

Quantification of the effects on greenhouse gas emissions of policies and measures Reference: ENV.C.1/SER/2007/0019

Final Report





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ii AEA

Executive summary

At the European level a comprehensive package of policy measures to reduce greenhouse gas (GHG) emissions has been initiated through the European Climate Change Programme (ECCP). The first ECCP was established in 2000, and was enhanced in 2005 with the launch of the second ECCP. The goal of the ECCP is to identify and develop all the necessary elements of an EU strategy to implement the Kyoto Protocol.

Whilst the policies under the ECCP have been implemented for some time, there is a lack of quantitative information on the impact of policies and measures implemented under the ECCP on emissions of greenhouse gases to date. This project has been commissioned to address this issue. The work has been led by AEA in partnership with Ecofys, Fraunhofer ISI and the National Technical University of Athens.

The specific objectives of the project were as follows:

- Develop suitable methodologies for the ex-post quantification of the impact of policies and measures (PAMs) on GHG emissions on both Member State (MS) and European Community (EC) level, clearly identifying the steps, data and tools needed.
- Provide an ex-post quantitative and qualitative analysis of the EU Emission Trading Scheme (EU ETS) and other selected PAMs implemented under the ECCP.
- Provide concrete recommendations for the ex-ante analysis of future climate change related PAMs and for the revision of Decision 280/2004 and its implementing provisions (Decision 2005/116).
- Build capacity at Member State level.

Methodology development

The development of the evaluation methodologies comprised a number of sequential steps. Firstly, a review was undertaken of Member States' current capacity in ex-post evaluation. Secondly, the expost evaluation methods developed by Member States or other institutes were reviewed and evaluated. Thirdly, an evaluation methodology was developed for application within this study.

Experience and data availability

The review found a large variation in the level of experience between different MS, of which there were three groups: those with well developed capacity and expertise in ex-post evaluation (for example, they had undertaken ex-post impacts of their climate change strategy); those with some expertise in ex-post evaluation but in a more ad-hoc way (for example, had experience in evaluating a few individual policies); and those with limited or no experience in ex-post evaluation of climate change policies. In broad terms the EU15 Member States tended to have more experience in ex-post evaluations and more often had formalised monitoring and evaluation systems in place than the EU12 Member States.

From a sectoral perspective, experience in ex-post evaluation of GHG emissions was greatest for policies acting upon the energy demand sector. This included policies targeting emissions from the road transport sector, and also policies targeting emissions from buildings. Experience was also strong in the evaluation of emissions from the electricity generation sector. Fewer studies were found for the waste sector, and fewer still for the agricultural sector and for emissions associated with industrial gases. In the energy demand sector, the future requirements of the Energy Services Directive (ESD) were cited as an important stimulus for Member States to evaluate the impacts of their policies addressing energy consumption.

Most Member State had no formal rules for the ex-post evaluation of climate policies. This meant that the methodological assumptions and data sources frequently varied between different studies. Likewise, where cost effectiveness analysis had been performed as a part of the evaluation, the analytical basis frequently varied. Taken together, these factors reduce the comparability of the results from different evaluations, and therefore the usefulness of the results for EU policy makers.

AEA iii

Review of potential methodologies

There are currently no standardised methodologies or models for the ex-post evaluation of climate change policies at a European level. A number of methodologies can be used, and have been used, for policy evaluation. These can be broadly categorised as:

- Top-down methods, which generally use macro-level statistical data to evaluate the impact of measures.
- **Bottom-up methods**, which allow more detailed modelling of the impact of policies and measures by determining what kind of technology or behaviour is influenced by the measure and in which way.
- Integrated methods, which combine elements from both top-down and bottom-up methods.

Each methodology has different strengths and weaknesses. The suitability of a particular methodology is a function of a wide range of inter-related factors, and these factors will change from one evaluation to the next. Selecting the preferred method will inevitably involve making trade offs. Amongst other things, this will include the cost of performing the evaluation, and the accuracy of the results. A further trade off may be between the consistency of the methods (e.g. between Member States) and the extent to which the methods can consider detailed issues (e.g. local markets, or local geographical and climatic conditions).

For all methodologies the selection of key underlying assumptions has an important influence on the results. The importance of these assumptions may also vary according to the sector to which the methodology is applied. For example, a key methodological decision for policies targeting electricity generation is the choice of the reference technology (i.e. the emission factor for savings from the electricity generation sector).

Development of an integrated, tiered approach

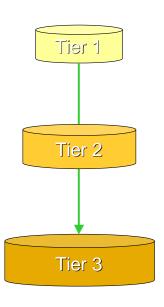
Each of the methodologies was evaluated for their suitability for use in this study. An important consideration was the requirement for the methodologies to reflect the varying levels of expertise in policy evaluation in Member States. This required an approach that was neither too complex (so required a large amount of resources) or too simplistic so did not adequately convey the complexity of the policy in the given Member States. It was also important to select methodologies that could actually be applied within the timescales and resources available to the study (taking into account constraints on data) but had the flexibility to be further refined in the future.

Taking these considerations into account, we concluded that the most appropriate methodology for the ex post evaluation of EU Climate Change policies within this study is an integrated (combining elements of both top-down and bottom up methods) and flexible (tiered) approach.

The approach developed by the team borrows from the principles presented in the IPCC Guidelines for National GHG inventories¹, and employs a methodology that is based on three tiers of growing detail and complexity. In general the data intensity, resolution of analysis, and accuracy of the estimate increases from Tier 1 to Tier 3.

iv AEA

 $^{1\ \} IPCC\ guidelines\ for\ National\ GHG\ Inventories,\ (2006),\ http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html$



- Based upon widely available aggregate statistical data which are updated on an annual basis
- Reflects EU average conditions e.g. EU wide default emission factors
- No disaggregation between National and EU policies, and other effects
- Based upon aggregate statistics with a greater level of resolution of the activity data (where available)
- Reflects country specific conditions e.g. national emission factor for electricity production
- Some examination of correction factors, e.g. autonomous development
- Detailed assessment of policy interactions
- Development of bespoke models or redevelopment of existing models
- Collection and analysis of additional data
- Aims to tackle complex methodological issues

The Tier 1 approach represents a high level assessment of the policy impacts. For most policies a top-down indicator based approach is used which draws on existing EU wide statistics. This means that the methods can be easily repeated without additional data collection. It can therefore provide a rapid estimate of GHG emission changes, utilising a limited number of easy to find input variables. It applies a number of simplifying assumptions to ease comparison between countries and policies, and consequently, may not reflect the full complexity of the policy in question. The ability of the Tier 1 approach to quantify policy impacts (as opposed to simply assessing changes in the variables that are targeted by a policy) will depend upon the policy under evaluation.

In contrast, the Tier 3 approach involves a much more detailed assessment of the policy impacts, using a much higher resolution of data (which is likely to require additional collection) and increasing complexity in the methods. It enables the analysis of policy effectiveness to be undertaken in a more comprehensive way, which may require the use of bespoke models and detailed bottom up data (on e.g. the number and type of measures installed) that is not currently collected and collated by statistical agencies. As far as possible the Tier 3 approach aims to consider all of the main methodological issues, and to isolate the impacts of the policy fully.

The Tier 2 approach provides an intermediate level of analysis. It aims to address some of the most important methodological issues that are unresolved in the Tier 1 approach, but it is still largely reliant upon existing established aggregate statistics. The extent to which the Tier 2 approach is able to isolate the policy impacts is therefore strongly reliant upon the availability and resolution of the data.

As far as possible, an iterative approach has been used in the development of the methods. This has meant that the results from the application of the Tier 3 approach have been used to improve the guidelines for the Tier 1 and Tier 2 approach. For example, the additional data that was collected as part of the Tier 3 approach has enabled a more robust estimate of the EU average conditions, which could then be applied in the Tier 1 approach.

Ideally, all of the policies would be evaluated using the most detailed (Tier 3) approach, since this would provide the most comprehensive understanding of the policy impacts. However, the Tier 1 or Tier 2 approaches can provide a useful first estimate where data or resources are scarce. The study has investigated how accurately policy impacts can be quantified using existing top down statistics (as part of a Tier 1 or Tier 2), without the need for a comprehensive Tier 3 approach.

Policy specific guidelines for ex-post evaluation were developed for each of the policies addressed under this study (see box below). The guidelines outline, step by step, how the methodological framework can be applied to the individual policies and measures.

AEA v

Policies for which methodologies were developed and applied under the study

Transport

- Voluntary agreement with car manufacturers to reduce CO2 emissions
- Biofuels Directive (Dir 2003/30/EC)

Energy sector and Industry

- RES-E Electricity production from renewable energy sources (Dir 2001/77/EC)
- Promotion of cogeneration (Dir 2004/8/EC)
- EU Emissions trading scheme (Dir 2003/87/EC) (including the linking Directive)
- Integrated pollution prevention and control (IPPC) (Dir 96/61/EC)
- Regulation (EC) No 842/2006 on certain fluorinated greenhouse gases

Households and Service

- Energy performance of buildings (Dir 2002/91/EC)
- Energy labelling of household appliances (Dir 2003/66/EC, 2002/40/EC, 2002/31/EC, 99/9/EC, 98/11/EC, 96/89/EC, 96/60/EC)

Waste

- Landfill Directive (Dir 1999/31/EC)
- Waste incineration Directive (Dir 2000/76/EC)

Agriculture

- Common rules for direct support schemes under CAP (Regulation (EC) No 1782/2003)
- Nitrates Directive (Dir 91/676/EEC)

Quantitative assessment of the policy impacts

A quantitative analysis was performed for 11 'case study' Member States selected for in-depth evaluation. In addition, a qualitative analysis was undertaken of the key factors that influence emissions but could not be captured within the quantitative approach.

Application of the methodologies

Application of the Tier 1 and Tier 2 methodologies involved the application of a spreadsheet model to collate and analyse the data. Since the Tier 1 and Tier 2 methods have been specifically developed to utilise existing datasets then no primary data collection was undertaken. However, this did require the manipulation and analysis of existing statistical datasets (e.g. Eurostat, UNFCCC, FAO etc). Tier 1 methodologies have been applied to all 13 of the ECCP polices and measures short-listed for detailed consideration. For certain policies the outcomes from the more detailed Tier 3 modelling has been used to refine the parameters within the Tier 1 and Tier 2 approaches.

In all cases the application of the Tier 3 approach required the use of specialised sector-specific models. It is unrealistic to believe that one model combines enough complexity in all sectors. On the other hand this raises questions, in how far policy interactions that concern different sectors, are reflected in the models.

It was not possible within the scope of this study to 'implement' Tier 3 methodologies for all of the policies. Instead we employed a range of new and existing models to demonstrate how a Tier 3 approach may be applied to a small selection of the policies. These examples demonstrate the level of analysis that might be performed as part of a Tier 3 approach.

The following measures were selected for detailed consideration using a Tier 3 approach:

o Voluntary agreements car manufactures (ASTRA model)

vi AEA

- Emissions Trading Directive (Econometric top-down/bottom-up approach for the analysis of the EU ETS impacts in the industrial sector, PowerACE model for the analysis of EU ETS impacts in the Power Sector)
- o Energy Performance of Buildings Directive (EPBD) (MURE simulation model)
- Directive on labelling of household appliances (appliance stock model as part of the MURE simulation model)
- o Biofuels Directive (Green-X model)
- RES-E Directive (Green-X model)

In addion to the above methods, a modified version of the PRIMES model has been used to refine and validate the tiered methodologies and to provide alternative estimate of the GHG impacts associated with the ACEA Agreement, the RES-E Directive and the Biofuels Directive.

Overall results

Results are presented for each of the individual policies, and for each of the separate methodologies. The values represent the estimated reduction in GHG emissions that can be associated with the individual policies, in accordance with the respective methodologies. This represents the difference between the actual observed emissions and the assumed emissions in the absence of the policy (i.e. the counterfactual).

Whilst the results have been generated using, as far as possible, a consistent methodological framework, there are number of reasons why the results of this study, for each of the individual policies, cannot be compared easily. These are described further below.

Firstly, the time frame considered may differ from policy to policy. Each policy has a different starting year: for example a policy like the European Directive for the Performance of Buildings (EPBD) entered into force in 2002 but will be fully transposed only in 2009 meaning that the main impact will occur in the future. Other policies, like the Directive for the promotion of renewables have already delivered impacts for a number of years or have spurred a very rapid growth in installed capacities.

Secondly, recent statistics are not available for some policies. This is particularly relevant for those policies that have the potential to deliver significant savings in a relatively short period of time. For certain policies, the actual impact in recent years may be considerably higher than the impact in the latest year for which data is currently available.

Finally, the relative complexity of the policies, and the availability of policy data, means that the methodologies are suited to certain policies more than others. Consequently, the relative uncertainty in the policy estimate is much greater for some policies than for others. In general, we advocate that the results are interpreted on a policy-by-policy basis, taking into account the unique circumstances of each individual policy.

For these reasons, we do not recommend that the results from the individual policies are replicated or compared without reflecting upon the relative uncertainties in the estimates. For a better understanding of the results for specific policies, we refer the reader to the individual policy chapters located in the Appendices to this report.

Taking into account these uncertainties, Table E1 compiles the ex-ante estimates of the ECCP impacts in 2010 and compares these with the results from our evaluation of the impact to date. The ex-post results are presented for each of the Tier 1, Tier 2 and Tier 3 approaches, with the values representing annual savings for the latest evaluation year available (specified for each policy). Results are presented for EU-15 and EU-27 where available. The policies are ordered according to the sector in which the savings arise. A sum of the results is also provided. However, it must be kept in mind that in order to compile this estimate, important choices had to be made on methodological options which are still open for debate. Also they comprise the sum of results from different years of impact. This sum should therefore be considered as indicative and cannot be considered as a definitive estimate of the impact of the policies investigated. It may nevertheless be useful to compare it in a preliminary way with the original ex-ante results to assess progress against expectations.

A traffic lights based colour coding has been employed to highlight the relative uncertainty of the estimates, allowing the values from the different policies to be presented in a single table. Values in

AEA vii

red cells are considered most uncertain, and should not be considered a robust assessment of the policy impacts. In contrast, the values in green cells, whilst not without limitations, are considered to be within a reasonable bound of uncertainty and the results can be used as a good estimate of the policy impacts. Values in Orange cells are deemed to be a fair approximation of the policy impacts, but the approach may need further development.

Allowing for these large uncertainties, the results obtained with the Tier 1 approach are of the same order of magnitude as the ex-ante estimates at 287 Mt CO₂ eq. for the EU15 when the impacts for the most recent year for which results are available (generally 2005-2007) are summed. Policy estimates derived from the Tier 1 approach tend to be the highest, frequently due to an insufficient correction for emissions reductions that would have happened anyway. This is mainly the case when the gap between Tier 1, Tier 2 and possibly Tier 3 is particularly large, e.g. in the case of the Landfill Directive.

The sum of the Tier 2 results is 113 Mt CO_2 eq. for the EU15, considerably lower than the Tier 1 result. This is partly due to the fact that not all policies considered were able to develop a Tier 2 approach (CHP Directive, IPPC, Labelling and EU ETS). Notwithstanding this issue, Tier 2 results are consistently lower as a result of the corrections introduced. The one exception of the EPB Directive, where the further refinement in Tier 2 approach results in a larger emission saving.

The Tier 3 approach indicates savings in the range of 194 Mt $\mathrm{CO_2}$ eq., so greater than the results for Tier 2. However, most of this difference can be explained by the inclusion of more recent data for the RES-E Directive in the Tier 3 approach. Whilst the estimates from the Tier 3 approach are more robust, they are not complete. Only a selected number of polices could be analysed. Also for an important policy such as the EU ETS only partial results are available to illustrate the methodologies. A complete analysis would show higher results.

For those results that are considered to be a reasonable estimate of the policy impact (see traffic light coding on table), the ex-post results for the latest year available are often considerably lower than the policy impact projected for 2010. In some cases (e.g. EPBD), recent implementation means that the bulk of savings will be achieved closer to 2010. However, for other policies (potentially ACEA and biofuels), it is possible that the ex-ante estimate has been over optimistic.

The decomposition analysis performed with PRIMES estimates the combined effect of the EU agreement with car manufacturers, the implementation of the Biofuels and the RES-E Directives to amount to a reduction of CO_2 emissions by close to 120 Mt CO_2 . The results from this analysis are very similar to (but slightly lower than) the results from the tiered methodologies for ACEA and Biofuels but significantly higher in the case of the Renewables Directive. This highlights the influence that data (e.g. different data sets), and methodological choices can have on the evaluation results.

viii AEA

Table E1: Comparison of ex-post and ex-ante estimates of GHG savings from selected policies

Mt CO ₂ eq.	Ex-ante estimates	Ex-post evalu	Ex-post evaluation estimates (annual savings in latest year)						
ССРМ	ECCP Review: annual savings in 2010 (EU-15)	T1	T2	T3 ³					
Voluntary agreements with car manufacturers	75 - 80	NE (EU27, 2005) 29.4 (EU15, 2005)	NE (EU27, 2005) 26.4 (EU15, 2005)	21.2/30.2 (EU27, 2005/2007) 17.9/25.4 (EU15, 2005/2007)	23.1 (EU27, 2005)				
Biofuels Directive (Dir 2003/30/EC) 1)	35 - 40	13.3 (EU27, 2007) 12.5 (EU15, 2007)	13.3 (EU27, 2007) 12.5 (EU15, 2007)	13.0 (EU27, 2007) 12.2 (EU15, 2007)	7.8 (EU27, 2005)				
		Energy S	Sector/Industry						
RES-E Directive (Dir 2001/77/EC) ²⁾	100 - 125	25.8 (EU27, 2005) 23.8 (EU15, 2005)	25.8 (EU27, 2005) 21.1 (EU15, 2005)	40.3/139 (EU27, 2005/2008) 34.1/118 (EU15, 2005/2008)	88.7 (EU27, 2005)				
Promotion of cogeneration (Dir 2004/8/EC)	65	61.2 (EU27, 2006) ⁽³⁾ NE (EU15, 2006)	NE	NE	NE				
EU ETS (Dir 2003/87/EC)	N/A	78.5 ⁴⁾ /21.7 ⁵⁾ (EU-15, 2006)	NE	4.5 (Germany, 2006) ⁶⁾	NE				
Integrated pollution prevention and control (Dir 96/61/EC)	60-70	176 (EU27, 2006) 155 (EU15, 2006)	NE	NE	NE				
F-Gases (Regulation EC No 842/2006)	23	NE	NE	NE	NE				
		Household	s/Service Sector						
Energy Performance of Buildings (Dir 2002/91/EC) 7)	35 - 45	83.8 (EU27, 2006) 33.5 (EU15, 2006)	156.5 (EU27, 2006) 44.2 (EU15, 2006)	0.0/31.7 (EU27, 2004/2010) 0.0/26.9 (EU15, 2004/2010)	NE				
Labelling Directive for electric appliances (Directive 92/75/EEC) 8)	26	21.5 (EU27, 2006) NE (EU15, 2006)	NE NE	13.3 (EU27, 2004) ⁹⁾ 12.1 (EU15, 2004)	NE				

² Factor Analysis PRIMES only carried out for three policies ³ Tier 3 estimates are only carried out for a selection of policies

Table E1 (continued)

Mt CO₂ eq.	Ex-ante estimates	Ex-post	estimates (annual savings	in latest year)	Factor Analysis PRIMES
ССРМ	ECCP Review: annual savings in 2010 (EU-15)	T1	T2	Т3	
		,	N aste		
Landfill Directive (Dir 1999/31/EC)	41	100.0 (EU27, 2006) NE (EU15, 2006)	30.5 (EU27, 2006) NE (EU15, 2006)	NE	NE
Waste Incineration Directive (Dir 2000/76/EC)	NE	0.8 (EU27, 2006) NE (EU15, 2006)	- 0.8 (EU27, 2006) NE (EU15, 2006)	NE	NE
		Ag	riculture		
Nitrates Directive (Dir 91/676/EEC)	10 10)	NE (EU27, 2005) 10.7 (EU15, 2005)	NE (EU27, 2005) 8.2 (EU15, 2005)	NE	NE
Common Agricultural Policy (Regulation EC No 1782/2003) 12)	2 11)	NE (EU27, 2006) 0.8 (EU15, 2006)	NE (EU27, 2006) 0.7 (EU15, 2006)	NE	NE
		All	sectors		
Sum ¹³⁾	472-527 (EU15)	287 (EU15) 482 (EU27)	113 (EU15) 225 (EU27)	194 (EU15) 231 (EU27)	- (EU15) 120 (EU27)

Notes:

Excluding large hydro. 2008 estimate based on installed capacities in 2008 as compared to 2005 (minus the capacities already installed up to 2003).

Excluding an assessment of the possible effects of indirect land-use change. Such effects, if taking place, may substantially reduce the impact calculated. Figures are, however, highly uncertain and require further investigation.

CO₂ savings based on primary energy savings. The Tier 1 approach assumes that CHP electricity production is replacing the average fuel mix of the EU-27 (fossil-fired public supply). It assumes further that CHP heat is replacing the marginal factor associated with heat from a natural gas-fired boiler with an efficiency of 85%. Savings relative to 2004, attributing them to the Directive. However, the impact of the CHP Directive is still non-existing and only expected from 2009/2010 onwards. There is a contribution of CHP to climate policy objectives regardless whether this contribution is policy induced or not.

Intensity approach.

⁵⁾ Direct projection of inventory data.

Includes only partial results for Germany and only the impacts in the power sector (dispatching effect only) and in the clinker production sector.

⁷⁾ T1/T2 results under the assumption that the EPBD has already produced impacts starting 2002. T3 makes the more realistic assumption that impacts will only start in 2008 taking into account delays in the implementation of the EPBD.

Table E1(continued)

Including existing labels which are estimated ex-ante to be around 20 Mt CO₂-eq.

Tier 3 results are based upon a more refined approach; however, data at a more refined level is only available to 2004.

10) The first ECCP quantified the potential savings from N₂O emission from soils in the EU-15 at 10 MtCO2eq in 2010 without allocating these possible savings to a particular policy.

The analysis has focussed two individual elements of the 2003 CAP reform only: the sheep and goat meat regime and the beef sector premia. Specifically, the change in livestock numbers arising from the reform in these sectors. Other important components have not been investigated within this study and would benefit from further investigation. In particular, the methodologies need to be extended to include impacts on carbon within soils and the broader impacts of land use change. Impacts in N2O emissions from soils and nitrate use are included in the impacts of the Nitrate Directive.

Based upon reductions in emissions from enteric fermentation (0.3 Mt CO2eq) and from anaerobic digestion (1.7 Mt CO2eq) estimated in the review of the ECCP. Further reductions were identified for emissions of N₂O from soils. These have been described in relation to the Nitrates Directive above.

