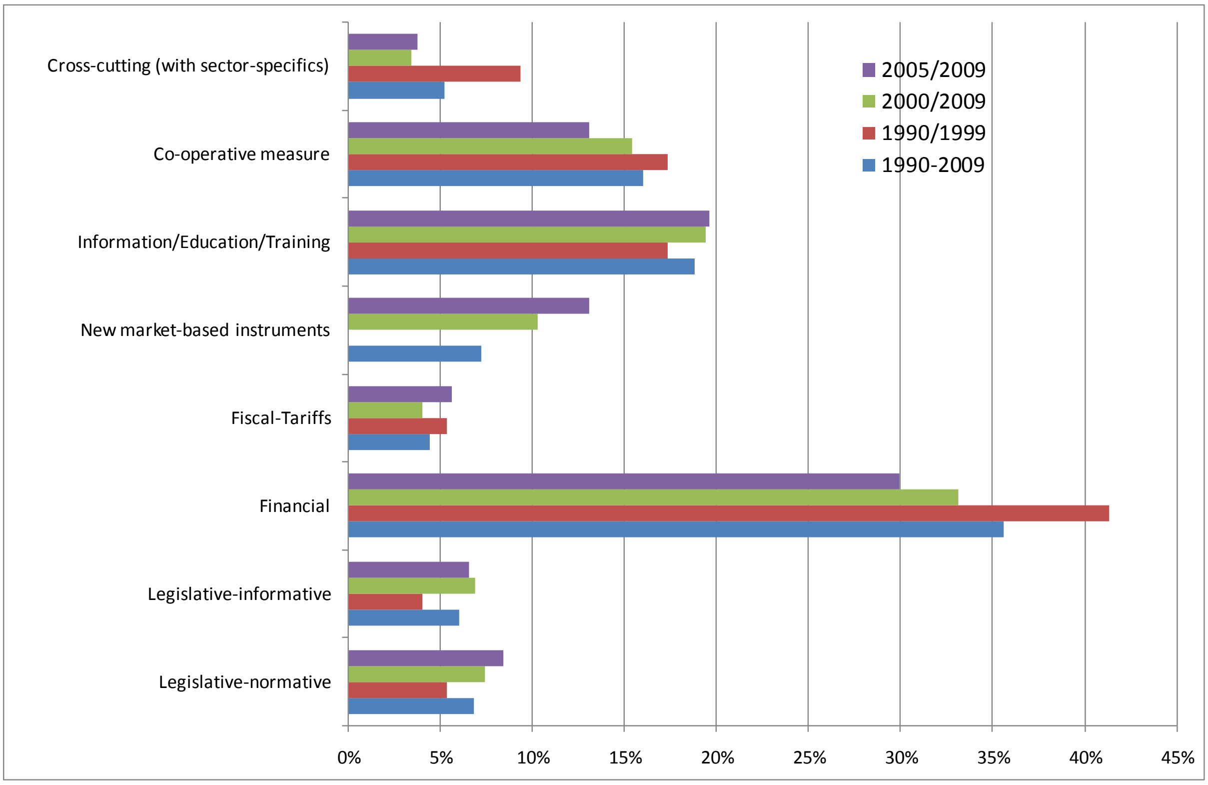
As described above, the current policy framework has already been successful in delivering significant reductions in greenhouse gas emissions in the waste sector. The increasing stringency of the policy targets – specifically under the Landfill Directive - will continue to deliver further reductions over the compliance period of the ESD. While there may be scope for some further reductions is emissions through greater stringency (for example, some regions have complete landfill bans), and the need for supporting policies (to encourage alternatives to landfill), the current policy framework captures the main sources of emissions from the waste sector. The only possible exception is the coverage of emissions from industrial and domestic wastewater. Emissions from these sectors are projected to show a much more limited reduction in emissions over the period, and this could be an area for further policy intervention.

3.2.5 Industry

This analysis is based on the policies and measures that are included in the MURE database on energy efficiency policies[44], the IEA database on energy efficiency and on global renewable energy (see the short description of these two data bases in the buildings section) as well as on the EEA's climate change polices and measures database. The latter especially to identify new policies directed towards process emissions from the industrial sector. It can be assumed that most of the policies mentioned in these two databases are included in the GAINS/PRIMES baseline; nevertheless it is useful to identify from those databases the newest measures implemented in 2009/2010 although the number of measures in these time period is quite limited. A further difficulty arises from the fact that quite frequently measures taken in the industrial sector do not distinguish ETS and non-ETS industries. This distinction can therefore not be made in this section. However, it is appropriate to state that energy efficiency measures are most likely the most important type of measures for the non-ETS industries given the fact that most of the process-related emissions and the heavy industrial processes are covered by the ETS. It is also important to underline here a large number of measures addressed to the non-ETS industry concerns electrical uses, hence indirect emissions.

[44] http://www.mure2.com/; http://www.iea.org/textbase/pm/index.html;

Figure 3-31 Classification to type of policy and measure (policies and measures can be classified to more than one category)



The MURE database contains measure descriptions for around 260 measures in the industrial sector for all 27 member states. According to Figure 3-31 the most important type of instruments for the industrial sector are by far financial instruments (e.g. subsidies for energy audits or for the implementation of energy efficiency measures), although their importance has somewhat been decreasing over time (the red and green arrows in the figure indicate decreasing/increasing measure types). The last update of MURE is from spring 2009. Therefore only few measures are indicated for the years 2009/2010, essentially aiming at financial subsidies for energy efficiency investment, for investment in clean fuels and for CHP, the development of heat maps, the realization of electricity savings from industrial cross-cutting technologies and the promotion of modal shift in industrial logistics. The next update of the MURE database will be undertaken in the coming few months and could be used to further inform this section about new measures))

The IEA database contains 101 policies or measures related to the industry sector for around two thirds of the Member States. The following table gives an overview of the measures for 2009/2010. Also in this overview financial incentives play an important role. A variety of these measures are linked to the support of industries concerning the impact of the economic and financial crises and are aimed to modernise the industries with respect to climate change mitigation technologies.

Table 3-11 Overview of policies in the industrial sector reported by Member State in the IEA database on energy efficiency policies

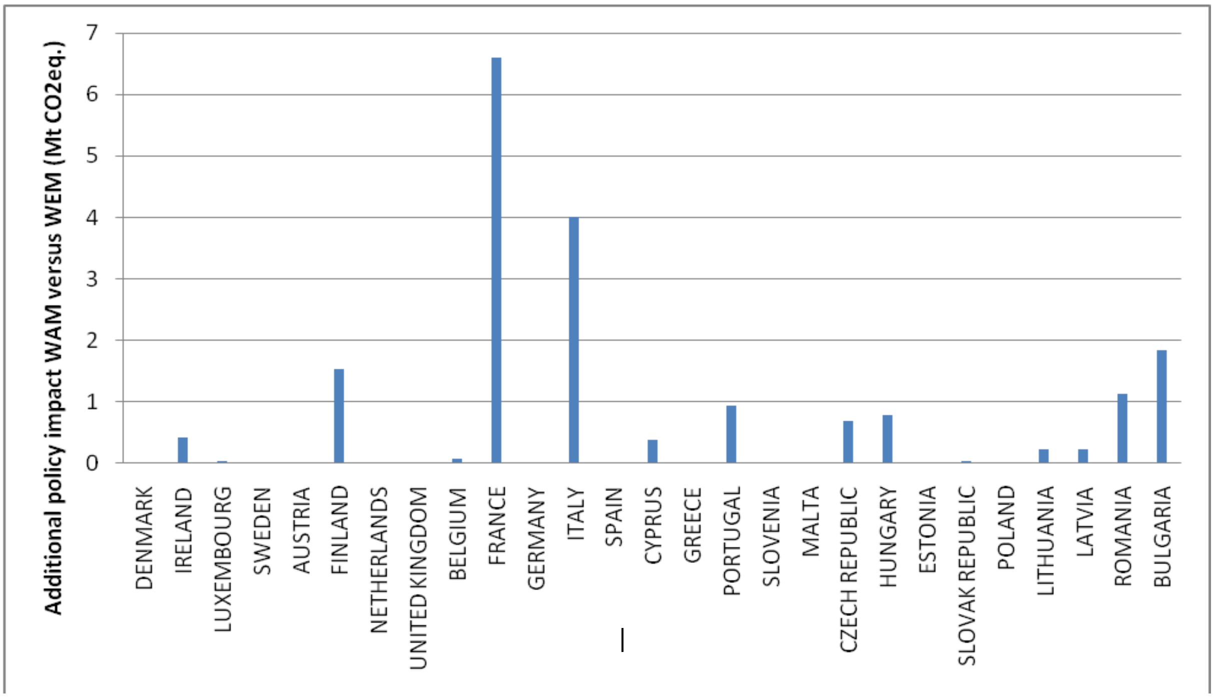
Country	Name	Type	Year
Austria	Combined Heat and Power Law (CHP Law - KWK Gesetz)	•Incentives/Subsidies	2009
Italy	Law concerning anti-crisis measures: energy provisions	•Financial •Incentives/Subsidies	2009
Poland	Polish Energy Policy until 2030	•Policy Processes	2009
Poland	Programme for renewable energy and high efficiency	•Incentives/Subsidies	2009

	cogeneration projects		
Portugal	Implementation of the EU Energy Services Directive	•Incentives/Subsidies •Policy Processes •Public Investment	2009
Slovak-Republic	Act on Support of Renewable Energy Sources and High Efficiency CHP	•Incentives/Subsidies •Policy Processes •Regulatory Instruments	2009
Slovak-Republic	Energy Efficiency Act	•Policy Processes •Regulatory Instruments	2009
Spain	Automotive Sector Competitiveness Plan	•Incentives/Subsidies	2009
Finland	Government Decision on Energy Efficiency Measures	•Education and Outreach •Financial •Incentives/Subsidies •Policy Processes •Public Investment •RD & D	2010
Italy	Smart Grid Development Incentives	•Incentives/Subsidies	2010
Italy	Special fund to support the implementation of energy efficiency targets	•Incentives/Subsidies	2010
Portugal	Energy Efficiency Fund	•Education and Outreach •Financial •Incentives/Subsidies •Public Investment •RD & D	2010
Portugal	Implementation of the CHP Directive	•Incentives/Subsidies •Regulatory Instruments	2010
Sweden	Energy Audits for Companies	•Incentives/Subsidies	2010
United-Kingdom	Carbon Reduction Commitment Energy Efficiency Scheme (CRC)	•Regulatory Instruments •Tradable Permits	2010

The EEA's climate policies database did not seem to contain any new Member State measure after 2008.

In Figure 3-32 the difference between the *with existing* (WEM) and *with additional measures* (WAM) scenarios are shown for the non-ETS industries. For a variety of MS no data were provided for the WAM projections. Only for some Member State data were provided and for some the emissions were similar in both projections. In total the estimates yield the relatively small number of 18 Mt CO_2eq. of additional savings for the countries that have provided the WAM estimates. However, large countries such as Germany, UK Spain or Poland seem not to have provided such information. It can be concluded from this nevertheless that the impact of the additional measures appears limited so far. For the remaining countries differences are partly linked to the size of the country but not exclusively as seen with the comparison of France and Italy which have similar GHG emissions under the ESD (see Figure 3-32) but largely different additional mitigation potentials which indicate different ambition in the level of additional policies.

Figure 3-32: Additional mitigation potential in WAM projection compared to WEM projection for the non-ETS industries.



3.3 Abatement potential

3.3.1 EU wide

In combination, the ESD sectors of agriculture, road transport, built environment, small industry and waste have an estimated technical abatement potential in 2020, that can be considered additional to any emission savings captured within the PRIMES/GAINS baseline, of 470 million tonnes of carbon dioxide equivalents ($MtCO_2$ eq), at an EU level.

Additional mitigation policies, introduced subsequently to the PRIMES/GAINS baseline will take up a proportion of the cost-effective abatement potential, reducing the remaining potential in 2020. After accounting for the impacts of the most important EU wide policies, the remaining abatement potential in 2020 is estimated to be 397 $MtCO_2$ eq.

Of this total remaining potential, an estimated 156 $MtCO_2$ eq is considered to be cost effective (i.e. below zero cost), on the basis of social discount rates, without the need for any further policy support e.g. a carbon price. In other words, the efficiency savings (e.g. reducing energy consumption) delivered by the measures over their lifetimes, is more than sufficient to offset the overall cost of their implementation and maintenance. These measures therefore offer a win-win option, by delivering both emissions reductions and financial savings.

At a carbon price €25/tCO_2 a further 56 $MtCO_2$ eq of abatement potential in 2020 becomes costs effective. Figure 3-33 shows the distribution of the abatement potential over the different cost-bands that were defined in Section 2.4.5.

Most of the remaining abatement potential in the building and the industry sectors can be delivered at a negative net cost. The majority of the abatement potential in the agriculture sector is realised at cost band B (<€25/tCO2 eq.). The remaining abatement potential in the transport sector is in the higher cost bands. Therefore, a much higher carbon price would be required to make these measures cost-effective. In the waste sector, the remaining abatement potential in 2020 is estimated to be much more limited, reflecting the effectiveness of the existing policy framework in delivering the available potential.

For further discussion on cost-effectiveness and a comparison between the social versus private (end-user) perspective and on the sensitivity of the cost curves see section 3.3.3 on the sensitivity of the cost curves.

Figure 3-33: Abatement potential in 2020 at an EU level, and distribution over cost bands and sectors

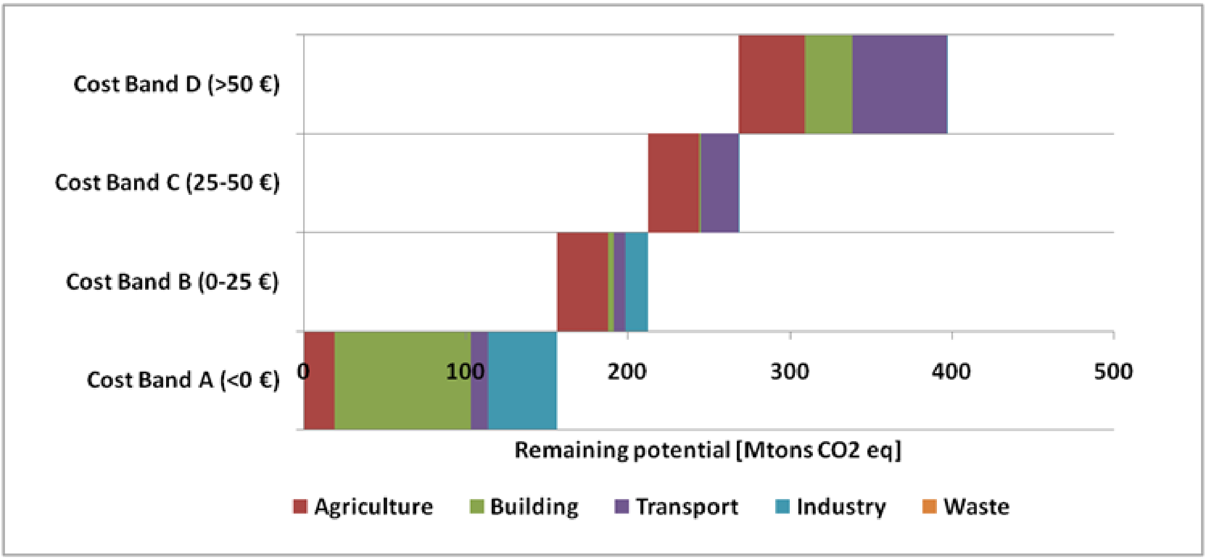


Table 3-12 shows the detailed distribution of the remaining abatement potential in each of the main sectors on EU level. It is important to note that the remaining abatement potential only includes direct emissions covered by the ESD. Certain measures will also influence emissions arising in the ETS sectors, such as measures that reduce electricity consumption. These savings are not captured in the analysis presented here. In addition, the estimates do not capture the abatement from certain smaller sources outside of the main sectors described above. Some further discussion of the potential abatement from these sectors is provided in section 3.3.9 below.

Across all sectors the results presented are strongly influenced by the activity assumptions within PRIMES/GAINS. As shown in Section 3.1.2, the emissions projections produced by these models differ from Member States' own projections. The same can therefore be inferred for the estimates of the abatement potential. As with the projections, the approach used here applies a consistent methodology to all Member States which aids comparisons. However, the estimates may not reflect the full complexity of activities within individual Member States.

A further consideration is that simplifications in the methodology will reduce the overall accuracy of the results at the level of individual Member States. In particular, the approach that has been used to updated the SERPEC values, on the basis of changes in the baseline projections from PRIMES, assumes that the baseline projections is subsequent model runs from PRIMES are fully consistent. Due to retrospective changes in the underlying energy statistics or modification to the model architecture, this may not be true in all cases. Where these issues have been identified some corrections have been applied – though this has not been possible in all cases.

To provide some further confidence in the overall results, a high level comparison has been carried out with the results from other studies (see end of each sub section). Accurate comparison are limited by differences in methodology; there may be differences in scope, in baseline assumptions (e.g. efficiencies, autonomous improvements, etc.), in timescale, in policy impacts. However, the comparison is still useful to check the overall order of magnitude of the estimated savings.

Table 3-12: Abatement potential in the EU per sector and per cost band

	EU 27	Agriculture	Building	Transport	Industry	Waste
Cost Band A (<0 €)	156	19	84	11	43	0
Cost Band B (0-25 €)	56	31	4	7	14	0
Cost Band C (25-50 €)	56	31	2	23	0	0
Cost Band D (>50 €)	129	41	29	58	0	0
EU 27	397	122	118	100	57	0

In Figure 3-34 the estimated abatement potential is compared with the emissions target implied by the ESD, and the current policy gap, as estimated in Section 3.1. The figure shows the EU level ESD target in 2020 (based on the PRIMES/GAINS analysis), the projected baseline emissions in 2020 (derived from PRIMES 2009 baseline but adjusted to take into account the effect of additional EU wide policies implemented subsequent to the PRIMES 2009 analysis) and the projected emissions in 2020 if all of the remaining cost-effective potential was taken up (where the remaining cost-effective potential includes both measures that can be delivered at a negative net cost, and also measures that can be delivered at a cost of less than €25/tCO_2 eq[45]).

It is important to note that the projected baseline emissions in 2020, and the policy gap, described here differs from the analysis shown in Section 2.2.3, due to an adjustment that has been made to account for additional EU wide policies that were not captured in the PRIMES 2009 baseline. These policies will exhaust some of the abatement potential (and at the same time reduce the policy gap). Taking into account these additional policies reduces the overall gap from 157 to 83 MtCO_2 eq. This can be attributed to the following emissions savings in 2020:

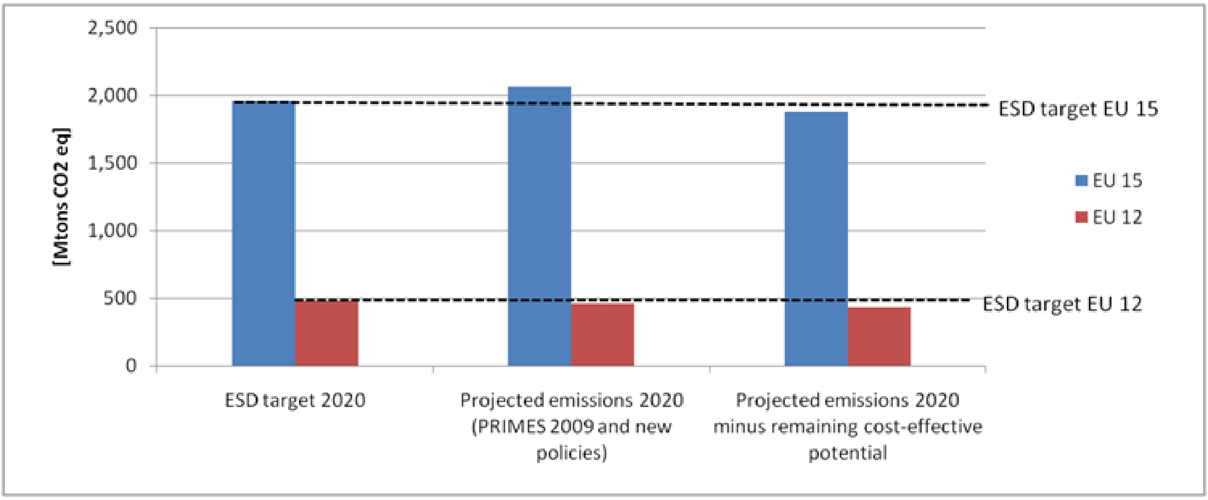
- 42.5 MtCO_2 in the buildings sector of from the Recast of the Energy Performance of Buildings Directive
- 17.2 MtCO_2 in the industry sector from national policies directed towards smaller industries.

[45] This latter group are not strictly cost-effective, but would be if the emissions were subject to a carbon price of €25/tCO_2 eq. (which is consistent with the carbon price needed to comply with the ETS cap, as modelled with PRIMES).

- 13.5 $MtCO_2$ in the transport sector from the proposed limits on CO_2 emissions from Vans

As Figure 3-34 illustrates, the implementation of the abatement measures within costs bands A and B is more than sufficient to deliver the emissions reductions required to deliver the EU wide ESD target. In fact, the take up of all measures in cost bands A and B, in combination with existing and planned policies, is sufficient to reduce EU emissions to 11% below 2005 levels. Furthermore, the overall costs for society of delivering the reductions are likely to negligible or even negative (depending on the mix of band A and band B measures taken up).

Figure 3-34: EU level ESD emissions target, projected emissions in 2020 and remaining cost-effective potential



The total emissions, ESD target, policy gap and the total remaining and cost-effective potential are summarised at an EU level in the following table:

Table 3-13: Overview of projected emissions, ESD target, total and cost-effective remaining potential in 2020 in $MtCO_2$ eq:

	Total emissions[1]	ESD Target	Policy Gap	Total remaining potential[2]	Cost-effective remaining potential at a carbon price of €25/tCO_2 eq.
Total	2,596	2,439	83	397	212

[1] PRIMES 2009 baseline (when the impact of additional policies is taken into account the baseline drops to 2,522 $MtCO_2$ eq and therefore the policy gap is reduced to 83 $MtCO_2$ eq).
[2] The analysis draws largely on the results of the Sectoral Emission Reduction Potentials and Economic Costs for Climate Change project. This analysis has been used since it provides the most comprehensive and complete dataset available, covering each of the main ESD sectors in a consistent and comparable basis. The data from SERPEC has been adapted to the requirements of the project. For this project only direct emissions has been considered just like the effect of the recession and the shorter time period.

The main conclusions from the EU wide analysis are as follows:

- The ESD sectors of agriculture, road transport, built environment, small industry and waste have an estimated technical abatement potential in 2020, that can be considered additional to any emission savings captured within the PRIMES/GAINS baseline, of 397 million tonnes of carbon dioxide equivalents ($MtCO_2$ eq), at an EU level.
- Of the 397 $MtCO_2$ eq. of abatement potential remaining in 2020, an estimated over 212 $MtCO_2$ eq. of abatement potential could be considered 'cost-effective' at a carbon price of €25/tCO_2 eq, of which 156 $MtCO_2$ eq can be addressed at a negative carbon price (below zero cost).

- The take up of this cost-effective potential in combination with existing and planned policies, is sufficient to reduce EU emissions to 11% below 2005 levels.
- The total cost effective abatement potential remaining in 2020 is estimated to be in excess of the policy gap in 2020. This suggests that the ESD target can be met, at an EU level, at no net cost to the European economy. In fact, delivery of the ESD targets using the cost-effective abatement potential will deliver net benefits to the economy through the efficiency savings.
- There are some uncertainties in the abatement cost analysis. The analysis, whilst based on bottom up technology estimates, has not been updated in detail to reflect new or emerging technologies, or account taken for changes in fuel prices.
- Furthermore, the cost estimates do not take into account certain hidden costs (e.g. time cost of installing measures) which may increase the cost estimates, or direct rebound effects (e.g. taking more heating comfort), which may reduce the emissions savings.
- The estimated abatement potential is based, in most cases, upon technical measures. Therefore the potential savings do not take into account most behavioural measures (e.g. turning down the heating), which have the potential to delivery additional savings.

3.3.2 Sensitivity analysis of the methodology for determination of the distribution of the remaining potential to four cost bands

In section 2.4.5 the methodology that was used to distribute the remaining abatement potential to each of the cost bands was described. This section examines the sensitivity of the results to alternative approaches to distribution.

One alternative approach would be to assume that the used up potential is taken out with equal share from each cost band. This approach would mean that if e.g. 65% of the abatement potential is used up, then every cost band will be reduced by 65% (**Error! Reference source not found.**). This outcome is less likely in practice as you would expect greater take up of measures in the lower cost bands.