13) The sums for the ex-post evaluations should be taken as indicative only. They combine results for varying years, based on particular methodological assumptions.

The colours in the fields for the Tier 1, 2, 3 approaches have the following meaning:

Red colour:	The approach provides only a rather approximate estimate of impacts and should not be considered a robust assessment
	of the policy impacts
Orange colour:	The approach provides a fair approximation to the impact assessment. However the approach may need to be worked out
	further. (This is for example the case for the EU ETS).
Green colour:	The results can be considered as a good estimate of the policy impact. However, frequently, still methodological choices
	have to be made, for example with respect to the emission factors. The data basis is, however, satisfactory to make these
	choices (This is for example the case of the RES-E Directive).

Abbreviations:

 MS_{sp} : Member State specific starting year for the ex-post evaluation

NE = not estimated

Sources: European Commission for the ex-ante estimates, this study for the ex-post estimates.

Overall, for certain policies we consider that the results derived from the application of a Tier 1 or Tier 2 approach provide a reasonable approximation of the policy impacts: see Table E2. Whilst the results derived for these policies are not without uncertainties, we consider that these uncertainties are within a reasonable bound that the Tier 1 or Tier 2 results can be used to provide an approximate estimate of the policy impact to date.

However, for certain other of the ECCP policies that were analysed, we do not consider that the results achieved by applying a simple Tier 1 or Tier 2 approach provide an accurate representation of the policy impacts. For these policies, the uncertainties in the estimates that are derived from applying a Tier 1 or Tier 2 approach are too great, and we recommend that a Tier 3 approach is developed in order to quantify the policy impacts within an acceptable bound of accuracy – see Table E2.

For a third group of policies, we consider it may be possible in the future to evaluate the policies using a Tier 1 or 2 approach. However, current limitations in the availability of data provide a barrier to the use of a more simplistic approach for the policy evaluation. Until additional data is made routinely available, a more extensive Tier 3 approach will be required for the evaluation of these policies, which will itself require additional data collection.

Table E2: Suitability of the tiered methodologies for evaluating the impacts of individual policies

Policies for which a Tier 1 and 2 methodology can be currently used to produce reasonable estimates of policy impact	Policies for which a Tier 1 and 2 methodology could in the future be used to produce reasonable estimates of policy impact	Policies for which a Tier 3 methodology is required due to the complexity of methodology or high resolution of data required
RES-E Directive Labelling Directive ACEA agreement Landfill Directive Biofuels Directive ¹	Nitrates Directive* CHP Directive* Energy Performance of Buildings Directive*	EU ETS* IPPC* Common Agricultural Policy (CAP) reform* F-gas Regulations* Waste incineration Directive*

^{*} At present there is insufficient data available for most of those policies to perform a complete evaluation. For the EU ETS, in principle most of the data is available but some important parameters such as elasticities for the demand of industrial products as a reaction to carbon pricing or the pass through behaviour for carbon prices of industrial and energy companies are insufficiently supported by empirical evidence.

Key findings from the application of the methodologies

The results from the analysis can be used to inform the development of future ex-post evaluation methodologies and initiatives. The main findings from the application of the methodologies cover a range of issues, but can be broadly related to 2 areas:

- Data requirements and availability
- Methodologies and methodological parameters

Data requirements

The availability of accurate, relevant and timely data is a prerequisite for the robust evaluation of policies and measures. However, the amount of data required in order to perform a robust evaluation of the impacts varies greatly between policies, depending on the complexity of the mechanisms involved and the coverage of the instrument.

For certain policies the **resolution**, **or granularity**, **of the data** was an important factor in determining the extent to which the policy could be evaluated without detailed modelling. This was particularly an issue for those policies that either acted upon a sub sector or where the emissions performance varied significantly within sub sectors. Whilst some of the evaluations were informed by data that was provided by Member States, in accordance with their monitoring requirements under the respective Directives, others used additional data sources. **In general, for most the policies additional supplementary data was required, over and above the current monitoring requirements, in order to perform a robust evaluation of the policy impacts.**

xii AEA

¹ Excluding any impacts associated with land use change

The collection of more refined data is important for ensuring the robustness of the emissions estimates, but is also important for isolating policy impacts from other contributory variables (e.g. structural changes in the sector that are unrelated to the policy impacts). This may require substantially more data to be collected for certain policies than for others. Importantly, for certain policies the isolation of the counter-factual emissions required data on the emissions-causing activities for a period prior to the policy implementation. This was necessary in order to isolate the policy impacts from pre-policy trends. Since data collection activities only begin once the policy has been implemented then this can create problems for any subsequent evaluations of the policies.

Another challenge was **access to data**. In some cases, data may be restricted e.g. commercially confidential data on industrial output or price data. In other cases the data required for the evaluation may be collected already by private sector organisations, but may not be accessible without payment.

A further consideration is the **timeliness of the data**. For example delays in reporting may mean that the impacts of recent activities may not be considered by the evaluation. For measures that have the potential to deliver savings over a relatively short period of time e.g. renewable energy, the impacts can increase significantly from one year to the next.

Finally, the **quality of the data** was found to be an important consideration in the development of the evaluation methodologies. Whilst emissions from energy consumption can be calculated with a reasonable degree of accuracy, emissions on non- CO_2 greenhouse gases, for example emissions from agriculture, are generally subject to a higher level of uncertainty. Whilst these uncertainties are known, and work is underway to improve the accuracy of the factors, this does have implication for the methodologies that are developed to quantify emissions reductions in these sectors. Specifically, where default emissions factors are applied, these may not adequately reflect the influence of the policies on the overall emissions.

Methodologies and methodological parameters

There are currently no fixed rules for what methodological assumptions should be made when carrying out an ex-post evaluation. Consequently, there is an element of subjectivity involved in the process. This leads to inconsistencies in the results of separate studies. It also makes it difficult to isolate the impact of key methodological decision on the overall results. Ultimately, this reduces the usefulness of the ex-post evaluation results to policy makers.

For some of the policies examined the **implementation of the policy** or regulation varied significantly from one Member State to the next. This included both the timing of the policy implementation, but also the nature in which the requirements were met. Differing assumptions on policy implementation lead to different evaluation results.

The influence of **policy overlaps** can also help to explain apparent variations in policy effectiveness between Member States. For example, measures implemented at a national level may have had a large impact upon greenhouse gas emissions prior to the implementation of the Directive. This may therefore reduce the potential (or most cost-effective potential) savings that remain to be delivered under the Directive.

The choice of **emission factor** has an important influence on the overall results. This is particularly relevant for those policies that deliver savings in the electricity generation sector. An important area of debate is whether to use emissions factors that represent the average or marginal generation technology (i.e. to consider which technologies have really been displaced by the new technologies in the day-to-day operation). There are similar issues relating to the choice of emissions factors in other sectors, particularly where the potential range in the values is large (e.g. life cycle emissions from different biofuels feedstocks).

There are a number of other methodological factors that can be potentially important for specific policies which may or may not be corrected for with additional data. In some cases adjustments can be made as part of the evaluation methodology to 'normalise' these variations, and isolate the influence of these variables on the overall outcome (e.g. temperature correction of savings from policies targeting energy demand of buildings).

AEA xiii

Recommendations

Building upon the key finding and conclusions from the study, a number of recommendations have been proposed for the further development of ex-post and ex-ante evaluation activities with the EU. This includes specific consideration of how the developments may be realised through amendments to the Monitoring Mechanism Decision and its Implementing Provisions.

Upscaling evaluation activity

To encourage Member States to perform regular and integrated policy evaluations and (re)appraisals, we recommend that the EC introduce a reporting requirement for MS to prepare a National Climate Change Policy Evaluation and Appraisal (NCCPEA) Report covering their most important measures or a specified set of EU policies.

Without reporting requirements set in legislation, policy evaluation and appraisal will continue to be ad hoc, unless required by national legislation, and methods may not be transparent. Reporting would stimulate evaluation activity by encouraging MS to report on their evaluation plans and activities.

Furthermore, reporting would make evaluation methods more transparent. This in turn allows the EC to compare and contrast MS results, to understand why results vary and to inform EC level evaluations. The information also provides a platform for MS to work together to overcome common difficulties and share best practice.

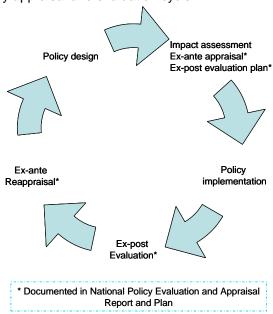
The National Climate Change Policy Evaluation and Appraisal Report

The National Climate Change Policy Evaluation and Appraisal (NCCPEA) Report should contain the results of policy appraisals and evaluations. Results should be presented in a common format using a standard reporting template.

The NCCPEA Report should be submitted on a regular basis. This report could be submitted alongside the projections report i.e. every other year: 2011, 2013, 2015. However, a less frequent interval may be more appropriate to limit the additional burden on Member States.

The report should encourage a cyclical approach to appraisal and evaluation of the policy (see Figure E1), whereby policies are re-appraised in the light of findings from the ex-post evaluation.

Figure E1 Policy appraisal and evaluation cycle



Whilst the NCCPEA report should, ideally, contain the latest evaluation evidence available, it should not necessarily mandate an evaluation of all policies and measures. It may be more appropriate to

evaluate certain policies less frequently than others, particularly where the costs of additional data collection are large. Reporting within the NCCPEA could therefore take into account existing policy evaluation cycles within Member States.

Likewise, MS should be given flexibility, at least initially, to choose the evaluation methodologies that they employ. There is an argument for including a requirement in the MM for MS to report impacts in accordance with a harmonised methodology and default set of methodological assumptions, since this will allow the full consistency of the results. However, it is clear from the work undertaken as part of this project that there is still debate on the most appropriate methodologies and methodological assumptions.

Further debate and discussion is required before harmonised methodologies or assumptions can be prescribed. We therefore recommend that the MM does not prescribe the evaluation methodologies to be used. However, it could require MS to report on the methodologies that they have used, the key data sources, methodological assumptions and main uncertainties in the estimates.

The NCCPEA report should, ideally, follow a consistent structure and format so as to enable a comparison of results from different member states. The report could include the following information:

a) List of policies evaluated

The report should include a list of the policies and measures that have been evaluated and are considered within the report. These should be identified as CCPMs or supporting national policies.

b) Quantitative estimates

The report should include a concise summary of the quantitative estimates of the policy impacts. The estimates should be provided in accordance with an agreed template. The template should allow key differences in the evaluation period, and the relative uncertainties of the methods, to be identified.

c) Scope of the policy evaluations

The report should include a clear description of the scope of the evaluation performed for each of the individual policies. This should include:

- A description of the evaluation period i.e. what is the assumed start data of the policy, and
 up to what point in time have the impacts been evaluated to. This should include any
 assumptions with respect to announcement effects or delay effects.
- A description of the **implementation** of the policy in the respective MS. This would include details of the scale and timing of implementation, the enforcement arrangements and details of any supporting initiatives. This should also include a qualitative description of the potential influence of key implementation assumption of the evaluation results.
- The report should also describe any boundary conditions relevant to the policies evaluated.
 For example, for certain policies it may be appropriate to consider indirect or life-cycle emissions.

d) Description of the data

The report should include a clear description of the data that has been used to underpin the policy evaluations reported. This may include the following information:

- Activity data
- Emissions factors (and their impact on the counterfactual)
- Data used to isolate the counter-factual
- Key data uncertainties
- Consistency with inventory data

e) Description of the methodologies

AEA xv

Methodological choices, such as emissions factors, can lead to discrepancies between Member States policy estimates and those derived at an EC level. To ensure the consistency and comparability of results, appraisals and evaluations should include an explanation of how the results have been derived and the main methodological assumptions used. This would also include a description of any adjustment factors that have been applied.

f) Future evaluations activities

Finally, it is important that monitoring and evaluation requirements are planned in advance of policy implementation to ensure appropriate monitoring data is collected over the lifetime of the policy to enable its future evaluation. The NCCPEA Report could therefore also include:

- a timeline of planned appraisal and evaluation activities for individual policies;
- details of the methodologies and data sets to be used;
- details of any primary data collection activities;
- details of any difficulties foreseen and how those difficulties will be overcome.

National system for policy evaluation and appraisal

The requirements described above could be further expanded to require MS to set up and report details of responsible institutions, processes, data flows and data management, QA processes etc for policy evaluation and appraisal. This would be akin to the requirements placed on Member States with respect to the setting up national systems for inventories in accordance with the UNFCCC. In this case, the requirement would extend beyond simply reporting policy impacts and the associated methodologies to setting up the institutional architecture to support such activities.

In this case, the national system would comprise the institutional, legal and procedural requirements necessary for monitoring and evaluating the effectiveness of climate change policies over time. Experiences from the setting up of national systems for emissions inventories suggest that this supporting framework is important for ensuring the quality of the inventories. It could therefore be argued that a similar system is necessary for ensuring the quality of data reported on policy impacts.

xvi AEA

Table of contents

1	Intro	oduction	1
	1.1	Study background	1
	1.2	Report Structure	2
2	Poli	cy context	3
	2.1	European Climate Change Programme (ECCP)	3
	2.2	Ex ante savings from ECCP	5
	2.3	Other policy drivers	9
3	App	roach	11
	3.1	Work programme	11
	3.2	Inception and scoping phase	11
	3.3	Review phase	13
	3.4	Methodology Development	18
	3.5	Methodology Implementation	22
	3.6	Results generation, reporting and development of recommendations	24
	3.7	Capacity building	25
4	Ove	rall results	26
	4.1	General overview of results: all sectors	26
	4.2	Transport sector	34
	4.3	Energy sector and Industry	43
	4.4	Households and Service Sector	61
	4.5	Waste	71
	4.6	Agriculture	77
	4.7	Key findings from the application of the methodologies	82
5	Ove	rall conclusions and recommendations	88
	5.1	Experience and capacity	88
	5.2	Data requirements and availability	89
	5.3	Methodologies and methodological parameters	95
	5.4	Recommendations for the evaluation of different types of policy instrument	101
6	Deta	ailed recommendations for the Monitoring Mechanism Decision	105
	6.1	Introduction	105
	6.2	Recommendations for the revision of the MM	106
	6.3	Developing experience and capacity	128
	6.4	Future activities	129
7	Ref	arancas	131

AEA xvii

Appendices

Appendix I Detailed policy methodology and results chapters

Appendix Ia Voluntary agreement with car manufacturers

Appendix Ib Biofuels Directive

Appendix Ic Electricity production from renewable energy sources

Appendix Id Promotion of cogeneration

Appendix le EU Emissions trading scheme

Appendix If Integrated pollution prevention and control

Appendix Ig F-gas regulation

Appendix Ih Energy performance of buildings

Appendix Ii Energy labelling of household appliances

Appendix Ij Landfill Directive

Appendix Ik Waste incineration Directive

Appendix II Nitrates Directive

Appendix Im Common Agricultural Policy reform

Appendix II Summary of the results of the decomposition analysis performed using the

PRIMES model

xviii AEA

1 Introduction

This is the final report submitted to the European Commission under the contract ENV.C.1/SER/2007/0019, which presents the results obtained from the project "Quantification of the effects on greenhouse gas emissions of policies and measures". The project has been led by AEA in partnership with Ecofys, Fraunhofer ISI and the Institute of Communication and Computer Systems (ICCS) of the National Technical University of Athens.

This report summarises the work done throughout the project, including the methodologies that have been developed and applied for each of the selected policies and measures, and the overall results. A separate report has been prepared to outline in more detail the methodologies that have been developed during the study. The detailed results from the application of these methodologies to each of the selected policies and measures, are presented in separate policy chapters in the appendices of this report. The appendices also include a paper outlining the results of the application of the PRIMES model to the ex-post evaluation of selected policies.

1.1 Study background

At the European level a comprehensive package of policy measures to reduce greenhouse gas (GHG) emissions has been initiated through the European Climate Change Programme (ECCP). The first ECCP was established in 2000, and was enhanced in 2005 with the launch of the second ECCP.

As part of the second ECCP a working group was set up to review the first ECCP. The objectives of the working group were to:

- Review the implementation of the climate change related EU-wide policies and measures;
- Assess their concrete implementation in Member States and the resulting actual and projected emissions reductions;
- Identify new opportunities for potential emission reduction.

The review found a significant variability in the implementation of polices and measures among Member States (MS), as well as in the actual trends for different sectors in the MS. It also indicated that the existing ECCP policies and measures database is, as yet, not detailed enough to fully assess the impacts of individual policies and measures on greenhouse gas emissions in a thorough quantitative manner. Thus, the working group in many instances had to limit their discussions to rather qualitative assessments.

This study has been commissioned to address the lack of quantitative ex-post estimates on the impacts of the policies and measures implemented under the ECCP on emissions of greenhouse gases within the EU. The specific objectives of the project are as follows:

- Develop suitable methodologies for the ex-post quantification of the impact of policies and measures (PAMs) on GHG emissions on both Member State (MS) and European Community (EC) level, clearly identifying the steps, data and tools needed.
- Provide an ex-post quantitative and qualitative analysis of the EU Emission Trading Scheme (EU ETS) and of selected PAMs implemented under the ECCP.
- Provide concrete recommendations for the ex-ante analysis of future climate change related PAMs and for the revision of Decision 280/2004 and its implementing provisions (Decision 2005/116).
- Build capacity at Member State level.

The scope of the study is broad and its successful delivery has required a number of significant challenges to be overcome. In particular, since there are currently no standardised methodologies or models for the ex-post evaluation of climate change policies at a European level, the study has been required to both *develop* methodologies and also to *implement* these methodologies. Inevitably, this has meant that the methodologies have undergone a number of iterations as new issues, or areas for harmonisation have been encountered. Within the resources available to the study it has been possible to take the methodologies further in some areas than in others. As such, certain issues have

not have been considered in as much detail as we would have liked and further areas of research remain. These uncertainties aside, we are confident that the work presented in this report provides an important first step in the development of consistent and comparable estimates of the ex-post impacts of policies and measures implemented under the ECCP.

1.2 Report Structure

In addition to this Section, the report is organised into the following sections:

Section 2 presents the policy context for the study. It describes the European Climate Change Programme and the component policies. It also provides a summary of the initial ex-ante estimates of the impacts of the Programme on emissions of GHGs, since these provide a benchmark against which the subsequent ex-post results can be compared.

Section 3 describes the overall approach that has been followed during the study. It provides a synthesis of the initial scoping and review phases of project, describing the selection of policies to be considered in detail and the selection of Member States as case studies. It also provides a brief review of the methodologies that are available to quantify the ex-post effects on GHG emissions of policies and measures. The findings from the review have been used to develop and refine the methodologies applied during the project.

Section 4 presents the results from the application of the methodologies to the policies considered for detailed assessment. The policies are evaluated using a three-tiered approach – which is applied consistently across all policies. The results are presented on a sectoral basis. Firstly, the overarching socio-economic trends for the sector are described. This is then followed by results of the three-tiered approach to an ex-post analysis from each of the policies analysed. The results of the ex-post analysis are systematically compared with ex-ante estimates. In each case the key uncertainties in the results are clearly described, linking them back to key uncertainties in methodological choices and in underlying data, identifying thus the fields for future action for each of the policies selected.

Section 5 describes the lessons learned from the exercise and recommendations for future improvements. It draws together the findings from each of the individual policies and presents a summary of the key recommendations for the design and subsequent evaluation of climate change polices. It is presents some ideas on how the outputs of this project can be taken forward in subsequent studies.

Finally, in Section 6 more specific recommendations are outlined for the EC's Monitoring Mechanism Decision. The Decision is currently under review with a view to making minor amendments to selected reporting requirements.

The report also includes two separate appendices

Appendix 1 contains individual chapters that outline the main results and research findings for each of the policies that have been considered as cases studies within the study. These chapters provide detailed information on the policy specific issues that have influenced the methodologies that have been employed, and the main uncertainties in the results. The main finding from the policy chapters are synthesised in Section 4 of the main report.

Appendix 2 contains a summary of the results of the decomposition analysis performed using the PRIMES model. The headline findings are summarised in Section 4 of the main report.

A stand-alone Methodologies Report describes the methodologies that have been developed during the project. The report also provides guidance for policy makers on ex-post evaluation, and tools to facilitate the implementation of a consistent approach the GHG policy evaluation.

Policy context 2

Under the Kyoto Protocol the European Community has committed to reduce its average annual collective greenhouse gas emissions in the commitment period (2008-2012) to 8% below base year emissions (1990 for CO2, CH4 and N2O, and 1995 for fluorinated gases). Only pre-2004 Member States (EU-15) are covered by the EU burden-sharing agreement which lays down differentiated emission limitations for each State. The 'new' (post-2004 accession) Member States have individual targets under the Kvoto Protocol4. In 2007 the EU27 made a firm independent commitment to achieve at least a 20% reduction of greenhouse gas emissions by 2020 compared to 1990, to be increased possibly to 30%, if an international agreement could be achieved for the post-Kyoto period after 2008-2012.

Member States are required, under Article 3 of the EU GHG Monitoring Mechanism Decision⁵, to devise and implement national programmes in order to fulfil MS and EC commitments under the UNFCCC and the Kyoto Protocol and to report actual and projected progress to the targets. The National Programmes are required to contain, amongst other details, information on national policies and measures to reduce emissions or enhance removals by sinks, including quantification and evaluation of the impact of PAMs. The Monitoring Mechanism Decision is currently under review with a view to making minor amendments to selected reporting requirements in advance of the next reporting deadline in 2011. A more substantial revision of the Decision will take place in advance of 2013 reporting to accommodate the 2020 targets.

European Climate Change Programme (ECCP) 2.1

The European Climate Change Programme (ECCP) was established in June 2000 to reinforce the ongoing actions by both Member States and the European Community. The goal of the ECCP is to identify and develop all the necessary elements of an EU strategy to implement the Kyoto Protocol. A key component of the ECCP was the identification of cost effective additional measures to help the EU meet its Kyoto Protocol target. These are known as common and coordinated policies and measures (CCPMs)⁶.

The first ECCP reviewed over 40 measures for their potential contribution to the Kyoto target. The programme estimated that a number of cost-effective options had a 'technical potential' to achieve savings of between 664 and 765 Mt CO₂eq in '2010' (average of emissions between 2008 and 2012). Put in context, 765 Mt CO₂ is equivalent to 14% of the base-year emissions⁷ reported for the EU-27 as a whole (based on data available from national greenhouse gas inventories as of 18 June 20088). A number of measures were identified across a range of sectors and included, for example, proposals for an EU ETS, EPBD, biofuels directive, energy efficient public procurement, and revision of the IPPC directive.

A progress report on the implementation of the ECCP was published in May 2003. The assessment showed a significant variability in the implementation of policies and measures amongst the Member States as well as in the actual emission trends for different sectors in the MS. It also showed the difficulty in assessing the impacts of individual policies and measures on greenhouse gas emissions in a thorough quantitative manner at EU and MS level.