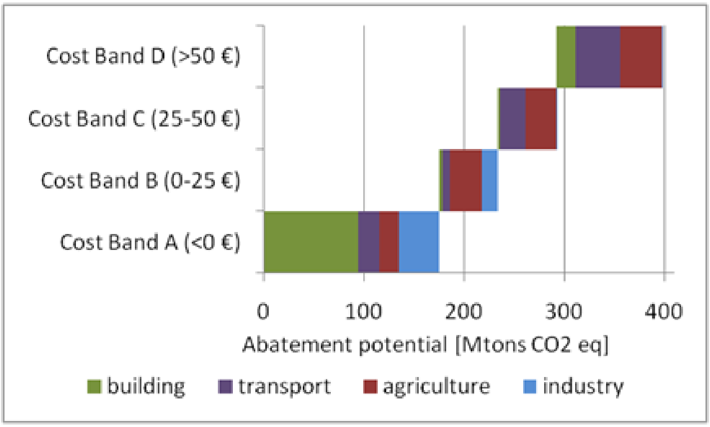


Figure 3-35: The used up potential has been equally taken out from each cost band.

A second alternative approach would be to assume that the potential used up follows a strict cost optimal way, i.e. that first all potential is used up from measure from cost band A, then from cost band B and so on (**Figure 3-36**). In this case cost band A would be reduced most. Whilst this is the most rational outcome, as discussed previously (see section 2.4), barriers to the take up of certain measures and market failures may limit a strict cost optimal approach.

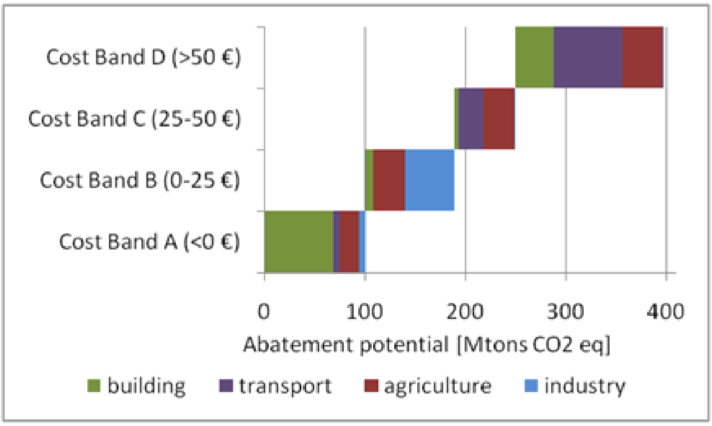
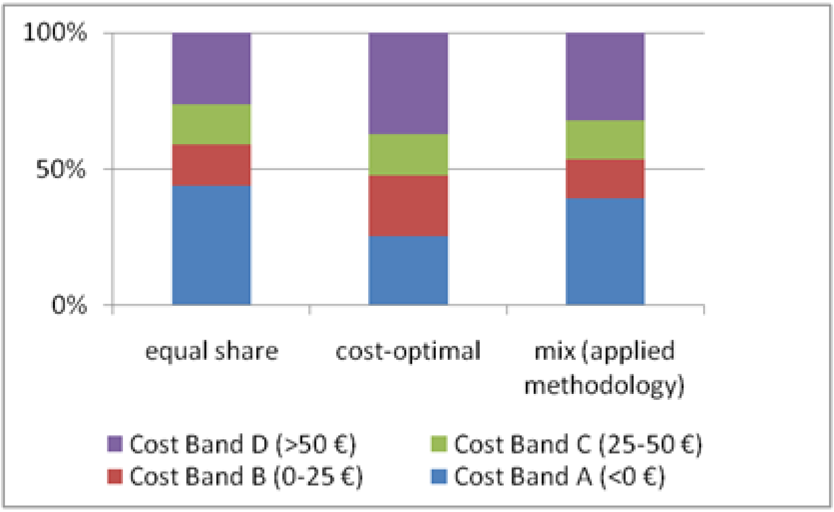


Figure 3-36: The used up potential has been taken out first from cost band A, then B, then C and at least D.

The applied methodology represents an intermediate approach by applying a higher weight to lower cost options, but also assuming the take up of some higher cost measures. Figure 3-37 illustrates the effect of every method in direct comparison.

Figure 3-37: Share of abatement potential in each cost band according to distribution of already used up potential between calculations in SERPEC and actual study



3.3.3 Sensitivity analysis of the cost curves in SERPEC

A cost curve illustrates which technology is cheapest per tonne of CO_2 abated. A cost curve should be regarded as a scenario outcome that is especially sensitive to certain input assumptions e.g. energy prices. As an illustration, compared to the social cost perspective, the private end-user faces higher discount rates and taxed energy prices. The former increases abatement costs, whereas the latter decreases the abatement costs because of higher revenues from energy savings. It is important to note, that cost curves as shown in this report, as tangible and straight forward as they may seem, are a function of input parameters. In SERPEC it was showed that the cost-curve is sensitive to a number of input parameters:

- the discount rate and energy prices
- the reference CO_2 emissions factor used for electricity
- the value of the denominator of the specific costs (€/t CO_2).

Because of these sensitivities, we recommend that the cost-curves be interpreted in a fairly generic way, rather than focusing on the precise position of individual options. The example in this chapter also illustrate that comparing the cost-effectiveness of options, within one study or across studies, is not always straightforward and should be carried out with great care.

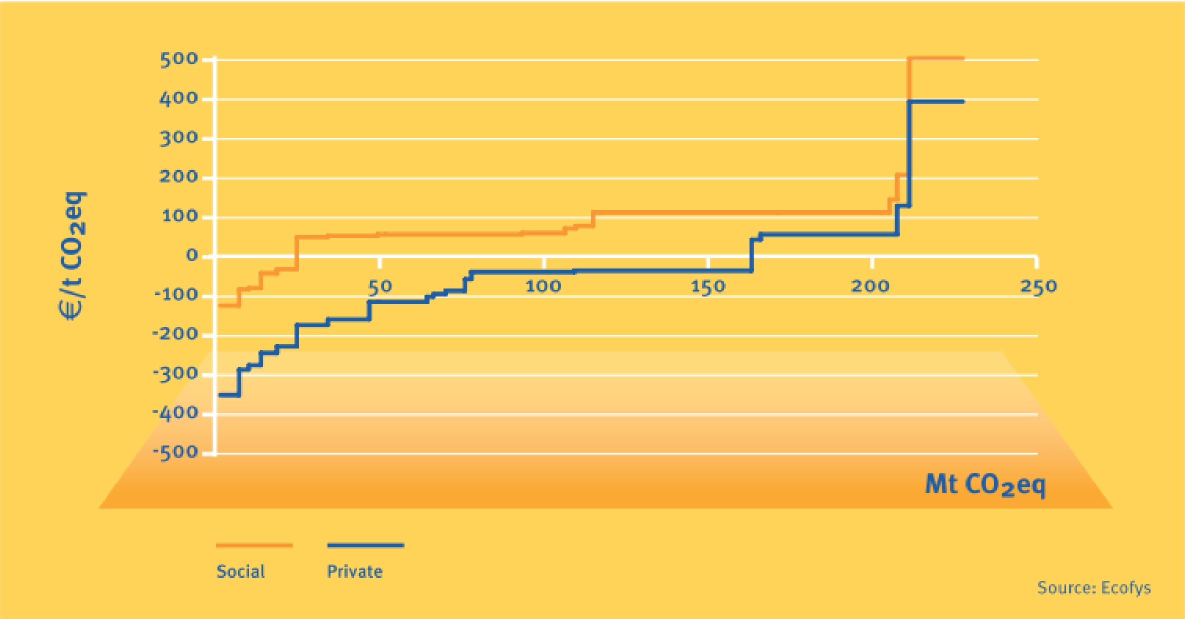
The social versus private (end-user) perspective
The SERPEC cost-curves are based on a ‘social’ cost perspective, in which we use discount rates of 4% and energy prices before taxation. Firstly, the outcomes of this exercise are sensitive to these assumptions. Secondly, the end-user perspective can be quite different. This is illustrated in Figure 3-38 for the transport options. Please note that this example is for illustrative purposes and is not specific to this project.

Figure 3-38 shows the specific costs of options in 2020 under two scenarios:

- the social cost perspective (upper curve)
- end-user perspective

In our default situation most of the options are not cost efficient in 2020. From the end-user perspective though, the financial revenues from energy savings are much bigger because of fuel taxation and technologies become (more) cost-efficient sooner (see Figure 3-38).

Figure 3-38: Cost-curve for transport (2020) in two variants: 1) social cost perspective (upper curve), 2) 9% discount rate and fuel prices after taxation (lower curve).



In other sectors, the effect of fuel taxation is less and the effect of the discount rate is more important so the cost-curves shows the opposite dynamics to those found for the transport sector.

This exercise illustrates, that the societal cost-calculations should be regarded as a scenario outcome that should not be confused with the end-users (investors) perspective.

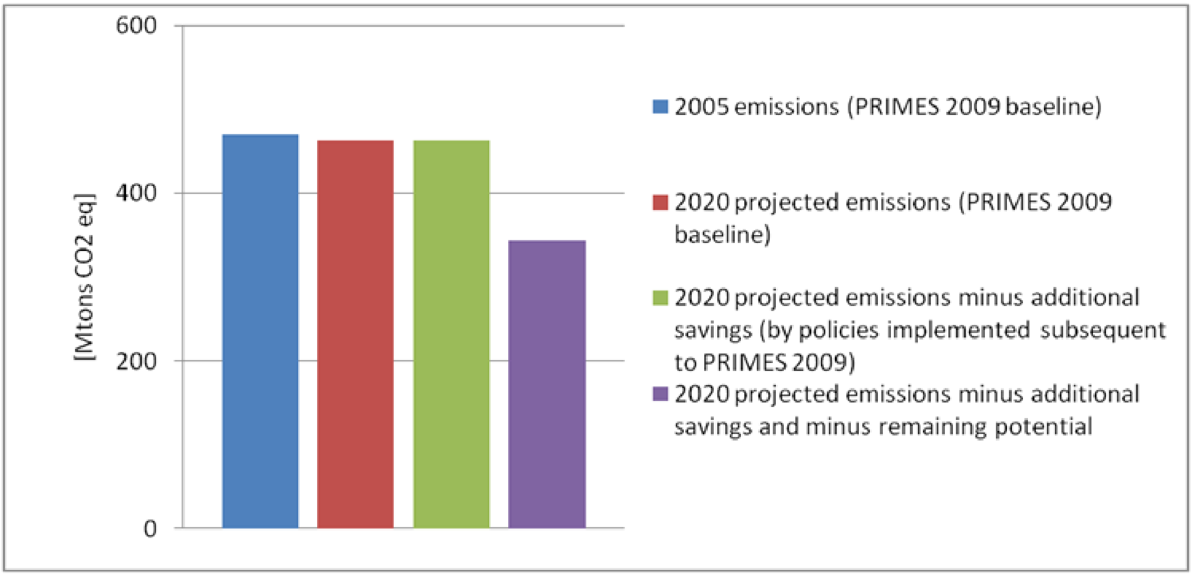
3.3.4 Sector level

3.3.4.1 Agriculture

Figure 3-47 illustrates the baseline emissions (based on the GAINS projections) and the GHG abatement potential for the agriculture sector (based on the updated SERPEC study). Overall, the sector has an estimated technical abatement potential of 122 $MtCO_2$-eq and therefore is able to bring down the total emissions of the agriculture sector to 344 $MtCO_2$-eq.

No major EU wide policies affecting GHG emissions from agriculture were implemented subsequent to GAINS 2009. Therefore, no further adjustments to the baseline emissions were made to those presented in Section 3.2.1

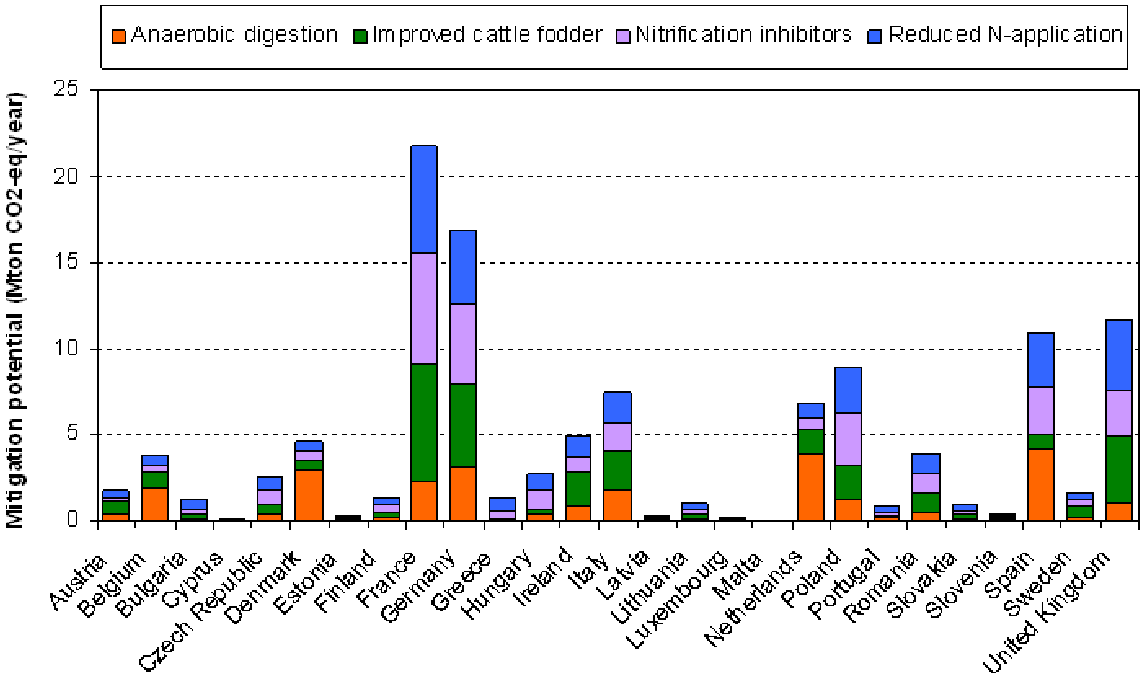
Figure 3-39: Emissions and abatement potential in the agriculture sector



Source: Calculations by Ecofys based on SERPEC data

The abatement measures for agriculture can be grouped into four main categories, i.e. anaerobic digestion and improved cattle fodder (mainly aimed at lower CH_4 emissions from ruminants and manure storage), nitrification inhibitors and reduced N-application (aimed at less N_2O from soil applications of fertilizer and manure). Reduced N application is already stimulated to a large extent by measures under the Nitrates Directive. For anaerobic digestion several Member States have or are developing policies to stimulate anaerobic digestion of animal manure. For nitrification inhibitors and improved cattle fodder both measures are currently still mainly at an experimental stage and not applied at large scale.

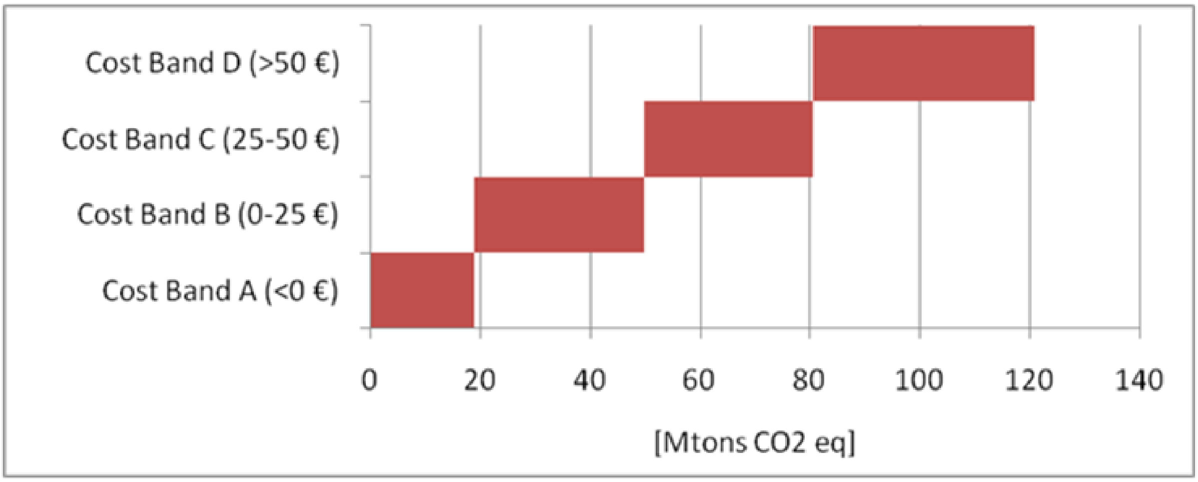
Figure 3-40 Technical mitigation potential per Member State by 2020 specified per measure group



Source: Calculations by Alterra based on SERPEC data

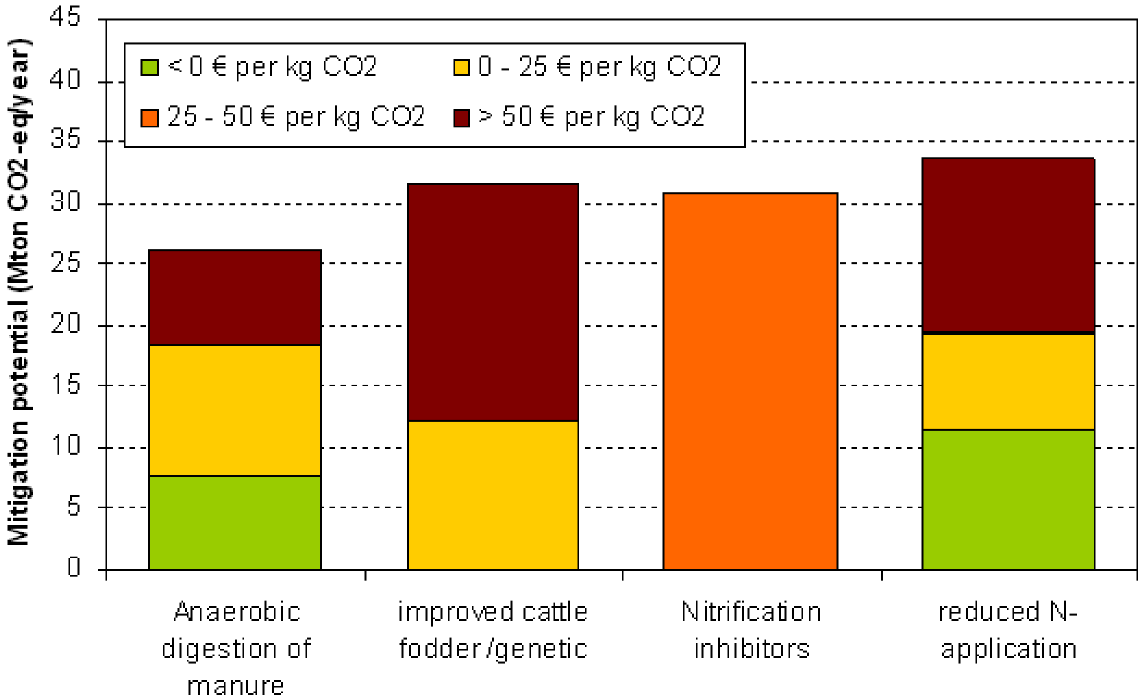
The total technical mitigation potential in agriculture by 2020 is about 122 $MtCO_2$-eq per year. The overall cost curves for the agriculture sector in 2020 in the EU 27 are shown in Figure 3-41. The figure shows that under the scenario conditions, a large share of the abatement potential is cost-effective (about 50 $MtCO_2$-eq). In Figure 3-42 this is specified per group of measures. The graph shows that most of these aggregated measures have different cost-effectiveness, which depends on type of measure and country. For example, in Belgium and The Netherlands the share of anaerobic digestion of manure is much higher in cost band A, compared to other countries, because of the high livestock density.

Figure 3-41 Technical mitigation potential and cost bands of the underlying options in the agriculture sector in the EU 27 in 2020.



Source: Calculations by Alterra based on the SERPEC data

Figure 3-42: Mitigation potential per measure in relation to cost categories for the EU-27



Source: Calculations by Ecofys and Alterra based on SERPEC data

About 19 $MtCO_2$-eq could be reduced without additional costs (anaerobic digestion and reduced N application), about 31 $MtCO_2$-eq can be mitigated for costs between 0 and 25 euro, about 31 $MtCO_2$-eq can be mitigated for costs between 25 and 50 euro (mainly application of nitrification inhibitors) and for 41 $MtCO_2$-eq the costs are more than 50 euro per kg CO_2-eq. For nitrification inhibitors we present results that are based on changes made in the original SERPEC data. According to the SERPEC study a 30% reduction of N2O emissions could be obtained for all fertilizer and costs were estimated at 10 euro per tonne CO_2-equivalent for both mineral and organic fertilizers, based on limited information. However, more recent literature, shows that cost estimates are higher and the effect on emissions lower. As a result, the cost effectiveness is also lower. A recent cost-abatement study for agriculture in the United Kingdom (Moran et al., 2010)[46] showed that for nitrification inhibitors the feasible potential is much (almost 10 times) lower (0.6 $MtCO_2$-eq) compared to the technical potential from the SERPEC study (5.4 $MtCO_2$-eq) and that also the costs are much higher (294 £/tCO_2-eq). In our newest assessment, presented in this report, we halved the mitigation potential for nitrification inhibitors, assuming that the 30% reduction can only be obtained for 50% of the fertilizers (e.g. nitrification inhibitors only work for ammonium based fertilizers and not for nitrate based fertilizers), and we changed the cost band for application of nitrification inhibitors from B to C.

In Europe, nitrification inhibitors are only applied at very small or experimental scale. In few other countries, e.g. New Zealand, their application is more widespread, and its use is also incentivized with policies and measures. This includes the definition and use of a specific (lower) emission factor for application of nitrification inhibitors in combination with fertilizers and manure/urine deposits in pastures and the set-up of a trading scheme of GHG emissions that will include the emissions of non-CO_2 gases from the sector agriculture. In the Netherlands, the realistic mitigation of N_2O from the use of nitrification inhibitors was much lower than the potential and estimated at 0.6 $MtCO_2$-eq, which is only 12% of the current emissions related to nitrogen use in agriculture (Kuikman et al., 2010). This illustrates that the realistic potential may well be overestimated and very country dependent and requires further research to improve the estimates of abatement potential and cost-effectiveness. Similar reasoning as for the effectiveness of nitrification inhibitors may apply to other measures and to all major regions across EU-27; many measures to mitigate N_2O emissions have not been tested at the field and farm scale.

Table 3-14 summarizes the data disaggregated at Member State level. As would be expected, Member States with large absolute emissions from agriculture (Germany, United Kingdom, France, Italy, Spain) also have the greatest overall abatement potential. However, the relative share of the technical abatement potential as compared to the projected emissions from agriculture in 2020 ranges from 11% (Portugal) to 50% (Denmark). Countries with intensive livestock production (Denmark, Belgium, the Netherlands and Germany) all have a high relative abatement potential, although this potential will be difficult to achieve in practice.

The balance of abatement potential between the cost-bands is broadly consistent across all Member States. However, there are some variations. For example, the relative importance of cost band A (< 0 euro) is more important in Belgium, Denmark and the Netherlands. This is mainly because of a large potential for anaerobic digestion of manure in cost band A, since these countries produce significant amounts of manure, and processing is relatively cheap because of the concentration of farms within short distance.

Table 3-14: Remaining abatement potential and cost bands in the agriculture sector in 2020 by Member State in $ktCO_2$ eq

Country	Remaining potential (sum of Cost Band A, B C and D)	Cost Band A (< 0 Euro)	Cost Band B (0-25 Euro)	Cost Band C (25-50 Euro)	Cost Band D (> 50 Euro)
EU 27	122,374	19,136	31,112	31,129	40,997
AUSTRIA	1,802	156	695	260	691
BELGIUM	3,886	1,024	1,289	403	1,170
BULGARIA	1,271	176	218	497	379

[46] http://onlinelibrary.wiley.com/doi/10.1111/j.1477-9552.2010.00268.x/abstract

CYPRUS	103	8	11	21	63
CZECH REPUBLIC	2,667	394	507	945	822
DENMARK	4,764	1,164	1,629	573	1,398
ESTONIA	285	32	61	87	105
FINLAND	1,376	192	325	465	394
FRANCE	22,478	2,761	5,749	6,686	7,282
GERMANY	17,408	2,452	4,924	4,793	5,240
GREECE	1,461	213	175	695	379
HUNGARY	2,806	413	527	1,122	744
IRELAND	5,087	728	1,436	871	2,051
ITALY	7,694	836	2,251	1,584	3,023
LATVIA	334	38	78	90	129
LITHUANIA	1,074	146	234	339	355
LUXEMBOURG	169	17	44	45	63
MALTA	12	1	3	3	5
NETHERLANDS	6,994	2,130	1,787	656	2,421
POLAND	9,263	1,604	2,064	3,130	2,465
PORTUGAL	878	172	163	246	296
ROMANIA	4,048	517	983	1,109	1,439
SLOVAKIA	970	120	224	287	339
SLOVENIA	460	33	125	89	213
SPAIN	11,227	2,354	1,517	2,858	4,497
SWEDEN	1,759	167	499	450	643
UNITED KINGDOM	12,098	1,290	3,593	2,825	4,390

Source: Calculations by Ecofys and Alterra based of the SERPEC data

Table 3-15. gives an overview of the measures in the 2020 abatement cost curve for the agriculture sector. This shows which cost bands each of the measures fall within, based on the average EU values. Individual measures may fall within a different cost band at a country level, due to different national circumstances.