In 2005, the European Commission launched the second European Climate Change Programme (ECCP II), establishing a number of stakeholder working groups to review ECCP 1 Progress and investigate new policy areas. The following revised ex-ante estimates of savings in 2010 were released for selected sectors:

⁴ These are an 8% reduction for most, except Hungary and Poland which have reduction targets of 6%. Cyprus and Malta do not have Kyoto

Decisions 2004/280/EC and the Implementing Provisions 2005/166/EC

⁶ CCPMs are policies and measures developed by the European Union that apply across Europe, as described in the 3rd National Communication of the EU to the UNFCCC in November 2001. The ECCP is the main (but not only) source of CCPMs that have an impact on GHG emissions, so that the EU-level directives and regulations included in the ECCP PAMs are a subset of those classified as CCPMs.

⁷ Cyprus and Malta and EU-27 do not have targets under the Kyoto Protocol and as such they do not have applicable Kyoto Protocol base years. Therefore 1990 data have been used for these two countries.

8 EEA, (2008), Annual European Community greenhouse gas inventory 1990 - 2006 and inventory report 2008, EEA Report No. 6/2008.

Table 2-1: EU ex-ante estimates in 2010 of GHG savings by sector

Sector	Mt CO₂ eq.
Energy Supply	236-278
Transport	152-185
Energy Demand	214-259
F-gas Directives	21
Agriculture	31

Sources: Energy Demand: Second ECCP Progress Report, April 2003, All other sectors: ECCP II Working Group Final Reports (2005/6)

In addition to CCPMs implemented by or strengthened through MS policies, many Member States have specific national policies and measures in place, which are not directly related to the EU initiatives. The linkage between the ECCP, between CCPMs and between national climate change policies is illustrated in the figure below.

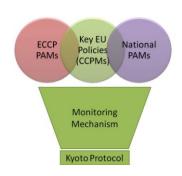


Figure 2-1 Illustration of the overlaps between climate change policies at EU and national level

Figure 2-2 further illustrates that the role of EU policy with respect to national policies and measures varies across Member States. We can see, for example, that Member States largely attribute the establishment of reinforcement of national policies on biofuels to the EU Directive on the Promotion of Biofuels while more than half of the EU-15 MS had landfill policies in place before the introduction of the Landfill Directive.

Figure 2-2 Member State implementation of CCPMs

CCPM	Austria	Belgium	Denmark	Finalnd	Frabce	Germany	Greece	Ireland	Italy	Netherland	Portugal	Spain	Sweden	š
Energy Supply: Taxation of Energy Products 2003/96/EC	R	N	В	R	В	В		В	R	В	N	R	R	B
Cross cutting: Emissions trading 2003/87/EC	N	N	R	N	N	N	N	N	N	N	N	N	N	R
Energy Supply: Promotion of electricity from resources 2001/77/EC	N	N	В	R	R	В	R	R	N	R	R	R	В	N
Energy Supply: Promotion of cogeneration 2004/8/EC	N	В	В	R	В	В	R	N	N	В	В	N	В	N
Energy consumption: Directives on energy labelling of appliances	N	N	В	N	N	N	N	N	R	N	N	N	N	N
Transport: Motorchallenge; voluntary EC programme			В			R		N		N			N	
Energy consumption: Energy performance of buildings 2002/91/EC	N	N	В	В	N	R	R	N	N	R	R	R	N	N
Energy consumption: Eco-management and audit scheme (EMAS) EC	N	N	N	N	N	N	R			В	N	N	В	
Energy consumption: Efficiency of hot water boilers 92/42/EEC	N	N	В		N	R	В	N		В	N	N	N	N
Transport: Transport modal shift to rail 2001/12/EC etc		N	R	N	В	В		N	N	В		N	R	N
Transport: Promotion of biofuels for transport 2003/30/EC	N	N	N	N	R	R	N	N	N	N	N	N	R	N
Transport: Consumer information on cars 1999/94/EC	N	N	R		N	N		N		N	N	N	N	N
Transport: Agreement with car manufacturers ACEA etc	N	N			R	R	R		В	N	N		N	R
Agriculture: Support under CAP (1782/2003)	R	В	Ν	N	R	NVR		N		N		N	N	N
Agriculture: Support under CAP - amendement (1782/2003)	R	В	N	N	R	WR		N		N		R	N	N
Waste: Landfill Directive 1999/31/EC	В	В	В	R	В	В	R	N	N	В	N	R	В	N

N	New National PAM implemented after CCPM was adopted
R	Existing National PAM re-enforced by CCPM
В	National PAM already in force before CCPM was adopted
	Not reported

Source: EEA, (2007), GHG Trends and Projections

2.2 Ex ante savings from ECCP

Whilst the focus of this study is clearly upon ex-post impacts i.e. the impacts of policies and measures to date, it is useful to consider the original ex-ante estimates of the project policy impacts. This provides a useful benchmark to assess whether the policies are on track to deliver the anticipated level of savings.

Two main sources of information are available on the projected ex-ante savings of the policies and measures within the European Climate Change Programme: estimates by the European Commission and estimates by Member States.

Error! Reference source not found. presents the European Commission's projected ex-ante savings. The savings are in general the result of expert judgements made by the working groups of the European Climate Change Programme or consultants in 2002, based on expected uptake of measures or reaching certain (indicative) targets as specified in the Directive and do not take account of all of the detailed provisions of proposals or adopted measures.

Estimates made by Member States on the projected savings from climate change policies and measures are captured within the ECCP database. This database compiles details of the policies and measures as reported by Member States under the UNFCCC and is freely available on the internet ¹⁰. The database covers the relevant sectors energy, industrial processes, agriculture, forestry, waste and cross-cutting policies and provides detailed and complete information on Member States' actions on climate change.

Table 2-3 summarises the ex-ante estimates of the projected savings from those CCPMs that are projected to deliver the greatest savings by 2010. It includes estimates made by Member States, on the basis of the data captured within the ECCP database. Whilst it is not the aim of this study to examine differences in estimated savings between MS estimates and those provided by the European Commission, it is clear from **Error! Reference source not found.** and Table 2-3 that there are large variations between the estimates.

⁹ See Methodologies Report for a description of the relationship between ex-post savings and ex-ante projections.

¹⁰ http://www.oeko.de/service/pam/

Table 2-2 European Commission ex-ante estimates of GHG impact of policies and measures

Cross sutting		ıction potential CO₂-eq.)	Stage of implementation / timetable			
Cross-cutting	in 2010 in the EU-15	in 2020 in the EU-27	comments			
EU Emission Trading Scheme	N/A	N/A	In force. First phase (2005–07). Second phase (2008–12). Planned third phase (2013–20). ETS cap will lead to a 21% reduction in emissions in 2020 compared to 2005 levels ¹¹ .			
Revision of the monitoring mechanism	N/A	N/A	In force			
Link Kyoto flexible mechanisms to emission trading	N/A	N/A	In force			
Energy supply						
Promotion of electricity from RES-E (2001)	100-125 ¹²		In force.			
(New) Renewable energy Directive		600-900 ¹³	In force.			
CCS Directive	N/A	0.875 ¹⁴	In force.			
Directive on promotion of cogeneration	65 ¹⁵		In force			
Further measures on renewable heat (including biomass action plan)	36-48 ¹⁶		Biomass Action Plan, Dec 2005, over 20 further actions planned. Renewable heat included in proposed new Directive on renewable energy			
Intelligent Energy for Europe: programme for renewable energy	N/A		Programme for policy support in renewable energy			
Developing the internal energy market	80-120 ¹⁴		Amendments to a number of directives ¹⁷ to continue to help complete the internal energy market.			
Energy demand						
Directive on the energy performance of buildings	35-45 ¹⁴		In force Monitoring and review			
Directive on the energy performance of buildings (recast)		190-290 ¹⁸	Currently in second reading; agreement expected for December 2009.			
Directive requiring energy labelling of domestic appliances	1 ¹⁴ N/A 10 ¹⁴ 15 ¹⁴		In force: monitoring and review Consultation on amending Directive held in 2008.			
Framework Directive on eco-efficiency requirements of energy-using products		200 ¹⁹	In force; preparatory studies for daughter directives underway;			
Directive on energy end use efficiency and energy services	92 ²⁰		In force. National Energy Efficiency Action Plans adopted in all EU-27.			

¹¹ This amounts to an approximate reduction of over 0.4 GtCO₂ based on verified emissions in 2005 (First Phase). Note the actual reduction will be larger as the scope of the scheme has been expanded in subsequent Phases. The reductions from the EU ETS should not be double counted with

other policies, which may also affect the participants either directly or indirectly.

12 Second ECCP progress report April 2003 http://ec.europa.eu/environment/climat/pdf/second_eccp_report.pdf

13 Directive on the promotion of energy from renewable sources, Citizens' Summary, 23 January 2008

14 EUROPEAN PARLIAMENT, CCS, text adopted at the sitting of 17 DEC 2008 (P6_TA-PROV(2008)12-17). The original figure refers to a cumulative estimate of 7 Mt CO2_eq by 2020. Assuming that the effect starts in 2012 when the Directive is expected to enter into force, we calculated the presult as the district the 2003 entire the 2003 entire the 2004 enter the participants.

calculated the annual saving by dividing the 2020 saving by 8 years.

15 Proposal for a Directive of the European Parliament and of the Council on the promotion of cogeneration based on a useful heat demand in the Proposal for a Directive of the European Familianism and of the Council on Find-Lise Energy market

16 COM (2005) 628 final 'Biomass Action Plan, December 2005

17 Decision No 1229/2003/EC, Regulation (EC) No 807/2004, Directive 2003/54/EC & 2003/55/EC, Regulation (EC) No 1228/2003

18 Energy performance of buildings – impact assessment on the revised directive SEC(2008) 2864

19 Proposal for a directive on Eco design of EuP, COM (2003) 453 final 20

20 Decision No 1229/2003/EC, Regulation (EC) No 1228/2003

21 Exercise 20 Secretary 20 Secretary

Proposal for a Directive of the European Parliament and of the Council on End-Use Energy Efficiency and Energy Services, COM(2003) 739

			ALA/LD00011/1 IIIai Nop			
		ction potential	Stage of implementation / timetable /			
Cross-cutting	in 2010 in the	O ₂ -eq.) in 2020 in the	comments			
	EU-15	EU-27	Comments			
Action Plan on Energy efficiency as a follow-up to the Green Paper	N/A	20 2.	Launched Oct 2006 ²¹ . Identifies 10 priority actions to achieve up to 20% energy savings by 2020.			
Action under the directive on integrated pollution prevention and control (IPPC) on energy efficiency	Not known		Reference document on Best Available Techniques regarding Energy Efficiency now finalised and will be adopted in 2008.			
Intelligent Energy for Europe programme for energy efficiency	N/A		Programme for policy support in energy efficiency			
Public awareness campaign on energy efficiency	N/A		Supporting program as part of Intelligent Energy for Europe: In implementation			
Programme for voluntary action on motors (Motor Challenge)	30 ¹⁴		Supporting programme for voluntary action on efficient motor systems			
Public procurement	25-40 ¹⁴		EU Handbook developed for guidance for increased energy efficient public procurement			
Transport						
Fuel quality Directive		62.5 ²²	First implemented in 1998. Revisions adopted in December 2008			
Directive on the promotion of transport bio-fuels	35-40 ¹⁴		In force			
Voluntary agreements with European, Japanese and Korean car manufacturers.	75-80 ¹⁴		Implemented			
Strategy for Car CO ₂		50 ²³	Adopted			
Infrastructure charging for heavy goods (revised Eurovignette)	N/A		Adopted			
Shifting the balance of transport modes	N/A		Package of measures in implementation			
Fuel taxation	N/A		In force Focus on EU harmonisation of taxation, not on CO ₂ reduction; ongoing review			
Directive on mobile air conditioning systems: HFCs	See regulation on fluorinated gases		In force			
Inclusion of Aviation in EU ETS		183 ²⁴	Adopted. Will include all flights from 1/01/2012			
Public procurement of vehicles		1.9 ²⁵				
Industry						
Regulation on fluorinated gases	23 ²⁶		In force			
IPPC & non-CO ₂ gases	60-70 ¹⁴		In force In 2008 the Directive was codified.			
Waste						
Landfill Directive	41 ¹⁴		In force			
Waste Framework Directive			Adopted. Launched December 2005 ²⁷ , including a revision of the original waste Directive of 1975, revised in 2008.			
Directives on waste electrical and electronic equipment (WEEE)	35 ²⁸		In force. Revised directive in 2008			
Research and development						

²¹ COM(2006)545 – final 'Action Plan for Energy Efficiency: Realising the Potential'
22 Estimate based savings of 1% of baseline transport emissions in 2020 from
http://ec.europa.eu/environment/climat/pdf/climat_action/analysis_appendix.pdf
23 Questions and answers on the EU strategy to reduce CO₂ emissions from cars, MEMO/07/46. The original figure refers to a cumulative estimate
of 400 MtCO2eq by 2020. Assuming that the effect starts in 2012 when the decision is expected to enter into force, we calculated the annual of 400 MtCO2eq by 2020. Assuming that the effect starts in 2012 when the decision is expected to enter into force, we calculated the annual saving by dividing the 2020 saving by 8 years.

24 Inclusion of Aviation in the EU Greenhouse Gas Emissions Trading Scheme (EU ETS), Summary of the Impact Assessment, SEC(2006) 1685

25 Directive on the promotion of clean and energy efficient road transport vehicles, 2005/0283 (COD)

26 Regulation proposal on certain fluorinated greenhouse gases, COM (2003) 492 final

27 Thematic Strategy on Waste Prevention, COM (2005) 666 and 667 (final)

28 Value in 2011 - Directive on waste electrical and electronic equipment (WEEE), (recast) Impact Assessment, {COM(2008) 810}, {SEC(2008) 2023}

^{2933}}

		ction potential	Stage of implementation / timetable /
Cross-cutting	in 2010 in the EU-15	in 2020 in the EU-27	comments
R&D Framework Programmes	N/A	2027	In force. Under the 7 th Framework programme (FP7), which runs from 2007 to 2013, a budget of EUR 53.2 billion will be allocated over the entire period. Over 2.3 billion to energy related R&D activities ²⁹ .
Competitiveness and Innovation Framework Programme (CIP)			CIP runs from 2007 to 2013 with a total budget of EUR 3.6 billion. The CIP is divided in three operational programmes two of which are related to energy and climate change ³⁰ .
Structural and cohesion funds			
Integration climate change in structural funds & cohesion funds	N/A	N/A	The Community Strategic Guidelines highlight investments to promote Kyoto commitments, including renewable energy, energy efficiency and sustainable transport systems as eligible areas for support. About EUR 48 billion are planned to co-finance projects on climate change in the 2007–2013 Cohesion Policy.
Agriculture			
CAP health check (2003 reform) Rural development policies Market policies	60-70 ³¹ 12 ³³		Adopted. In 2008 the EU Commission decided to move to new changes to the CAP.
Rural development policy	N/A		Rural development policy for 2007–13 focus on: Improving competitiveness Improving the environment Improving quality of life and encourage diversification of the rural economy.
Support scheme for energy crops	N/A		In force, to be abolished as from 2010
N ₂ O from soils	10 ¹⁴		Improved implementation of the nitrates Directive
Proposed soil Directive	N/A	N/A	The European Climate Change Programme (ECCP) Working Group on Sinks Related to Agricultural Soils estimated this potential at equivalent to 1.5 to 1.7% of the EU's anthropogenic CO ₂ emissions during the first commitment period under the Kyoto Protocol ³²
Forests			
EU Forest Action Plan	N/A	N/A	Adopted. The Forest Action Plan presented in June 2006 builds on the EU's Forestry Strategy adopted in 1998.
Afforestation and reforestation:	14 ¹⁴		Possibility for support through forestry scheme of rural development
Forest management (various measures)	19 ¹⁴		Possibility for support through forestry scheme of rural development, dependent on national implementation.

European Commission Cordis, http://cordis.europa.eu/fp7/energy/home_en.html

Competitiveness and Innovation Framework Programme, http://ec.europa.eu/cip/docs/factsheets_en.pdf

From ECCP working group on agriculture and sub-group on carbon sinks related to agricultural soils. Some of potential for bioenergy crops will be covered within potential from biofuels, cogeneration from biomass, further promotion of RES-H etc.

Thematic Strategy for Soil Protection, COM(2006)231

Table 2-3 Member States' ex-ante estimates of GHG impact of policies and measures

ССРМ		s savings from the ember States	MS estimated savings in MtCO2 equivalents)				
	2005 ?	2010 ?	2005	2010			
RES-E Directive	GR, LU, LT, NL, SE	AT, BG, CZ, ES, FR, GR, HU, IE, IT, LT, LU, LV, NL, PT, SI, UK	6	61.8			
EU ETS	DK, ES, FI, LU, NL, SE	AT, CZ, DE, ES, FI, FR, IE, IT, LU, NL, SI, SK, UK	10	107.5			
Kyoto Protocol project mechanisms	None	AL, FI	0	11			
Energy performance of buildings	LUX, NL	CZ, DE, FR, HU, IT, LV, PT, SI, UK	0	28.2			
Promotion of cogeneration	GR, LT	CZ, DE, GR, HU, IE, LT, PT, SI,	1	15			
Voluntary agreements with car manufacturers	NL	DE, FR, GR, IE, IT, PT, UK	0.2	28.6			
Landfill Directive	CZ, ES, NL, SK	CZ, DK, EE, FI, GR, IE, IT, LT, PT, SI, SK	3	7.3			
Biofuels Directive	ES, GR, LT	AT, DE, GR, IE, IT, LT, LU, PT, SI, SK, UK	0.5	32.1			
IPPC	ES	IT, LT, NL, SI	2.7	5.6			
Energy Labelling Directive	NL	GR, IT, NL, SI, UK	0.3	4.3			
F-gas regulation (Reg No 842/2006)	NL	FI, IE, NL, SE, SK	0.5	1.5			
Nitrates Directive	HU, NL	NL, SK	0.4	0.9			
Common rules for direct support schemes under CAP (Regulation (EC) No 1782/2003)	NL	BG, IE, NL	0.1	2.9			

Source: Member State estimates published in the ECCP database (extract March 2009). For EC estimates see Table 2-1.

One observation from the table is that for all CCPMs, EU estimates of 2010 emission reduction potentials for the EU-15 are significantly higher than the total impacts estimated by Member States as part of their national reporting. This may be explained by the fact that estimated policy impacts are only provided by a limited number of Member States. The ECCP database should therefore be considered a partially representation of the full ex-ante impacts.

This finding also reinforces the need for the European Commission to provide their own estimates of the impacts of the European Climate Change Programme – since reliance upon Member State estimates will not provide a complete coverage.

2.3 Other policy drivers

It is important to recognise that the policies and measures that are covered by the European Climate Change Programme are also influenced by a range of other policy objectives i.e. climate change mitigation is unlikely to be the only driver. Indeed for certain policies climate change mitigation is not the primary driver, with other policy drivers more important.

For example, the primary focus of the Nitrates Directive is the protection of water bodies from nutrient loading, with any reductions of N_2O emissions from soil a secondary benefit. Likewise the 2003 CAP Reforms include a wide range of economic, social and environmental objectives, of which the mitigation of GHG emissions is just one component.

Restricted - Commercial AEA/ED05611/Final Report

A number of climate policies will also have an important influence upon other environmental objectives. Of particular note is the interrelationship between air quality and climate change objectives where there is a large potential for synergistic effects. Consequently, policies are frequently appraised to reflect the impacts on these duel-objectives³³.

Furthermore, certain broader energy objectives influence policies relating to the energy supply and energy demand sectors. For example, energy efficiency policies and policies to promote indigenous energy supplies are important to deliver energy security objectives. Likewise certain social objectives, such as fuel poverty, are important in some member states.

On this basis it is important to recognise that the design, implementation and operation of ECCP policies and measures are done so as to optimise a range of welfare benefits. Therefore, the focus of this report on GHG abatement represents just a sub-set of the total impacts.

³³ For example, the NEC-Directive Review has considered the cost-effectiveness of the abatement techniques including both air quality (SO2, NOx, PM) and greenhouse gas pollutants (CO2 etc).

3 Approach

This section illustrates the overall approach that has been followed during the study. It provides a synthesis of the initial scoping and review phases of project, describing the selection of policies to be considered in detail and the selection of Member States as case studies. It also provides a brief review of Member States experience in the ex-post evaluation of climate change mitigation policies. A short description is also provided of the methodology development and implementation stages of the project, and also the capacity building activities.

The Methodologies Report, which accompanies this report, provides further details on the methodological framework and tiered approach that has been developed during this study. This includes technical guidelines that explain the methodologies that have been used to evaluate each of the policies and measures that we have considered in detail.

3.1 Work programme

The programme of work comprised a number of inter-linked activities that can be broadly described in terms of six sequential phases. These are:

- Phase 1: Inception and scoping
- Phase 2: Data collection and review
- Phase 3: Methodology development
- Phase 4: Methodology implementation
- Phase 5: Results generation, reporting and development of recommendations
- Phase 6: Capacity building

Each of these phases is described in more detail below.

3.2 Inception and scoping phase

This initial phase was concerned with scoping out the detailed programme of work. Following an initial review of the scope and scale of policies within the ECCP, and of Member States experience in the ex-post evaluation of climate change policies and measures (PAMs), two key decisions were made during the scoping phase. These were:

- 1. the selection of policies to be consider in detail during the project
- 2. the selection of Member States to use as case studies.

3.2.1 Selection of policies for detailed consideration

It was necessary to select a number of policies under ECCP that could be used as case studies to test the ex-post evaluation methodologies. The following policies were short-listed, in agreement with the project steering group³⁴, so as to largely cover all sectors:

Transport sector

- Voluntary agreement with car manufacturers to reduce CO2 emissions (ACEA, KAMA, JAMA)
- Biofuels Directive (Dir 2003/30/EC)

Energy sector and Industry

- RES-E Electricity production from renewable energy sources (Dir 2001/77/EC)
- Promotion of cogeneration (Dir 2004/8/EC)
- Large combustion plant Directive (Dir 88/609/EEC)
- EU Emissions trading scheme (Dir 2003/87/EC) (including the linking Directive)

AEA 11

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³⁴ The project steering group was composed of members of Unit C.1. of DG Environment of the European Commission.

- Integrated pollution prevention and control (IPPC) (Dir 96/61/EC)
- Regulation (EC) No 842/2006 on certain fluorinated greenhouse gases

Households and Service Sector

- Energy performance of buildings (Dir 2002/91/EC)
- Energy labelling of household appliances (Dir 2003/66/EC, 2002/40/EC, 2002/31/EC, 99/9/EC, 98/11/EC, 96/89/EC, 96/60/EC)

Waste

- Landfill Directive (Dir 1999/31/EC)
- Waste incineration Directive (Dir 2000/76/EC)

Agriculture

- Common rules for direct support schemes under CAP (Regulation (EC) No 1782/2003)
- Nitrates Directive (Dir 91/676/EEC)

Cross-cutting

End-use efficiency and energy services (Dir 2006/32/EC)

The rationale for the selection of the policies is as follows:

- GHG emission savings potential: the selected policies account for more than three quarters
 of the potential savings that can be attributed to CCPMs.
- Sectoral coverage: the policies are chosen from the sectors estimated to have the largest impact upon emissions of greenhouse gas in 2005 and 2010. The policies therefore cover all of the key sectors³⁵.
- **Temporal coverage:** there is a mix of older and newer policies, e.g. the Landfill and Biofuels directives, respectively.
- **Geographic coverage:** there is a good spread of Member States that have estimated savings from these policies.

Subsequently, the Directive on end-use efficiency and energy services was removed from the list on the grounds that a large programme of work (EMEEES) had been set up specifically to develop methodologies to evaluate energy savings under this directive³⁶. Therefore, whilst the methodologies developed during this parallel programme were considered within our study, it was considered important not to duplicate effort. The Large Combustion Plant Directive was also removed from the short list later in the study to allow more resources to be focused on the other policies.

3.2.2 Selection of case study Member States

Given the large scope of the study in terms of sectors and policies it was not be possible to evaluate the impacts for each of the European Union's individual Member States³⁷. Instead, the detailed evaluation of the short-listed ECCP policies and measures was undertaken for a representative sample of Member States.

The criteria used to ensure that the selected Member States were representative of the whole EU were:

- Emission levels
- Geographic area
- Economic situation
- Level of implementation of ECCP policies
- Population

 $^{^{\}rm 35}$ The only exception is the Forestry sector

http://www.evaluate-energy-savings.eu/emeees/en/evaluation_tools/index.html

³⁷ The exception is the analysis that it performed using the PRIMES model, where analysis was possible for each of the EU 27 Member States. For some policies, where data were readily available, nevertheless EU27 and EU15 figures were provided. In other cases impacts were scaled from a sample of countries covering a large share of the impacts to the whole set of European countries.

13

In addition, we included the following screening criteria:

- Projected GHG impacts in 2005 (to ensure that the largest impacts overall are captured)
- Existing ex-post evaluations (to enable comparison with modelled estimates)

Collectively, these criteria reflect the significance of the emissions/savings, and to some extent also the key socio-economic drivers of emissions. In addition, the inclusion of the screening criteria helped to ensure that sufficient information would be available from the selected Member States to model the impacts of the individual policies and measures, and that the most significant impacts to date were considered.

Applying these criteria, the following Member States were selected for in-depth evaluation of the GHG impacts of PAMs;

- **Germany**, **France**, **Spain**, **Italy** and the **United Kingdom** on the basis of their high overall emissions, and high projected savings from implemented policies.
- Denmark, Austria and the Netherlands since they have each undertaken an ex-post evaluation of their existing GHG policies and measures³⁸
- Poland, Czech Republic and Romania since these represent the most significant of the non-EU 15 Member States in terms of absolute emissions.

The final choice of Member States was discussed and agreed with the project steering group. It was also agreed that in the event that the Member States and the ECCP PAMs chosen for the detailed analysis do not match well, it would be necessary to look at other Member States with better data available for the particular ECCP PAM in question.

3.3 Review phase

The review phase of the study was designed to inform the subsequent stages of the study in two ways. Firstly, the review assessed Member States' current capacity in ex-post evaluation. This ensured that the methodologies that are employed are consistent, as far as possible, with existing activities, and applicable to all of the Member States. Secondly, the ex-post evaluation methods developed by Member States or other institutes were reviewed and evaluated to inform the approaches developed within the study, and to record the alternative estimates for comparison purposes.

The following sections describe in more detail the approach, methods used during this analysis and the results obtained.

3.3.1 Data collection

The data collection involved two main activities. The first was a desk-based review of existing literature. This included published peer-reviewed papers and also the grey literature. In addition, evaluations undertaken directly by ministries within Member States, or other independent international organisations, were also reviewed. The literature reviewed was supported by direct consultation with Member States. Initially a questionnaire was disseminated by e-mail, which was then followed up with selected Member States by phone interviews.

The following data and subjects where investigated:

- Level of capacity within MS in the evaluation of GHG PAMs
- Existing evidence on the ex-post impact of GHG PAMs
- Methodologies available for the ex-post evaluation of GHG PAMs

Member States capacity in ex-post evaluation

Drawing upon the evidence collected as part of the initial discussion with Member States, and the review of published documentation, it is possible to draw a number of broad conclusions with respect

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³⁸ the United Kingdom also meet this criteria

to the level of capacity within Member States for performing ex-post evaluations of PAMs. These are summarised below.

We note that these conclusions are based upon the review phase of the project, which was carried out early in the work programme, so some of the Member States specific conclusions may not necessarily reflect the current levels of experience/capacity³⁹.

It is also important, to distinguish the experience in ex-post impact analysis from the experience in exante analysis: Member States may have developed more frequently ex-ante analysis capacities than ex-post analysis capacities.

General conclusions

There is a large variation in the level of experience between the different Member States. In broad terms the EU15 Member States tended to have more experience in ex-post evaluations and more often have formalised monitoring and evaluation systems in place than the EU12 Member States, although not in all cases. One of the reasons that was put forward to explain this is the fact that a number of the new Member States expect to meet their Kyoto target without the need for additional policies or measures. Therefore, they are less concerned with the effectiveness of their climate change polices than those countries that are further from their Kyoto targets.

Although evidence is limited, where ex-post evaluations have been performed they appear to have been led by the ministries responsible for individual sectors and policies rather than prescribed centrally. In some cases, evaluations have been performed in accordance with general guidelines. Responsibility for the monitoring and evaluation of climate change policies, where it exists, is often spread across a wide range of government ministries depending on the sector and policy concerned. This also applies to the generation of statistical data.

In terms of monitoring data, several Member States reference the data provided to the European Commission as part of the progress reporting requirements of Directives as the best source of data. This implies that data is most abundant where there is an explicit requirement e.g. to comply with the Directive.

From a sectoral perspective, experience in ex-post evaluation appears to be greatest for the energy demand sector and for renewables. The future requirements of the Energy Service Directive were cited as providing a stimulus for Member States to evaluate the impacts of their policies addressing energy consumption. Likewise, the regular review of the impacts of renewables as required by the RES-E Directive has triggered an intensive data collection for different types of renewables.

A number of countries cited statistical data, which could potentially be related to policies and is likely to be available for most Member States. For example, the registry of allocated emission allowances and annual verified emission reports under the EU ETS Directive, emissions inventories, energy balance statistics, reporting under EU ETS, UNFCCC, Monitoring Mechanism Decision etc.

14 AEA

³⁹ For example, we are aware that Ireland is currently implementing a programme of ex-post evaluation.

Member State specific findings

Member States could be broadly classified into three groups: those that had well developed capacity and expertise in ex-post evaluation (for example, had undertaken ex-post impacts of their climate change strategy); those that had some expertise in ex-post evaluation but in a more ad-hoc way (for example, had experience in evaluating a few individual policies); and those with limited or no experience in ex-post evaluation of climate change policies.

In the first group were Denmark, the UK, the Netherlands, Austria and Germany. All of these countries had carried out relatively comprehensive ex-post evaluations of their climate change policies. The Czech Republic was also in the process of beginning a comprehensive ex-post evaluation of their climate package at the time of carrying out this review, and more recently Ireland has begun a similar evaluation exercise.

A number of Member States had carried out bespoke ex-post evaluations for an individual policy or collection of policies, but on a much smaller scale to the group above. Finland (energy efficiency), Sweden, Spain, Slovenia, Hungary (energy efficiency policies between 2000 and 2004), Slovakia, Ireland (demand management programme), Italy, Poland (Renewables policy between 2000 and 2004) fall into this grouping.

More qualitative evaluations have been carried out by Bulgaria, Slovenia and Spain (also quantitatively for some policies). Slovenia and Spain report the use of expert groups to evaluate policies.

Other countries, such as France, were known to have undertaken some ex-post studies, but details were not readily available. The above findings should therefore be considered partial, and may not capture the full extent of evaluation activities – particularly where the evaluation results have not been published.

Existing evidence on the ex-post impact of climate change policies and measures

Certain Member States have carried out cross-sectoral ex-post evaluations of their national climate change programmes or strategies. As part of the review phase a comparison was made between the methodologies, data and results used within these studies. The comparison focussed upon the evaluations that have been performed of the national climate change strategies in Austria, Denmark, the Netherlands and the United Kingdom. Further details on the methods and results from these evaluations were presented in the Background Report for this study, and are not repeated here.

The analysis highlighted that the methodological basis for assessing of climate change policies is often very different from one evaluation to another. For example, Austria breaks some of its savings results into sub-sectoral groups, such as into savings made by policies governing different renewable technologies (hydropower, biomass, wind). Others, such as the UK and the Netherlands, report savings calculated for individual policies, but not necessarily by technology. In some cases the savings are apportioned to the source sector e.g. energy generation sector, and in other cases the savings are allocated to the end use sector e.g. households.

These differences make direct comparisons difficult and require care in drawing firm conclusions between different ex-post evaluation results. On the basis of the data collected and the analysis performed the following conclusions were drawn:

- Existing evaluations have tended to focus upon national policies and measures rather than policies under the European Climate Change Programme. Whilst it is possible to determine the impacts of some ECCP PAMs e.g. the voluntary agreement for passenger cars, for other policies it will be more difficult to disentangle the impacts from the existing national policy packages.
- The analysis suggests that the impacts of the existing national policies are significant. It is therefore important than any methodologies are able to distinguish the impacts that result from the national policies from those that result from the ECCP measures. An assumption that the ECCP is the only polices driver would lead to an overestimate of the actual policy impact of the ECCP measure. On the other hand it is clear that there are also many cases were ECCP measures and

national measures are intimately interlinked. In these cases a separation process may be arbitrary, and where attempted the assumptions used must be transparent.

- Where cost effectiveness analysis has been performed as a part of the evaluation process, the analytical basis varies between evaluations. This can lead to a large variation in the reported impacts, and reduce the comparability of the results.
- Of particular note is the sensitivity of results to the inclusion of external costs in the valuation. In some cases, the external costs may be significant, and lead to a switching of the policy from delivering a net social cost for each t CO₂e saved to providing a net social benefit. This can have a large influence upon the ranking of the options.

3.3.2 Review of methods

The background analysis, and the review of existing evaluations, highlighted that a variety of methods are available for the ex-post evaluation of policies under the ECCP. These can be broadly categorised into three main types of approach:

- The use of **top-down methods** that generally use macro-level statistical data in order to evaluate the impacts of the measures.
- ➤ **Bottom-up methods** which allow more detailed modelling of the impacts of policies and measures by parametrising the measure impacts, i.e. by determining what kind of technology or behaviour is influenced by the measure and in which way.
- Integrated methods combine elements from both top-down and bottom-up methods

The full spectrum of methods, however, is much broader depending on the degree of detail available for the data. For example, Nilsson et al (2007), Nilsson et al (2008) and Eichhammer (2008), summarising the results from the EMEES⁴⁰ project, identified 9 separate methodologies, classified into four separate types - two top-down and two bottom-up approaches.

The background analysis focused on the strengths and weaknesses of each of the available approaches and on its applicability to different constraints and policy evaluation goals of this study. A more detailed description of the methodologies that were identified during the review phase, and their applicability to this study is provided in the Methodologies Report.

Overall the review of methods drew the following conclusions:

There is no single approved methodology for the ex-post evaluation of climate change polices and measures PAMs, or for environmental policy evaluation generally. A number of methodologies can be used, and have been used, in the evaluation of climate change policies and measures. These can be broadly categorised into **top-down**, **bottom up** and combined (or **integrated**) methods.

The suitability of a particular methodology is a function of a wide range of inter-related factors, and these factors will change from one evaluation to the next. The most important factors are typically the **overall scope and resolution of the evaluation**, and the **availability of resources** to perform the evaluation. Other important considerations include:

- The amount of and resolution of the data available;
- The number of competing policy instruments;
- The coverage of sectors required;
- The coverage of counties required;
- The number of actors influenced by the policy;
- The level of expertise required to perform the evaluation;

16 AEA

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⁴⁰ http://www.evaluate-energy-savings.eu/emeees/en/home/index.php

• The type of policy instrument.

Where the evaluation is required to consider a technology based policy, in a sector with a number of competing policy instruments, then it might be most appropriate to collect detailed bottom up data on installed measures to evaluate the policy impacts. This has been the approach taken with the evaluation of certain energy efficiency policies and measures in the Netherlands and the United Kingdom.

However, where the evaluation is required to estimate the impacts across a range of sectors, with variable levels of policy data then a top-down approach might be the most efficient method of determining the initial policy impacts. This was the approach used by Austria in the evaluation of its National Climate Strategy - although it was supported by a series of bottom-up sector specific evaluations. In practice most methods involve both top-down and bottom-up elements, at the very least to calibrate the results, or provide a consistency check on the findings. Combining top-down with bottom-up evaluation in a consistent manner, remains, however, a very challenging task.

Selecting the preferred method will inevitably involve making trade offs. Amongst other things, this will include the cost of performing the evaluation, and the accuracy of the results. A further trade off may be between the consistency of the methods (e.g. between Member States) and the extent to which the methods can consider detailed issues (e.g. local markets, or local geographical and climatic conditions).

The selection of the methodology is important, as it will influence the overall results. A number of different outcomes can be obtained depending on the choice of method and reference situation. It is therefore important that the methodology employed and key underlying assumptions are clearly specified.

Within each of the methodologies the selection of the key underlying assumptions are important. This may also vary according to the sector to which the methodology is applied. For example, for policies targeting electricity generation, the choice of the reference generation mix is a key methodological decision. For certain policies this reference factor is embedded in the quantification methodologies. Whilst this will ensure that the methodology for the ex-ante and ex-post is consistent and also ensure consistency across Member States, it will not necessarily be consistent with the actual emissions from the sector.

3.3.3 Evaluation of methodologies

A series of criteria were drawn up to evaluate the strengths and weakness of the available approaches, to inform the selection of the methods to be developed further during this study. The evaluation was carried out at a high level since the applicability and effectiveness of a particular method to one policy may differ to that of another policy. The emphasis was therefore upon the high level framework. The evaluation criteria were:

- Applicability The methodology or methodologies should be applicable to the ex-post evaluation of different policy instruments, different sectors and across all Member States.
- Consistency The methods should make use of existing national and international data sources and data collection frameworks. In particular, the methods should be consistent with National Inventories and Registries⁴¹. It will also be important to take into account any ongoing or proposed data collection activities e.g. the requirements of the Energy Services Directive.
- Transparency The methods should be transparent and simple, i.e. policy makers should be
 able to work out for themselves how the impacts are determined. This will include a clear

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⁴¹ The requirement of consistency with national inventories may have a very important implication for some policies: e.g. for biofuels, analysis based on the life cycle or the investigation of indirect land-use change is not consistent with the way in which the inventories have been designed which have the territorial principle as a main guiding element. Nevertheless, such issues may have an important impact on the appreciation of a policy and cannot be neglected in a policy analysis, similar to policies that may have a beneficial impact on climate change (e.g. shifting cars to Diesel fuel) but a negative impact on health (particle emissions from Diesel cars). The linkage of the methodologies with national inventories is discussed more fully later in this report.

disaggregation of the policy impacts upon emissions, from the impacts of other socioeconomic variables. Nevertheless, the requirement of simplicity need to be distinguished from the notion of simplistic, given the complexity of policy interaction for some policies, e.g. the EU Emission Trading Scheme.

- Robustness The methods should be based upon robust principles, with uncertainties clearly identified and a far as possible quantified.
- Policy relevant The methods should be able to explain the impact of EU climate change
 policies at the national and/or sectoral level. It will also be important to understand the impact
 of ECCP PAMs as opposed to other national policies.
- Complexity The methods should be sufficient develop to ensure a robust quantification of the GHG whilst not being too complex. The methods should not require a large amount of new data or expertise. However, it must be emphasised that for some policies, some sectors and in a variety of Member States data collection is clearly underdeveloped.
- **Flexibility** The methods should be sufficient flexible to deal with variable data quality and also be able to be adjusted to reflect updated assumptions.

Building upon the review of the strengths and weaknesses of the respective methodologies the team concluded that an integrated approach (combining elements of both top-down and bottom up methods) is the most appropriate methodology for the ex-post evaluation of the EU climate change policies. However, as described above, the extent to which a given methodology can actually be applied is largely determine by factors such as the availability and resolution of data, which may vary from one policy to the next. A key consideration was therefore what is achievable within this study (given the current constraints on data) and what are the recommendations for future monitoring to enable improved evaluation of policies in the future.

3.4 Methodology Development

On the basis of the results of the preparatory work, a basic methodological framework was developed for application within the study. The framework was designed to take advantage of the respective strengths of the top-down and bottom up methods, and to provide the flexibility to deal with differing amounts and resolution of data across the policies and sectors considered. It was also designed to be pragmatic, since it had to enable a first estimate of the GHG impacts of the policies and measures within the timescales and resources available to the study.

The initial framework was presented and discussed with stakeholders from the EU Commission and member states on February 26th, 2008, during a workshop held in Brussels, Belgium. Feedback was solicited and gathered on the general framework and on evaluation issues and options associated with individual policies.

The inputs obtained during the preparatory work and the workshop led to the development of a series of policy specific guidelines. In essence these guidelines described how the methodological framework could be applied to the individual policies and measures. Alongside the policy specific guidelines a more general guidance document was prepared on the main methodological issues associated with ex-post evaluation.

Initial drafts of the guidelines were circulated to stakeholders, who were invited to review and validate the proposed methods and to refine the guidelines. A number of questions, comments and proposals were put forward by stakeholders. This feedback was very valuable and led to the modification and improvement of some of the methodologies, for example, by characterising better the data constraints and uncertainties and improving the clarity of the guidelines.

The draft guidelines were then implemented to provide a first quantitative estimate of the impacts of the selected policies in the case study Member States. This followed an iterative process, whereby the implementation of the guidelines provided further insight on the applicability, strengths and

weaknesses of the proposed methodology, which in turn lead to further revisions of guidelines and associated quantification methods.

The policy specific guidelines, and the more general guidance on ex-post evaluation, can be found in the Methodologies Report.

3.4.1 Overall approach: Three tiers of growing detail and complexity

An important factor that emerged during the background analysis and the workshop is that resource constraints are an important consideration when developing suitable methodologies for ex-post policy evaluation. Methods may become increasingly complex and resource demanding with disproportionate increases in the quality of estimates. Furthermore, the availability and quality of data can vary from one Member State to the next, from policy to policy, and between sectors.

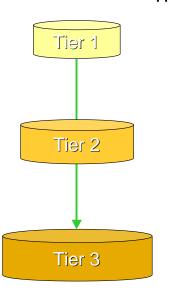
The methodological approach also needed to reflect that Member States had varying levels of experience and expertise in policy evaluation. At the same, Member States did not want to be restricted to a specific methodology which may either be too complex (so require a large amount of resources) or too simplistic so did not adequately convey the complexity of the policy in the given Member States (e.g. where National policies supported to EU policy).

Taking these considerations into account, we concluded that an integrated approach (tiered approach, combining elements of both top-down and bottom up methods) if applied in a flexible manner, is the most appropriate methodology for the ex post evaluation of EU Climate Change policies within this study.

The approach borrows from the principles presented in the IPCC Guidelines for National GHG inventories⁴², and employs a methodology that is based on **three tiers of growing detail and complexity**. In general the data intensity, resolution of analysis, and accuracy of the estimate increases going from Tier 1 to Tier 2 to Tier 3.

Ideally, all of the policies would be evaluated using the most detailed (Tier 3) approach, since this would provide the most comprehensive understanding of the policy impacts. However, in developing the guidance we have been conscious that resources are not always available to perform detailed analysis, so we have sought to develop a flexible approach that allows the adoption of a basic approach (Tier 1 or Tier 2) where data or resources are scarce. Indeed one of the wider aims of the study has been to investigate how accurately the policy impacts can be quantified using existing top down statistics (as part of a Tier 1 or Tier 2), without the need for further data collection.

Figure 3-1 The 3-tiered approach to ex-post evaluation



- Based upon widely available aggregate statistical data which are updated on an annual basis
- Reflects EU average conditions e.g. EU wide default emission factors
- No disaggregation between National and EU policies, and other effects
- Based upon aggregate statistics with a greater level of resolution of the activity data (where available)
- Reflects country specific conditions e.g. national emission factor for electricity production
- Some examination of correction factors, e.g. autonomous development
- Detailed assessment of policy interactions
- Development of bespoke models or redevelopment of existing models
- Collection and analysis of additional data
- Aims to tackle complex methodological issues

⁴² IPCC guidelines for National GHG Inventories, (2006), http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html

The Tier 1 approach represents a high level assessment of the policy impacts. For most policies it represents a top-down indicator based approach, drawing upon existing EU wide statistics. This means that the methods can be easily repeated without additional data collection. It can therefore provide a rapid estimate of GHG emission changes, utilising a limited number of easy to find input variables. It applies a number of simplifying assumptions to ease comparison between countries and policies, and consequently, may not reflect the full complexity of the policy in question. Therefore, the ability of the Tier 1 approach to quantify policy impacts (as opposed to simply assessing changes in the variables that are targeted by a policy) will depend upon the policy under evaluation. A Tier 1 assessment is therefore best suited for situations in which time and resources available are limited, and when the goal is to rapidly gain information on a specific target variable, but where a precise estimate of the impacts specific policy is not required or not yet available.

In contrast, the Tier 3 approach involves a much more detailed assessment of the policy impacts, using a much higher resolution of data (which is likely to require additional collection) and increasing complexity in the methods. It enables the analysis of policy effectiveness to be undertaken in a more comprehensive way, which may require the use of bespoke models and detailed bottom up data (on e.g. the number and type of measures installed) that is not currently collected and collated by statistical agencies. As far as possible the Tier 3 approach aims to consider all on the main methodological issues, and isolate the impacts of the policy fully.

The Tier 2 approach provides an intermediate level of analysis. It aims to address some of the most important methodological issues that are unresolved in the Tier 1 approach, but it is still largely reliant upon existing established aggregate statistics. The extent to which the Tier 2 approach is able to isolate the policy impacts is therefore strongly reliant upon the availability and resolution of the data.

As far as possible, an iterative approach has been used in the development of the methods. This has meant that the results from the application of the Tier 3 approach have been used to improve the guidelines for the Tier 1 and Tier 2 approach. For example, the additional data that was collected as part of the Tier 3 approach has enabled a more robust estimate of the EU average conditions, for application in the Tier 1 approach.