Table 3-15: List of measures in the 2020 abatement cost curve for the agriculture sector

Group	Measure	Cost band
Soils	Reduce N application through precision farming	A
Soils	Reduced N application through improved spreader maintenance	A
Manures	Centralized anaerobic digestion: dairy - West (warm)	A
Manures	Centralized anaerobic digestion: dairy - East (temperate)	A
Manures	Centralized anaerobic digestion: dairy - West (temperate)	A
Manures	Centralized anaerobic digestion: pigs - East (temperate)	A
Manures	Centralized anaerobic digestion: pigs - West (temperate)	A
Manures	Centralized anaerobic digestion: pigs - West (warm)	A
Soils	Reduce N application through fertiliser free zone	A
Enteric	Long term management and use of genetic resources (Non-dairy cattle Eastern Europe)	B
Enteric	Long term management and use of genetic resources (Dairy cattle Eastern Europe)	B
Enteric	Long term management and use of genetic resources (Dairy cattle Western Europe)	B
Manures	Reducing the rate of microbial action	B
Manures	Removal of the gas source	B
Enteric	Long term management and use of genetic resources (Non-dairy cattle Western Europe)	B
Soils	Addition of Nitrification inhibitors - Mineral	C
Soils	Addition of Nitrification inhibitors - Manures	C
Soils	Reduced grazing on wet areas	B
Soils	Reduce N application through enhanced distribution geometry	B

Soils	Reduce N application through allowance for manure/residual N	D
Manures	On farm anaerobic digestion: dairy - West (warm)	D
Manures	farm anaerobic digestion: dairy - East (temperate)	D
Manures	Centralized anaerobic digestion: dairy - East (warm)	D
Manures	On farm anaerobic digestion: for pigs - West (warm)	D
Manures	Centralized anaerobic digestion: pigs - East (warm)	D
Enteric	Adding oils and oilseeds (Dairy cattle Western Europe)	D
Manures	On farm anaerobic digestion: dairy - West (temperate)	D
Enteric	Adding oils and oilseeds (Dairy cattle Eastern Europe)	D
Manures	On farm anaerobic digestion: pigs - East (warm)	D
Manures	On farm anaerobic digestion: dairy - East (warm)	D
Manures	On farm anaerobic digestion: pigs - West (temperate)	D
Manures	On farm anaerobic digestion: pigs - East (temperate)	D
Enteric	Adding oils and oilseeds (Non-dairy cattle Eastern Europe)	D
Enteric	Adding oils and oilseeds (Non-dairy cattle Western Europe)	D
Enteric	Replacement of roughage with concentrates (Dairy cattle Western Europe)	D
Enteric	Replacement of roughage with concentrates (Dairy cattle Eastern Europe)	D
Enteric	Replacement of roughage with concentrates (Non-dairy cattle Eastern Europe)	D
Enteric	Replacement of roughage with concentrates (Non-dairy cattle Western Europe)	D
Soils	Better livestock nutrient use efficiency - grazing	D
Soils	Better livestock nutrient use efficiency - fertiliser	D

Source: SERPEC 2009d

To provide some further confidence in the overall results, a high level comparison has been carried out with the results from other studies (see Table 3-16). The results are not directly comparable with those presented; there may be differences in scope, in baseline assumptions (e.g. efficiencies, autonomous improvements, etc.), in timescale, in policy impacts. However, the comparison is still useful to check the overall order of estimated savings.

Table 3-16: Comparison of abatement potentials with other studies ($MtCO_2$-eq)

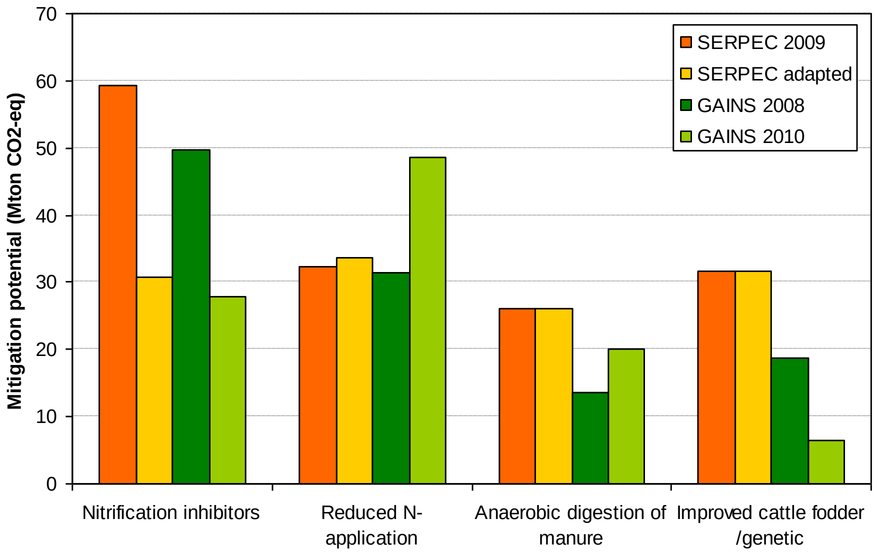
	Abatement potential ($MtCO_2$)			
Country	**Current study (based on SERPEC 2009)**	**Alternative estimate**	**Comment**	**Source**
EU-27	122	116 (of which 13.4 from measures not included in SERPEC)	Abatement potential in 2030	Höglund-Isaksson et al., 2010
United Kingdom	12.1	8.6-18.9	Abatement potential in 2022	SAC (2010)
Germany	17.4	10	Scope is Germany	McKinsey (2007)
Czech Republic	2.7 (of which 0.9 with costs < 25€/tCO_2)	2.6 (of which 2.5 with costs < 25€/tCO_2)	Abatement potential in 2030	McKinsey (2008)
Sweden	1.8 (of which 0.7 with costs < 25€/tCO_2; 1.1 with costs < 50€/tCO_2)	0.8 (with costs < 50€/tCO_2)		McKinsey (2008a)
Poland	9.3 (of which 3.7 with costs < 25€/tCO_2)	9 (with costs < 80 €/tCO_2)	Abatement potential in 2030	McKinsey (2009)

A number of the estimates provide broadly comparable results, which presents some further confidence in the current results. However, difference in assumptions e.g. impacts of existing policies, impacts of the economic recession, can have a major impact on the overall results. This may explain the differences in the apparent abatement potential with some studies. However, it has not been possible to test this further.

In Figure 3-43 and Figure 3-44 a more detailed comparison is provided between the mitigation potentials and cost-effectiveness from the SERPEC study and from the GAINS studies (Amann et al., 2008; Höglund-Isaksson et al., 2010). The control options from the GAINS studies were assigned to the four main mitigation measures from the SERPEC study. The GAINS 2010 study also comprises some measures that are not included in SERPEC study, i.e. improvements in rice cultivation (1.4 $MtCO_2$-eq), ban on straw burning (0.7 $MtCO_2$-eq) and extensification of cultivated organic soils (11.3 $MtCO_2$-eq). The difference between SERPEC 2009 and SERPEC adapted is due to the nitrification inhibitors. In SERPEC (2009) a mitigation potential of 60 $MtCO_2$-eq was estimated, all in cost band B. As explained before, we now assume higher costs (Cost band C) and a lower mitigation potential lower (30 $MtCO_2$-eq), which is also more in line with the GAINS 2010 data.

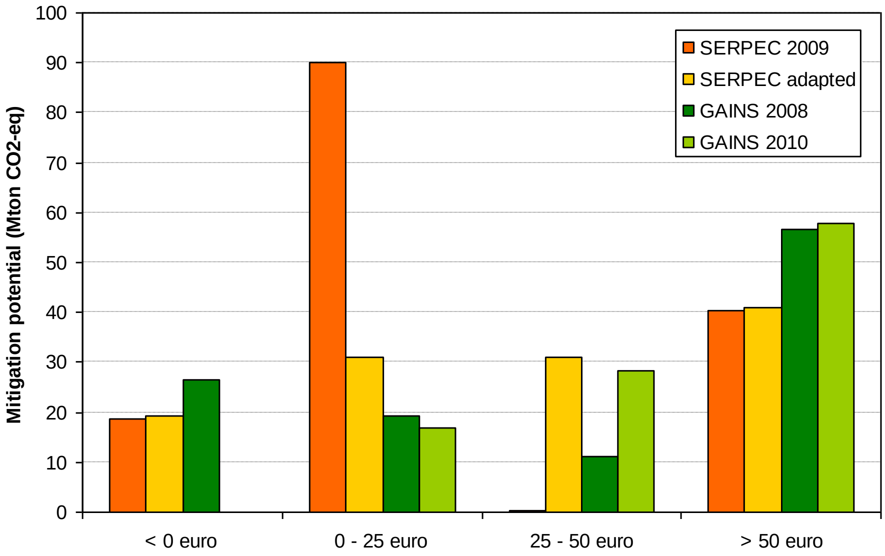
The total mitigation potentials in agriculture of GAINS 2010 is 116 $MtCO_2$-eq (103 $MtCO_2$-eq with comparable measures) and for SERPEC adapted 122 $MtCO_2$-eq, which is in the same order of magnitude. However, GAINS assumes higher costs compared to SERPEC. Part of this can be explained by the use of different discount rates - GAINS calculates with private, not with social discount rate, and given that taxes do not play a role in this sector, this leads to higher abatement costs. However, it is also likely that GAINS assigns different costs to certain measures. According to GAINS 2010 no zero-cost measures are available and also the mitigation potential for cost band B (0-25 euro) is much lower compared to the SERPEC study. This results in a cost-effective mitigation potential of only 17 $MtCO_2$-eq, versus 50 $MtCO_2$-eq in the adapted SERPEC study. To explain this difference a more detailed comparison is needed, in order to check assumptions made on costing and calculated mitigation potentials.

Figure 3-43 Estimated technical mitigation potential of measures in agriculture based on the SERPEC and GAINS data.



Source: Calculations by Alterra based on SERPEC and GAINS data

Figure 3-44 Estimated technical mitigation potential in agriculture per cost class based on the SERPEC and GAINS data.



Source: Calculations by Alterra based on SERPEC and GAINS data

Although the estimated mitigation potentials are comparable, the SERPEC estimates are in general higher compared to most other studies. The SERPEC study applied EU-wide mitigation measures/technologies to all Member States. However, the selection and parameterization of these measures may not necessarily reflect regional conditions or practices sufficiently to enable robust estimates at the country level. The measures might not work in the same way for each Member State due to specific climatic and environmental conditions and agricultural practices applied in individual countries. This is a limitation with the EU average estimates in the methodology chosen for this study and in the SERPEC study. An approach based on bottom-up data that reflected the regional differences in agricultural practices may have delivered a different outcome. Whilst this type of data may be available for some of the Member States it is unlikely to be available for all. Also the diversity across Member States on polices and measures is large (see Figure 3-22) and this would indicate that there will exist major differences between Member States. Finally, more technologies than recognized in this study may be feasible regionally and worthwhile to consider in future assessment as they would reflect regional agricultural practices better.

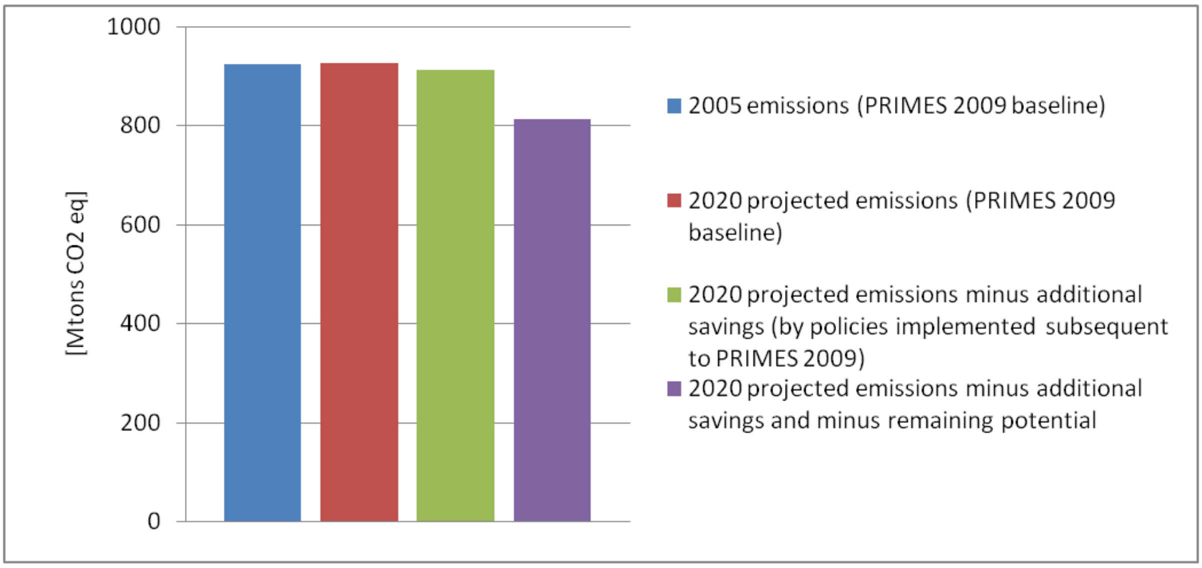
The possible overestimation of the cost-effective mitigation potential was also indicated by some Member States (Ireland and Finland) in feedback to our study. It was argued that the SERPEC data do not reflect their regional agricultural practices and as a result may overestimate the mitigation potential; this would be a direct consequence of using assumptions on e.g. fertilizer use, grazing practices, feed choice, manure management that will vary from region to region. For example, the mitigation potential of anaerobic manure digestion might be overestimated for Ireland, as cattle and dairy cows in Ireland spend more than half their time on pastures, which is more compared to the EU average. Therefore, the results are to be used with care and some of the mitigation potential assigned to the sector agriculture may be theoretical potential only as agricultural practices may prevent certain types of action.

3.3.5 Transport

Figure 3-45 illustrates the baseline emissions (based on the PRIMES/GAINS projections) and the CO_2 abatement potential for the transport sector (based on the SERPEC study). Overall, the sector has an estimated technical abatement potential of 100 $MtCO_2$ eq by 2020. The take up of this full potential would reduce the absolute emissions from the sector, within the scope of the ESD, to 813 $MtCO_2$ eq. by 2020. This represents a 12% reduction in the 2005 emission level.

The figure also shows the potential influence of policies introduced subsequent the 2009 PRIMES/GAINS analysis. In this case the proposed limits on CO_2 emissions from vans are expected to reduce emissions from the transport sector by about 14 MCO_2 eq by 2020. This would take up a proportion of the abatement potential from the sector, hence the estimated potential remaining in 2020 has been reduced accordingly.

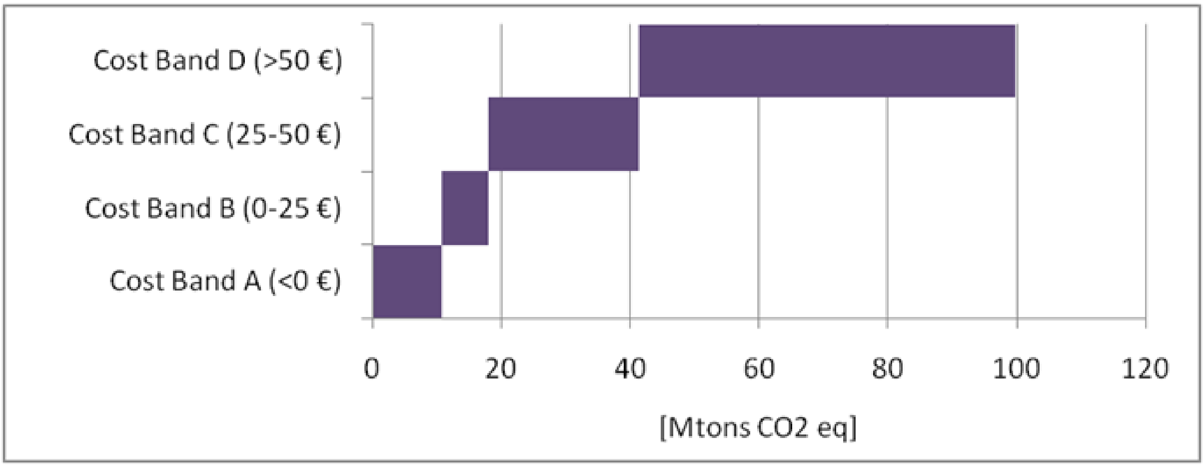
Figure 3-45: Emissions and abatement potential in the transport sector



Source: Calculations by Ecofys based on SERPEC data

The distribution of the remaining abatement potential within each of the costs bands in shown in Figure 3-46 below. It is clear that for the transport sector, a large proportion of the abatement potential falls within the higher cost-bands. Specifically, only 11% (or 11 $MtCO_2$ eq) of the abatement potential is cost-effective without a carbon price. Around 7% (or 7 $MtCO_2$ eq) of the abatement potential can be realised at a carbon prices of €25/tCO_2 eq. Over 81% (or 81 $MtCO_2$ eq) of the abatement potential has a cost-effectiveness of >€25/tCO_2 eq.

Figure 3-46: Abatement potential and cost bands of the underlying options in the transport sector in the EU 27 in 2020. The abatement potential is relative to the baseline (PRIMES 2009 plus policies implemented subsequent to PRIMES until June 2010).



Source: Calculations by Ecofys based on SERPEC data

Further details on the types of abatement measures included within the analyses, and their relative cost, is shown in Table 3-17 below. The list of measures is based on the original SERPEC analysis, and has not been updated for this study. The original list focused on measures that would be able to deliver material emissions reductions by 2030 but should not be considered exhaustive. Additional abatement potential is available from technical measures not captured within the SERPEC assessment. This applies, in particular, to abatement measure for trucks (e.g. improved/alternative powertrains). The results should be viewed with this limitation in mind.

It is important to recognise that certain costs will vary between Member States (e.g. reflecting the nature of the vehicle stock and driving characteristics), and also within measure types (e.g. eco-driving may include a range of eco driving initiatives). Thus the cost bands presented represent averages on an EU level.

While the transport sector has abatement potential in all of the cost bands, it is clear the remaining technical potential in the lower cost bands is less. This may reflect the fact that there is less abatement potential in absolute terms from the low cost measures, or that a greater proposition of the low cost measures are likely be taken up in the baselines scenario – so the potential remaining in 2020 is less. Both of these explanations are plausible. In particular, it is notable that existing policies, such as the passenger car regulations, will require vehicle manufacturers to take up a number of the abatement options in order to decrease the average emission from vehicles in line with the regulations. Likewise, the Biofuels Directive, the Renewable Energy Directive and the Fuel Quality Directive will all drive the take up of biofuels, and therefore exhaust a large proportion of the abatement potential from this measure by 2020. Finally, Regulation (EC) No 661/2009 mandates the uptake of tyre pressure monitoring systems (TPMS), low rolling resistance tyres (LRRT) and gear shift indicators (which can support eco-driving techniques) in new passenger cars.

The impacts of these policies have already been taken into account in Figure 3-45. However, the overall trend in emissions shows only a small decline on the level of emissions in 2005. In other words, the existing policies are expected to temper the increase in emissions, but are not sufficient to deliver significant absolute reductions in emissions from this sector. To do so, would require the take up of more expensive technical measures, or the use of other abatement options (e.g. demand management). Alternatively, it might be more cost effective to deliver the overall ESD targets by abating emissions in other sectors.

The following table gives an overview of the measures in the 2020 abatement cost curve for the transport sector. This shows which cost bands each of the measures fall within, based on the average EU values. Individual measures may fall within a different cost band at a country level, due to different national circumstances. This explains why in the following table no measure is found in cost band B, however for the EU 27 presented in the figure above some potential is identified.

Table 3-17: List of measures in the 2020 abatement cost curve for the transport sector

Measure	Name	Cost band
Freight road (trucks)	Driver training	A
Passenger road cars diesel	Eco-driving	A
Passenger road cars petrol	Eco-driving	A
Passenger road cars diesel	Type pressure monitoring system (TMPS)	A
Passenger road cars petrol	Type pressure monitoring system (TMPS)	A
Passenger road cars diesel	Low rolling resistance Types (LRRT)	C
Passenger road cars petrol	Full hybrid	C
Passenger road cars diesel	Improved aerodynamics	C
Passenger road cars alternative fuels	Biofuels	C
Passenger road cars petrol	Low rolling resistance Types (LRRT)	D
Passenger road cars petrol	Improved aerodynamics	D

Passenger road cars diesel	Full hybrid	D
Freight road (trucks)	TMPS	D
Passenger road cars petrol	New powertrain + weight reduction	D
Passenger road cars diesel	New powertrain + weight reduction	D
Freight road (trucks)	Wide-based tires	D
Freight road (trucks)	Reduced idling (APU)	D
Freight road (trucks)	Improved aerodynamics	D
Passenger road cars alternative fuels	Electric cars	D

Source: SERPEC 2009b

The abatement potential can also be examined at a Member State level. While, as described above, the disaggregation of the cost estimates at the level of individual Member States will be more uncertain, it is interesting to examine the variation in potential across different countries. Figure 3-18 summarises the remaining abatement potential disaggregated by Member State in $MtCO_2$ eq.

Table 3-18: Remaining abatement potential and cost bands in the transport sector in 2020 by Member State in $MtCO_2$ eq:

Country	Remaining potential (sum of Cost Band A, B C and D)	Cost Band A (< 0 Euro)	Cost Band B (0-25 Euro)	Cost Band C (25-50 Euro)	Cost Band D (> 50 Euro)
EU 27	99,680	10,861	7,112	23,308	58,400
AUSTRIA	0	0	0	0	0
BELGIUM	0	0	0	0	0
BULGARIA	728	1	0	114	613
CYPRUS	0	0	0	0	0
CZECH REPUBLIC	1,301	0	0	0	1,301
DENMARK	257	0	64	45	148
ESTONIA	391	66	0	60	264
FINLAND	540	0	0	0	540
FRANCE	23,190	2,131	4,118	5,541	11,401
GERMANY	24,390	479	0	5,053	18,859
GREECE	2,785	1,272	0	1,289	224
HUNGARY	1,764	535	44	240	944
IRELAND	1,025	86	0	342	598
ITALY	5,638	0	0	0	5,638
LATVIA	560	192	0	76	292
LITHUANIA	849	319	0	146	384
LUXEMBOURG	0	0	0	0	0
MALTA	0	0	0	0	0
NETHERLANDS	4,234	383	415	1,182	2,255
POLAND	2,872	246	426	478	1,722
PORTUGAL	6,256	3,909	269	1,123	956
ROMANIA	2,320	211	14	397	1,698
SLOVAKIA	1,074	374	0	149	551
SLOVENIA	0	0	0	0	0
SPAIN	3,861	0	0	0	3,861
SWEDEN	1,803	0	366	352	1,085
UNITED KINGDOM	13,843	656	1,396	6,723	5,068

Source: Calculations by Ecofys based on SERPEC data

As you would expect, those Member States with some of the large absolute emissions from the transport sector (Germany, France, United Kingdom, France) also have the greatest overall abatement potential. However, it is notable that the remaining abatement potential does not reflect the size of the current emissions in a simple linear way. For example, the remaining abatement potential in Italy is estimated to be much smaller than in the United Kingdom, though current emissions are not too dissimilar. This variation can in part be explained by fact that the average efficiency of vehicles in Italy is currently lower than in the United Kingdom, therefore the relative savings from more efficient vehicles is smaller.

Other country specific circumstances are also important. For example, vehicle ownership levels, replacement rates for vehicles, and the proportion of vehicle purchases that are new cars will all be important factors, as will be the choice of vehicles (size, fuel type) and respective load factors. While the methodology that has been used to apportion EU wide savings to individual Member States has accounted for some of these factors, it has not been possible to make adjustments for all factors. This may in part explain why some Member States apparently have zero remaining abatement potential.

Clearly it is unrealistic that no further abatement potential (over and above existing policies) exists within those Member States with an apparent zero abatement potential. It is therefore likely that some of the assumptions that have been applied in the abatement cost analysis do no distinguish sufficiently between the conditions in specific Member States. Further limitations are associated with the use of the PRIMES projections as the basis for the emissions modelling. Changes in the energy consumption and activity statistics, between the 2007 and 2009 model versions, will further reduce the accuracy of the results. On this basis the results at Member State level should be treated as more uncertain than the results at an EU 27 level.

The balance of abatement potential between the cost-bands has a degree of consistency across all Member States. This is not unexpected since the abatement measures are equally applicable from one Member State to the next – though not to the same extent. However, there are some notable variations. For example, the relative importance of the €25 to €50 cost band is more important in the UK that in similar sized Member States. This variation may relate to the relative cost of the measures in different Member States. It is not clear if the apparent variation represents a true variation in the cost of the measures group, or simply a small variation which shifts a technology from one cost band to the next in a Member State. This latter case may reflect, for example, different fuel price assumptions.

To provide some further confidence in the overall results, a high level comparison has been carried out with the results from other studies (see Table 3-19 below). The results are not directly comparable with those presented; there may be differences in scope, in baseline assumptions (e.g. efficiencies, autonomous improvements, etc.), in timescale, in policy impacts. However, the comparison is still useful to check the overall order of estimated savings.