3.4.2 Development of guidelines

As indicated above, guidelines were developed for each of the policies and measures selected for detailed consideration The structure of the guidelines followed the tiered approach described above, providing explanations on the methodology adopted, detail guidance on Tier 1 and 2 calculations and discussing data and uncertainty factors (see guideline template below – a more detailed discussion of the guidelines and the guidelines text is available in the Methodologies Report). Detailed guidelines were not developed for a Tier 3 approach given the increased complexity of these methods, however, illustrative Tier 3 methodologies were developed an implemented for a selection of the case study policies.

Guideline Template

[Short title]

1. Official title of the Directive/Regulation

2. Short outline of contents of the Directive/Regulation

2.1 Relevant reporting requirements under the Directive/Regulation

3. Policy interaction

EU policies

[Link between the EU Directive/Regulation and other EU policies, in other words what does the polices landscape look like at an EU level, for the target sector(s)]

National policies

[Link between the EU Directive/Regulation and the national policies, in other words how does the EU directive work on the national level, and how is it linked to national policies]

Also indicate start year from which EU policy is considered to have an impact.

4. IPPC emission categories affected

[list any related inventory activity data available - check CRF tables / UNFCCC webpages]

5 Methodological approach

[Within each tier list the methodological issues and parameters that need to be covered in order to ensure proper evaluation of the Directive and indicate the assumption made for each. Tier 1 should identify all issues but need not quantify them all (correction = 0)]

5.1 TIER 1 - based upon EU wide values

5.2 TIER 2 - based upon MS specific values

5.3 TIER 3 - based upon detailed statistics/data and analysis

6. Issue to consider for future evaluations

[Data gaps, requirements to build into future revised Directives]

Annex A: explanations for main methodological assumptions

Determination of the policy impact since the introduction of the directive/regulation Uncertainty analysis

Data sources

Annex B: Detailed elaboration of TIER 1 and TIER 2 approach

3.4.3 Linkage with inventories

Under the UNFCCC (United Nations Framework Convention on Climate Change) participating countries are required to implement an emissions inventory that records historical emissions of greenhouse gases. Therefore, statistical information is available on the overall historical changes in GHG emissions that have occurred over the period during which the ECCP PAMs have been implemented.

As part of the development of the methodologies explicit consideration has been given to the potential linkages with these national GHG emissions inventories. As shown in the guideline template above, reference is made in each of the policy guidelines to the emissions categories that are affected by the respective policy.

However, whilst the inventories provide a comprehensive database of the emissions arising in the sectors targeted by the policies, based upon a consistent set of guidelines, they have been designed for emission reporting and not for policy assessment. Consequently, the emissions inventories have some limitations when used for policy evaluation.

Some Member States have in place monitoring and tracking systems related to specific policies, such as information on the number and capacity of renewable energy devices installed, or the number and type of new cars registered. Some of this data can be directly related to data within the emissions inventories – so firm linkages between policies and the inventory data can be made. However, this relationship is seldom straightforward. More frequently policies will act upon several target sectors, or will act upon sub-sectors that cannot easily be isolated from the activity data within the inventory. In addition, several policies may act upon the same activities, making it difficult to disentangle the impacts of individual policies – and this is without any adjustments for the influence on non-policy parameters on the emissions trend. In other cases important emissions impacts may arise beyond the territorial boundary, so will not be captured within the national inventories.

Whilst these difficulties mean that linking changes in the inventory to individual policies is far from straightforward it does not discount the usefulness of the inventories in providing a robust database that can be used the underpin the policy evaluations. Therefore, as far as possible, the evaluation methodologies have been developed to at least ensure consistency with the national inventories.

In implementing the guidelines a number of 'data-related' issues were identified. These relate to both the availability and quality of the data. Many of these issues relate to the data that is available from the emissions inventories and other data repositories (e.g. Emission Trading System (EU ETS) Community Independent Transaction Log). These issues are discussed further in Section 5.2.

Overall, the development of methodologies to evaluate policy impacts and the further development of emissions inventories are mutually supportive activities. Therefore, encouraging the ex-post evaluation of policies is only going to reinforce the importance of robust emissions inventories.

3.5 Methodology Implementation

The previous section outlined the approach that has been followed in developing the methodologies for the ex-post evaluation of the ECCP policies and measures. This is the first objective of the project. The second objective of the project is to implement the methodologies, to test them, and to enable a first estimate of the ex-post impacts of the selected policies and measures.

The development and application of the methodologies are closely interlinked tasks. Our approach has been: to develop the methodologies based upon currently available data and methods; to disseminate the methods to stakeholder and request feedback; to refine the methods based on the stakeholder feedback; to test and apply the methods, and finally; to refine the methods based on the results of the initial applications.

There are three strands of analysis that have been applied to test and refine the methodologies. These can be defined as:

- application of Tier 1 and 2 methodologies using bespoke spreadsheet models that replicate the calculations in the policy guidelines
- application of Tier 3 methodologies using detailed models which are described in more detail in the corresponding Tier 3 reports
- application of the PRIMES energy model to some policies to carry out a factor analysis on the sectoral level

The rationale for applying three different stands is that it enabled a comparison of the results, and an understanding of the key limitations of the methodologies and most important methodological issues. For example, the Tier 1 and Tier 2 approach provide a relatively simplistic methodology that is easily repeated, but may not convey the full complexity of the policy in questions. The Tier 3 modelling allows some of the detailed methodological issues to be investigated further, and provides a useful insight into the accuracy of the more simplistic Tier 1 and Tier 2 approaches. Finally, the use of PRIMES allows the estimates for the energy policies derived using the bespoke sector/policy models to be compared with the outputs from an integrated macroeconomic model. The PRIMES analysis also allows some examination of the wider socio-economic drivers for the energy sector that are less well captured in the Tier 1/2/3 methods.

Each strand of the analysis has sought to quantify the impact of individual EU policies on the emissions of each of the 11 Member States chosen as case studies and, where possible, the EU as a whole. In addition, the analysis has explicitly considered the overall uncertainties in the methods and

associated result. This includes uncertainties related to data, but also the impact of key methodological choices upon the overall results.

3.5.1 Application of Tier 1 and Tier 2 methods

Application of the Tier 1 and Tier 2 methodologies has effectively involved the implementation of the policy specific guidelines. For each of the policies a spreadsheet model has been developed to collate and analyse the data. Since the Tier 1 and Tier 2 methods have been specifically developed to utilise existing datasets then no primary data collection has been undertaken. However, this did require the manipulation and analysis of existing statistical datasets (e.g. Eurostat, UNFCC, FAO etc). The Tier 1 and Tier 2 methodologies have been applied to all 13 of the ECCP polices and measures that were short-listed for detailed consideration. For certain policies the outcomes from the more details Tier 3 modelling has been used to refine the parameters within the Tier 1 and Tier 2 approaches.

The results of the Tier 1 and Tier 2 analysis has provided an important understanding into the circumstances when a simplified top-down methodology can provide a reasonable estimate of the policy impacts, and the circumstances where a more refined analysis (including additional data collection) is required. This is discussed further in Section 4.7.3.

3.5.2 Application of Tier 3 methods

The Tier 3 approach represents a detailed assessment of the policies impacts using additional bottomup data, and explicitly considering the influence of the key methodological issues. In many cases the application of a Tier 3 approach required the use of models which are frequently specialised for a given sector. It is unrealistic to believe that one model combines enough complexity in all sectors. On the other hand this raises questions, in how far policy interactions that concern different sectors, are reflected in the models.

Whilst the policy guidelines include an initial description of the approach that may be used as part of a Tier 3 assessment of the policy impacts (i.e. the additional data to be collected, methodological issues to be resolved), it was not possible within the scope of this study to define in detail or 'implement' the guidelines for each of the polices within each of the case study Member States. Instead we have employed a range of new and existing models to demonstrate how a Tier 3 approach may be applied to a small selection of the policies. These therefore represent an illustration of the level of analysis that might be performed as part of a Tier 3 approach.

The following measures have been selected for detailed consideration using a Tier 3 approach:

- Voluntary agreements car manufactures (ACEA etc.) (ASTRA model)
- Emissions Trading Directive (Econometric top-down/bottom-up approach for the analysis of the EU ETS impacts in the industrial sector, PowerACE model for the analysis of EU ETS impacts in the Power Sector)
- > Energy Performance of Buildings Directive (EPBD) (MURE simulation model)
- Directive on labelling of household appliances (appliance stock model as part of the MURE simulation model)
- ➤ Biofuels Directive (Green-X model)
- RES-E Directive (Green-X model)

As a consequence the results that are available for these policies are naturally more extensive that for those where only a Tier 1 and Tier 2 approach has been applied.

3.5.3 Application of the PRIMES model

The model PRIMES simulates the European energy system and markets on a country-by-country basis and provides detailed results on energy balances, CO₂ emissions, investment, energy technology penetration, prices and costs by 5-years intervals over a time period from 2000 to 2030.

The PRIMES model has not been designed specifically for the ex-post evaluation of climate policies, and consequently certain elements of the model make it less suited to ex-post evaluation For example, impacts can only been evaluated over a 5 year period, with no assessment possible in intervening years. However, the PRIMES model does provide an integrated assessment of policies

that act upon the energy sector, it provides coverage across all EU-27 Member States, and it allows the examination of the key socio-economic drivers of emissions within the energy sector.

The main application of the model within the study has been to assess the influence of these key socio economic variables on CO_2 emissions. For each of the main energy sub-sectors the trend in CO_2 emissions between 2000 and 2005 has been decomposed so as to reflect:

- the activity changes effects,
- the structural changes effects,
- the energy intensity changes effect and
- the fuel mix changes effect

This decomposition has been performed both at the aggregate energy system level and at the sectoral level. The results can therefore be compared and cross-checked against those obtained from the Tiered approach as well as providing some insights on the effects that cannot be directly captured (e.g. impact of price signals) by the other methods.

The outputs from PRIMES have therefore been used to:

- provide an alternative estimate of the GHG impacts associated with the ACEA Agreement, the RES-E Directive and the Biofuels Directive which are the only policies that can so far be evaluated separately with the PRIMES model;
- refine the methodologies of the tiered approach;
- identify the areas where sensitivity analysis is required; and
- validate the findings from the tiered approach.

In addition, the outputs from the PRIMES analysis provide an indicative estimate of the CO₂ emission impacts of the ECCP on those Member States not covered by the detailed case studies.

3.6 Results generation, reporting and development of recommendations

This phase in the project has brought together the results from the previous phase. The methods have been applied to each of the policies selected for detailed considerations. The findings have been reported in individual policy chapters. These can be found in the Appendices of this report and are summarised in the following chapter.

Quantitative analysis

Implementation of the tiered methodologies, together with the PRIMES modelling has enabled quantification of the impacts of the policies on emissions of greenhouse gases within the European Union. Results have been reported in terms of the annual savings in the latest year to date (to ease comparison with the ex-ante estimates) for each of the case study Member States. For certain policies, due to data limitations or methodological challenges it has not been possible to quantify all areas. The results from the quantitative analysis are synthesised in the next section.

Qualitative analysis

Given the research nature of elements of this study, it is recognised that the methodologies that have been developed may not be able to fully quantify the range of factors that influence the policy impacts across the range of sectors and Member States. Therefore, alongside the quantitative analysis, the individual policies, and their impacts on GHG emissions, have been reviewed in qualitative terms. This has considered issues that have either not been captured within the quantitative framework, or are subject to significant uncertainty. This includes, for example, variations in the implementation of the policies within different member states, overlaps with other policies and the ability of the quantitative data to describe policy impacts.

3.7 Capacity building

The initial results from the project and of the evaluation methodologies were presented to Member States and EU Commission representatives, during a two day workshop that took place on October 8th and 9th, 2008. The workshop was followed, on October 10th by a capacity building seminar. The workshop and training seminar were attended by a total of 33 delegates, representing 19 Member States.

The goal of the seminar was to improve Member States' capacity in the ex-post evaluation of climate change policies and measures. Specifically the seminar aimed to:

- Improve the understanding on the main methodological issues associated with the ex-post evaluation of ECCP;
- Discus the methodological choices incorporated in the guidelines;
- Familiarise Member States with the tools used in ex-post evaluation.

After a general overview of the issues associated to ex-post evaluation the following topics were discussed in more detail: policy overlaps, autonomous technical progress, choice of emission factors and other exogenous factors. The training seminar drew heavily upon the contents of the Methodologies Report.

For each of the topics addressed in the case studies, definitions were provided and theoretical and methodological issues were discussed. A series of worked examples were developed, with practical breakout sessions used to test delegates understanding of the key issues.

4 Overall results

This section presents a summary of quantitative results from the implementation of the Tier 1, Tier 2 and Tier 3 methodologies⁴³ as well as the results obtained from the factor decomposition method using the PRIMES model. It also provides a discussion on the overall findings from the application of the methodologies.

For each of the individual ECCP policies that have been evaluated an expanded discussion of the results, and the associated uncertainties, can be found in the detailed policy chapters and the report on the PRIMES factor analysis. Likewise, more extensive details on the methodologies that have been developed and applied can be found in the Methodologies Report.

When considering the quantitative results, it is important to recognise that the main objective of this study is not just to generate quantitative results, but also to develop and test a range of evaluation methodologies. In practice this means that, for certain policies, there is currently a large range of uncertainty in the estimated policy impacts. This reflects both uncertainties associated with the data that the methodologies have utilised, and also the influence of methodological choices. Therefore, when comparing results from different policies the relative uncertainties and methodological differences need to be acknowledged. These uncertainties aside, it is still useful to compile and compare the results across each of the ECCP policies considered in order to spur further discussion on the methodologies and also to identify those policies with the largest impact, and the largest uncertainty.

4.1 General overview of results: all sectors

4.1.1 Overall emissions reductions

Results are presented for each of the individual policies, and for each of the separate methodologies. The values represent the estimated reduction in GHG emissions that can be associated with the individual policies, in accordance with the respective methodologies. This represents the difference between the actual observed emissions and the assumed emissions in the absence of the policy (i.e. the counterfactual).

Whilst the results have been generated using, as far as possible, a consistent methodological framework, there are number of reasons why the results of this study, for each of the individual policies, cannot be compared easily. These are described further below.

One reason is that the time frame considered may differ from policy to policy. Each policy has a different starting year: for example the Energy Performance of Building Directive (EPBD) entered into force in 2002 but will be fully transposed in 2009 meaning that the main impact will occur in the future. Other policies, like the Directive for the promotion of renewables have already delivered impacts for a number of years. Therefore, when comparing the results in a given year or period one should not conclude directly that a given policy is more effective than another; this conclusion can only be drawn by either considering the impacts relative to the original ex-ante estimates for the policies (i.e. comparing actual impacts to expected impacts) or by making the comparison only after all of the policies are fully operational.

In practice, it is seldom straightforward to compare the ex-post impacts of a given policy to its projected (ex-ante) impacts at inception. To be fully consistent, the ex-ante and ex-post estimates should use comparable data and modelling assumptions. However, this is frequently not the case. Furthermore, most of the ex-ante estimates are only available for a given year in the future, which may not be the same year as that for which the ex-post estimate is available. Nevertheless, a crude comparison of the ex-ante and ex-post estimates, allowing for the likely trajectory of the policy impacts, can provide an indication of the relative effectiveness of the policies to date.

26 AEA

⁴³ A Tier 3 analysis was only carried out for the following policies: ACEA, Biofuels, RES-E, EU ETS, EPBD and Labelling.

Another reason why the results cannot be compared directly stems from the fact that for some policies relevant and timely statistics were available, while for other policies **data is not yet available for the most recent years**. This is particularly relevant for those policies that have the potential to deliver significant savings in a relatively short period of time. For example, in the evaluation of the Directive concerning renewables for electricity generation most of the generation capacity has been installed in the last 2-3 years. Consequently, the impact of the policy in the year 2008 is 139 Mt CO₂eq., which is considerably higher than the results in 2005 of 40 Mt. Therefore, for certain policies, the actual impact in recent years may be considerably higher than the impact in the latest year for which data is currently available.

Finally, the relative complexity of the policies, and the availability of policy data, means that the methodologies are better suited to certain policies than others. Consequently, the relative uncertainty in the policy estimate is much greater for some policies than for others. In general, we advocate that the results are interpreted on a policy-by-policy basis, taking into account the unique circumstances of each individual policy.

For these reasons, we do not recommend that the results from the individual policies are replicated or compared without reflecting upon the relative uncertainties in the estimates. For a better understanding of the results for specific policies, we refer the reader to the individual policy chapters located in the Appendices to this report.

Taking into account these uncertainties, Table 4-1 compiles the ex-ante estimates of the ECCP impacts in 2010 and compares these with the results from our evaluation of the impact to date. The ex-post results are presented for each of the Tier 1, Tier 2 and Tier 3 approaches, with the values representing annual savings for the latest evaluation year available (specified for each policy). Results are presented for EU-15 and EU-27 where available. The policies are ordered according to the sector in which the savings arise. A sum of the results is also provided. However, it must be kept in mind that in order to compile this estimate, important choices had to be made on methodological options which are still the subject of debate. In addition, the estimates comprise the sum of results from different years of impact. This sum should therefore be considered as indicative and cannot be considered as a definitive estimate of the impact of the policies investigated. It may nevertheless be useful to compare it in a preliminary way with the original ex-ante results to assess progress against expectations.

A traffic lights based colour coding has been employed to highlight the relative uncertainty of the estimates, allowing the values from the different policies to be presented in a single table. Values in red cells are considered most uncertain, and should not be considered a robust assessment of the policy impacts. In contrast, the values in green cells, whilst not without limitations, are considered to be within a reasonable bound of uncertainty and the results can be used as a good estimate of the policy impacts. Values in Orange cells are deemed to be a fair approximation of the policy impacts, but we consider that the approach may need further development.

Table 4-1 CCPMs: Comparison of ex-post and ex-ante impact estimates for the policies delivering the largest GHG savings in 2005 and 2010

Mt CO ₂ eq.	Ex-ante estimates	PRIMES ⁴⁴			Factor Analysis PRIMES ⁴⁴
ССРМ	ECCP Review: annual savings in 2010 (EU-15)	T1	T2	T3 ⁴⁵	
		Tr	ansport		
Voluntary agreements with car manufacturers	75 - 80	NE (EU27, 2005) 29.4 (EU15, 2005)	NE (EU27, 2005) 26.4 (EU15, 2005)	21.2/30.2 (EU27, 2005/2007) 17.9/25.4 (EU15, 2005/2007)	23.1 (EU27, 2005)
Biofuels Directive (Dir 2003/30/EC) 1)	35 - 40	13.3 (EU27, 2007) 12.5 (EU15, 2007)	13.3 (EU27, 2007) 12.5 (EU15, 2007)	13.0 (EU27, 2007) 12.2 (EU15, 2007)	7.8 (EU27, 2005)
		Energy S	ector/Industry		
RES-E Directive (Dir 2001/77/EC) ²⁾	100 - 125	25.8 (EU27, 2005) 23.8 (EU15, 2005)	25.8 (EU27, 2005) 21.1 (EU15, 2005)	40.3/139 (EU27, 2005/2008) 34.1/118 (EU15, 2005/2008)	88.7 (EU27, 2005)
Promotion of cogeneration (Dir 2004/8/EC)	65	61.2 (EU27, 2006) ³⁾ NE (EU15, 2006)	NE	NE	NE
EU ETS (Dir 2003/87/EC)	N/A	78.5 ⁴⁾ /21.7 ⁵⁾ (EU-15, 2006)	NE	4.5 (Germany, 2006) ⁶⁾	NE
Integrated pollution prevention and control (Dir 96/61/EC)	60-70	176 (EU27, 2006) 155 (EU15, 2006)	NE	NE	NE
F-Gases (Regulation EC No 842/2006)	23	NE	NE	NE	NE
Households/Service Sector					
Energy Performance of Buildings (Dir 2002/91/EC) 7)	35 - 45	83.8 (EU27, 2006) 33.5 (EU15, 2006)	156.5 (EU27, 2006) 44.2 (EU15, 2006)	0.0/31.7 (EU27, 2004/2010) 0.0/26.9 (EU15, 2004/2010)	NE
Labelling Directive for electric appliances (Directive 92/75/EEC) 8)	26	21.5 (EU27, 2006) NE (EU15, 2006)	NE NE	13.3 (EU27, 2004) ⁹⁾ 12.1 (EU15, 2004)	NE

⁴⁴ Factor Analysis PRIMES only carried out for three policies ⁴⁵ Tier 3 estimates are only carried out for a selection of policies

Table 4-1 (continued)

Mt CO ₂ eq.	Ex-ante estimates	Ex-post estimates (annual savings in latest year)			Factor Analysis PRIMES
ССРМ	ECCP Review: annual savings in 2010 (EU-15)	T1	T2	Т3	
		V	Vaste		
Landfill Directive (Dir 1999/31/EC)	41	100.0 (EU27, 2006) NE (EU15, 2006)	30.5 (EU27, 2006) NE (EU15, 2006)	NE	NE
Waste Incineration Directive (Dir 2000/76/EC)	NE	0.8 (EU27, 2006) NE (EU15, 2006)	- 0.8 (EU27, 2006) NE (EU15, 2006)	NE	NE
		Agı	riculture		
Nitrates Directive (Dir 91/676/EEC)	10 10)	NE (EU27, 2005) 10.7 (EU15, 2005)	NE (EU27, 2005) 8.2 (EU15, 2005)	NE	NE
Common Agricultural Policy (Regulation EC No 1782/2003) 12)	2 11)	NE (EU27, 2006) 0.8 (EU15, 2006)	NE (EU27, 2006) 0.7 (EU15, 2006)	NE	NE
		All	sectors		
Sum ¹³⁾	472-527 (EU15)	287 (EU15) 482 (EU27)	113 (EU15) 225 (EU27)	194 (EU15) 231 (EU27)	- (EU15) 120 (EU27)

Notes:

Excluding an assessment of the possible effects of indirect land-use change. Such effects, if taking place, may substantially reduce the impact calculated. Figures are, however, highly uncertain and require further investigation.

Excluding large hydro. 2008 estimate based on installed capacities in 2008 as compared to 2005 (minus the capacities already installed up to 2003).

CO₂ savings based on primary energy savings. The Tier 1 approach assumes that CHP electricity production is replacing the average fuel mix of the EU-27 (fossil-fired public supply). It assumes further that CHP heat is replacing the marginal factor associated with heat from a natural gas-fired boiler with an efficiency of 85%. Savings relative to 2004, attributing them to the Directive. However, the impact of the CHP Directive is still non-existing and only expected from 2009/2010 onwards. There is a contribution of CHP to climate policy objectives regardless whether this contribution is policy induced or not.

⁴⁾ Intensity approach.

Direct projection of inventory data.

Includes only partial results for Germany and only the impacts in the power sector (dispatching effect only) and in the clinker production sector.

⁷ T1/T2 results under the assumption that the EPBD has already produced impacts starting 2002. T3 makes the more realistic assumption that impacts will only start in 2008 taking into account delays in the implementation of the EPBD.

Table 4-1 (continued)

Including existing labels which are estimated ex-ante to be around 20 Mt CO₂-eq.

9) Tier 3 results are based upon a more refined approach; however, data at a more refined level is only available to 2004.

⁰⁾ The first ECCP quantified the potential savings from N₂O emission from soils in the EU-15 at 10 MtCO2eq in 2010 without allocating these possible savings to a particular policy.

The analysis has focussed two individual elements of the 2003 CAP reform only: the sheep and goat meat regime and the beef sector premia. Specifically, the change in livestock numbers arising from the reform in these sectors. Other important components have not been investigated within this study and would benefit from further investigation. In particular, the methodologies need to be extended to include impacts on carbon within soils and the broader impacts of land use change. Impacts in N2O emissions from soils and nitrate use are included in the impacts of the Nitrate Directive.

12) Based upon reductions in emissions from enteric fermentation (0.3 Mt CO2eq) and from anaerobic digestion (1.7 Mt CO2eq) estimated in the review of the ECCP. Further reductions were identified for emissions of N₂O from soils. These have been described in relation to the Nitrates Directive above.

13) The sums for the ex-post evaluations should be taken as indicative only. They combine results for varying years, based on particular methodological assumptions.

The colours in the fields for the Tier 1, 2, 3 approaches have the following meaning:

Red colour:	The approach provides only a rather approximate estimate of impacts and should not be considered a robust assessment of the policy impacts
Orange colour:	The approach provides a fair approximation to the impact assessment. However the approach may need to be worked out further. (This is for example the case for the EU ETS).
Green colour:	The results can be considered as a good estimate of the policy impact. However, frequently, still methodological choices have to be made, for example with respect to the emission factors. The data basis is, however, satisfactory to make these choices (This is for example the case of the RES-E Directive).

Abbreviations:

MS_{sp}: Member State specific starting year for the ex-post evaluation

NE = not estimated

Sources: European Commission for the ex-ante estimates (see also Table 2-1) this study for the ex-post estimates.

The **main quantitative results** are as follows (see Table 4-1):

- The first ECCP reviewed over 40 measures for their potential contribution to the Kyoto target.
 The programme estimated that a number of cost-effective options had a 'technical potential' to
 achieve savings of between 664 and 765 Mt CO₂eq in 2010 for the EU-15. A number of the
 measures reviewed are covered by this study.
- The ex-ante estimates available for the policies covered by this study indicate possible total GHG savings of the policies in the range of 472-527 Mt CO₂ eq. in 2010 for the EU15.
- The results obtained with the Tier 1 approach are of the same order of magnitude as the exante estimates at 287 Mt CO₂ eq. for the EU15 when the impacts for the most recent year for which results are available (generally 2005-2007) are summed. Policy estimates derived from the Tier 1 approach tend to be the highest, frequently due to an insufficient correction of autonomous progress (see below). This is mainly the case when the gap between Tier 1, Tier 2 and possibly Tier 3 is particularly large, e.g. in the case of the Landfill Directive.
- The sum of the Tier 2 results is 113 Mt CO₂ eq. for the EU15, considerably lower than the Tier 1 results. This is partly due to the fact that not all policies considered were able to develop a Tier 2 approach (CHP Directive, IPPC, Labelling and EU ETS). Notwithstanding this issue, Tier 2 results are consistently lower as a result of the corrections introduced. The one exception of the EPB Directive, where the refinement in Tier 2 lead to a larger emissions saving.
- There are also indications, when considering the Tier 3 results, that due to methodological choices, e.g. for emission factors in the case of renewables (RES-E Directive), the Tier 2 approach may have underestimated the policy impacts. The Tier 3 approach indicates savings in the range of 194 Mt CO₂ eq., so greater than the results for Tier 2 most of this can be explained by the inclusion of more recent data for the RES-E Directive.
- However, the Tier 3 analysis is not complete; only a selected number of polices could be analysed. Also for an important policy such as the EU ETS only partial results are available to illustrate the methodologies. A complete analysis would show higher results. In addition, some policies such as RES-E, have introduced a rapid change in technologies. It can be estimated that the impact of around 40 Mt CO₂ eq. for RES-E in 2005 for the EU27 has grown in 2008 to around 139 Mt CO₂ eq. and will continue to grow considerably until 2010. While it is difficult, based on the Tier 1 analysis to judge on the impacts of policies such as the IPPC Directive and the Landfill Directive, the RES-E Directive has so far been without doubt the most successful of the policies considered, although a more final conclusion should be left to a complete analysis. It must also be recalled that some of the policies such as the EPBD or the CHP Directive will become most effective in future years.
- For those results that are considered to be a reasonable estimate of the policy impact (see traffic light coding on table), the ex-post results for the latest year available are often considerably lower than the policy impact projected for 2010. In some cases, recent implementation means that savings will be greater closer to 2010. However for other policies (potentially ACEA and biofuels), it is possible that the ex-ante estimate has been over optimistic.
- The decomposition analysis performed with PRIMES estimates the combined effect of the EU agreement with car manufacturers, the implementation of the Biofuels and the RES-E Directives to amount to a reduction of CO₂ emissions by close to 120 Mt CO₂. The results from this analysis are very similar to (but slightly lower than) the results from the tiered methodologies for ACEA and Biofuels but significantly higher in the case of the Renewables Directive.

4.1.2 Sector specific results

The following sections synthesise the main results for the individual policies. More details can be found in detailed policy chapters and the report on the PRIMES factor analysis, which are annexed to this report. The sections deliver concise information on the following items:

- Short discussion of the main results obtained with Tier 1, Tier 2 and Tier 3 approaches (the latter for the policies and measures where available).
- A characterisation of the main methodological differences between Tier 1, Tier 2 and Tier 3 approaches in table form, considering issues such as the treatment of autonomous progress, the choice of emission factor, the impacts of overlapping national and other European policies, geographic circumstances, structural change as well as time delays or announcement effects in the implementation of the policies. For consistency, a standard set of methodological characteristics have been used to summarise each of the methodologies. These characteristics are outlined in the table below, and are elaborated further in the Methodologies Report.

Table 4-2 Methodological characteristics

Characteristic	Description
Activity indicator	This describes the emissions causing activities that the policy acts upon, and that have been used to underpin the evaluation
Emission factor	This describes the basis for the emission estimate that has been applied in relation to the respective activity data. In the Tier 1 approach emission factors have typically been defined on the basis of EU average data. However, for the Tier 2 and Tier 3 approaches member state specific emission factors have been applied
Policy interaction	National policies or other EU wide polices may interact with the policy in questions. This describes the extent to which adjustments have been made in the Tiered approach to account for policy interaction. Adjusting for policy interaction usually reduces the savings that are attributed to the policy in question.
Autonomous developments	This may include, for example, the impact of autonomous <i>technological</i> improvement (i.e. innovation in technology). This is most applicable to policies that influence the take up of particular technologies. It also includes autonomous <i>behaviour</i> , where an activity would have occurred anyway, but has instead occurred in relation to a specific policy (for example, to take advantage of a subsidy).
Structural effects	Structural changes can be described in terms of the activity data that is used to estimate the emissions from the sector. Changes in the structure of this activity data (e.g. fuel switching) may result in changes in the associated emissions, however, these structural changes may be effectively 'hidden' in the overall aggregate statistics (e.g. if only changes in energy are considered and not the mix of fuels) – so the impacts of these changes are not isolated from the other factors driving emissions.
Timing issues (announcement and delay effects)	An announcement effect can be defined in terms of an action taken to reduce emissions as a result of a policy, between the time of the announcement of the policy and its implementation, when this action would not have been taken if the policy had not been announced. Likewise a delay effect, relates the fact that whilst a policy may have officially begun on a certain data, the measures implemented as a results of the policy may have been delayed.
Geographic factors	These include factors such as climate (which is has an important influence on energy demand) and weather (which can influence the effectiveness of renewable energy such as wind turbines, and agricultural productivity). Adjustments can be made with the evaluation methodology to 'normalise' these variations, and isolate the influence of these variables on the overall outcome.
Rebound effects	The rebound effect is an umbrella term for a number of mechanisms which reduce the size of the 'energy savings' achieved from improvements in energy efficiency. Direct rebound effects can occur where energy efficiency measures reduce the cost of an energy service (e.g. heating), and the financial savings are spent on greater level of consumption of the service (e.g. warmer homes).
Other exogenous factors	Certain factors may be exogenous to the analysis, but can still have an influence upon the level of savings. The most significant factor is typically market prices. For example, energy prices will influence the demand for energy, and the associated CO ₂ emissions from industry, likewise, livestock numbers may be affected by meat and milk prices.

- A graphic overview of results containing:
 - the development of the inventory categories related to the policy concerned from 1990-2006;
 - ex-ante projections for 2010;
 - the results from the implementation of the Tier 1, Tier 2 and Tier 3 methodologies (the latter for the policies and measures where available).

As discussed previously, the ex-ante and ex-post results are not strictly comparable since savings are for different years and also due to the fact that the estimates are likely to have been derived using varying assumptions and methodologies. Since the basis for calculation of the ex-ante estimates is not known, it is not possible to accurately determine why the ex-ante estimates differ to the findings of the ex-post evaluation.

- A table with the key uncertainties for the different policies, distinguishing in general uncertainties related to data issues and uncertainties related to methodological choices, where relevant. In cases where the main uncertainties are related to data issues, future improvements require improved data collection. Where methodological choices have to be made, the issue needs to be discussed further in expert groups. Frequently, however, this also implies an improvement of the underlying data sets (e.g. the choice of marginal hourly emission factors for the evaluation of RES-E implies the knowledge of the power sector in the EU27 on an hourly basis).
- A quantitative discussion of the main sensitivities in the results, separating again sensitivities related to methodological choices and data.
- A review of **cost-effectiveness estimates**. Whilst the focus of this study has been on the quantification of the effectiveness of the ECCP, policy efficiency is also important. Whilst no new estimates of the cost-effectiveness of the policies have been derived during this study, existing estimates, where available, have been captured.

4.2 Transport sector

4.2.1 Trends in emissions

The overall trends in emissions the transport sector have been examined using a modified version of the PRIMES model. A decomposition analysis has been performed to examine the key factors that have influenced the trends in emissions, within the sector, between 2000 and 2005.

 CO_2 emissions in the transport sector exhibit a significant growth in 2000-2005 (+63 Mt CO_2 or +6.4%). This increase is mainly driven by activity growth which is estimated at +92.5 Mt CO_2 . Demographic developments account for around 26.5% of this increase the rest being the result of economic growth. Structural changes in the EU transport sector (increasing role for private cars, trucks and aviation transport activity) also lead to an increase of CO_2 emissions in the transport sector (+25.2 Mt CO_2).

The purchase of more efficient vehicles (with efficiency improvements accelerated due to the implementation of voluntary agreements) in road transport as a result of normal replacement of old stock and additional transport activity demand, the further dieselisation of the private cars stock, the continuous electrification of the rail network and the need for new airplanes (with significantly improved efficiencies compared to old ones) arising from the high growth of aviation activity, result in a significant improvement of energy intensity in the transport sector which in turn leads to an estimated reduction of CO₂ emissions by -52 Mt CO₂. Changes in the fuel mix also lead to a limited reduction of CO₂ emissions in the sector (-2.7 Mt CO₂), a result mainly related to the penetration of biofuels.

These factors, driven both by policies and exogenous factors, are illustrated below:

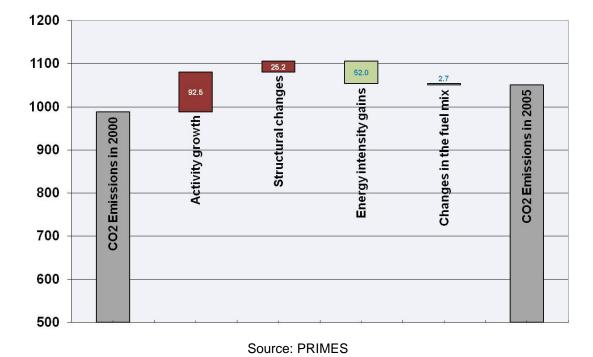


Figure 4-1 Decomposition analysis of transport sector

4.2.2 Key results: Voluntary agreements for cars (e.g. ACEA)

The European Commission secured voluntary agreements with the European (ACEA), Japanese (JAMA) and Korean (KAMA) car manufacturers associations to reduce the average CO₂ emissions of new passenger cars sold in the European Union, i.e. 140 gCO₂/km (to be achieved by 2009 by JAMA and KAMA and by 2008 by ACEA).

The effectiveness of the voluntary agreements has been evaluated using a Tier 1, Tier 2 and Tier 3 approach. In addition, an estimate of the impacts of the agreements has also been made using the PRIMES factor analysis.

For the ACEA agreement, detailed data is available on emissions performance and numbers of new cars purchased, as reported by Member States. This enables a comprehensive ex-post analysis of the policy. A simple spreadsheet model has been used to evaluate the impacts of the agreement in accordance with the Tier 1 and Tier 2 approaches. We consider that the results from the Tier 1 and 2 analyses provide a reasonable approximation of the policy impacts. The ASTRA model has been used to demonstrate a more refined Tier 3 approach, allowing other explanatory variable (such as fiscal policies and fuel prices) to be examined also.

Table 4-3 details the main methodological differences between the tiered methodologies, showing that the Tier 1 methodology is a relatively simple calculation and does not take account certain complicating factors such as dieselisation, policy interaction and other non-policy drivers.

Approach	Tier 1	Tier 2	Tier 3
Activity indicator	Vehicle km	Vehicle km	Vehicle km
Emission factor of new vehicles (g CO ₂ /km)	EU	MS	MS
	average	average	average
Policy interaction:			
+ Taxation policies (registration tax, annual	no	no	yes
car tax, mineral oil tax, ecotax)			
+ Biofuels policy	no	no	screened
+ Other policies	no	no	screened
Autonomous development	no	no	yes
Structural effects (Dieselisation trend)	no	yes	yes
Rebound effects (car size, more mileage)	no	no	yes
Multiplier effects	no	no	no
Geographic factors	no	no	no
Timing issues / delay or announcement effects	yes	yes	(yes)*
(policy impact starting 1995)	-	_	
Other exogenous factors (Impact of energy	no	no	yes
market prices)			-

Table 4-3 Key methodological choices ACEA agreement

The analysis (see Figure 4-2) indicates that the policy has delivered a moderate level of emissions improvement, especially when compared to ex-ante projections, although in total the savings achieved are not negligible.

The various sensitivity runs with the ASTRA model have also demonstrated the (surprising) weakness of some of the factors which were considered to have a potential impact on technological development, such as fuel prices, fiscal measures and the adoption of larger vehicles. The weakness of all these factors left only two drivers of the technological improvement – autonomous technical change (i.e. development carried out by the auto industry as part of the competitive strategies of manufacturers) and the effect of the voluntary agreement. The actual estimated savings attributed to the ACEA agreement are thus heavily dependent on what is assumed with respect to the levels of autonomous technical change.

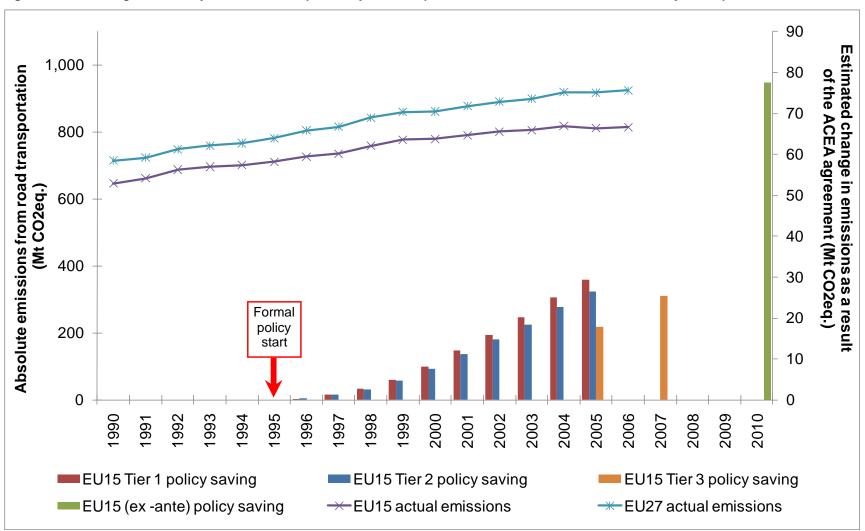
The ACEA agreement will not lead to large scale adoption of alternative technologies such as electric vehicles or hydrogen fuel cell vehicles. This reinforces the findings of the EU Strategy review, which concluded that further legislative measures are necessary to achieve the target of $120g\ CO_2/km$ by $2012\ for\ new\ cars\ and\ LDVs$.

^{*} Brackets mean that the issue should in principle be considered but was not considered relevant for the expost evaluation period investigated here.

ENV.C.1/SER/2007/0019

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AEA/ED05611/Final Report

Figure 4-2 ACEA agreement: Key results of the ex-post analysis in comparison with ex-ante estimates and inventory development



Notes: Emission trends are shown on the primary axis while estimated policy savings are shown on the secondary axis. The final year for which ex-post estimates are available varies between policies. See Table 4-1 for further details. The geographical coverage of ex-post policy savings varies due to data constraints and is detailed in the legend above.

Sources: Policy savings for 2010 are European Commission ex-ante estimates while savings for historic years are ex-post estimates generated under this study. The source for absolute emissions is

the 2006 GHG inventory (EEA, 2008).

In general, there is a good match between the results obtained from the different tiered methodologies. However, the Tier 1 and, to a lesser extent, the Tier 2 approach do appear to overestimate savings; delivering an estimate which are greater than those estimated under the more methodologically robust Tier 3.

For all approaches, the ex-post savings for the latest year are considerably lower than the European Commission's ex-ante estimate of the policy savings in 2010. This is not surprising assuming that the ex-ante estimate was based on the achievement of an average vehicle efficiency of 140g CO₂/km, which has not been achieved in reality.

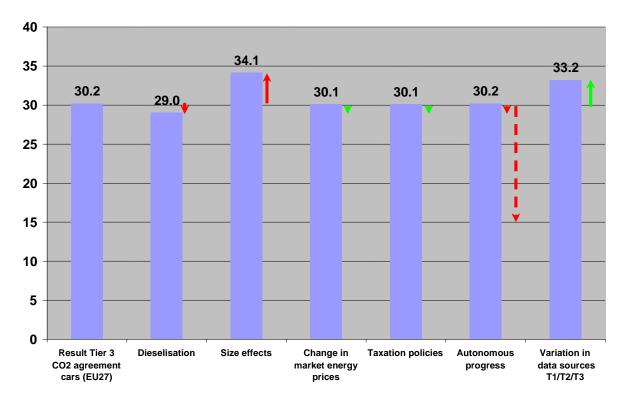
Table 4-4 and Figure 4-3 show the main uncertainties associated with the ex-post estimates of the policy impact. In particular, a change in assumptions regarding autonomous progress in vehicle efficiency could significantly reduce the estimated impact.

Table 4-4 Key uncertainties ACEA agreement

Key uncertainties in data
Data sources: Variation in the data sources between Tier 1/2/3 approaches.
Key uncertainties in methods
Autonomous progress: Evaluation of the autonomous progress/impact of previous policies in the pre-
agreement period.
Size effects: Changes in the size of cars (considered in Tier 3).

In Figure 4-3 the results from the sensitivity analysis are reported. This shows the impact of using specific methodological assumptions, and the influence of data uncertainties, upon the overall results. The arrows show the relative variability in the results depending upon the particular assumptions that are used. The results represent the historic importance of the different factors. This does not necessarily mean that the factors will have the same importance in the future.

Figure 4-3 ACEA agreement: Sensitivity analysis for the different factors affecting the estimated CO₂ savings of the ACEA agreement (Mt CO₂ equ. in 2007 for the EU27)



Notes: Variations due to methodological choices are in red. Variations due to data issues are in green. Solid arrows represent an absolute assessment of the variation, as calculated in the current analysis. Dashed arrows show an estimate of the variation, but the absolute value is much more uncertain.

The **cost-effectiveness** of the ACEA agreement should include two cost components: The administrative and 'transactions' costs associated with the development and implementation of the agreement and the R&D and investment costs to the industry of developing more fuel efficient cars.

The cost of implementing a voluntary agreement comes in the time and effort spent by the parties in reaching the agreement and the costs of monitoring the agreement. Such costs are typical small in comparison to other policies. The cost of monitoring the agreement is also small, because the necessary CO2 emissions test figures were easily combined with the fuel test measurements. Therefore, the costs involved with implementing this policy are overall small.

TNO (2006) assessed the cost of abatement to vehicle manufacturers as ranging from €233/tonne CO2 at an oil price of €25/bbl to €132/tonne CO2 at an oil price of €74/bbl. This estimate does not take into account the fuel cost savings that consumers will enjoy after having purchased a more fuel-efficient car.

4.2.3 Key results: Biofuels Directive (2003/30/EC)⁴⁶

Directive (2003/30/EC) on the promotion of the use of biofuels or other renewable fuels for transport requires Member States to ensure that a minimum proportion of biofuels is placed on their markets.

The effectiveness of Biofuels Directive in delivering reductions in emissions of greenhouse gases has been evaluated using a Tier 1, Tier 2 and Tier 3 approach. In addition, an estimate of the impacts of the Biofuels Directive has also been made using the PRIMES factor analysis.

The shift from fossil transport fuels to biofuels reduces the emission of CO_2 emissions from the transport sector, but on the other hand can have an adverse effect on the emission of CH_4 and N_2O compared to fossil fuel use due to impacts associated with the biofuel supply chain. Taking into account lifecycle emissions associated with the fuel supply chain reduces the overall emissions savings. These lifecycle emissions vary considerably between the different biofuel feedstocks. Therefore, from a methodological standpoint, the choice of emission factor for the different biofuels is the most critical element in the evaluation.

Table 4-5 provides a summary of the assumptions used to generate the results illustrated in Figure 4-4. In particular, it shows how the Tier 1 and 2 approach use simplifying assumptions with respect to the biofuel feedstocks, whereas the Tier 3 approach uses more refined assumptions.

38 AEA

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⁴⁶ Disclaimer: The analysis of the Biofuels Directive has been prepared by Fraunhofer ISI. The final presentation of the results from the Biofuels Directive does, however, not reflect the views of Fraunhofer ISI.