Table 3-19: Comparison of results with other studies

	Abatement potential ($MtCO_2$)			
Country	**Current study (based on SERPEC 2009)**	**Alternative estimate**	**Comment**	**Source of alternative estimate**
EU 27	3% of baseline emissions for trucks	5% of baseline emissions for heavy duty vehicles	Sectoral definitions are not directly comparable. The PRIMES definition of trucks used in the current analysis is assumed to represent a larger component of the total baseline emissions	AEA (2011)
United Kingdom	13.8	8.5 (excluding biofuels, and conventional efficiency improvements in cars and vans)	CCC report has different baseline assumptions. Total abatement for the transport sector is 25.6 $MtCO_2$ in 2020, but has been revised down here to account for savings from biofuels and conventional efficiency improvement in cars	Committee on Climate Change (CCC) 2010

			and vans. The estimate is therefore comparable[47] with the current study.	
Germany	24.4 (of which 0.5 with costs < 25€/tCO_2)	33 (of which 10 with costs < 20€/tCO_2)	Scope of McKinsey report is Germany. Total abatement potential of 37 MtCO_2 revised down here to account for savings from rail and aviation, which are not covered in the current study.	McKinsey (2007)
Netherlands	4.2	5-12	Differences might be result of different assumptions regarding autonomous improvements (In SERPEC large potential is covered by autonomous improvements (about 4.5 MtCO_2)	ECN, Option document and Monitweb (2008)
Czech Republic	1.3	2.5 (of which 1.1 with costs < 25€/tCO_2)	Abatement potential in 2030	McKinsey (2008)
Sweden	1.8 (of which 0.4 with costs < 25€/tCO_2; 0.7 with costs < 50€/tCO_2)	1.1 (with costs < 50€/tCO_2)		McKinsey (2008a)
Poland	2.9 (of which 0.7 with costs < 25€/tCO_2)	17 (with costs < 80€/tCO_2)	Abatement potential in 2030	McKinsey (2009)

In the transport sector the estimated abatement potential in the current analysis shows less consistency with Member States own estimates than in some of the other sectors, but in most cases is still broadly comparable. In part any discrepancy may relate to generic differences in the methodologies e.g. impacts of existing policies, impacts of the economic recession, which can have a major impact on the overall results. However, these discrepancies can also be related to the approach that has been applied. In particular, the original SERPEC analysis used EU wide assumptions on vehicle efficiency which may not be representative of the conditions in all Member States. In addition, the abatement potential was assessed relative to the activities and emissions represented in the PRIMES model. Difference between the representation of the transport sector in the PRIMES projections and those in the Member State level analysis (for example with respect to load factors, and stock replacement rates) can also explain this discrepancy. Since the transport sector is more dynamic and responsive to economic conditions that certain other sectors, it is perhaps not surprising that these issues are more notable in this sector.

One estimate worth further examination is the estimate by AEA (2011) on the abatement potential from heavy duty vehicles (HDVs). This sub-sector is potentially important for the delivery of targets under the ESD, as HDVs are not yet subject to the same regulatory limits on the CO2 emissions performance of vehicles as passenger cars and light duty vehicles. Whilst there are some key differences between the updated SERPEC analysis presented in this report and the AEA (2011) study[48], the results are broadly comparable – but do suggest that the SERPEC estimates may slightly underestimate the total abatement potential from this sub-sector

[47] Note the CCC estimate include 8% penetration of biofuels compared to 6.5% assumed in PRIMES 2009.
[48] In particular the AEA analysis includes a wider range of abatement technologies

3.3.6 Building sector

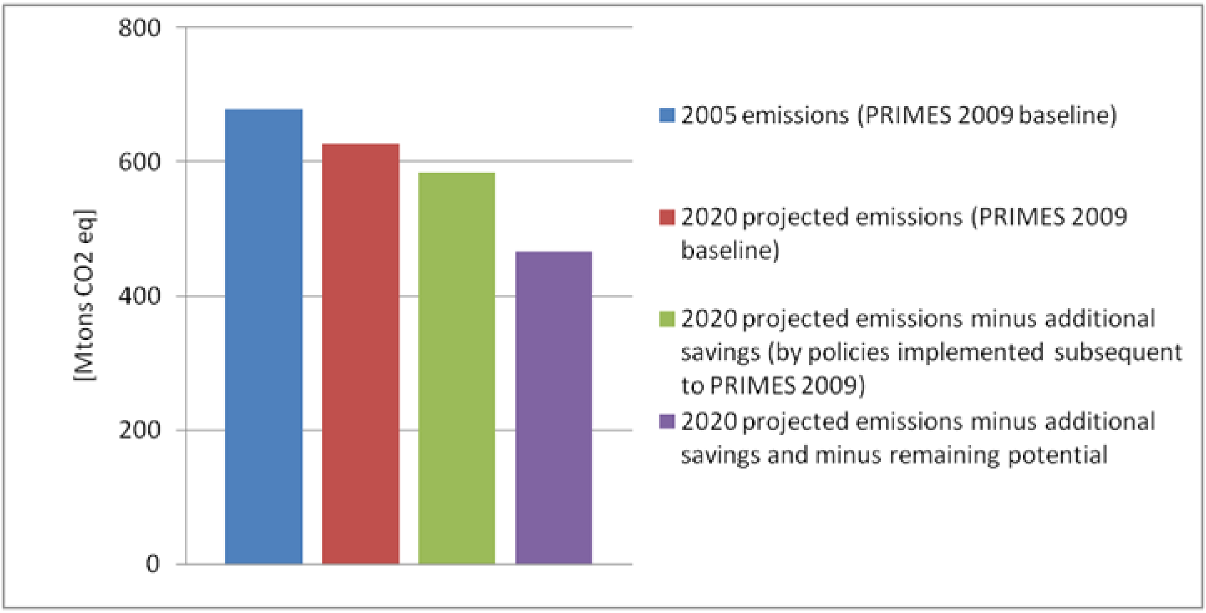
3.3.6.1 Results

Developments in the building sector are in general quite slow. This is caused by long renovation cycles of approximately 30-40 years. This means that a building that has been built new or has been renovated will not undergo major changes or improvements during this timeframe.

This can lead to significant lock-in effects, if energy efficiency measures are not applied at all or are realized at a too low ambition level. At the same time it becomes obvious that new buildings or renovation of buildings need to be carried out practically as from today, but the latest from 2020 on, at an ambition level which is desired for these buildings in 2050.

Figure 3-47 illustrates the baseline emissions and the CO_2 abatement potential for the built environment as identified in this study (residential and non-residential sector together). The building sector has a significant remaining abatement potential. The projected direct emissions of 584 $MtCO_2$ eq in 2020 (626 $MtCO_2$ eq projected by PRIMES 2009 reduced by 42 $MtCO_2$ eq through additional policies implemented subsequent to PRIMES 2009 until June 2010) can be further reduced by 118 $MtCO_2$ eq and bring down the baseline emissions to 466 $MtCO_2$ eq (further 20% reduction). 88 $MtCO_2$ eq which corresponds to 75% of this remaining abatement potential is cost-effective at a carbon price of <€25/tCO_2 eq, thereof 84 $MtCO_2$ eq of this remaining abatement potential at a carbon price of <€0/tCO_2 eq. Please note that emissions and possible savings related to the use of electricity are not part of the effort sharing decision (but part of the EU ETS) and are therefore not included in above mentioned numbers.

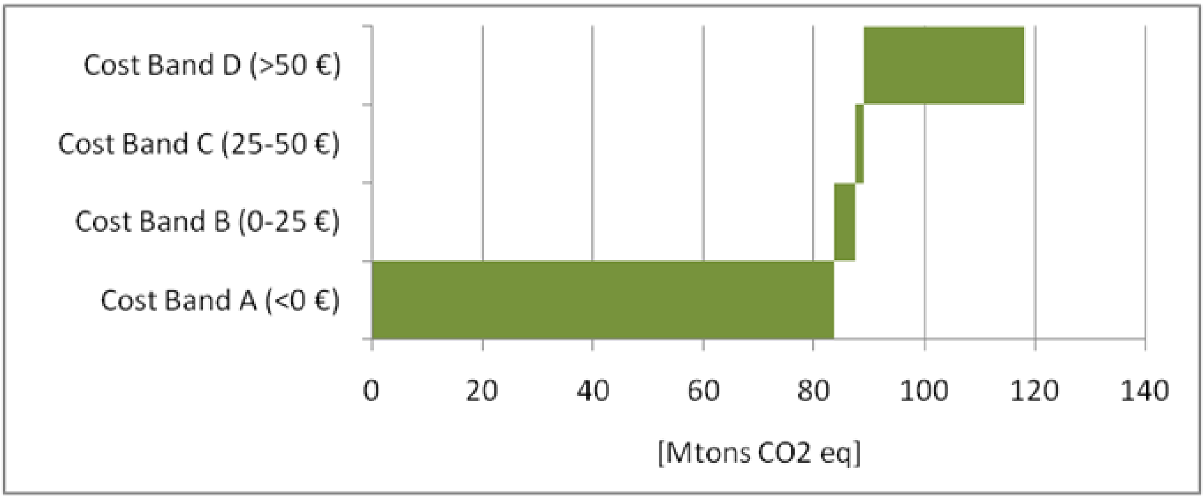
Figure 3-47: Emissions and abatement potential in the building sector



Source: Calculations by Ecofys on base of the SERPEC data

The overall cost curves for the built environment sector in 2020 in the EU 27 are shown in Figure 3-48. Note, that the cost-curve is sensitive to the energy price assumptions and the discount rate used (see chapter 3.3.3). Here, the so-called social cost perspective was chosen, where investment costs are annualised over the technical lifetime of the measure using a discount rate of 4% and energy savings are calculated against energy prices before taxation. Under these scenario conditions, a very large share of the abatement potential can be achieved at negative costs, i.e. with net economic savings.

Figure 3-48: Abatement potential and cost bands of the underlying options in the building sector in the EU 27 (residential and non-residential) in 2020.The abatement potential is relative to the baseline (PRIMES 2009 plus policies implemented subsequent to PRIMES until June 2010).



Source: Calculations by Ecofys based on SERPEC data

Error! Reference source not found. summarizes the data disaggregated at a Member State level. In the building sector about 75% of the remaining abatement potential is cost-effective. Most of the remaining abatement potential in the building sector lies in the existing building stock and therefore can be realised by suitable renovation measures. The most cost-effective measures are related to the improvement of the building shell in terms of insulation and to the replacement of heating systems by more efficient ones. Further details on the types of abatement measures included within the analyses, and their relative cost, is shown in Table 3-21.

Table 3-20: Abatement potential and cost bands of the underlying options in the building sector in the EU 27 in 2020 in ktCO$_2$ eq

Country	Remaining potential	Cost Band A (< 0 Euro)	Cost Band B (0-25 Euro)	Cost Band C (25-50 Euro)	Cost band D (> 50 Euro)
EU 27	118,064	83,716	3,649	1,624	29,076
AUSTRIA	1,464	899	14	5	546
BELGIUM	6,399	5,256	216	12	916
BULGARIA	750	551	10	13	176
CYPRUS	147	68	5	7	67
CZECH REPUBLIC	2,264	1,615	108	8	532
DENMARK	818	238	7	0	573
ESTONIA	43	20	1	0	22
FINLAND	788	382	46	23	337
FRANCE	15,219	10,071	162	477	4,510
GERMANY	23,210	16,300	166	682	6,062
GREECE	2,046	1,405	150	15	477
HUNGARY	1,192	665	48	3	477
IRELAND	2,829	2,290	16	74	450
ITALY	12,145	8,007	1,107	73	2,959
LATVIA	360	292	6	2	60
LITHUANIA	497	397	9	2	88
LUXEMBOURG	214	172	1	0	40
MALTA	47	25	1	7	14
NETHERLANDS	6,906	5,240	44	16	1,606
POLAND[1]	10,703	8,574	73	21	2,035
PORTUGAL	1,009	245	105	49	609
ROMANIA	297	0	0	0	297
SLOVAKIA	437	287	18	1	131

SLOVENIA	192	106	2	6	78
SPAIN	10,941	8,333	776	87	1,745
SWEDEN	0	0	0	0	0
UNITED KINGDOM	17,145	12,278	559	41	4,267

There have been significant policy developments in recent years for the building sector, for example the recast of the Energy Performance Building Directive (Directive 2010/31/EU). This means that a significant part of the identified potential in the original SERPEC analysis is assumed will be delivered by current policy.

For some countries the calculation results in very low or even zero remaining abatement potential in the building sector (Estonia, Romania, Sweden). This results from the fact that the new PRIMES business as usual scenario already assumes in these countries savings in the order of magnitude of the saving potentials derived from SEREPC. This seems reasonable for Sweden, where the potential derived from SERPEC was already low due to a high share of district heat and electricity which are not covered by the ESD and with its already well established building standards. For Estonia and Romania this result does not match with expectations and from an expert view it can be assumed that there is still remaining potential to be covered by additional or improved policies[49].

The countries with most abatement potential are France, Germany, Italy, UK, Poland and Spain (about 75% of the remaining potential in the European Union). The remaining potential did not account structural or behavioural changes that could lead to further savings. Due to the limitations of the approach the figures should be considered as indicators for areas of action. A key action to unlock the remaining cost effective abatement potentials of the building stock is deep renovation (i.e., a high retrofit rate combined with high ambition level of the measures applied).

Table 3-21 gives an overview of the measures in the 2020 abatement cost curve for the building sector. This shows which cost bands each of the measures fall within, based on the average EU values. Individual measures may fall within a different cost band at a country level, due to different national circumstances.

Table 3-21: List of measures in the 2020 abatement cost curve for the building sector (the table represents the EU average, the cost of the measures vary within the Member State)

Measure	Cost band			
	Retrofit		New building	
	Small building	Large building	Small building	Large building
Improving building shell: wall insulation	A	A	Not investigated	
Improving building shell: roof insulation	A	A		
Improving building shell: ground floor	A	A		
Improving building shell: windows	A	A		
Improved regulation & heat distribution	A	A		A
Heating: Condensing boilers	A	A		
Efficient tap water	A	A	A	A
Passive Houses/zero energy houses	Not investigated		B	C
Heating: Biomass (Pellets etc.)	C	A	D	B
Heat pumps	D	A	D	A
Solar water heater	D		D	
Micro CHP	D	D	D	D
Ventilation system with heat recovery			D	D

Source: SERPEC 2009e

To provide some further confidence in the overall results, a high level comparison has been carried out with the results from other studies (see Table 3-22). The results are not directly comparable with those presented; there may be differences in scope, in baseline assumptions (e.g. efficiencies,

49 A possible explanation for this anomalous results in these Member States is a change in the energy statistics, or sector definitions, between the PRIMES modelling that was used in the SERPEC study, and the current PRIMES modelling.

autonomous improvements, etc.), in timescale and in policy impacts. To enable a more consistent comparison the alternative estimates whenever referring to both, indirect and direct emissions have been corrected by indirect emissions to make the results more comparable to those presented in this study. This comparison is useful to check the overall order of estimated savings.

Table 3-22: Comparison of results with other studies

Country	Abatement potential ($MtCO_2$)			Comment	Source
	ESD (based on SERPEC 2009)	Alternative estimate	Alternative estimate, only direct emissions[1]		
Germany	23 (of which 16 with costs < 25€/tCO_2)	72 (of which 63 with costs < 20€/tCO_2)	52 (of which 45 with costs < 20€/tCO_2)	Indirect emissions included, effects of recession not included	McKinsey (2007)
Czech republic	2.3	4.4		Abatement potential in 2030	McKinsey (2008)
Sweden	0	0.2 with costs < 50€/tCO_2)	0.05 with costs < 50€/tCO_2)	Indirect emissions included	McKinsey (2008a)
United Kingdom	17 (of which12 with costs < 25€/tCO_2)	33	24	Abatement potential in 2030, effects of recession not included	CBI 2007
Poland	11 (of which 9 with costs < 25€/tCO_2)	44 (with costs < 80€/tCO_2)	33 (with costs < 80€/tCO_2)	Abatement potential of indirect and direct emissions in 2030	McKinsey (2009)

[1] The indirect emissions have been subtracted from the alternative estimates based on fuel mixes and emission factors from PRIMES.

A number of the estimates provide broadly comparable results, which presents some further confidence in the current results. However, difference in assumptions e.g. impacts of existing policies, impacts of the economic recession and in scope (direct and indirect emissions) can have a major impact on the overall results. This may explain the differences in the apparent abatement potential with some studies. However, it has not been possible to test this further.

3.3.7 Waste

For waste, the 2010 baseline is significantly below the SERPEC baseline. Given the scale of emission reductions being delivered by current policies in this sector, in particular the Landfill Directive, it was assumed that no further abatement potential is available from the measures outlined in the previous SERPEC analysis. This effectively assumes that the abatement measures identified in the previous analysis will be exhausted in order to meet the requirements of current policies. This is a conservative approach, and is to some extent a consequence of the simplified approach that has been used to update the SERPEC results.

Further confidence in the results can be drawn from comparisons with alternative sources. The following table gives an overview of the abatement potential calculated in other studies. The results are not fully consistent with those presented; there may be differences in scope, in baseline assumptions (e.g. efficiencies, autonomous improvements, etc.), in timescale, in policy impacts. However, the comparison is still useful to check the overall order of estimated savings.

Table 3-23: Comparison of results with other studies

	Abatement potential ($MtCO_2$)			
Country	**ESD (based on SERPEC 2009)**	**Alternative estimate**	**Comment**	**Source**
Germany	0	0	McKinsey report makes the same assumption as ESD study: all potential abatement in the waste sector is implemented autonomously before 2020	
EU 27	0	14.5 (with cost less than 100€/tCO_2	This includes abatement from waste water treatment	Höglund-Isaksson et al, (2010)
Czech republic	0	0.3 (of which 0.1 with costs < 25€/tCO_2)		McKinsey (2008)
Sweden	0	0.1		McKinsey (2008a)
Poland	0	11 (with costs < 80€/tCO_2)	Abatement potential in 2030	McKinsey (2009)

A number of the estimates provide comparable results, with little additional potential from the sector foreseen. However, differences in assumptions e.g. impacts of existing policies, impacts of the economic recession, can have a major impact on the overall results.

One study worth further examination is Höglund-Isaksson et al (2010) which suggests that some further abatement potential may be available within the waste sector. More specifically, the control of solid waste from the food sector (anaerobic digestion with biogas recovery) and further control of food in municipal solid waste, were the two main options identified. Potential savings from these measures might amount to around 7 $MtCO_2$ eq in 2020[50].

It is also notable that the Höglund-Isaksson et al analysis, identified some further abatement that could be delivered by alternative treatment of waste water. Savings from these measures could be of a similar order as the savings from solid waste. The scope of the SERPEC analysis did not include waste water measures, and therefore these measures can be considered additional. They also explain part of the discrepancy with the SERPEC estimates.

Taken together the comparison with alternative estimates would suggest that whilst the assumption that a large proportion of the abatement potential from the waste sector will be taken up by existing policies is valid, the SERPEC results may underestimate the overall potential from the sector (assuming an expanded sector definition to include waste water treatment).

3.3.8 Industry

Figure 3-47 illustrates the baseline emissions (based on the PRIMES/GAINS projections) and the CO_2 abatement potential for the industry sector (based on the SERPEC study), both are limited to the share of industry estimated to be within the scope of the ESD.

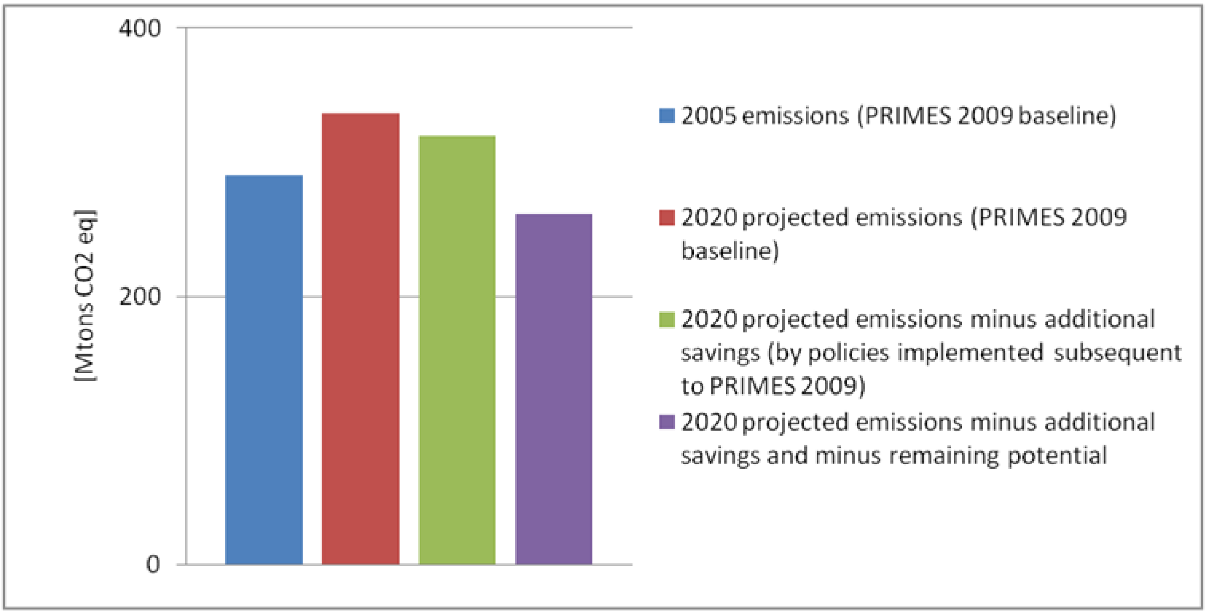
The figure also shows the potential influence of policies introduced subsequent the 2009 PRIMES/GAINS analysis. In this case the some national financial subsidy schemes directed towards small industries and impacts of the recast EPBD on industrial buildings which are not yet considered in the PRIMES 2009 baseline are expected to reduce emissions from the industry sector by about 17

[50] Estimated on the basis of the information in the report by Höglund-Isaksson et al (2010). This assumes that savings from solid waste are approximately half of the identified abatement potential in 2020.

MCO_2 eq by 2020. This takes up a proportion of the originally abatement potential from the sector, hence the estimated potential remaining in 2020 has been reduced accordingly.

Overall, the sector has an estimated technical abatement potential of 57 $MtCO_2$ eq by 2020. The take up of this full potential would reduce the absolute emissions from the sector, within the scope of the ESD, to 262 $MtCO_2$ eq. by 2020.

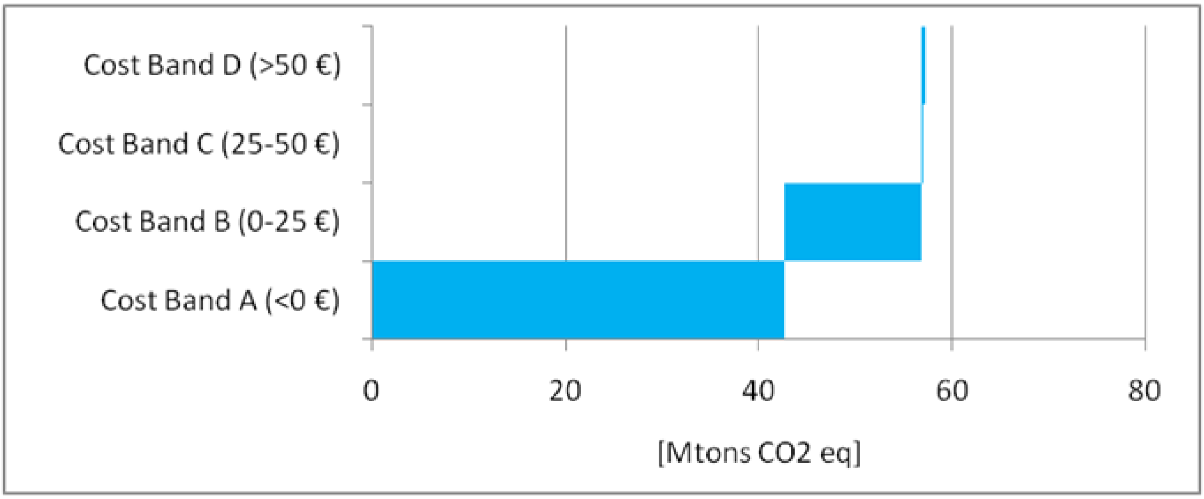
Figure 3-49: Emissions and abatement potential in the industry sector



The overall cost curves for the industry sector in 2020 in the EU 27 are shown in Figure 3-48. Under these scenario conditions, a very large share of the abatement potential can be achieved at negative costs that is with net economic savings. At a carbon price of €25/tCO_2 measures in cost band B can also be considered cost-effective., which captures almost all of the abatement potential.

Note, that the cost-curve is sensitive to the energy price assumptions and the discount rate used (see chapter 3.3.3). Here, the so-called social cost perspective was chosen, where investment costs are annualised over the technical lifetime of the measure using a discount rate of 4% and energy savings are calculated against energy prices before taxation. The absolute level of abatement is also sensitive to the assumptions with respect to the proportion of emissions from the industry sector that are assumed to fall within the scope of the ESD. As described in Section 3.1.1, this estimate is more uncertain for the industry sector than for other sectors.