Key methodological choices Biofuels Directive Table 4-5

Approach	Tier 1	Tier 2	Tier 3
Activity indicator	Volume of Biofuels	Volume of Biofuels	Volume of Biofuels
Emission factor (kg CO₂eq/GJ)	EU average / default IPCC emission factor	MS averages for bioethanol/ biodiesel	(1) Direct CO ₂ emission reduction (gross impact) (2) Life cycle EF based on MS feedstocks (net excl. LUC) (3) EF Elec prod. (cogeneration uses) (4) Sensitivity analysis: life cycle EF incl. LUC (net imports)
Impact of biofuels imports/exports on emission factor	no	no	yes (type of feedstock; sensitivity analysis: iLUC)
Policy interaction with national biofuels policies ⁴⁷	no	no	(yes) ⁴⁸
Policy interaction with other national and EU-wide policies	Combined effect of biofuels and non-biofuels policies	Combined effect of national + EU policies. Combined effect of closely related national and EU policies.	Interaction of biofuel policy with non-biofuels agriculture and spatial policies (iLUC)
Autonomous progress 49	no	(yes)	(yes)
Geographic factors	no	no	(yes) ⁵⁰
Timing issues / delay or announcement effects	no	no	MS specific

Note: Brackets indicate that the issue is considered in principle but was not considered relevant for the specific ex-post evaluation period investigated. iLUC = indirect land use change.

The net GHG savings for Tier 1 and Tier 2 approaches amount to approximately 13.3 Mt CO₂-eq in 2007 for Europe (EU-27). The results of the Tier 3 methodology are similar, since the results are all underpinned by the same default emissions factors. These factors may be subject to variations depending on scientific advances on individual parts of the biofuel production chain.

In 2007, approximately 30% of EU biofuels consumption was imported. Of the remainder produced in the EU, those that were produced on recently abandoned agricultural land or land that would otherwise have been abandoned can be assumed to not result in any land use change. In addition, the biofuel co-products will have replaced other agricultural commodities, leading to a saving of land elsewhere. These considerations should be taken into account when evaluating the land use change effects of this policy.

As illustrated below, ex-post savings in the latest year are still considerably lower than those forecast by the European Commission for 2010 and are small in comparison to the challenge of sizeable and increasing road transport emissions in the EU.

49 Profitable biofuels + previous national policies.
50 Normalisation to climatic conditions: annual ha yield.

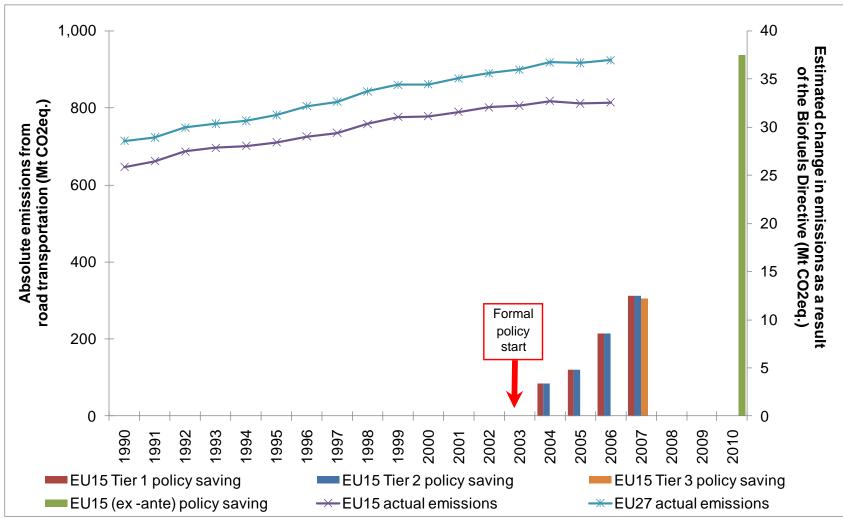
⁴⁷ Interaction with national biofuels policies (Tax exemptions/quotas, Energy taxes on Diesel/Gasoline, Support for Agricultural Land (CAP

All biofuels after transposition of Directive are supposed to be related to the introduction of the Biofuels Directive.

ENV.C.1/SER/2007/0019

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AEA/ED05611/Final Report

Figure 4-4 Biofuels Directive: Key results of the ex-post analysis in comparison with ex-ante estimates and inventory development



Notes: Emission trends are shown on the primary axis while estimated policy savings are shown on the secondary axis. The final year for which ex-post estimates are available varies between policies. See Table 4-1 for further details. The geographical coverage of ex-post policy savings varies due to data constraints and is detailed in the legend above.

Sources: Policy savings for 2010 are European Commission ex-ante estimates while savings for historic years are ex-post estimates generated under this study. The source for absolute emissions is the 2006 GHG inventory (EEA, 2008).

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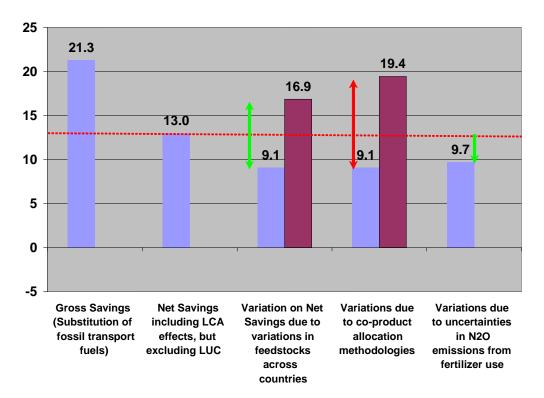
There are a number of uncertainties around the ex-post policy impact estimates, as outlined in Table 4-6 and Figure 4-5 below.

Table 4-6 Key uncertainties Biofuels Directive

Key uncertainties in data	
Land-use change: Uncertainties in occurrence of LUC (impact on emission factors)	
Feedstock data: Feedstock composition in country and feedstock composition of imports.	
Emission factors: Uncertainties in N ₂ O emissions from the use of fertilisers.	
Key uncertainties in methodologies	
Co-products: Choices in the treatment of co-products (allocation/substitution).	
Land use change: Choices on LUC factors	

The Figure below shows the influence of the key uncertainties on the overall results. The arrows show the relative variability in the results depending upon the particular assumptions that are used. In particular, alternative assumptions regarding LCA aspects (e.g. the debate on N_2O emissions from fertilisers) and differing methodological choices (e.g. allocation of co-products which are usually allocated based on the energy contents but other methods such as the more complex substitution approach are possible) are shown to alter the results considerably.

Figure 4-5 Biofuels Directive: sensitivity analysis for the different factors affecting the CO₂ savings (Mt CO2 equ. in 2007 for the EU27)



Note: The dotted red line represents the result derived using EU average conditions. Variations due to methodological choices are shown as red arrows. Variations due to data issues are shown as green arrows.

With the possible growth of the share of biofuels of 2.6% in 2007 to the planned 5.75% in 2010 and the proposed 10% in 2020, more complications arise for the methodological aspects related to GHG impact quantification in relation to the issue of land-use change. However, displacement effects through indirect land-use change are particularly difficult to establish. Therefore, careful analysis of such impacts is more necessary than in the past and this issue dominates the current debate on biofuels.

In terms of the policy **cost-effectiveness**, biofuels are more expensive than conventional transport fuels. Therefore financial support schemes had to be introduced at Member State level. In the Concawe/Eucar/JRC (2007) study costs of biofuels have been assessed. Even in the "high" oil price

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scenario of 50\$/bbl, few options are under 100 \in /t CO₂, still much higher than the current value of CO₂ of 15-25 \in /t, but in the range of other alternatives for reducing GHG emission and oil dependency in the transport sector.

4.3 Energy sector and Industry

The overall trends in energy-related emissions the energy sector, district heating sector and industry sector have been examined using a modified version of the PRIMES model. A decomposition analysis has been performed to examine the key factors that have influenced the trends in emissions, within the sector, between 2000 and 2005.

In the power generation sector (see Figure 4-6) CO_2 emissions increased between 2000 and 2005 by 65.4 Mt CO_2 (+5.2%), an increase solely attributed to activity growth in the sector which was partly counterbalanced by improvements in terms of energy intensity as well as changes in the fuel mix towards less carbon intensive energy forms.

Activity growth increased CO_2 emissions by +127.4 Mt CO_2 . There are three different factors driving this increase: demographic changes (population growth as well as the change of households' size) which are estimated to account for 14% of the increase, economic development which accounts for 56% of the increase and changes in the demand side fuel mix (driven by various factors such as structural changes, behavioural patterns and fuel prices) which account for the remaining 30% of the increase.

On the other hand the EU27 power generation system underwent significant improvements both in terms of energy intensity (-32.1 Mt CO2) and changes in the fuel mix (-28.9 Mt CO2). The increasing role of natural gas in power generation (the share of which reaches 21% in 2005 from 16.8% in 2000) involving investment and operation of new efficient natural gas power plants as well as the increasing deployment of renewable energy sources (and especially wind turbines with an attributed efficiency of 100%) are the main factors that explain this development.

These factors, driven both by policies and exogenous factors, are illustrated below:

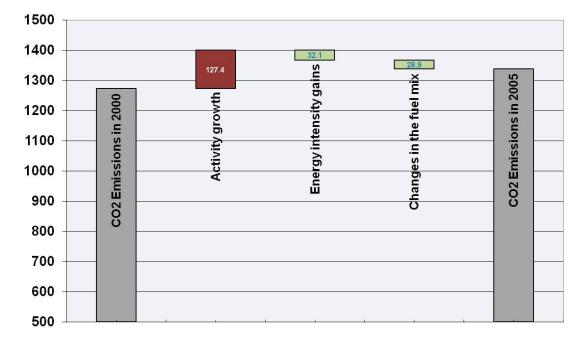


Figure 4-6 Decomposition analysis of power generation sector

Source: PRIMES

With regard to district heating, a strong decline in steam production (mainly due to the restructuring of new Member States energy systems) is the key driver for the decline of CO_2 emissions in 2000-2005 (-11 Mt CO_2 or -23.3%). Thus, activity development in the sector has the most pronounced negative effect (-9.6 Mt CO_2) followed by changes in the fuel mix (-2.2 Mt CO_2) whereas some slight worsening of energy efficiency leads to an increase of CO_2 emissions (+0.8 Mt CO_2).

 $\mathrm{CO_2}$ emissions in industry exhibited a strong decline in the period 2000-2005 (-33.0 Mt CO2 or 5.3%). On the basis of activity growth effects $\mathrm{CO_2}$ emissions increased by 53.8 Mt $\mathrm{CO_2}$ in 2000-2005 (22% of this increase being attributed to population growth and the rest to economic developments). Structural changes (involving shifts away from energy intensive industrial sectors and towards value added intensive ones) had a negative effect on the evolution of $\mathrm{CO_2}$ emissions (-16.2 Mt $\mathrm{CO_2}$). The role of energy intensity gains is even more pronounced in reducing industrial $\mathrm{CO_2}$ emissions (-40.7 Mt $\mathrm{CO_2}$).

Investment in more efficient technologies, the shift towards less energy intensive processes within industrial sectors (e.g. increased role for electric arc processing instead of integrated steelworks in iron and steel, significantly more pronounced growth for pharmaceuticals production compared to basic chemicals) as well as the restructuring of the industrial sector in new Member States (involving the closure or retrofitting of old inefficient industrial units but also the construction of new efficient units) are the main drivers that lead to the improvement of energy intensity in the EU energy.

The changes in industrial production are also reflected on the fuel mix with demand for less carbon intensive energy forms gaining additional market shares (demand for electricity, distributed steam and biomass in industry exhibits a growth in 2000-2005 in industry compared to a decline for total industrial energy demand; demand for natural gas declines less than that for solid and liquid fuels). Thus, the carbon intensity of the EU industrial sector improves between 2000 and 2005 leading to a reduction of CO_2 emissions due to changes in the fuel mix by -30 Mt CO_2 . The decomposition of CO_2 developments in industry is illustrated in Figure 4-7.

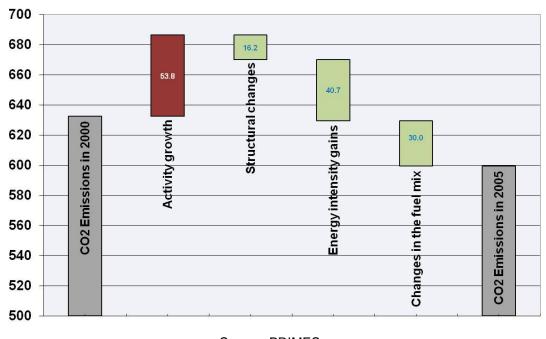


Figure 4-7 Decomposition analysis of industry sector

Source: PRIMES

The remaining challenge for policy modellers is to determine the extent to which individual policies have been responsible for reducing activity growth, encouraging structural change, changes in fuel mix or energy efficiency improvements.

The main policies considered in this sector under this study are:

- The RES-E Directive
- The CHP Directive
- The EU ETS
- The IPPC Directive
- The F-Gases Regulation

4.3.1 Key results RES-E Directive (2001/77/EC)

The RES-E Directive defines indicative targets for the share of renewable electricity in gross electricity consumption for all Member States. Furthermore it requires Member States to implement national support schemes to promote renewable energy.

The RES-E Directive has been evaluated using a Tier 1, Tier 2 and Tier 3 approach. In addition, an estimate of the impacts of the Directive has also been made using the PRIMES factor analysis.

The RES-E Directive has a direct impact on the emissions of the power sector. Since renewable energy sources replace conventional power plants the corresponding emissions of the conventional power plant will be avoided. Key parameters influencing the quantitative level of the impact are the amount of renewable electricity generated based on the policy and the emission coefficient of the replaced conventional power plant.

Emission factors differ significantly between the countries depending on the conventional power system in each country. In the Tier 1 approach the emission factor of the EU-27 is used for all Member States (Table 4-7). The average EU emission factor is strongly influenced by the low coefficient in France, due to the high share of nuclear power in this country. Therefore the average EU-27 emission coefficient is lower for all countries compared to the national value, except for France. In the Tier 2 approach and Tier 3 approach a Member State specific emission factor is applied.

Table 4-7 Key methodological choices RES-E Directive

Methodology	Tier 1	Tier 2	Tier 3
Activity indicator	kWh produced	kWh produced	kWh produced
Emission factor (g CO ₂ /kWh)	EU average	MS average	MS average fossil park/ hourly short-term marginal
Policy interaction:			
+ EU ETS	no	no	yes
+ Other policies (e.g. taxation)	no	no	screened
Interaction national RES-E policies	no	no	
all RES-E after transposition of Directive			yes
RES-E after Directive beyond trend			(yes)
RES-E beyond trend (expert judgement)			(yes)
Autonomous RES-E (profitable RES-E)			
Large hydro	yes	yes	yes
Other profitable RES-E	no	no	(yes)
Impact of electricity imports/exports on emission factor	no	no	(yes)
Geographic factors (normalisation to climatic conditions for hydro, wind, solar)	no	no	yes
Timing issues / delay or announcement effects	no	no	no
Impact of other policies:			
+ EU ETS	no	no	yes
+ Other policies (e.g. taxation)	no	no	screened

Note: Brackets mean that the issue is considered in principle but was not considered relevant for the ex-post evaluation period investigated.

Overall, the RES-E Directive has the largest single impact of any of the measure evaluated under the ECCP. Figure 4-8 illustrates a close match between ex-post savings for the policy in the latest year and the European Commission's original ex-ante estimate for 2010. Of particular note is the sharp increase in savings in recent years as additional capacity has been installed.

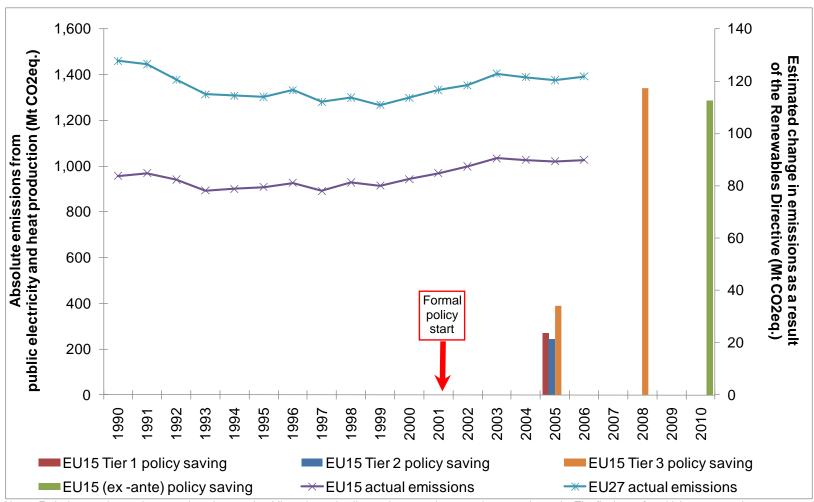
The results of the Tier 1, Tier 2 and Tier 3 approaches show significant differences, but are in the same range. The main variable influencing the difference in the results is the emission factor.

The impact of the RES-E Directive across Member States differs significantly and scales directly with the induced growth of renewable electricity in the Member States and with the carbon intensity of the power system.

ENV.C.1/SER/2007/0019

Restricted - Commercial
AEA/ED05611/Final Report

Figure 4-8 RES-E Directive: Key results of the ex-post analysis in comparison with ex-ante estimates and inventory development



Notes: Emission trends are shown on the primary axis while estimated policy savings are shown on the secondary axis. The final year for which ex-post estimates are available varies between policies. See Table 4-1 for further details. The geographical coverage of ex-post policy savings varies due to data constraints and is detailed in the legend above. The results in this figure exclude large hydro. 2008 results are extrapolation of 2005 results, taking into account actual capacities of wind and solar power installed in 2008.

Sources: Policy savings for 2010 are European Commission ex-ante estimates while savings for historic years are ex-post estimates generated under this study. The source for absolute emissions is the 2006 GHG inventory (EEA, 2008).

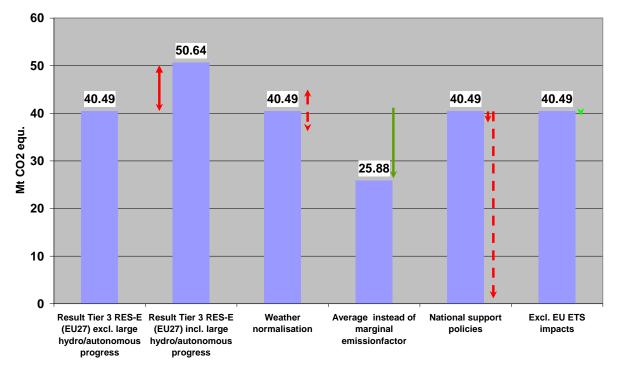
Two key uncertainties exist with regard to the tiered approach for ex-post evaluation: the choice of emission factor and the treatment of autonomous development.

Table 4-8 Key uncertainties RES-E Directive

Key uncertainties in data
None
Key uncertainties in methodologies
Choice of emission factor: Use of average emission factors versus hourly calculations.
Autonomous progress: Evaluation of the autonomous progress/impact of previous national policies
in the pre-Directive period.

The impact of using different assumptions regarding autonomous development, policy interaction and emissions factor are illustrated below. This shows the impact of using specific methodological assumptions, and the influence of data uncertainties, upon the overall results. The arrows show the relative variability in the results depending upon the particular assumptions that are used. The results represent the historic importance of the different factors. This does not necessarily mean that the factors will have the same importance in the future.

Figure 4-9 RES-E Directive: Sensitivity analysis for the different factors affecting the cumulated GHG savings (Mt CO2 equ. In 2005 for the EU27)



Notes: Includes large hydro. Variations due to methodological choices are in red. Variations due to data issues are in green. Solid arrows represent an absolute assessment of the variation, as calculated in the current analysis. Dashed arrows show an estimate of the variation, but the absolute value is much more uncertain.

It can be seen that normalisation according to the weather conditions (i.e. normalisation of the specific year under investigation to a long term average) can amount to about plus/minus 10% of the total emission savings calculated, depending of the specific RES-E portfolio of a country. The impact of using an average emission factor instead of a marginal one can be substantial. For the EU-27 this impact amounts to about one third of the total emissions. This is a very important factor which explains the different results that are achieved from the different Tiered methods. The extent to which the change in emissions is attributed to the RES-E Directive or to "independent" national policies can be crucial. In the extreme case where all of the emissions impacts from RES-E are attributed to the national policies the effect of the RES-E Directive would be zero. The impact of excluding the contribution of large hydropower - as a way to account for autonomous progress - is substantial and amounts to about 20% of the total emission reductions at EU-27 level. The EU ETS had in the past no impact on the emission reductions by the RES-E Directive since additional support had to be given in all countries in order to develop renewable electricity generation using specific support schemes.

In terms of the **cost-effectiveness** of the RES-E directive then, in general, renewable energy sources have caused additional generation costs when compared to conventional alternatives. Therefore financial support schemes had to be introduced at Member State level. These support schemes can now be evaluated regarding their policy costs. Such evaluations have been performed in different communications of the European Commission, e.g. SEC(2008)57, COM(2005)627. One general conclusion from these evaluations is that technology specific support schemes, which give long term price guarantees for investors, tend to be more cost effective than technology neutral instruments. Although this has not been an issue studied in this project. The additional generation costs of renewable energy sources triggered by the RES-E Directive can be estimated at the order of 1 billion € in 2005 for the EU-27. It has to be emphasised, however, that renewable energy sources also bring additional benefits such as increased security of supply.

4.3.2 Key results CHP Directive (2004/8/EC)

The CHP directive came into force in 2004. The purpose of the directive is to increase energy efficiency and security of supply by creating a framework for promotion and development of high efficiency cogeneration.

As a requirement of the CHP Directive, Member States have started to collect CHP statistics on a structural and harmonised basis. Currently, for the period 2004-2006 a comparable dataset is available for all EU-27 Member States. This dataset does however not allow the assessment of the impact of the CHP Directive for several reasons:

- > Due to a lack of historical data it is difficult to determine the impacts of the Directive over and above what would have happened anyway (i.e. the counter-factual).
- Implementation of the CHP Directive has been delayed; the CHP Directive is unlikely to lead to a direct impact (over and above national policies) until at least 2009. Any impact of the CHP Directive, therefore, can only be analysed from 2011 on, when 2009 statistics will become available.

For these two reasons the analysis has been limited to a Tier 1 assessment. Overall, it can be argued that the Tier 1 results should not be considered a policy impact assessment. It is impossible, based on aggregated statistics only, to split any policy effect (whether national or European) from other effects such as autonomous development of CHP, changing economic activity from year to year in sectors that apply CHP, cold winters versus warm winters (relevant for district heating plants) etc. What Tier 1 does show us is the contribution of CHP to climate policy objectives regardless whether this contribution is induced by the CHP Directive or not.