Figure 3-50: Abatement potential and cost bands of the underlying options in the industry sector covered by the ESD in the EU 27 in 2020. The abatement potential is relative to the baseline (PRIMES 2009 plus policies implemented subsequent to PRIMES until June 2010).



Source: Calculations by Fraunhofer Institute, in part based on SERPEC data with additional information on the split on ETS/ESD from Fraunhofer (2009)

Table 3-24 summarizes the data disaggregated on Member State level. On average for the EU27 the remaining technical potential (most of which is economic or "near economic") is about 17%. For individual Member States the potentials reach up to 33%. These potentials may appear high but it has to be recalled that these are not the very energy-intensive large industrial processes which have more limited potentials (generally not exceeding 10-15%).

In the industry sector cost effective measures are essentially energy efficiency measures for industries outside the EU ETS (retrofit of existing processes and new processes), improved industrial boilers for steam raising and hot water, energy efficient industrial ovens and dryers, retrofit of industrial buildings (some industries under the ESD have space heating shares of up to 50%), fuel switch including to waste-fuels and renewables, more efficient waste heat use, especially at lower temperature waste heat and combined heat power generation (CHP) in production facilities.

The high share of space heating and cross-cutting industrial technologies such as steam raising or hot water preparation explains the comparatively high potential. The example shown in Figure 3-51 from the dena energy efficiency award where nearly 100% of the thermal energy for heating of the production facilities was saved due to an intelligent use of the heat generated from the production machine. The winner from the same competition in 2010 "only" saved 44% on its energy. Centralising heat recovery was the central part of the savings; the aim was to make use of any waste heat streams in an integrated energy network[51].

There are a variety of countries which appear to have no further potential left such as as Belgium, Bulgaria, Finland, Hungary, Poland, Romania and Slovakia. It is unlikely that those countries do not have any potential left in practice. Most likely this outcome is a consequence of the method that has been used for correcting the potentials, together with some unexplained large differences between the PRIMES 2009 and 2007 baselines which cannot be solely linked to the impact of the economic crisis. It has not been possible to fully resolve these issues in the current project, which would require re-running the original full-scaled modelling approach. Given these methodological limitations, the results at the level of individual Member States should be treated with come caution.

[51] http://www.industrie-energieeffizienz.de/fileadmin/InitiativeEnergieEffizienz/referenzprojekte/downloads/EEA/EEA10/IEE_EB_EEA2010_Viessmann_engl_RZ_04.pdf

Table 3-24: Abatement potential and cost bands of the underlying options in the industry sector in the EU 27 in 2020 in ktCO$_2$ eq.

	Remaining potential (sum of Cost band A, B C and D)	Cost Band A (< 0 Euro)	Cost Band B (0-25 Euro)	Cost Band C (25-50 Euro)	Cost band D (> 50 Euro)
EU 27	57,289	39,920	16,908	55	406
AUSTRIA	3,332	2,592	710	8	22
BELGIUM	0	0	0	0	0
BULGARIA	0	0	0	0	0
CYPRUS	40	32	7	0	0
CZECH REPUBLIC	2,353	1,999	332	3	19
DENMARK	1,186	638	547	1	0
ESTONIA	308	275	32	0	2
FINLAND	0	0	0	0	0
FRANCE	5,094	3,530	1,551	5	9
GERMANY	8,377	8,190	185	1	2
GREECE	1,221	1,113	106	0	1
HUNGARY	0	0	0	0	0
IRELAND	201	197	3	0	0
ITALY	2,713	2,077	612	1	24
LATVIA	85	73	12	0	0
LITHUANIA	3	3	0	0	0
LUXEMBOURG	342	264	76	0	2
MALTA	10	10	0	0	0
NETHERLANDS	3,631	2,115	1,510	2	5
POLAND	0	0	0	0	0
PORTUGAL	568	418	124	1	25
ROMANIA	0	0	0	0	0
SLOVAKIA	0	0	0	0	0
SLOVENIA	275	186	86	0	3
SPAIN	12,651	9,744	2,874	12	21
SWEDEN	1,944	1,197	487	5	255
UNITED KINGDOM	12,954	8,026	4,899	16	13

Source: Calculations by Fraunhofer Institute, in part based on SERPEC data with additional information on the split on ETS/ESD from Fraunhofer (2009)

Figure 3-51: Savings achieved by the 1st Award of the dena Energy Efficiency Award 2009 in Germany (ebm-papst Mulfingen GmbH & Co. KG – construction of new energy-efficient production plant in Hollenbach)

Figures that speak for themselves.
(heating, cooling and ventilating system)

	New constructions with waste heat recovery	New constructions without waste heat recovery[2]	Savings through waste heat recovery
Energy costs[1]	€7,728	€95,213	€87,485
Power consumption	67,750 kWh/year	83,300 kWh/year	15,550 kWh/year
Thermal energy consumption	2,400 kWh/year	750,000 kWh/year	747,600 kWh/year
CO_2 emissions[3]	43 t/year	340 t/year	297 t/year
Investment	€1,000,000	€940,000	Additional costs from waste heat recovery €60,000

Annual energy cost savings[1]	**€87,485**
Energy savings (total)	91%
Electricity savings	19%
Savings on thermal energy	99%
Return on investment[4]	146%

[1] Fuel oil price of €84.40 per 100 l and electricity price of € 0.11 kWh
[2] Estimate based on a simulation, calculated according to the heat energy requirement of the building
[3] Factors were determined according to GEMIS: Electricity: 621.6 gCO_2 per kWh; fuel oil: 385.1 gCO_2 per kWh
[4] Return on investment of additional investment in energy efficient measures

Energy efficiency measures:
* Waste heat recovery from work machines.
* Optimised heat distribution.
* Use of a heat pump with a coefficient of performance greater than 4.
* Displacement ventilation via source air outlets.
* Optimal dimensioning of the piping.
* Use of heating and cooling water pumps with energy efficiency class A.
* Use of energy-saving EC fans.
* Use of a 153-kWp photovoltaic system.

Source: dena (2009)
http://www.industrie-energieeffizienz.de/energy-efficiency-award/energy-efficiency-award-2009-english/1st-prize-ebm-papst-mulfingen-gmbh-co-kg.html

Table 3-25 gives an overview of the main groups of measures in the 2020 abatement cost curve for the industry sector that were investigated in SERPEC and which are relevant for ESD industries. This shows which cost bands each of the measures fall within, based on the average EU values. Individual measures may fall within a different cost band at a country level, due to different national circumstances. Below these groups are a larger number of individual saving measures which cannot be shown in detail here.

Table 3-25: List of measures in the 2020 abatement cost curve for the industry sector (the table represents the EU average, the cost of the measures vary within the Member State)

Measure	Cost band
Industry: New BAT installations	A/C
Industry: energy efficiency (retrofit)	A
CHP: chemicals and refineries	B
CHP: other industry	D

To provide some further confidence in the overall results, a high level comparison has been carried out with the results from three other studies (see Table 3-26). The results are not directly comparable with those presented; there may be differences in scope, in baseline assumptions (e.g. efficiencies, autonomous improvements, etc.), in timescale, in policy impacts. However, the comparison is still useful to check the overall order of estimated savings. The estimates from the three studies provide broadly comparable results, which presents some further confidence in the current results.

Table 3-26: Comparison of results with other studies

	Abatement potential [$MtCO_2$]			
Country	**ESD (based on SERPEC 2009)**	**Alternative estimate**	**Comment**	**Source**
Germany	8.4	8 (of which 5 related to buildings and heating system, 3 to processes outside the ETS)	Overall industrial potential is 41 Mt CO_2eq incl ETS and CO_2-emissions from electricity savings	McKinsey (2007)[52]
United Kingdom	13	12	Includes all emissions from the industry sector, so includes ETS emissions. Abatement options include renewable heat. Estimate for energy efficiency measures is regarded as a lower bound given that existing emissions reduction models do not include the full range of abatement options for industry.	Committee on climate change (2010)
Czech republic	2.4	1.3-2.7	Abatement potential in 2030	McKinsey (2008)

3.3.9 Other sources

Certain other emissions sources will fall within the scope of the ESD, but are not captured in the sectors described above. These include fugitive emissions from the oil and gas sector, and coal mining sector. The emissions and abatement potential from the sectors have not been examined in detail in this current study[53]. However, previous studies have examined the abatement potential that might be available from these other source, and the results are repeated below.

Hoeglund Isaakson et al (2010) included these sectors in their assessment of the abatement potential from non-CO_2 greenhouse gases. Whilst the results are not directly comparable with those provided for the other sectors above, for example they are based upon the abatement potential in 2030, they are indicative of the level of abatement from these sub-sectors.

Table 3-27: Abatement potential associated with fugitive emissions from the oil and gas, and coal mining sectors.

Activity	Measure	Abatement potential in 2030 ($MtCO_2$ eq)
Long-distance natural gas transmission	Reduced leakage at compressor stations	17.5
Production of natural gas and oil	Extended flaring instead of venting	3.0
Oil refinery	Extended flaring instead of venting	0.2
Mining of brown coal/lignite	Extended mine gas recovery, upgrading and utilization	2.8
Natural gas distribution	Doubling of leak control frequency of gas distribution network	1.5
Natural gas distribution	Replacement of grey cast iron gas distribution	2.7

[52] http://www.mckinsey.at/html/presse/2007/20070925_treibhausgasemissionen.asp
[53] Although emissions from these sector are estimated to represent <8% of the total ESD emissions

3.3.10 Key findings from sector level analysis

The following headline conclusions can be drawn from the sector level analysis

- Most of the abatement potential from the buildings and industry sectors is realised with negative costs. The majority of the abatement potential in the agriculture sector is realised at a cost band <€25/tCO_2 eq. The remaining abatement potential in the transport sector is mostly at a cost >€25/tCO_2 eq. Thus each of the sectors might be expected to make a differential contribution to the overall target.
- The building and industry sector has largest potential in cost band A (< 0 Euro/tCO2)
- The agriculture sector has significant abatement potential in cost band B (0-25 Euro/tCO2) and in several of the Member State has the largest or the second largest cost-effective remaining potential.
- Measures in the transport sector are generally more expensive (remaining potential in cost band D >50 Euro/tCO2).

3.3.11 Member States

The remaining abatement potential has also been examined at a Member State level. For each Member State it is interesting to know how much of the remaining abatement potential is cost effective. The following table shows the cost-effective abatement potential at a carbon price of €25/tCO_2 eq., and the share of the remaining cost effective abatement potential from each sector. The dark blue coloured cells indicate sectors with the most or the second most share of the cost-effective remaining abatement potential. The cost effective potential is country specific, the percentage score reflects the distribution of abatement potential in the respective Member States.

Table 3-28: Share of remaining cost-effective abatement potential in each sector by Member State

Member state	Total remaining cost effective potential [MtCO2 eq]	Share of cost-effective potential (Cost band A and B) per sector [%]				
		Building	Transport	Agriculture	Industry	Waste
AUSTRIA	5,066	18%	0%	17%	65%	0%
BELGIUM	7,785	70%	0%	30%	0%	0%
BULGARIA	957	59%	0%	41%	0%	0%
CYPRUS	131	56%	0%	14%	30%	0%
CZECH REPUBLIC	4,955	35%	0%	18%	47%	0%
DENMARK	4,287	6%	1%	65%	28%	0%
ESTONIA	487	4%	14%	19%	63%	0%
FINLAND	945	45%	0%	55%	0%	0%
FRANCE	30,072	34%	21%	28%	17%	0%
GERMANY	32,694	50%	1%	23%	26%	0%
GREECE	4,434	35%	29%	9%	27%	0%
HUNGARY	2,232	32%	26%	42%	0%	0%
IRELAND	4,757	48%	2%	46%	4%	0%
ITALY	14,889	61%	0%	21%	18%	0%
LATVIA	690	43%	28%	17%	12%	0%
LITHUANIA	1,108	37%	29%	34%	0%	0%
LUXEMBOURG	575	30%	0%	11%	59%	0%
MALTA	40	65%	0%	10%	25%	0%
NETHERLANDS	13,624	39%	6%	29%	27%	0%
POLAND	12,987	67%	5%	28%	0%	0%
PORTUGAL	5,405	6%	77%	6%	10%	0%
ROMANIA	1,725	0%	13%	87%	0%	0%
SLOVAKIA	1,022	30%	37%	34%	0%	0%

SLOVENIA	538	20%	0%	29%	51%	0%
SPAIN	25,599	36%	0%	15%	49%	0%
SWEDEN	2,717	0%	13%	25%	62%	0%
UNITED KINGDOM	32,696	39%	6%	15%	40%	0%

The different distribution across the Member States is in part due to the structures of the sectors, but also the national policy framework. . In the building sector the potential variation can also be related heating degree days (climate), standards (thermal performance of buildings) and different mix of heating systems. In the transport sector, the mix of transport modes, the vehicle ownership levels and the preference for different vehicle types are all important, as are the assumed load factor. In the industry sector the balance of different types of industry activities is important, and the presence of existing national policies. Climatic and market factors help explain the variation in the agriculture sector.

3.3.12 Key findings from Member State level analysis

- Projections based on PRIMES and GAINS baselines predict that only 10 of the EU-27 Member States will meet or exceed their requirement under the ESD, with domestic actions alone. Furthermore, PRIMES and GAINS projections show nine Member States with a policy gap of over 10% (i.e. 10% further reduction between 2005 and 2020 is required under the ESD than is projected).
- Considering the PRIMES 2009 projection and including additional policies implemented subsequent to PRIMES baseline, 16 Member State still have a policy gap (and 11 Member States do not). Taking into account the cost-effective potential (at a carbon price of €25/tCO_2 eq.) 7 more Member States can close the policy gap. Taking into account all remaining potential (also not cost-effective), 4 more Member States can close the policy gap and therefore 5 Member States cannot close the policy gap even if all of the remaining technical abatement potential was taken up.
- In terms of the relative share of the cost-effective abatement potential at a Member State level, 20 of the Member States have the most or second most share of cost-effective remaining abatement potential in the building sector, 16 in the agriculture, 13 in the industry and just five in the transport sector

3.4 Preparedness, capacity and performance

A high level of preparedness is important for all Member States irrespective of whether they are going to meet their ESD targets. The flexibility provisions associated with the Decision mean that emissions associated with overachievement have an economic value. Therefore, good preparation would help to ensure that targets are met at least cost (in those Member States which may struggle to deliver their targets) and that potential returns from flexibility provisions are maximized (in those Member States that may deliver their targets more easily). Furthermore, since a proportion of the abatement potential can be delivered at a negative net cost, introduction of these abatement measures has an economic justification in its own right.

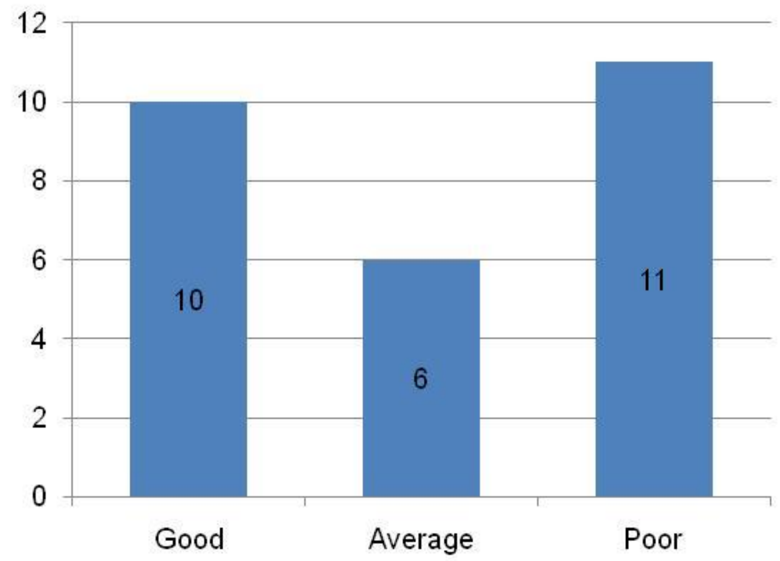
When evaluating the preparedness and capacity of Member States to meet their ESD targets, we based our analysis on the documents listed in section 2.5. Using both quantitative and qualitative information each Member State was scored and an overall rating of Good, Average or Poor was allocated. It is important to note that this scoring reflects a ‘snap-shot’ of the information that was available at the time of the review, and required a degree of subjective judgment. The overall scores should therefore (assuming that preparedness improves over time) represent a worst case estimate of the level of preparedness amongst Member States.

More generally, the specific scores that have been allocated should not be given too much importance. The real value from the analysis is an improved understanding of the level of preparedness and capacity across the EU as a whole. While an understanding of which Member States are well prepared and less well prepared is useful, what is more useful is sharing practical experiences, so that all Member State can learn from those Member States who are more advanced in their preparations.

3.4.1 Overall results

Out of the 27 Member States surveyed, 10 (37%) were assessed to be well prepared, 6 (22%) were assessed to have average preparation and 11 (41%) were assessed to have poor preparation and capacity to address their ESD targets.

Figure 3-52: Preparedness of EU Member States to address ESD targets (number of Member States).



Of the 10 Member States that are assessed to be well prepared, the majority are northern European countries with the exception of 2 southern European Member States. All of the 11 Member States assessed to be poorly prepared are either southern European or Eastern European. Of the 6 Member States assessed as having average preparation, 3 are northern European, 2 are Eastern European and 1 is southern European.

As outlined in section 3.1.2 of this report, the majority of Member States are expected not to meet their ESD targets. Only 10 out of the 27 EU Member States (37%) are expected to meet their ESD targets and 17 (63%) are expected not to meet their targets.

An assessment that a country is well prepared is not necessarily an indication that they will meet their ESD targets, more it is an indication that the government is aware that there is a target and they are engaging in relevant preparatory actions to meet the target. For example, out of the 10 EU Member States assessed to be well prepared, 8 countries are expected not to meet their ESD targets and only 2 of the countries are expected to meet their targets (see Table 3-29 below).

Poor preparedness does not necessarily indicate that a country will not meet its targets. For example, out of the 11 countries assessed to be poorly prepared, 6 are expected to meet their targets and 5 are expected not to meet their targets. Poor preparedness is more an indication of one of the following things:

- That the country is expected to meet its targets easily and therefore there is little perceived need for more extensive preparation (e.g. some of the Southern and Eastern European Member States).
- That the county is expected not to meet it targets and is either not aware that further action is needed and/or there is little evidence that the country is actively preparing itself to meet the targets.

It should be noted that Cypus and Malta do not have targets under the Kyoto Protocol and so have not engaged in the processes and preparation that other Member States have had to comply with, which has to some degree prepared the other Member States and built capacity relevant for ESD.

Table 3-29 below summarises the number of Member States that are expected to meet/not meet their ESD targets and how well prepared they are to address any gaps (good preparation, average preparation, poor preparation).

Table 3-29: Number of Member States that are expected to meet/not meet their ESD targets and how well prepared they are to address any gaps.

Assessment	Number of MS	%
Expected to meet ESD targets, good preparedness and capacity	2	7
Expected to meet ESD targets, average preparedness and capacity	2	7
Expected to meet ESD targets, poor preparedness and capacity	6	22
Not expected to meet ESD targets, good preparedness and capacity	8	30
Not expected to meet ESD targets, average preparedness and capacity	4	15
Not expected to meet ESD targets, poor preparedness and capacity	5	19
Total number of Member States assessed	**27**	**100**

The results presented above can be compared with the results from a questionnaire sent to Member States prior to the stakeholder conference that was held as part of the project in November 2010. Of the 9 Member States that returned the completed questionnaire 6 of these agreed with our initial analysis in terms of their overall level of preparedness. Of the 3 that did not agree 2 of these reported themselves as good but were as assessed on the basis of our methodology as poor. This difference might be explained by the fact that certain activities may be underway, but not captured by our simple indicators. As described above our results present the worst case scenario in most cases. In the one remaining case our scoring suggested a more favorable level of preparedness than the Member States own scoring.

For countries that have good preparation and are still expected to miss their ESD targets, there are further options available to them (via the flexibility provisions allowable under the ESD) in order to comply with the targets set.

The Eurobarometer survey “European’s attitudes towards climate change” carried out in 2009 was used to assess public perception of the seriousness of climate change in Member States and public perception of the actions taken by the national governments. In only one Member State did the population not see climate change as a very serious problem. With regards to tackling climate change the population of all but one of the EU 27 of the Member States thought that their Governments are not doing enough. These results suggest a strong public level of support for further action in almost all Member States.

4 Conclusion and discussion

Detailed analysis has been performed on the projected emissions, policy impacts and abatement potential within the scope of the Effort Sharing Decision. The analysis has been performed at three levels of resolution: on an EU wide basis, on a sectoral basis, and at the level of individual Member States. In addition, the preparedness and capacity of Member States to implement measures at a national level under the ESD has been examined. The key results and associated conclusions from the analysis are drawn together below.

A summary of the key results is provided in the table below. The results should be interpreted recognising the full context provided in the main report. This would take into account, for example, the fact that the estimated abatement potential only includes a sub-set of the total available potential by only including a limited number of behavioural measures. Further interpretation of the main results is provided below.

Table 4-1: Summary of key results, by sector. (in $MtCO_2$ eq.):

	Agriculture	Buildings	Industry	Transport	Waste	Other
Emissions in 2005 (PRIMES/GAINS)	471	690	290	924	147	170
Emission in 2020 (PRIMES/GAINS)	464	626	336	927	83	160
Emissions in 2020 (MS WEM)	465	638	416	844	128	186
Indicative emissions target in 2020[1]	*431*	*618*	*261*	*826*	*138*	*164*
Abatement potential in 2020 (adjusted SERPEC)	122	118	57	100	-	n.q
Reduction by additional policies in 2020		42	17	14	-	n.q
Potential emissions in 2020 with full take up of the remaining abatement potential	344	466	262	813	0	n.q

[1] No sectoral emissions targets exist. The emission targets used here are illustrative and assume a pro-rata allocation of the ESD target as a whole, based on the sum of Member States individual targets, and the relative emissions from the sectors in 2005.
n.q = not quantified

EU wide

4.1.1 Emissions projections

- Projections of future emissions within the scope of the ESD are available from EU wide modelling (such as the outputs from the PRIMES and GAINS models) and from modelling undertaken by Member States of emissions at a national level.
- Current projections suggest that with measures in place mid 2009 the EU-27 will not meet its target reduction in emissions from the ESD sectors of about 10% by 2020 compared to 2005. This is the outcome from both the PRIMES/GAINS EU wide modeling, and Member States' own projections.
- The PRIMES/GAINS analysis suggests a 'policy gap' equivalent to 5.8% of the 2005 emissions levels, with Member State projections suggesting a gap of 1.6% to 10.0% depending on the assumed take up of additional measures. This 'policy gap' represents the additional reduction in emissions required to meet the ESD target, across all of the relevant emissions sources.

- Projected performance against target has also been assessed for those Member States with an emissions growth limit, as a group, and those Member States with an emissions reduction target, as a separate group. The projections suggest that the 'growth limit' group is on track to meet its overall target. The 'reduction target' group is projected to fall short of its target by between 2 and 11 percent.
- The projections represent a snap shot of the policy gap at a given point in time. Additional greenhouse gas mitigation policies, introduced subsequently to the latest emissions modelling, will reduce the extent of the policy gap. However, changes in other variables (such as economic growth projections) may increase the projected gap.
- A number of uncertainties surround the estimated performance of the EU, with respect to the ESD target. These include uncertainties associated with the estimation of emissions within the scope of the Decision, and uncertainties associated within the modeling of the future projections (including economic growth rates, energy prices, policy impacts etc). These uncertainties, and their treatment in the projection methodologies, mean that it is difficult to compare projections from the different sources on an equivalent basis.
- By far the largest greenhouse gas contributor to the ESD is carbon dioxide, accounting for almost 70% of the global warming potential from ESD-covered emissions in 2005 in the EU-27. CO_2 emissions do not contribute to the overall slight decrease in GHG emissions projected between 2005 and 2015, and significant reductions are only achieved beyond 2020.

4.1.2 Policy impacts

- A number of existing and planned EU wide policies and measures will deliver emissions reductions in the ESD sectors over the target period. The policies therefore have an important role in helping Member States meet their national targets.
- The EU wide projections that have been made using the PRIMES and GAINS models already include the most important policies in the 2009 baseline projections, such as the CO2 and cars regulation and EU waste legislation. Therefore the estimated 'policy gap' (described above) already includes the effects of these policies.
- However, a few key policies have been (or are planned to be) implemented subsequent to the PRIMES/GAINS baseline, which will act to reduce emissions (and the extent of the policy gap) further. In particular, the recast of the Energy Performance of Building Directive will deliver further emissions reductions in the buildings sector and the Renewable Energy Directive will deliver additional saving in the transport and heat sectors. Finally, the regulations on CO2 emissions from vans, once implemented, is likely to deliver additional emissions reductions from road transport.

4.1.3 Abatement potential – EU wide

- In combination, the ESD sectors of agriculture, road transport, built environment, small industry and waste have an estimated technical abatement potential in 2020, that can be considered additional to any emission savings captured within the PRIMES/GAINS baseline, of 470 million tonnes of carbon dioxide equivalents ($MtCO_2$ eq), at an EU level.
- Additional mitigation policies, introduced subsequently to the PRIMES/GAINS baseline will take up a proportion of the cost-effective abatement potential, reducing the remaining potential in 2020. After accounting for the impacts of the most important EU wide policies, the remaining abatement potential in 2020 is estimated to be 397 $MtCO_2$ eq.
- Of the 397 $MtCO_2$ eq. of abatement potential remaining in 2020, an estimated 156 $MtCO_2$ eq is considered to be cost effective (i.e. below zero cost), from a social perspective, without the need for any further policy support e.g. a carbon price. In other words, the efficiency savings (e.g. reducing energy consumption) delivered by the measures over their lifetimes, is more than sufficient to offset the overall cost of their implementation and maintenance. These measures therefore offer a win-win option, by delivering both emissions reductions and financial savings.
- The total cost effective abatement potential remaining in 2020 is estimated to be in excess of the policy gap in 2020. This suggests that the ESD target can be met, at an EU level, at no net cost to the European economy. In fact, delivery of the ESD targets using the cost-effective abatement potential will deliver net benefits to the economy through the efficiency savings.
- A further 56 $MtCO_2$ eq. of annual emissions reductions in 2020 is available at a cost less than €25/tCO_2 eq. Thus over 212 $MtCO_2$ eq. of abatement potential could be considered 'cost-effective'

at a carbon price of €25/tCO_2 eq . The take up of this cost-effective potential would represent an 8.5% reduction in the 2005 emissions level.

- Most of the abatement potential from the buildings and industry sectors can be realised at a negative costs. The majority of the abatement potential in the agriculture sector can be realised at a cost band <€25/tCO_2 eq. The remaining abatement potential in the transport sector is mostly at a cost >€25/tCO_2 eq. Thus each of these sectors might be expected to make a differential contribution to the overall target. Abatement potential remaining in the waste sector in 2020 is much more limited, largely as a result of the assumed effectiveness of existing policies in exhausting the potential.
- There are some uncertainties in the abatement cost analysis. The analysis, whilst based on bottom up technology estimates, has not been updated in detail to reflect new or emerging technologies, or account taken for changes in fuel prices. Furthermore, the cost estimates do not take into account certain hidden costs (e.g. time cost of installing measures) which may increase the cost estimates, or direct rebound effects (e.g. taking more heating comfort), which may reduce the emissions savings.
- The estimated abatement potential is based, in most cases, upon technical measures. Therefore the potential savings do not take into account most behavioural measures (e.g. turning down the heating), which have the potential to delivery additional savings. On this basis the results can be considered conservative..

Sectors

4.1.4 Agriculture

Emission projections

- The agriculture sector in the EU-27 is responsible for emissions of 472 MtCO_2 eq according to the latest UNFCCC submissions of 2008. This is about 9% of the total EU-wide GHG emissions and about 18% of the GHG emissions within the ESD.
- The sector shows a historic trend of lower GHG emissions since 1990. This downward trend is mostly based on structural changes (less livestock) and management of nitrogen (less N mineral fertilizer use). However, as of 2006, emissions apparently stabilize.
- The baseline emissions projections from PRIMES/GAINS for 2020 only show a very minor decline, from 471 MtCO_2 eq in 2005 to 463 MtCO_2 eq. in 2020. The WEM (with existing measures) projections from Member States results in almost the same projected GHG emission from agriculture for the EU-27, although among Member States larger differences occur between both projections.
- The projections involve considerable uncertainty, especially in the activity data. The main drivers of GHG emission from agriculture, i.e. livestock numbers and fertilizer consumption, are difficult to predict and depend on global markets and bioenergy policies.

Policy impacts

- Within the sector agriculture several EU and national policies have been identified that result in greenhouse gas emissions mitigation. However, most of these policies are not specifically aimed at climate mitigation action, but relate to actions to deal with concerns on other environmental issues. Nevertheless, these policies often have positive side-effects for climate mitigation, e.g. the Nitrates Directive and reduced nitrogen inputs.
- The quantification of the mitigation potentials of these specific policies is limited. Most member states do not provide the relevant and needed information, or only on highly aggregated, sometimes cross-sector levels.
- The available quantified mitigation potentials reported by Member States for policies and measures (PAMs) in the agriculture sector are relatively low (i.e. 3.4 MtCO2-eq per year by 2020, less than 1% of the total emissions from agriculture). However, some Member States may have policies that deliver emission reduction but are not reported.

Abatement potential

- According to the projected technical mitigation potentials from the SERPEC study the total mitigation potential in agriculture could be as high as 122 $MtCO_2$-eq per year by 2020, which is in the same order of magnitude as the GAINS results. This is 26% of the projected 2020 baseline emissions from agriculture.
- The mitigation potential generally is the result of improving efficiency of nitrogen fertilizer use and lower nitrogen input, improved feed conversion in ruminants and prevention of emissions from manure storage and application.
- About 25% of this projected mitigation potential comes from application of nitrification inhibitors. However, these are not yet part of any EU or national Member State policy. In Europe, the nitrification inhibitors are only applied at very small or experimental scale. In few other countries, e.g. New Zealand, their application is more widespread, and its use is also incentivized with policies and measures. The abatement potential and cost-effectiveness appear to be very country specific, which requires further research to improve the estimates of abatement potentials.
- For certain measures there are some large difference in the projected emissions savings from Member State policies, and from the technical potentials in the SERPEC study. This may indicates that it might be difficult to deliver the potential emission reductions in practice.

4.1.5 Transport sector

Emission projections

- Transport has the single largest contribution of any sector to emissions within the Effort Sharing Decision. Almost all of the greenhouse gas emissions associated with the transport sector, with the exception of emissions from aviation, are covered by the ESD. For the EU as a whole, emissions in 2020 are projected to differ by less than 1% from the level of emission seen in 2005.
- While no sector specific target exists, if the transport sector were to make a proportionate contribution to the overall ESD target, in line with the emissions from the sector in 2005, then this would require further policies to be implemented – or abatement equivalent to 92 $MtCO_2$ in 2020.
- Member States' own projections suggest a lower level of emissions from the transport sector in 2020 than those from PRIMES/GAINS. However, on the basis of a proportionate contribution to the target, a policy gap is still projected.

Policy impacts

- Existing policies will deliver important reductions in emissions from transport, and take up some of the lower cost abatement measures. In particular, the Regulation on CO2 from passenger cars and the Biofuels Directive will both have an important role.
- Future policies will also deliver additional abatement. The proposed policy to limit CO2 emissions from vans and light vehicles is expected to reduce emissions from the transport sector by about 14 $MtCO_2$ eq by 2020. Also Member States' actions taken in response to the Renewable Energy Directive may deliver further reductions. These policies would reduce the overall policy gap, and take up a proportion of the abatement measures that may otherwise be available in 2020.

Abatement potential

- Overall, on the basis of the updated SERPEC analysis, the sector has an estimated technical abatement potential of 100 $MtCO_2$ eq available in 2020. This is additional to any emissions reductions captured in the PRIMES/GAINS baseline, and also allows for the take up of certain measures by the proposed policy to limit CO2 emissions from vans and light vehicles.
- While the transport sector has available abatement options in all of the cost bands examined, a large proportion of the abatement potential falls within the higher cost-bands. Specifically, only 11% (or 11 $MtCO_2$ eq) of the abatement potential is cost-effective without a carbon price. Around 7% (or 7 $MtCO_2$ eq) of the abatement potential can be realised at a carbon prices of €25/tCO_2 eq. Over 81% (or 81 $MtCO_2$ eq) of the abatement potential has a cost-effectiveness of >€25/tCO_2 eq.
- This distribution may reflect the fact that there is less abatement potential in absolute terms from the low cost measures, or that a greater proportion of the low cost measures are likely be taken up

in the baseline scenario – so the potential remaining in 2020 is less. Both of these explanations are plausible.

- However, even with these existing policies the overall trend in emissions shows only a small decline on the level of emissions in 2005. In other words, the existing policies are expected to temper the increase in emissions, but are not sufficient to deliver significant absolute reductions in emissions from this sector. To deliver significant reductions would require the take up of more expensive technical measures, or the use of other abatement options (e.g. demand management). Alternatively, it might be more cost effective to deliver the overall ESD targets by abating emissions in other sectors.
- The existing EU policy landscape (as captured in the PRIMES/GAINS baseline and the additional policies described above) targets energy performance of vehicles across most modes, and also the carbon intensity of energy used in the transport sector. Whilst the stringency of these measures could be increased (at greater cost) the policies already cover most emission sources within the scope of the ESD. One area where it could be argued that the current EU policy framework is less extensive is with respect to policies that influence activity levels (i.e. the total vehicle km). While certain instruments (e.g. fiscal policies) are largely the domain of national governments; this is potentially one area where the current policy landscape could be reinforced.
- The take up of this full potential would reduce the absolute emissions from the sector, within the scope of the ESD, to 813 MtCO_2 eq. by 2020. This represents a 12% reduction in the 2005 emission level. The estimated reduction includes the impact of the proposed policy to limit CO2 emissions from vans and light vehicles.

4.1.6 Buildings sector

Emission projections

- In the EU-27, the recent historical trend in buildings sector emissions has been a gradual decline that is partly masked by large annual fluctuations. From 1990 to 2008, emissions declined, caused by largely rehabilitation activities on existing buildings (and partly demolition) which more than compensates for the additional emissions from new (and more efficient) buildings. The fluctuations from year to year can be explained by annual ambient temperature fluctuations that lead to variations in heating demand.
- According to PRIMES/GAINS the baseline emissions projections show a decline in emissions, from 689 MtCO2 eq. to 626 MtCO2 eq from 2005 to 2020, which is a decrease of about 9%. Thus, current projections suggest that the buildings sectors will make an important contribution to the overall ESD targets within Member States.
- In the building sector the levels of future emissions are driven by new constructions, the retrofitting of the existing building stock and the demolition rate. For new construction the main drivers of emissions are the construction rate and the level of compliance with the respective building codes (i.e. under the EPBD recast). The main drivers for the existing building stock are the speed of the energy related retrofit rate, and the level of ambition of standards set by Member States.
- Whilst no sector specific target exist, if the buildings sector were to make a proportionate contribution to the overall ESD target, in line with the emissions from the sector in 2005, then this would relate to an absolute emission in the EU 27 of 620 MtCO_2 eq in 2020, based on the ESD targets for each Member States. Compared to the current PRIMES baseline projection, the calculated emission reduction required to meet the ESD target is slightly lower (1%) than the current expectation.
- Thus current policies are almost sufficient to reduce emissions from buildings proportionally to the ESD target. However, Member States own projections suggest higher baseline emissions in 2020, and a larger policy gap. This suggests further additional measures would be required to meet this illustrative target. This also assumes that all other sectors are able to deliver a proportionate share

Policy impacts

- There have been significant policy developments in recent years for the building sector, for example the recast of the Energy Performance Building Directive (Directive 2010/31/EU). This means that a significant reduction in emissions within the buildings sector will already be delivered by current policy.

- A key action to unlock the remaining cost effective abatement potentials of the building stock is deep renovation (i.e., a high retrofit rate combined with high ambition level of the measures applied). This may require new policies at Member State level.

Abatement potential

- The building sector has an estimated technical abatement potential equivalent to 118 $MtCO_2$ eq remaining in 2020. This is the potential after the policies included within the PRIMES/GAINS baseline are accounted for, and also additional policies such as the EPBD recast. Implementation of this full potential will reduce the baseline emissions in the sector to 466 $MtCO_2$ eq.
- Of this potential 88 $MtCO_2$ eq, which corresponds to 75% of this remaining abatement potential, is cost-effective at a carbon price of <€25/tCO_2 eq. This estimate only includes emissions falling within the scope of the ESD. Further cost-effective emissions reductions are available for emissions outside the scope of the ESD (i.e. from measures that reduce electricity consumption).

4.1.7 Waste sector

Emission projections

- Emissions from the waste sector have reduced significantly since 2005 (and before) and are projected to continue to decline to 2020. The rate of decline, however, is project to be much slower over the next 10 years than over the past 10 years.

Policy impacts

- The emissions reductions have been strongly influenced by the requirements of the Landfill Directive and its controls on the disposal of biodegradable waste to land. This, and also increased landfill gas capture, have significantly reduced emissions of methane.
- The Landfill Directive will continue to influence waste policy and emissions in the future, and Member States policies are often designed to meet the requirements of the landfill Directive.

Abatement potential

- Existing policies are projected to exhaust most of the technical abatement potential identified in the SERPEC analysis. Other studies have identified some further opportunities for abatement, including emissions from wastewater treatment. These options may deliver further additional emissions reductions, but are likely to require additional policies interventions in order to be realised.

4.1.8 Industry sector

Emission projections

- Industrial emissions covered by the ESD cannot be estimated as easily as emissions from other sectors, due to uncertainties about the split of those industrial emissions falling within the scope of the ESD, and those within the scope of the EU Emissions Trading Scheme (ETS).
- An estimated 46 % of industrial GHG emissions are captured by the ESD with current definition of the EU ETS, and 37 % after 2012 due to the increased scope of the EU ETS. The PRIMES/GAINS baselines, when disaggregated at a sub-sector level, suggest a lower share of around 27 % after 2012, which may suggests the disaggregation approach applied here underestimates the ESD share.
- The disaggregated PRIMES and GAINS baselines suggest emissions from non-ETS industry may increase from 290 $MtCO_2$ eq. in 2005 to 336 $MtCO_2$ eq. in 2020 (+15.9%). Member States' own projections, when disaggregated using the ETS/ESD split from PRIMES, suggest a higher level of emissions from the industrial sector in 2020 (416 $MtCO_2$ eq.). This difference occurs less with process-related emissions but more for the energy-related emissions (211 $MtCO_2$ eq. for the PRIMES/GAINS baseline projection and 286 $MtCO_2$ eq. for the Member State projections).

Policy impacts

- At present there are few common EU polices to tackle direct emissions from non-ETS industry (while for indirect emissions, instruments like the Eco-design Directive exist).
- At a national level additional measures, i.e. policies planned but not implemented, would reduce emissions further by the relatively small number of 18 $MtCO_2$eq.
- Whilst no sector specific target exists, if the non-traded industry sector were to make a proportionate contribution to the overall ESD target of 10 %, in line with the emissions from the sector in 2005, then this would require further policies to be implemented – or abatement equivalent to around 30 Mt CO_2-eq. in 2020.

Abatement potential

- According to our analysis there is still at least a cost effective potential of close to 60 $MtCO_2$eq. remaining in the non-ETS industry. Most of the potentials in the non-ETS industries are cost-effective and rather equally split across Member States.
- The gap to the target if applied uniformly across the sectors is comparatively high for the non-traded industries across most EU Member States including the new EU Member States. Energy efficiency options constitute the most important fields of action in those non-ETS industries. Actions to reduce emissions from non-traded industries include reduction in space heating requirements (some non-ETS industries have 50 % space heat shares), industrial steam boilers (around 30% of industrial fuel use is for steam raising), improved furnaces and dryers, improved industrial processes.
- There are large indirect abatement potentials in non-ETS industries due to electricity savings (164 $MtCO_2$ eq. by 2020). Although the issue of indirect emissions from electricity use is cross-cutting over all sectors, it is particularly relevant for the non-ETS industries. These potentials are economic but are frequently hampered by non-economic barriers; hence the price signal from the EU ETS is not sufficient and specific instruments are required to address them.

4.1.9 Member State results

Emissions projections

- Projections based on PRIMES and GAINS baselines predict that only 10 of the EU-27 Member States will meet or exceed their requirement under the ESD, with domestic actions alone. Furthermore, PRIMES and GAINS projections show nine Member States with a policy gap of over 10% (i.e. 10% further reduction between 2005 and 2020 is required under the ESD than is projected).
- Member States' own projections paint a similar overall picture, though there are marked differences for some Member States. Overall, Member State '*with existing measures'* projections agree with PRIMES and GAINS modelling in the direction of the policy gap (whether the Member State is projected to meet its ESD target or not) for all but 9 of the EU-27.
- On the basis of the PRIMES/GAINS projections, only one of the Member States in the reduction targets group (Greece) is projected to meet its respective targets in 2020. In contrast, 9 of the 12 Member States in the growth limits group have projected emissions in 2020 within the required limits
- It is encouraging to note that Member States' *with additional measures* projections indicate a considerable narrowing of the policy gap, which may indicate the impact of policies not included in the PRIMES / GAINS baseline, such as recent national policy measures, the implementation of the renewable energy directive or the implementation of the recast of the buildings directive.

Policy impacts

- Under the EU Monitoring Mechanism Decision Member States are require to report information on their policies and measures to reduce greenhouse gas emissions. However reporting of information on policies is incomplete, and the policy information that is reported is not always consistent between Member States.

- These limitations make it difficult to draw firm conclusion on the impacts of individual policies and measures at a Member State level.

Abatement potential

- The abatement potential has been assessed relative to the latest PRIMES/GAINS projections. It takes into account the potential take up and effectiveness of the individual abatement measures at a Member State level. The performance of certain measures has necessarily been based on EU wide assumptions. The results for individual Member States are therefore subject to a greater level of uncertainty than for the EU as a whole.
- In terms of the relative share of the cost-effective abatement potential at a Member State level, 20 of the Member States have the most or second most share of cost-effective remaining abatement potential in the building sector, 16 in the agriculture, 13 in the industry and just five in the transport sector (see Table ES3).
- The following table shows the cost-effective abatement potential at a carbon price of €25/tCO2 eq and the share of the remaining cost-effective abatement potential from each sector. The dark blue coloured cells indicate sectors with the most or the second most share of the cost-effective remaining abatement potential. The cost-effective potential is country specific; the percentage score reflects the distribution of abatement potential in the respective Member State.
- Considering the PRIMES 2009 projection and including additional policies, implemented subsequent to PRIMES 2009 (until June 2010), 16 Member State still have a policy gap (and 11 Member States do not). Taking into account the cost-effective potential (at a carbon price of €25/tCO_2 eq.) 7 more Member States can close the policy gap. Taking into account all remaining potential (also not cost-effective), 4 more Member States can close the policy gap and therefore 5 Member States cannot close the policy gap even if all of the remaining technical abatement potential was taken up.

4.1.10 Member States' preparedness and capacity to implement necessary measures for meeting their commitments under the ESD

- A high level of preparedness is important for all Member States irrespective of whether they are projected to meet their ESD targets.
- Out of the 27 Member States surveyed, 10 (37%) were assessed to be well prepared, 6 (22%) were assessed to have average preparation and 11 (41%) were assessed to have poor preparation and capacity to address their ESD targets.
- Of the 10 Member States that are assessed to be well prepared, the majority are northern European countries with the exception of 2 southern European Member States. All of the 11 Member States assessed to be poorly prepared are either southern European or eastern European. Of the 6 Member States assessed as having average preparation, 3 are northern European and 2 are eastern European.
- An assessment that a country is well prepared is not necessarily an indication that they will meet their ESD targets, more it is an indication that the government is aware that there is a gap and they are engaging in relevant policies and practices to try and close the gap. Likewise poor preparedness does not necessarily indicate that a country will not meet its targets.
- Poor preparedness is more an indication of one of the following things: That the country is expected to meet its targets easily and does not recognise the potential value of transfers, that the country is expected not to meet it targets and is either not aware that further action is needed and/or there is little evidence that the country is actively preparing itself to meet the targets.

Number of Member States that are expected to meet/not meet their ESD targets and how well prepared they are to address any gaps.

Assessment	Number of Member States	%
Expected to meet ESD targets, good preparedness and capacity	2	7
Expected to meet ESD targets, average preparedness and capacity	2	7
Expected to meet ESD targets, poor preparedness and capacity	6	22
Not expected to meet ESD targets, good preparedness and capacity	8	30
Not expected to meet ESD targets, average preparedness and capacity	4	15
Not expected to meet ESD targets, poor preparedness and capacity	5	19
Total number of Member States assessed	**27**	**100**

Further discussion

The current analysis suggests that further effort will be required by Member States to reduce emissions in order to deliver the targets on the ESD, using domestic actions alone.

This analysis will change over time, both as economic circumstances change and additional policies are implemented. The current analysis is based on the projections from the PRIMES and GAINS modelling, with some comparison with Member State projections. New projections from Member States are required to be submitted to the European Commission under the Monitoring Mechanism in Spring 2011. Assuming these updated projection take into account recently implemented national policies, and allow the separation of emissions captured by the ESD and ETS sectors, they may provide a more accurate estimate of the extent of any policy gap at Member State level. However, assessment of the position at an EU level might be better served through an approach that models all Member States consistently, using EU wide models.

Existing EU wide policies are already making an important contribution to the delivery of these targets, and this contribution will continue in the future.

One area worthy of further examination is the potential actions taken at Member State level to deliver renewable energy in accordance with the Renewable Energy Directive. In particular, the use of renewable energy in the heat and transport sectors would potentially deliver additional abatement in the sectors relevant to the Decision. Since the latest PRIMES BASELINE[54] projections did not consider the impacts of Member State actions in this area in great deal, some further examination of these impacts using bottom-up data would be beneficial.

More generally, it is important that Member States actions to meet the requirements of the ESD needs are considered alongside their other relevant objectives. Delivery of targets for renewable energy is clearly one area where this is relevant, but also deliver of energy efficiency actions should also be considered (e.g. as part of Member States' Energy Efficiency Action Plans). Furthermore, certain abatement measures will deliver emissions reductions whilst also delivering cost reductions to the end users. Policies to support the uptake of these measures can form an important component of low carbon economic growth strategies.

Future policies should focus on those sectors where abatement opportunities can be realised at lowest costs. Overall, the abatement cost analysis suggests that there is more than

[54] The PRIMES reference scenario does show the important impact of RES directive fulfilment on ESD target achievement. However, some for cross checking of the assumptions used in this reference scenario, with Member States on renewable energy projections would be worthwhile.

sufficient technical abatement potential to deliver the ESD targets with zero social cost measures.

A large amount of remaining abatement potential was identified in the zero cost and low cost brackets. Clearly, these are the areas where future policy interventions should be targeted first. However, it is important to recognise that market and practical barriers may existing which explain why this cost – effective potential has not been realised already. This includes for example the 'time cost' associated with having abatement measure installed. Further work to understand these barriers, at a sectoral level, is important so that effective and realistic policies can be put in place to overcome the barriers and help deliver the cost-effective potential.

From a sectoral perspective the buildings sector and the small industry sector are both areas where substantial zero cost potential was identified. The small industry case in particular is interesting, the latest projections – whilst more uncertain than for other sector – suggest a trend of increasing emissions from this sub-sector. It is also potentially a sector that is perhaps less well captured by existing policies than other sectors.

It is also important that future policies take into account interactions between sectors. The analysis present above has largely concerned the emissions from sector, and their associated abatement options in isolation. However, policies in one sector are intrinsically linked to emissions arising in other sectors (both within and outside of the scope of the ESD). For example, delivery of the renewable energy requirements will interact with the emissions from the agriculture sector, which may be required to deliver additional renewable fuels. Likewise emission from the agricultural systems are not restricted to just emissions from production. Emissions from transport, processing and storage of food products are all important – but these emissions will be realised in other sectors.

For the abatement to be delivered at least cost for the EU as a whole will require action from all Member States. Whilst almost half of the EU's Member States have been assessed to be well prepared for meeting the requirements of the Decision, and equal number were found to be poorly prepared, at the time the review was carried out.

The flexibility provisions associated with the Decision mean that emissions associated with overachievement have an economic value. Therefore, good preparation would help to ensure that targets are met at least cost (in those Member States which may struggle to deliver their targets) and that potential returns from flexibility provisions are maximized (in those Member States that may deliver their targets more easily). Furthermore, since a large proportion of the abatement potential can be delivered at a negative net cost, introduction of these abatement measures has an economic justification in its own right.

5 References

AEA (2011) Reduction and Testing of Greenhouse Gas (GHG) Emissions from Heavy Duty Vehicles – Lot 1: Strategy

Capros et al, (2010). EU energy trends to 2030 - update 2009. (E3M-Lab): Prof. P. Capros, Dr. L. Mantzos, N. Tasios, A. De Vita, N. Kouvaritakis

CBI (2007): Climate Change: Everyone's business

Committee on Climate Change (CCC) 2010: The Fourth Carbon Budget - Reducing emissions through the 2020s

DECC (2009). UK Low Carbon Transition Plan Emissions Projections, July 2009. URN 09D/678

ECN, Option document and Monitweb (2008): Optiedocument – energie en emissies 2010/2020)

EU (2009). Greenhouse gas emission trends and projections in Europe 2009 tracking progress towards Kyoto targets. Report prepared by AEA, Öko-Institut, Umweltbundesamt.

European Commission (2007). Press release: Emissions trading: Commission adopts decision on Portugal's national allocation plan for 2008-2012 Reference: IP/07/1566

Grubb et al. (2009): Plugging the gap in energy efficiency policies

Höglund-Isaksson L, Winiwarter W, Wagner F, Klimont Z, Amann M (2010). Potentials and costs for mitigation of non-CO2 greenhouse gas emissions in the European Union until 2030. Report to the European Commission, DG Climate Action. IIASA.

Kuikman, P. Schils, R., van Beek, C. and Velthof, G. (2010). Nitrificatieremmers in de Nederlandse landbouw, potentiële vermindering van lachgasemissie. Alterra-report 2016. Alterra, Wageningen, the Netherlands.

McKinsey (2007): Costs and Potentials of Greenhouse Gas Abatement in Germany

McKinsey (2008): Costs and Potentials of Greenhouse Gas Abatement in Czech Republic

McKinsey (2008a): Greenhouse Gas Abatement Opportunities in Sweden

McKinsey (2009): Assessment of Greenhouse Gas Abatement Potential in Poland by 2030

SERPEC 2009a: Sectoral Emission Reduction Potentials and Economic Costs for Climate Change (SERPEC-CC). Summary report

SERPEC 2009b: Sectoral Emission Reduction Potentials and Economic Costs for Climate Change (SERPEC-CC). Transport – Passenger cars, road freight and aviation; available at: http://www.ecofys.com/com/publications/documents/SERPEC_transport_report.pdf

SERPEC 2009c: Sectoral Emission Reduction Potentials and Economic Costs for Climate Change (SERPEC-CC). Industry & refineries sector; available at http://www.ecofys.com/com/publications/documents/SERPEC_industryrefineries_report.pdf

SERPEC 2009d: Sectoral Emission Reduction Potentials and Economic Costs for Climate Change (SERPEC-CC). Agriculture: methane and nitrous oxide; available at: http://www.ecofys.com/com/publications/documents/SERPEC_agriculture_report.pdf

SERPEC 2009e: Sectoral Emission Reduction Potentials and Economic Costs for Climate Change (SERPEC-CC). Residential buildings and service sector; available at: http://www.ecofys.com/com/publications/documents/SERPEC_builtenvironment_report.pdf

Appendices

Appendix 1: Policies included within the PRIMES and GAINS baseline scenarios

Legislation included in GAINS baseline

Policy	Description
Landfill Directive (1999/31/EC), the Waste Directive (2006/12/EC) and the Waste Management Framework Directive (2008/98/EC)	All EU-27 countries are assumed to meet the required diversion of biodegradable waste away from landfills, i.e., 25 percent in 2006, 50 percent in 2009 and 65 percent in 2016 of the 1995 amounts land-filled. All landfill sites should by 2009 be equipped with gas recovery equipment. Countries with a heavy reliance on landfills have been granted a four years grace period for compliance (i.e., Greece, Ireland, Italy, Spain, Portugal, United Kingdom, Cyprus, Estonia, Hungary, Slovenia, Poland, and Slovakia). The EU waste hierarchy is followed to the extent that recycling and composting are preferred to incineration and deposition on landfills. Waste incineration is not assumed to increase above currently implemented levels, unless information from national experts suggests otherwise.
Nitrate Directive (1991/676/EEC), Common Agricultural Policy (CAP) Reform (2006/144/EC), the CAP "Health Check" and the "Set aside" regulation (73/2009)	Assumptions on agricultural policies in the activity projections produced by the CAPRI model comprise the effects of the "Health Check" of the CAP, the abolition of the "Set aside" and the milk quota regulations, as well as, the impacts of the Nitrate Directive. In addition, agricultural premiums are considered largely decoupled from production levels, and implementation of the WTO December 2008 Falconer proposal on trade with agricultural products is assumed.
F-gas Directive (2006/842/EC) and Motor Vehicles Directive (2006/40/EC):, sports equipment etc.	The F-gas Directive stipulates that by 2010 end-of-life recollection of refrigeration and air-conditioning equipment should be in place as well as adoption of good practice measures involving leakage control and improved components of refrigeration and air-conditioning equipment in use. From 2011, the use of HFC-134a in mobile air conditioners should be replaced by a cooling agent with a GWP of less than 150 in all new vehicles placed on the market. In addition, the F-gas Directive stipulates an increased use of alternative blowing agents for one component foams, use of alternative propellants for aerosols, leakage control and end-of-life recollection and recycling of high-and mid voltage switches, SF_6 replaced by SO_2 in magnesium production and casting, and a ban of use of SF_6 in soundproof windows
Emissions Trading System	The baseline scenario assumes adoption of mitigation technologies within the sectors included in the EU emissions trading system (ETS) to the extent that marginal mitigation costs are lower than the established carbon price in the market for emission permits. Non-CO_2 sector sources included in the ETS are production of adipic and glyoxal/glyoxylic acid, nitric acid, and primary aluminium. Expected future carbon price levels in the ETS permit market were taken from the results of the PRIMES model (December 2009), i.e., 13.6 Euro/t CO_2 in 2010, 18.7 Euro/t CO_2 in 2015, 23.4 Euro/t CO_2 in 2020, 30 Euro/ton CO_2 in 2025, and 36.6 Euro/ton CO_2 in 2030 (in Euro 2005 prices). It is assumed that these carbon prices imply use of catalytic reduction in nitric acid production (from 2015 onwards), catalytic reduction in adipic acid production (adopted voluntarily from 2000 onwards in all countries, except Italy where adoption starts from 2010 onwards), twin reduction system in adipic acid production (technology assumed readily available from 2020 onwards), and retrofitting of vertical stud Söderberg (VSS) technology in primary aluminium production (from 2015 onwards).
Voluntary agreement to reduce PFC emissions in the semiconductor industry	The voluntary agreement to reduce PFC emissions in the semiconductor industry is assumed to have achieved considerable reductions by 2005 (ESIA, 2006). The effect of the control in place in 2005 is assumed to continue into the future.
Other EU wide policies	Other relevant EU-wide legislation that has indirect effects on non-CO_2 GHGs, include regulations on transport-related emissions and the Biofuels Directive (2009/28/EC). Production of biofuels in EU-27 is assumed to develop as projected by PRIMES (see Amann et al., 2010).
National policies	National legislation affecting emissions of non-CO_2 GHG includes complete bans on depositing biodegradable waste on landfills in Denmark, Germany and Sweden, and national legislation controlling emissions of nitrogen compounds (NO_X, NH_3) indirectly affecting non-CO_2 GHG emissions.

Source: Höglund-Isaksson et al. (2010).

Policies and measures included within the PRIMES baseline scenario

	Measure		Adoption	How the measure is reflected in PRIMES
Regulatory measures				
	Energy efficiency			
	Ecodesign implementing measures			
1	Stand-by	Regulation No 1275/2008	2008	Adaptation of modelling parameters for different product groups. As requirements concern only new products, the effect will be gradual (none in 2010; rather small in 2015 and up to full effect by 2030)
2	Simple Set-to boxes	Regulation No 107/2009	2009	
3	Office/street lighting	Regulation No 245/2009	2009	
4	Household lighting	Regulation No 244/2009	2009	
5	External power supplies	Regulation No 278/2009	2009	
6	Labelling Directives	Directive 2003/66/EC	2003	Enhancing the price mechanism mirrored in the model
7	Cogeneration Directive	Directive 2004/8/EC	2004	National measures supporting cogeneration are reflected
8	Directive on end-use energy efficiency and energy services	Directive 2006/32/EC	2006	National implementation measures are reflected
9	Energy performance of buildings Directive	Directive 2002/91/EC	2002	National measures e.g. on strengthening of building codes and integration of RES are reflected
	Energy markets and power generation			
10	Completion of the internal energy market (including provisions of the 3rd package)	http://ec.europa.eu/energy/gas_electricity/third_legislative_package_en.htm		The model reflects the full implementation of the Second Internal market Package by 2010 and Third Internal Market Package by 2015. It simulates liberalised market regime for electricity and gas (decrease of mark-ups of power generation operators; third party access; regulated tariffs for infrastructure use; producers and suppliers are considered as separate companies).
11	EU ETS directive	Directive 2003/87/EC as amended by Directive 2008/101/EC and Directive 2009/29/EC	2003, 2008, 2009	Cap for GHGs is respected[55]; additional financing for CCS in the order of several billion euros by 2013 from the New Entrants Reserve is reflected as support to CCS
12	Energy Taxation Directive	Directive 2003/96/EC	2003	Tax rates (EU minimal rates or higher national ones) are kept constant in real term. The modelling reflects the practice of MS to increase tax rates above the minimum rate due to i.a. inflation.
13	Large Combustion Plant directive	Directive 2001/80/EC	2001	Emission limit values laid down in part A of Annexes III to VII in respect of sulphur dioxide, nitrogen oxides and dust are respected; derogations are taken into account
14	IPPC Directive	Directive 2008/1/EC	2008	Costs of filters and other devices necessary for compliance are reflected in the

[55] For the allocation regime for allowances in 2010, the current system based on National Allocation Plans and essentially cost-free allowances is assumed, with price effects stemming from different investment and dispatch patterns triggered by need to submit allowances. For the further time periods, in the power sector there will be a gradual introduction of full auctioning, which will be fully applicable from 2020 onwards, in line with the specifications of the amended ETS directive. For the other sectors (aviation and industry), the baseline follows a conservative approach which reflects the specifications in the directive on the evolution of auctioning shares and the provisions for free allocation for energy intensive sectors based on benchmarking.

				parameters of the model
15	Directive on the geological storage of CO_2	Directive 2009/31/EC	2009	Enabling measure allowing economic modelling to determine CCS penetration
16	Directive on national emissions' ceilings for certain pollutants	Directive 2001/81/EC	2001	Checked with RAINS/GAINS modelling regarding classical pollutants (SO2, NOx)
17	Water Framework Directive	Directive 2000/60/EC	2000	Hydro power plants in PRIMES respect the European framework for the protection of all water bodies as defined by the Directive
18	Landfill Directive	Directive 99/31/EC	1999	Provisions on waste treatment and energy recovery are reflected
	Transport			
19	Regulation on CO_2 from cars	Regulation No 443/2009	2009	Limits on emissions from new cars: 135 gCO_2/km in 2015, 115 in 2020, 95 in 2025 – in test cycle
20	Regulation EURO 5 and 6	Regulation No 715/2007	2007	Emissions limits introduced for new cars and light commercial vehicles
21	Fuel Quality Directive	Directive 2009/30/EC	2009	Modelling parameters reflect the Directive, taking into account the uncertainty related to the scope of the Directive addressing also parts of the energy chain outside the area of PRIMES modelling (e.g. oil production outside EU).
22	Biofuels directive	Directive 2003/30/EC	2003	Support to biofuels is reflected in the model
23	Implementation of MARPOL Convention ANNEX VI	2008 amendments - revised Annex VI	2008	Amendment of Annex VI of the MARPOL Convention reduce sulphur content in marine fuels which is reflected in the model by a change in refineries output
Financial support				
24	TEN-E guidelines	Decision No 1364/2006/EC	2006	The model takes into account all TEN-E realised infrastructure projects
25	EEPR (European Energy programme for Recovery)	Regulation No 663/2009	2009	Financial support to CCS demonstration plants; off-shore wind and gas and electricity interconnections is reflected in the model
26	RTD support (7th framework programme- theme 6)	energy research under FP7		Financial support to R&D for innovative technologies such as CCS, RES, nuclear and energy efficiency is reflected by technology learning and economies of scale leading to cost reductions of these technologies
27	State aid Guidelines for Environmental Protection and 2008 Block Exemption Regulation	Community guidelines on state aid for environmental protection	2008	Financial support to R&D for innovative technologies such as CCS, RES, nuclear and energy efficiency is reflected technology learning and economies of scale leading to cost reductions of these technologies
National measures				
28	Strong national RES policies			National policies on e.g. feed-in tariffs and green certificates
29	Nuclear			Nuclear, including the replacement of plants due for retirement, is modelled on its economic merit and in competition with other energy sources for power generation except for MS with legislative provisions on nuclear phase out. Several constraints are put on the model such as decisions of Member States not to use nuclear at all or closure of existing plants in some new Member States according to agreed schedules. Member States experts were invited to provide information on new nuclear investments/programmes and commented on the PRIMES baselines results in spring 2009, which had a significant impact on the modelling results for nuclear capacity.

Source: Capros et al (2010)

Appendix 2: Overview of the analysis carried out in the SERPEC project

The starting point for the analysis of the abatement potential in the current project is the work that was carried out as part of the Sectoral Emission Reduction Potentials and Economic Costs for Climate Change (SERPEC) project.

The SERPEC project identified the potentials and social costs i.e. the costs of the technology option and the financial benefits from energy savings accounted for with a social discount rate of technical control options to reduce greenhouse gas emissions across all European Union sectors and Member States in 2020 and 2030. The analysis did not include additional benefits such as air quality improvements or increased energy security. The results were presented in so-called marginal abatement cost curves (MACCs, or also called cost curves) that provide a least-cost ranking of options across technologies and sectors in the EU. For more specific data and further explanations on approach, see SERPEC study[56].

Determination of the reference case – baselines

The CO_2 abatement potential of new technologies is compared with the average performance of comparable technologies in 2005.

The reference for the development of *energy related* CO_2-emissions over time was a so-called Frozen Technology Reference Level scenario (FTRL). The FTRL scenario was based upon the PRIMES 2007-baseline scenario (EC, 2008; Capros et al., 2008). The FTRL exhibits all the characteristics of the PRIMES baseline, such as an average economic growth rate of 2.2% per year until 2030, with the exception of the technology characteristics of sectors which remain 'frozen' at the 2005-level. As a result, autonomous and policy-driven energy and carbon efficiency improvements (which are included in the baseline scenario) are not taken into account in the FTRL.

The rationale for using a FTRL scenario is that the bottom-up estimates of the abatement potentials from the individual measures also used 2005 technologies as a reference when estimating the emissions savings. Thus, the overall bottom-up identified abatement potential were compared with this macro-economic FTRL-scenario.

For policy makers, however, a baseline scenario that includes ongoing technology development, both autonomous and affected by policies, is more useful. For that reason, in the SERPEC study the PRIMES 2007-baseline scenario (EC, 2008; Capros et al., 2008) was also presented. This scenario includes autonomous technology improvements and policies and measures implemented in the Member-States up to the end of 2006 and was used as the basis for proposed additional policies in the Commissions' 2008 Energy & Climate package[57] (see Figure A 1) Note, however, that the SERPEC project did not assess to what extent the abatement potential of individual measures calculated would be delivered under current (climate) policies.

[56] Download of the SERPEC study available at:
http://www.ecofys.com/com/publications/brochures_newsletters/ambitious_emission_reductions_costneutral_for_the_EU.htm
[57] See http://eur-lex.europa.eu/JOHtml.do?uri=OJ:L:2009:140:SOM:EN:HTML for final legislative texts on Climate Package

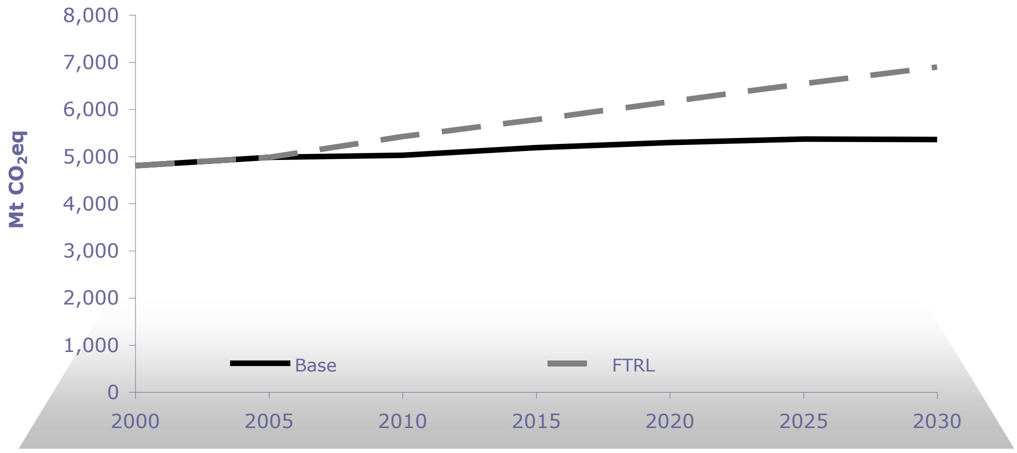


Figure A 1: Emission curves for the EU 27, showing the Frozen Technology Reference development (FTRL, upper line) and the PRIMES 2007-baseline (Base, lower line).

For so-called *process emissions* of CO_2, nitrous oxide (N_2O), methane (CH_4) and fluorinated gases (F-gases) new baselines were calculated, which include the impact of existing policies[58].

Implementation rates

In the SERPEC study the potential of individual technologies to reduce GHG emissions was assessed. Structural changes in the economy, as well as behavioural changes, were *not* considered. All the identified technologies were either already in application today, or judged to become commercially viable in the near future. To identify their abatement potentials maximally feasible implementation rates were estimated, often governed by the turnover rate of existing technology stock. Overall, around 650 individual technology measures were identified.

Technology learning

For technologies that are currently on the market, but have not yet fully matured, the SERPEC analysis assumed a decrease of investment costs over time, due to technology learning and economies of scale. For these technologies, progress ratios were derived from literature, which express the expected cost-reduction of technologies following a doubling of market capacity.

Specific abatement costs

The specific abatement cost of a measure reflects how much money is spent (positive €-values) or saved (negative €-values) compared to the cost of a reference, when abating one kilotonne of greenhouse gases in a certain year.

In SERPEC the specific abatement cost of a measure (€ / t-CO_2eq) was calculated from the sum of annualised investment costs and annual operation and maintenance (O & M) costs minus the annual financial savings from the measure's energy costs, divided by mean annual greenhouse gas emissions savings of the measure. Both the CO_2 savings and the costs are relative to a reference situation:

$$\text{specific costs} = \frac{\text{annualised capital costs} + \text{annual O \& M} - \text{annual energy cost savings}}{\text{annual } CO_2 \text{ emissions savings}}$$

This cost calculation method used is also referred to as the '*social cost method*'. The method allows for comparison of the 'bare' costs of technologies, across measures, sectors and countries. A negative

[58] Baselines are comparable to the baselines included in the Commissions 2008 Climate Package, see Ilasa (2008)

cost indicates that from a social perspective there will be a net economic gain from taking these measures, while a positive cost indicates a net economic loss.

Energy prices

In SERPEC, the revenues from energy savings (and thus the specific cost of abatement) were calculated using energy prices (development) from the PRIMES baseline scenario (EC, 2008; Capros et al., 2008), which are time and energy carrier specific. These specific cost calculations are always sensitive to the energy price assumptions and comparisons between studies need to look closely at the energy price scenarios used.

Marginal abatement cost curves

For each of the sectors, the abatement options were sorted by increasing costs per ton of abated CO_2. This resulted in a so-called marginal abatement cost-curve (MACC), an illustration of which is shown in Figure A 2

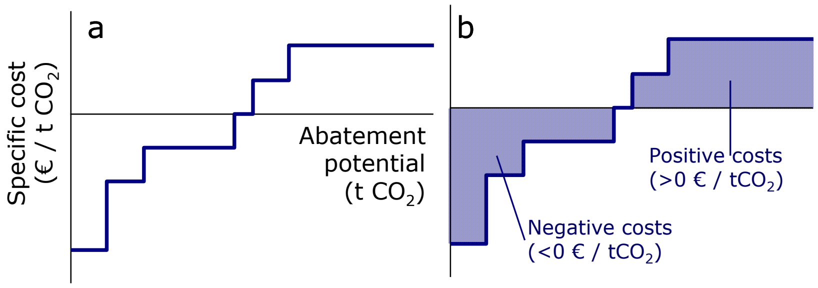


Figure A 2: Illustration of a marginal abatement cost curve (MACC). Specific costs of measures, ranked in ascending order, are plotted versus cumulative abatement. The total cost of abatement is equal to the area under the curve.

The left-hand side of the illustrative MACC in diagram A shows technologies which have negative abatement costs (€ / tCO_2eq). This can occur when over the lifetime of technologies, (fossil) energy savings more than compensate for investment costs and / or operation and maintenance (O & M) costs are lower than the reference O & M costs. The options on the right hand side of the MACC have positive costs.

Diagram B illustrates how the area under the curve represents the total cost of abatement, i.e.

$$\text{Total cost (€) = Specific cost (€ / tCO}_2\text{eq) x Abatement (tCO}_2\text{eq)}$$

On the left-hand side of the MACC in Diagram B, this total cost is negative, since the measures have negative specific costs. On the right-hand side, it is positive. The overall social costs of reaching the total reductions potential can thus become negligible or even negative.

Appendix 3: Methodology for updating the SERPEC values in each sector

Agriculture

Adjustment of GWP

To gain an insight into what factors needed to be taken into account to calculate new reductions in the non-CO_2 sectors, two baselines were compared:

- Höglund-Isaksson et al. (2010). New baseline provided by IIASA in May 2010
- SERPEC (Ecofys et al., 2009). 'Own' baselines calculations, based on the same activity data as IIASA 2008.

Note: IIASA uses the Global Warming Potential (GWP) values provided by the 2nd IPCC assessment report whereas the SERPEC study uses the GWP values provided by the 4th IPCC assessment report. Specifically, IIASA applies Global Warming Potentials for N2O of 310 and for CH4 of 21. In SERPEC we applied factors of 298 and 25. To compare the SERPEC baseline (and potentials) the values were therefore readjusted to the GWP values used by IIASA this means a correction factor of 21/25 for CH_4 and of 310/298 for N_2O (see Table A 1).

Table A 1: overview of baseline in IIIASA (2008), IIIASA (2010) and SERPEC (Ecofys et al., 2009)

N2O	**IIASA May 2010 scenario**	**2005**	**2020**
	TOTAL	385	353
	Agriculture	268	268
	SERPEC (gwp = 310)	**2005**	**2020**
	Agriculture	265	269
	SERPEC (gwp = 298)	**2005**	**2020**
	Agriculture	255	259
CH4	**IIASA May 2010 scenario**	**2005**	**2020**
	TOTAL	422	334
	Agriculture	203	196
	Waste	119	55
	SERPEC (GWP = 25)	**2005**	**2020**
	Agriculture	235	218
	Waste	132	83
	Waste – maximum abatement	-	69
	SERPEC (GWP = 21)	**2005**	**2020**
	Agriculture	197	183
	Waste	111	70
	Waste – maximum abatement	-	58
F-GASES	IIASA May 2010 scenario	72	79
	SERPEC	72	78

Effect of the recession on abatement potential

In the agriculture sector, the differences in baseline are not so large so it was assumed that the SERPEC FTRL and potential did not need updating for the effect of the recession.

Effect of shorter delivery timescales

For the agricultural sector, many of the measures can be done over short timescales and maximum feasible implementation rates were not included explicitly. As a first approximation for this study, we assume that for this sector if policies were put in place all the abatement potential could be delivered in 10 years rather than 15. The potential from SERPEC was therefore used without adjustment (apart from the GWP correction)

Identification of additional policies and estimation of their mitigation potential and the calculation of the remaining abatement potential

For agriculture, no major mitigation policies were introduced across member states in the period 2007 (FTLR) and 2009 (PRIMES-GAINS). Given the high uncertainties with respect to the emissions of the sector agriculture, which we consider are mainly due to activity data, this difference to 2007-2009 we do not consider to be delivered by policy, but due to data uncertainties and differences in model parameterisation. Therefore only the technical abatement potentials of the SERPEC study were considered.

Our analysis of the policy and measure database from the EEA website also reveals that for few policies quantitative information about the mitigation potential is provided. In addition, the current savings (direct potential) are more related to measures than to policies, e.g. for nitrification inhibitors so far no policies exist that stimulate the use of nitrification inhibitors. Therefore no additional savings has been identified.

1.1.1.1 Building sector

Effect of the recession the abatement potential

The effect of the recession on the building sector emissions and abatement potential was calculated by comparing the PRIMES 2009 and 2007 emissions for two periods, 2005 to 2010 and 2010 to 2020. In the period 2005-2010, the new policies accounted for in the 2009 PRIMES projections would be expected to have a very small effect and the recession a larger one. From 2010 to 2020, the effect of policies would be expected to be much larger. By looking at the relative differences in the periods separately it is possible to estimate how much of the difference in 2020 results from the recession. The building sector is largely covered by the residential and non-residential sector emissions in PRIMES. From the analysis, we concluded that 60% of the baseline difference in 2020 is due to the recession. To determine the recession effect we took the added value as indicator. We determined what would have been the 2020 energy use in PRIMES 2009 without additional policies (assuming PRIMES 2007 efficiency) and then subtracted the projected energy use in 2020 according to PRIMES 2007.

On EU average, the CO_2 emissions of the combined residential and non-residential sectors in 2020 in the new baseline are 9% below the old baseline**.** Therefore the recession alone reduces the emissions by 5.4% (9% multiplied by 60%) on EU average. Due to large differences in the Member States, this calculation has been made on Member State level. The Member State specific factors have been applied for the calculation.

Effect of the new base year on the abatement potential

In the SERPEC analysis, the abatement potential for a given year was based on maximum feasible annual implementation rates for each of the new clean technologies and fuels. Between 2005 and 2020 the annual rates were assumed to be constant. Assuming that these rates cannot be increased, the potential that could be implemented in the period 2010 to 2020 is 10/15 (0.66) of the original potential

Combining the effect of the new base year and the recession, the remaining potential is (1-0.054)*0.66 = 0.624 of the original SERPEC potential on an EU average basis. This calculation has been made at on Member State specific basis.

Calculation of the remaining abatement potential

The factor to account for the effect of the recession is applied to the original FTRL emissions in 2020. This gives a new FTRL, which takes into account the recession but not policy delivery. The difference between the PRIMES 2009 baseline emissions at 2020 and this new FTRL is the reduction delivered by policies included in the PRIMES model. Taking this value from the abatement potential in 2020 gives a **new abatement potential.**

The following policies are included in the PRIMES 2009 model version that provided the baseline. Those (assumed to be) captured in the previous PRIMES model version, are coloured grey.

The 2009 Baseline includes policies and measures implemented in the Member States **by April 2009** and legislative provisions adopted by April 2009 that are defined in such a way that there is almost no uncertainty how they should be implemented in the future:

	Measure		Adoption	How the measure is reflected in PRIMES
Regulatory measures				
	Energy efficiency			
	Ecodesign implementing measures			
1	Stand-by	Regulation No 1275/2008	2008	Adaptation of modelling parameters for different product groups. As requirements concern only new products, the effect will be gradual (none in 2010; rather small in 2015 and up to full effect by 2030)
2	Simple Set-to boxes	Regulation No 107/2009	2009	
3	Office/street lighting	Regulation No 245/2009	2009	
4	Household lighting	Regulation No 244/2009	2009	
5	External power supplies	Regulation No 278/2009	2009	
	Other energy efficiency			
6	Labelling Directives	Directive 2003/66/EC	2003	Enhancing the price mechanism mirrored in the model
7	Cogeneration Directive	Directive 2004/8/EC	2004	National measures supporting cogeneration are reflected
8	Directive on end-use energy efficiency and energy services	Directive 2006/32/EC	2006	National implementation measures are reflected
9	Energy performance of buildings Directive	Directive 2002/91/EC	2002	National measures e.g. on strengthening of building codes and integration of RES are reflected

The following policies have been adopted subsequent to the PRIMES analysis

- Recast of the EPBD (Directive 2010/31/EU on the energy performance of buildings-recast)
- On Member State level outside EPBD recast there are
    - Policies and schemes that exist already since a longer time and are assumed to be e included in the PRIMES baseline (e.g. soft loan schemes of governmental bank KfW in Germany).
    - New policies or schemes outside the EPBD process that have been newly implemented after April 2009. According to the Mure Database, this is not the case (however several initiatives are in a planning status). Only one Member State has implemented a policy measure additional to PRIMES 2009 and that policy relates to the EPBD recast.

The impact of the EPBD recast on the uptake of abatement potential was estimated based on the analysis carried out as part of the impact assessment for the EPBD recast (2008). The impact assessment refers only to direct emissions (without electricity) and has been realized for EU27.

In that assessment, the impact had been calculated with savings of 139 Mt CO_2 in 2020 compared to a baseline for a case where:

- the threshold of 1.000 m² for renovation requirements was removed
- higher retrofit rates would be achieved via improved regulations on building certificates and compliance checks and

- more ambitious standards would be applied, due to implementation of a methodology to design national standards with a view to cost optimal requirements.

Looking at the final version of the EPBD recast as adopted in May 2010, such measures have in fact been implemented with the new EPBD. However the impact assessment assumed a theoretical start of the measures in 2010, whereas the EPBD recast was only adopted in 2010. This leaves time for the Member States until 2012 to adapt their national regulations. After that there will be also some response time until the new regulations are visible in the market.

Additionally the impact assessment of the energy savings action plan (draft, 2010) revealed that a scheme consisting of financial support, information campaigns and capacity building (the European building initiative) is necessary to harvest the full effect of the EPBD recast.

As a result, the net effect of the EPBD recast beyond the PRIMES baseline was estimated to be 51 Mt CO_2 in the time period until 2020. The overall emission savings assessed for the EPBD recast were allocated to 6 different climate zones in the EU with help of the BEAM model[59]. Then a distribution of these savings was done in relation to the size of the national building stocks (according to the Ecoheatcool Work Package 2 study[60]) within the respective climate zone (see Table A 2).

Table A 2: Distribution of the residential and non residential area in the EU 27 in Mio m^2

MS	Residential	Non-residential	Total
AUSTRIA	308	119	427
BELGIUM	416	151	567
BULGARIA	233	31	264
CYPRUS	33	7	40
CZECH REPUBLIC	333	100	433
DENMARK	279	114	393
ESTONIA	38	14	52
FINLAND	198	101	299
FRANCE	2643	861	3504
GERMANY	3492	1852	5344
GREECE	452	149	601
HUNGARY	310	101	411
IRELAND	162	58	220
ITALY	2395	453	2848
LATVIA	54	23	77
LITHUANIA	78	14	92
LUXEMBOURG	22	7	29
MALTA	14	4	18
NETHERLANDS	667	183	850
POLAND	802	382	1184
PORTUGAL	441	126	567
ROMANIA	530	87	617
SLOVAK REPUBLIC	173	81	254
SLOVENIA	59	16	75
SPAIN	1885	341	2226
SWEDEN	399	161	560
UNITED KINGDOM	2226	892	3118

Source: Ecoheatcool Work Package 2 – The European Cold Market – Final report – 2005-2006.

Several countries, such as Germany, Denmark, Portugal, Finland, Czech Republic and Latvia did not have the threshold of 1.000m² in case of retrofits before the recast of the EPBD[61]. These countries

[59] Ecofys developed over the last years a model of the EU building stock called Built Environment Analysis Model (BEAM) that has been used in various assignments on national and EU level.
[60] Ecoheatcool Work Package 2 – The European Cold Market – Final report – 2005-2006
[61] Effects from different options for the EPBD – Information provided for impact assessment - 2008

therefore have a lower additional saving potential through the EPBD recast and this potential has been allocated to these countries where the threshold has not been abolished. The reallocation has been calculated by taking out the effect assigned specifically to the removal of the threshold within the calculations of the saving effects of the EPBD recast (approx. 37%).

In a third step the additional savings have been adjusted at a Member State level to separate out the savings from fuel use in the sector i.e. direct emissions and those from the use of district heating.

1.1.2 Transport sector

Effect of the recession on abatement potential

PRIMES provides activity data (ton-km and passenger-km) for transport. Comparing the 2009 and 2007 baseline shows that passenger transport activity in 2020 is 4.7% lower than in PRIMES 2007 and for trucks the reduction is 7.1%. When the reduction is CO2-emission-weighted the overall activity of road transport reduces by 5.7% on average across the EU. Due to a high level of variability, a correction factor to account for the effects of the recession has been calculated for each Member State individually.

This reduction in emissions could be explained by a number of variables. The recession is likely to be a major factor, leading to an overall reduction in economic activity. Some of this reduction could also be related to transport policies, for example, policies to promote modal switching. Finally, changes in assumptions on model parameters, such as energy prices or load factors, will also affect the modelled level of activity.

The analysis assumes that the impact of the recession will lead to a decrease in emissions which is based solely upon the change in activity data, and is unrelated to any changes in the emissions performance of the vehicles. In therefore does not take into account the impacts of, for example, changes in vehicle purchase decisions such as switching to smaller more energy efficient vehicles which may have been influenced by the recession.

Effect of shorter delivery timescales

In SERPEC, maximum feasible annual implementation rates were defined for each of the clean technologies and fuels. These rates are related to factors such as stock turnover, so would be influenced by vehicle replacement rates. Between 2005 and 2020 the annual rates were assumed to be constant.

The original SERPEC analysis used 2005 as the reference year. It is therefore necessary to update the estimates of the maximum implementation potential by 2020 to reflect the fact that a certain period has already elapsed. An important methodological issue is the extent to which vehicle efficiencies have improved over the period 2005 to 2010. Simply scaling the abatement potential by the elapsed time would (10/15=0.66) would effectively assume that 5 years of potential improvement in vehicle efficiencies were lost. This is not a valid assumption as there will certainly have been development between 2005 and 2010 for all transport modes covered – cars are strongly influenced by the passenger CO2 regulations[62] and trucks are strongly influenced by fuel prices[63]. To reflect these drivers a scaling factor of 0.8 has been applied to passenger cars, and a factor of 0.73 to trucks. This correction factor is assumed to apply to all Member States equally.

Calculation of the remaining abatement potential

A new FTRL is estimated for the transport sector, which is consistent with the 2009 PRIMES projections, by applying the adjustment factors that were estimated above for the effect of the recession, and the shorter delivery timescales, on the abatement potential[64]. This is applied to the original FTRL emissions that were used in the SERPEC analysis (and based on PRIMES 2008 model

[62] On average new car CO2 improved by 10% between 2005 and 2009
[63] Baseline reduction in heavy truck fuel consumption is 7.5% from 2005 to 2010 in the TREMOVE model.
[64] A further correction was also made for differences in the base year statistics between PRIMES 07 and PRIMES 09. For certain Member States, the statistical data for the base year 2005 have been changed in PRIMES 09 from PRIMES 07. Some of this relates to changes in energy consumption, some to the split of energy consumption between transport modes, and some to changes in activity levels. These correction aim, as far as possible, to ensure that the SERPEC FTRL data (which is based on PRIMES 07) consistent with the PRIMES 09 projections. However, not all issues could be resolved fully.

runs) in 2020. The output is a new FTRL, which takes into account the effects of the recession but not policy delivery.

We assume that the difference between the PRIMES 2009 baseline emissions at 2020 and this new FTRL can be largely explained by the influence of policies. Whilst it is possible that the take up of some abatement measures may have occurred anyway in the absence of policies, we assume that this is limited in the current analysis. Subtracting this value from the total abatement potential in 2020 gives a **new abatement potential.**

A number of EU wide policies are included in the baseline scenario for the PRIMES 2009 model version. The 2009 Baseline also includes policies and measures implemented in the Member States **by April 2009** and legislative provisions adopted by April 2009 that are defined in such a way that there is almost no uncertainty how they should be implemented in the future. The key policies included are.

The main policies were listed below. Those (assumed to be) captured in the previous PRIMES 2007 model version, are coloured grey.

- Regulation on CO2 from cars (Regulation No 443/2009) Limits on emissions from new cars: 130 gCO2/km for 2015 (in 2012, 65% of each manufacturer's newly registered cars must comply on average with the limit value curve set by the legislation. This will rise to 75% in 2013, 80% in 2014, and 100% from 2015 onwards) , plus an additional 10 gCO2/km from a series of other technical measures and biofuel use.The 2020 target is 95 gCO2/km
- Regulation EURO 5 and 6 (Regulation No 715/2007). Emissions limits introduced for new cars and light commercial vehicles
- Fuel Quality Directive (Directive 2009/30/EC) Modelling parameters reflect the Directive, taking into account the uncertainty related to the scope of the Directive addressing also parts of the energy chain outside the area of PRIMES modelling (e.g. oil production outside EU).
- Biofuels directive (Directive 2003/30/EC) Support to biofuels is reflected in the model
- Implementation of MARPOL Convention (ANNEX VI 2008 amendments - revised Annex VI). Amendment of Annex VI of the MARPOL Convention reduce sulphur content in marine fuels which is reflected in the model by a change in refineries output.

The key policies introduced subsequent to the PRIMES 2007 analysis will lead to the take up of a certain proportion of the abatement potential in the original SERPEC analysis. For example, Regulation on CO2 from cars (Regulation No 443/2009) will deliver additional take up of abatement measures from passenger cars. We assume that the tyre rolling resistance measures, tyre pressure monitoring systems, advanced powertrains, weight reduction, and hybrid cars (as included in the original SERPEC report) are all used in combination to meet the 2020 target of 95 gCO2/km included in Passenger car CO2 regulation 443/2009. The Fuel Quality Directive (Directive 2009/30/EC) will lead to some further abatement by reducing the GHG emissions from fuel. However, a large proportion of these savings will come from biofuels, so will overlap with the savings from the Biofuels Directive which are already included in the SERPEC analysis. However, since the SERPEC analysis assumed that the 10% target for 2020 is met, then this a higher level of biofuels use than the PRIMES baseline. Therefore, some further abatement from biofuels may be possible by 2020, relative to the current PRIMES baseline.

The above policies are captured in the PRIMES analysis carried out in 2009, so will help to explain the difference in emissions in the baseline scenario between the 2009 projections and those made in 2007. These policies are also expected to take up some of the abatement potential identified in the SERPEC study.

In addition to the above, some further policies have been proposed more recently, that were not captured in the 2009 PRIMES analysis. These included:

- CO2 limits for vans. This is not yet a regulation but is likely to go ahead shortly and has been captured by some Member States in their additional policies. This policy will deliver additional take up of abatement measures, largely more advanced powertrains.
- 2009/33/EC Clean and Energy-efficient road transport. It is difficult to quantify the impacts of this policy, as there are no targets. The Directive only requires the following: “contracting

entities as well as certain operators to take into account lifetime energy and environmental impacts, including energy consumption and emissions of CO2 and of certain pollutants, when purchasing road transport vehicles with the objectives of promoting and stimulating the market for clean and energy-efficient vehicles and improving the contribution of the transport sector to the environment, climate and energy policies of the Community"

- Regulation (EC) No 661/2009 introduces a number of measures aimed at passenger cars and light vehicles that mandate the uptake of certain energy efficiency measures. Specifically, the regulations require the mandatory equipping of new passenger cars with tyre pressure monitoring systems (TPMS), and also set requirements for all new cars to be equipped with low rolling resistance tyres (LRRT). Article 11 of Regulation requires new cars to be equipped with gear shift indicators.
- The Renewable Energy Directive (RED) imposes stretching renewables targets for 2020 across the EU. This requires 10% of energy used in the transport sector to be from renewable sources by 2020. The requirement of the RED work alongside the Fuel Quality Directive which requires which will require a 6% reduction in the greenhouse gas intensity of transport fuels by 2020.

The impact assessment for the proposed CO2 limits for vans "Setting Emissions performance standards for new light commercial vehicles as part of the Community's integrated approach to reduce CO2 emissions from light-duty vehicles[65]", estimated that the reduction in the GHG emissions from LDVs in year 2020 for targets from 2012 to 2015 targets corresponds roughly to 5% of the total reduction effort i.e. .13.5 $MtCO_2$, required under the Effort Sharing Decision. For the purposes of the abatement cost analysis, this emission savings was distributed amongst Member States on the basis of new vehicle registration data (for vans <3.5 tonnes) from ACEA[66].

1.1.1 Small industry

For the non-ETS industries the following step had to be carried out:

- Correction of the original frozen SERPEC baseline for the effects of the economic recession and the shift in the base year from 2005 to 2010. Further the SERPEC baseline had to be split on ETS and non-ETS industries
- Split of the PRIMES 2009 baseline into ETS and non-ETS industries. This split was taken from the PRIMES projections.
- Correction of the original frozen efficiency SERPEC potentials for the effects of the economic recession and the shift in the base year from 2005 to 2010. Further the SERPEC potentials had to be split on ETS and non-ETS industries.

Effect of the recession on abatement potential

PRIMES provides activity data (value added and tons) for industry. It can be assumed that most of the changes in the activity levels between the PRIMES 2007 and the PRIMES 2009 baseline could be related to the effect of the economic crises. However, for the industrial sector there have also been considerable changes in the historic data which were not related to the economic crises. The effect of such differences in base level was not taken into account in the corrections. Further the reduced activity levels are correlated to lower capacity use and hence higher specific energy consumption and emissions. This effect was also integrated by considering the ration of emission levels.

Effect of shorter delivery timescales

The original SERPEC analysis used 2005 as the reference year. It is therefore necessary to update the estimates of the maximum implementation potential by 2020 to reflect the fact that a certain period has already elapsed. We assume that the annual uptake rates are unchanged, so that total uptake of measures is scaled back to reflect the elapsed time between 2005 and 2010. On this basis a scaling factor of approximately 10/15=0.66 is applied to the estimated maximum potential in 2020. However, not all of the potentials 2005/2010 have been realised autonomously. About 1/3 of these potentials

65 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SEC:2009:1454:FIN:EN:PDF
66 http://www.acea.be/images/uploads/ind/ind_0004.pdf

needed policy intervention. This ratio was derived from the EU Potentials Study which considered autonomous progress. Such policy intervention did, however, not materialise for non-ETS industries.

Split of the potentials in ETS and non-ETS industries

The split of the potentials in ETS and non-ETS industries was carried out based on the data established in the EU Energy Efficiency Potential study which made this distinction. Further, N_2O was assumed to be fully covered by the ETS. Potentials for F-gases where corrected for the aluminium industry which is under the ETS.

Calculation of the remaining abatement potential

A new FTRL is estimated for the non-ETS industry sector, which is consistent with the 2009 PRIMES projections, by applying the adjustment factor that was estimated above for the effect of the recession on the abatement potential. This is applied to the original FTRL emissions for the non-ETS industries that were used in the SERPEC analysis (and based on PRIMES 2008 model runs) in 2020. The output is a new FTRL, which takes into account the effects of the recession but not policy delivery.

We assume that the difference between the PRIMES 2009 baseline emissions for non-ETS industries at 2020 and this new FTRL can be largely explained by the influence of policies. Whilst it is possible that the take up of some abatement measures may have occurred anyway in the absence of policies, we assume that this is limited in the current analysis. Subtracting this value from the total abatement potential in 2020 gives a **new abatement potential.**

A number of EU wide policies are included in the baseline scenario for the PRIMES 2009 model version. The 2009 Baseline also includes policies and measures implemented in the Member States **by April 2009** and legislative provisions adopted by April 2009 that are defined in such a way that there is almost no uncertainty how they should be implemented in the future.

In addition to the above, some further policies have been proposed more recently, that were not captured in the 2009 PRIMES analysis.

Determination of remaining cost bands

The difference between the ‘old’ emission abatement potential in SERPEC and the remaining potential, i.e. the potential used up through the recession, the different reference year and new policies was subtracted from the cost bands. We assumed the same unit costs as calculated in SERPEC. This means that (additional) investment costs are the same, and fuel prices (to calculated revenues from energy savings) are also the same.

1.1.2 Waste

For waste, the 2010 baseline is significantly below the SERPEC baseline. Given the scale of emission reductions being delivered by current policies in this sector, in particular the Landfill Directive, it was assumed that no further abatement potential is available. This effectively assumes that the abatement measures identified in the previous SERPEC analysis will be exhausted in order to meet the requirements of current policies.

Appendix 4: Results matrix for comparing performance across Member States

ESD Illustrative Emissions Summary Matrix

	ESD target gap		Agriculture gap		Buildings gap		Small industry gap		Transport gap		Waste gap		Other gap	
	$MtCO_2e$	%	$MtCO_2e$	%	$MtCO_2e$	%	$MtCO_2e$	%	$MtCO_2e$	%	$MtCO_2e$	%	$MtCO_2e$	%
DENMARK	-4.5	-12.8%	-1.7	-17.7%	-0.0	-0.9%	-1.5	-38.5%	-0.8	-6.0%	+0.1	+5.7%	-0.6	-24.9%
IRELAND	-11.4	-24.6%	-3.5	-16.9%	-3.1	-33.1%	-1.6	-91.6%	-3.2	-25.5%	+0.1	+6.2%	-0.0	-6.6%
LUXEMBOURG	-2.4	-23.5%	-0.1	-13.9%	-0.2	-16.1%	-0.4	-36.6%	-1.7	-24.2%	-0.0	-18.6%	-0.0	-25.0%
SWEDEN	-3.8	-8.6%	-0.9	-12.1%	+0.7	+19.3%	-0.8	-13.8%	-3.2	-14.4%	+0.6	+34.0%	-0.2	-8.5%
AUSTRIA	-7.9	-13.1%	-1.1	-14.3%	-1.5	-11.2%	-3.6	-26.8%	-2.2	-10.0%	+0.6	+26.5%	-0.2	-8.8%
FINLAND	-1.8	-5.6%	-0.5	-8.6%	-0.0	-0.8%	-0.6	-11.8%	-0.5	-4.1%	+0.6	+23.1%	-0.9	-26.0%
NETHERLANDS	-7.6	-6.9%	-3.2	-17.1%	-0.9	-3.2%	-3.7	-30.9%	-1.5	-4.4%	+3.1	+51.9%	-1.4	-12.1%
UNITED KINGDOM	-8.6	-2.3%	-5.7	-12.0%	+4.8	+4.6%	-9.6	-17.3%	-6.7	-5.3%	+7.4	+33.0%	+1.3	+12.0%
BELGIUM	-10.8	-14.5%	-1.6	-15.5%	-3.6	-12.7%	-3.6	-81.9%	-1.4	-5.2%	-0.1	-5.7%	-0.5	-14.7%
FRANCE	-27.4	-7.2%	-10.6	-11.2%	-5.9	-5.7%	-11.1	-36.7%	-4.4	-3.4%	+3.0	+22.6%	+1.5	+12.6%
GERMANY	-14.1	-3.1%	-5.0	-8.6%	+5.7	+3.3%	-8.3	-20.8%	-9.7	-6.3%	+1.8	+16.1%	+1.4	+7.3%
ITALY	-32.2	-10.5%	-4.6	-12.7%	-10.8	-13.3%	-9.7	-28.8%	-10.3	-8.7%	+5.2	+27.0%	-2.0	-10.9%
SPAIN	-44.2	-18.9%	-7.6	-16.7%	-2.8	-9.5%	-11.9	-40.7%	-23.1	-22.4%	+3.5	+25.9%	-2.3	-19.2%
CYPRUS	-0.8	-17.8%	-0.1	-11.3%	-0.4	-89.8%	-0.0	-5.2%	-0.3	-16.9%	+0.1	+24.1%	-0.1	-22.3%
GREECE	+1.1	+1.9%	+0.0	+0.1%	-1.2	-10.8%	+2.5	+31.6%	-0.3	-1.4%	+0.7	+20.0%	-0.5	-6.9%
PORTUGAL	+5.6	+12.0%	+0.1	+1.0%	+0.9	+17.1%	+0.3	+6.7%	+0.1	+0.6%	+3.8	+53.4%	+0.5	+11.1%
SLOVENIA	-2.8	-25.6%	+0.2	+10.2%	+0.0	+1.3%	-0.4	-48.7%	-2.9	-66.4%	+0.5	+52.7%	-0.2	-41.2%
MALTA	+0.2	+17.7%	+0.0	+26.5%	+0.0	+1.1%	+0.0	+36.2%	+0.1	+15.4%	+0.0	+32.9%	-0.0	+37.3%
CZECH REPUBLIC	+5.4	+8.6%	+1.2	+13.4%	+1.8	+15.5%	+1.6	+10.2%	-1.7	-9.9%	+2.2	+65.1%	+0.4	+5.6%
HUNGARY	+4.0	+8.4%	+1.1	+11.9%	+2.1	+12.9%	-0.4	-23.5%	-2.5	-21.5%	+3.2	+72.1%	+0.5	+13.6%
ESTONIA	+0.1	+1.2%	+0.3	+21.7%	+0.1	+20.4%	-0.8	-187.8%	+0.1	+4.3%	+0.4	+50.5%	-0.0	-0.3%
SLOVAK REPUBLIC	-0.8	-4.1%	+0.7	+20.2%	+0.2	+4.3%	-1.2	-56.2%	-1.7	-33.1%	+1.3	+54.5%	-0.2	-12.5%
POLAND	-6.3	-4.1%	+3.6	+10.6%	+4.5	+11.4%	-7.3	-64.3%	-17.0	-49.9%	+6.6	+56.2%	+3.3	+12.9%
LITHUANIA	+1.4	+10.9%	+0.9	+23.0%	+0.3	+23.1%	-0.1	-13.9%	-0.8	-19.7%	+1.1	+58.9%	+0.1	+6.1%
LATVIA	+0.9	+10.7%	+0.4	+19.7%	+0.1	+13.3%	-0.0	-1.7%	-0.5	-17.8%	+0.7	+82.0%	+0.2	+33.4%
ROMANIA	+6.8	+9.5%	+4.0	+20.1%	+0.7	+5.6%	-1.7	-24.1%	-4.6	-38.3%	+5.4	+70.4%	+3.1	+24.2%
BULGARIA	+5.4	+20.9%	+1.2	+23.8%	+0.2	+10.9%	-1.2	-123.6%	+0.5	+7.0%	+3.7	+80.4%	+1.1	+16.2%
EU27	**-156.8**	**-6.4%**	**-32.5**	**-8.4%**	**-8.5**	**-0.8%**	**-75.2**	**-26.0%**	**-100.2**	**-10.2%**	**+55.6**	**+33.6%**	**+4.1**	**-4.4%**

Notes: Using PRIMES/GAINS baselines and projections and assuming all sectors need to meet the target reduction uniformly.

Key:

	Total ESD target		Sectors	
Colour coding key	**Policy gap, $MtCO_2e$**	**Policy gap, %**	**Policy gap, $MtCO_2e$**	**Policy gap, %**
Threshold between small and large gap	-8.0	-15.0%	-3.0	-15.0%

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