Table 4-9	Key methodological choices CHP Directive
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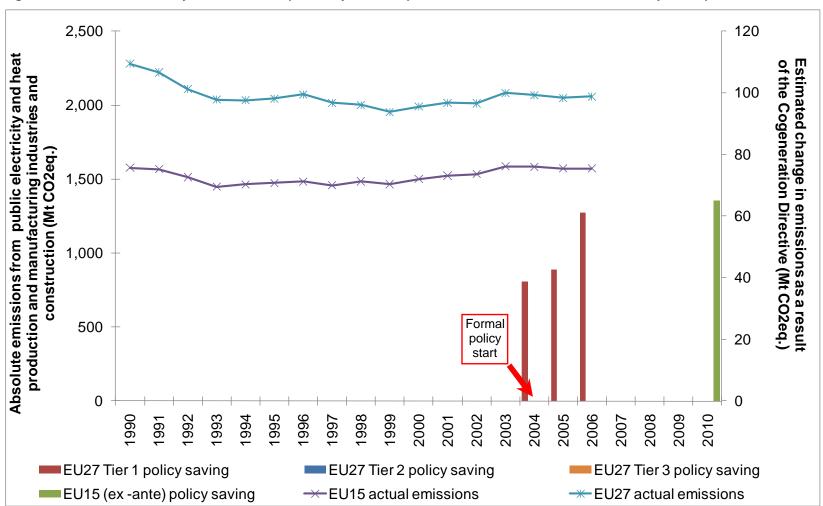
Methodology	Tier 1	Tier 2 *	Tier 3 *
Activity indicator	CHP electricity	CHP electricity	CHP electricity
Emission factor (g CO ₂ /kWh)	EU average	MS average	MS average fossil
			park/
			hourly short-term
			marginal
Autonomous CHP deployment	No	First order	yes
Policy interaction:			
+ Interaction with other ECCP policies	no	no	yes
(decomposition of European policy impact)			
+ Decomposition of European versus	no	yes	yes
national policy impact			
+ Quantify the impact of feed-in subsidies	no	no	first order
(operational support)			
Geographic factors (normalisation to climatic	no	yes	yes
conditions for space heating)			
Timing issues / delay / announcement effects		delay taken into a	ccount
Other factors being relevant for CHP:			
+ Identify upcoming CHP technologies	no	yes	yes
+ Correction for base/target year deviations	no	first order	yes

^{*} The Tier 2 and 3 approaches could not be further elaborated in the course of this study.

ENV.C.1/SER/2007/0019

Restricted - Commercial
AEA/ED05611/Final Report

Figure 4-10 CHP Directive: Key results of the ex-post analysis in comparison with ex-ante estimates and inventory development



Notes: Emission trends are shown on the primary axis while estimated policy savings are shown on the secondary axis. The final year for which ex-post estimates are available varies between policies. See Table 4-1 for further details. The geographical coverage of ex-post policy savings varies due to data constraints and is detailed in the legend above. The CHP Directive may also influence the following inventory activities (but to less a degree that for the two sectors presented in the graph: 1.A.4 (Fuel Combustion Activities – other Sectors) and 1.A.5 (Fuel Combustion Activities - non-specified).

Sources: Policy savings for 2010 are European Commission ex-ante estimates while savings for historic years are ex-post estimates generated under this study. The source for absolute emissions is the 2006 GHG inventory (EEA, 2008).

At the EU-27 level the CO_2 savings from CHP grew strongly (+44%) between 2005 and 2006. In 2006 CHP contributed more than 60 Mt of CO_2 savings to the European climate change objectives as compared to 40 Mt in 2004. However, the increased CO_2 savings for most Member States can be explained by the higher EU average CO_2 emission factor for electricity in 2006. Only Germany and Italy also show increased CO_2 savings in the period 2004-2006 when correcting for the higher emission factor. This immediately shows how sensitive the calculation outcomes are for the reference development.

Table 4-10 Key uncertainties CHP Directive

Key uncertainties in data

Autonomous progress: Member States have started to collect CHP statistics on a structural and harmonised base. However, no similar data collection is available for the pre-Directive period before 2004. This is a strong obstacle to the evaluation of the autonomous progress/impact of previous national policies in the pre-Directive period.

Key uncertainties in methodologies

Choice of emission factor: The result obtained for Tier 1 is rather sensitive to the reference CO₂ emission factor for electricity, the assumed overall efficiency for calculating CHP fuel from total fuel, the reference efficiency value for heat production and the assumed CO₂ emission factor for CHP fuel. Both the separate and combined effect of these indicators can either lead to overall savings of over 100 Mt or even negative overall savings for 2006 (both as compared to no CHP at all. The most important sensitivities are:

- 1. Using a fixed (base year) EU average emission factor instead of a moving average emission factor.
- 2. Using national emission factors instead of an EU average emission factor.
- 3. Using a marginal approach instead of an average emission factor.
- 4. Using 85% overall CHP efficiency to calculate the CHP fuel instead of 75%.
- 5. Using 90% reference heat efficiency instead of 85%.
- 6. Using 70 kg CO2 /GJ as fuel emission factor for CHP (weighted average of the emission factors of the fuels used for CHP production) instead of 56.8 kg/GJ (natural gas as reference fuel for CHP).

Figure 4-11 CHP: Sensitivity analysis for the different factors affecting the cumulated GHG savings (2006)

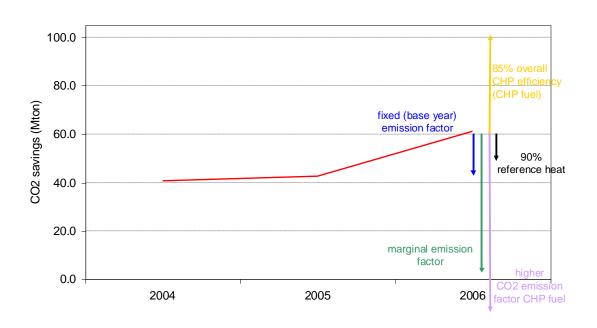
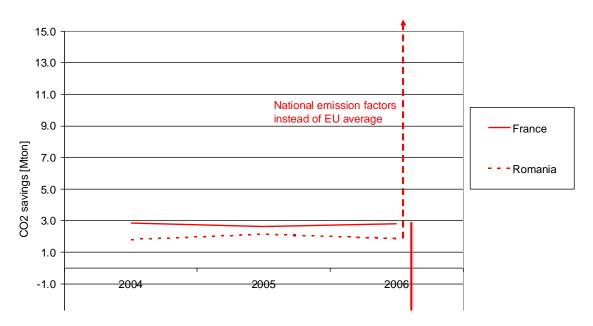


Figure 4-12 Impact of applying a national emission factor for electricity production instead of an EU average for France and Romania



In terms of the **cost-effectiveness** of CHP policies, the Energy research Centre of the Netherlands (ECN) has analysed the cost-effectiveness of the feed-in subsidy in the Netherlands. ⁵¹ Calculations show that cost-effectiveness is 25 euro/ton CO2 saved. An earlier study of ECN included a full indepth analysis of the costs for national CHP policies. ⁵² For the period 1990-2000 the cost-effectiveness of CHP policies amounted to 10 euro/ton CO2 saved.

4.3.3 Key results: EU ETS Directive (2003/87/EC)

Directive 2003/87/EC, commonly known as the ETS Directive, introduces a mandatory cap-and-trade system for GHGs for the energy sector (power plants, refineries, coke ovens, other combustion installations) and the energy-intensive industry (iron & steel, cement, ceramics, pulp & paper).

The Directive has been evaluated using a Tier 1, Tier 2 and Tier 3 approach.

The Tier 1/2 approach as explored in this evaluation provides results which are not realistic. In general the impact estimates are far too high. This is due to the complexity of the EU ETS. The intensity approach leads to savings of nearly 79 Mt CO_2 eq. in 2006 for the set of 10 countries investigated as compared to 2005. This is certainly too high and is caused by the fact that the data delimitation in the inventories and in the activity indicators are not very consistent due to the high level of aggregation in the data. The direct projection of the inventories without making use of activity data leads to more realistic results of 22 Mt for the 10 countries but is not satisfactory from the methodological point of view. Refinements may be possible on the Tier 1/2 approach but in order to achieve realistic results it is most likely that so many corrections have to be applied that one has gone a good deal of the way to a Tier 3 approach anyhow.

The Tier 3 approach has delivered realistic results for the two examples chosen here: the dispatching in the power sector (3.6 Mt CO_2 savings in 2006 compared to 2005) and the impacts in the cement sector in Germany (0.12 Mt from direct impacts of the ETS and 0.77 Mt from indirect impacts of the ETS on production volumes). The result for the impact of dispatching in the power sector depends strongly on the actual CO_2 prices on the market and the relative prices of energy carriers: in 2005

⁵² ECN (2002) Besparingstrends 1990-2000. Besparing, instrumenten en effectiviteit.

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⁵¹ ECN (2004) Milieukosten energiemaatregelen 1990-2010. Overzicht kosten en mogelijke verbeteringen in de monitoring.

there was mainly a switch to gas, in 2006 mainly a switch of lignite to hard coal (Reason: Increasing gas prices in 2006, slight decrease in hard coal prices in 2006).

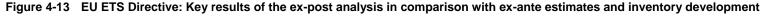
The calculations in the Tier 3 approach are fairly complex and require substantial amount of additional data. Given the fact that the EU ETS is a major instrument within the ECCP, however, there is no way around the use, and further development, of a more refined approach. Current models, such as PRIMES are not well adapted to capture the multitude of effects. So more dedicated models need to be developed such as an hourly dispatching model for the European power sector exemplified here with the PowerAce model for Germany, as well as econometric approaches in the case of industrial sectors. These models need to be gauged to the CO₂ registries which provide more and more information over time.

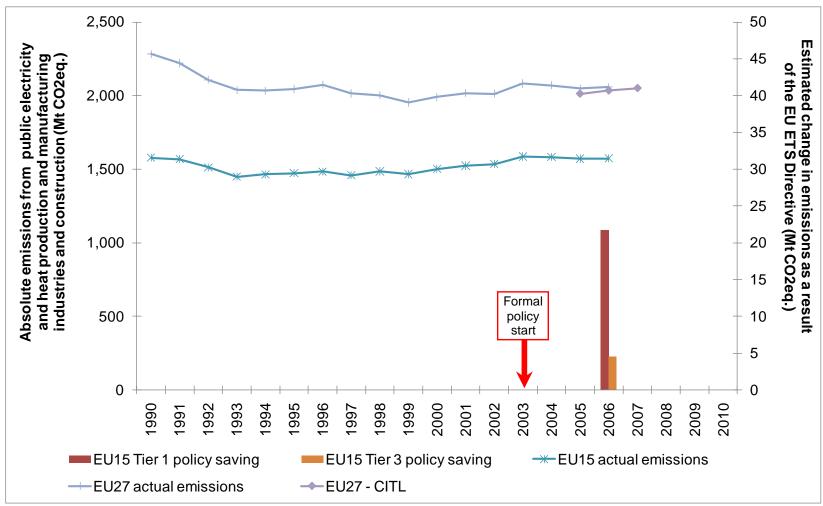
Table 4-11 Key methodological choices EU ETS Directive

Methodology	Tier 1	Tier 2 *	Tier 3
Activity indicator	Value added	kWh produced	kWh produced/ t of product
Emission factor (g CO ₂ /kWh)	EU average	MS average	MS average fossil park/ hourly short-term marginal
Approach	Statistical approach	Statistical approach	Model-based Energy sector: PowerAce Industry: Econometric model
Policy interaction:			
+ RES-E Directive	yes	yes	yes
+ Energy efficiency policies	no	no	yes
Autonomous development	yes (at aggre- gate level)	yes (at aggre- gate level)	yes
Impact of energy prices	no	no	yes
Indirect impacts (reduced industry, production)	yes (implicitly)	yes (implicitly)	yes (explicitly)
Geographic factors (normalisation to climatic conditions for renewables)	yes	yes	yes
Timing issues / delay / announcement effects	no	no	no
Structural change	no	no	Ind. sector

^{*} Elaborating a Tier 2 approach did not appear as attractive as any substantial improvement over Tier 1 would lead inevitable to a Tier 3 approach given the complexity of the policy measure.

ENV.C.1/SER/2007/0019





Notes: Emission trends are shown on the primary axis while estimated policy savings are shown on the secondary axis. The final year for which ex-post estimates are available varies between policies. See Table 4-1 for further details. The geographical coverage of ex-post policy savings varies due to data constraints and is detailed in the legend above. The figure also includes data from the Community Independent Transaction Log CITL.

Sources: Policy savings for 2010 are European Commission ex-ante estimates while savings for historic years are ex-post estimates generated under this study. The source for absolute emissions is the 2006 GHG inventory (EEA, 2008).

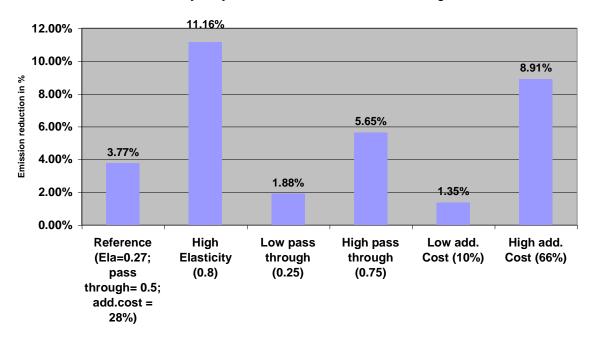
Table 4-12 Key uncertainties EU ETS Directive

Key uncertainties in data
Elasticities: to evaluate demand reduction effects.
Cost pass through: for carbon prices.
Autonomous progress: evaluation of the autonomous progress/impact of previous national policies
in the pre-Directive period.
Key uncertainties in methodologies
Choice of emission factors: use of average emission factors versus hourly calculations.
Interaction with other key policies: such as RES-E or energy efficiency policies

To illustrate the impact of the various blocks on indirect (i.e. demand-induced) and direct emission reductions, the values for the key parameters are varied. Figure 4-14 shows the results compared to the reference case, when the elasticity of demand is high (i.e. 0.8 rather than 0.27), when 25 percent or 75 percent of the additional (average) costs are passed on to consumers (rather than 50 percent), and when this cost increase is 10% and 66% (rather than 28%).

Figure 4-14 EU ETS Directive: Sensitivity analysis for the different factors affecting the cumulated GHG savings (case of German clinker production, 2006): first graph for demand induced emissions savings in the German clinker production, second graph for direct effect of EU ETS on emissions savings in the German clinker production

Sensitivity analysis for demand induced emission savings



times reference)

1.40% 1.16% 1.20% 0.97% 1.00% Emission reduction in % 0.80% 0.56% 0.60% 0.36% 0.40% 0.20% 0.07% 0.00% Reference High tech High fuel price Low techn Low fuel price change (1.0) elasticity (1/3 of elasticity (3 change (0.1)

Sensitivity analysis for autonomous technological change and fuel-cost effects

The arguments in favour of market-based instruments such as tradable allowances to generate a strong carbon price signal are well-known:

They use market forces and all the information at the disposal of economic agents to improve the allocation of scarce resources;

reference)

- > They can provide firms with flexibility to meet regulatory requirements;
- > By allowing greater flexibility they ensure better efficiency through lower compliance costs;
- In the longer-term they encourage innovation and technological development

However, quantitative ex-post estimates on the actual costs of the EU ETS to date are more limited.

4.3.4 Key results IPCC Directive (96/61/EC)

The IPPC Directive has been evaluated using a Tier 1 approach only.

The development and testing of a Tier 1 methodology for IPPC has proved challenging. The results have highlighted several methodological difficulties which require more in-depth analyses at Member State, sector and installation level in order to be resolved. This would require further data collection and a much more refined methodology.

The current Tier 1 methodology uses GHG emissions inventory data and production indices to calculate changes in emissions intensity over time which may have been affected by the Directive. It is assumed that following the implementation of the Directive all changes in emissions intensity are attributed IPPC i.e. the Directive is assumed to be the single driving influence on changes in the emissions intensity within the given sectors. This is consistent with the top-down methodology that has been applied for the other polices at a Tier 1 level.

However, this simplified approach does not adequately represent a number of important factors relevant to an evaluation of the IPPC Directive. In particular:

- The aggregate statistics do not allow emissions and activities associated with installations covered IPPC to be isolated from non-IPPC installations and non IPPC activities.
- No adjustments have been made for the influence of other policies on the overall trend in emissions from the installations considered.
- No adjustments have been made for autonomous progress (i.e. the influence of on-going technological innovation on the trend in emissions)

- No adjustments have been made for structural changes in activity data (i.e. changes in production processes, closure of facilities)
- No adjustments have been made for other exogenous factors such as energy prices.

These factors would ideally be addressed as part of a Tier 3 approach, as illustrated in the table below.

Table 4-13 Key methodological choices IPPC Directive

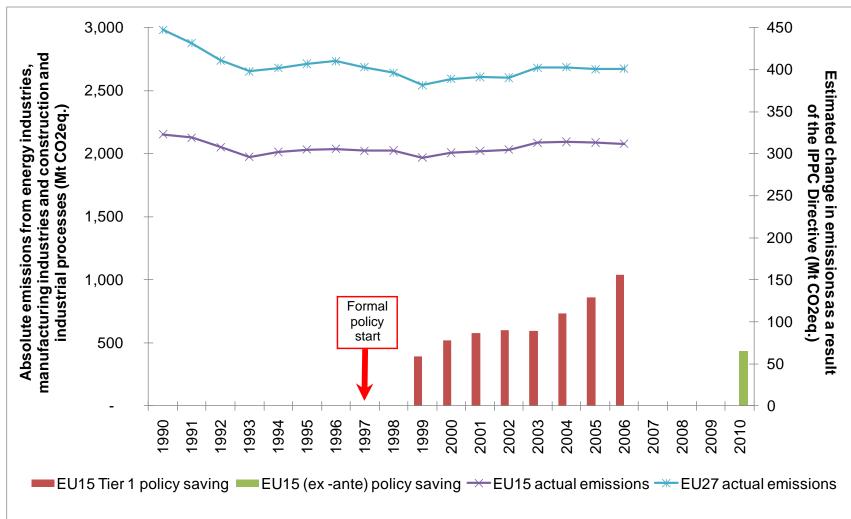
Approach	Tier 1	Tier 2	Tier 3 *
Activity indicator	Industrial production index	Industrial production index	Installation or industry specific activity data.
Emission factor (g CO ₂ eq/unit of activity)	EU average	EU average	MS specific
Policy interaction (Policy overlaps with Large Combustion Plant Directive LCPD, Waste Incineration Directive WID, Landfill Directive, VOC, EU ETS.)	no	no	yes
Autonomous development (previous trend in related emissions)	no	yes	yes
Structural effects	no	no	yes (if data allows for corrections)
Geographic factors	no	no	no
Timing issues / delay or announcement effects	no	Consideration of MS implementation da and new vs existing installation effects.	
Source data	Eurostat/UNFCCC	Eurostat/UNFCCC	Installation or industry specific

^{*} The Tier 3 approach could not be further elaborated in the course of this study.

The Tier 1 methodology can help to explain, to some extent, the trends in emission intensity in the sectors concerned. However, the results derived are likely to overestimate the true impacts of the policy. Further analysis is required to isolate the policy impacts from the other drivers of emissions in the sectors concerned.

On this basis, and taking into account the complexity of the sectors and the simplicity of the approach, we do not consider the results sufficiently robust to recommend the use of a Tier 1 approach to quantify the impacts of the IPPC Directive. A more sophisticated, Tier 3, methodology would need to be developed in order to move towards a more accurate estimate the of the policy impact.

Figure 4-15 IPPC Directive: Key results of the ex-post analysis in comparison with ex-ante estimates and inventory development



Notes: Emission trends are shown on the primary axis while estimated policy savings are shown on the secondary axis. The final year for which ex-post estimates are available varies between policies. See Table 4-1 for further details. The geographical coverage of ex-post policy savings varies due to data constraints and is detailed in the legend above.

Sources: Policy savings for 2010 are European Commission ex-ante estimates while savings for historic years are ex-post estimates generated under this study. The source for absolute emissions is

the 2006 GHG inventory (EEA, 2008).

Table 4-14 Key uncertainties IPPC Directive

Key uncertainties in data

Installation data: identification of installations under IPPC

Policy implementation: Knowledge on the implementation of the IPPC Directive in the MS

Key uncertainties in methodologies

Autonomous progress: assumptions made on the pre-Directive trends

Policy overlaps: specifically the overlap with the Large Combustion Plant Directive LCPD, Waste Incineration Directive WID, Landfill Directive, the VOC policies, the EU Emission Trading Scheme ETS.

No quantitative estimates were identified on the cost-effectiveness of the IPPC Directive in delivering GHG emissions reductions.

4.3.5 Key results F-Gases Regulation (EC No. 842/2006)

Regulation (EC) No. 842/2006 aims to reduce emissions of the fluorinated greenhouse gases covered by the Kyoto Protocol by addressing various different sectors and appliances that use fluorinated greenhouse gases (Hydrofluorocarbons HFCs, Perfluorocarbons PFCs Sulphur hexafluoride SF₆).

Due to the heterogeneity and complexity of the affected sectors a simple top-down assessment (i.e. a Tier 1 or Tier 2 approach) would not lead to a realistic assessment of the impact of this policy. Such approach could only be applied to a small number of 'simpler' sectors.

The Refrigeration and Air conditioning sector can be seen as a key category for most of the countries. It accounts to approximately 65% of the total F-Gas emissions of the EU-27. However this is a very heterogeneous sector as it consists of several different subsectors such as domestic refrigeration, commercial refrigeration, transport refrigeration, industrial refrigeration, stationary and mobile air conditioning. Therefore an assessment of this sector especially in terms of the impact of the Regulation with a simple top-down approach is rather not possible. Other bigger emission sources are the aluminium industry, emissions from foam blowing and emissions from the use of gas insulated switchgear.

A Tier 3 approach, applied at sub-category level, appears the most appropriate to capture the interactions between the policy and F-Gas emissions. Undertaking such assessment, however, would require a significant amount of data that are currently not available. Therefore no adequate results could be calculated in the scope of this study. As the policy on F-gases also mandates the collection of some critical data, the required review of the regulation by July 2011 will offer the opportunity to undertake a more detailed assessment of the impact of the regulation.

Table 4-15 Key methodological choices F-Gases Regulation

Approach	Tier 1	Tier 2	Tier 3
Activity indicator	Aggregated activity data in	Disaggregated	Detailed consumption and
	National Inventory Submissi-	Inventory consumption and	stock data disaggregated on
	ons to UNFCCC	stock data on sub-	each sub-application
	Annual chemical	application level.	reported to the MS.
	consumption data and stock		
	data (banks) derived from		
	annual consumption data		
Emission factor	Emission factors (e.g.	Country specific emission	
	leakage rate) from the 2006	factors per sub application.	
	IPCC Guidelines for National		
	Greenhouse Gas		
	Inventories.		
Policy interaction ⁵³	no	no	yes
Autonomous	Current formula assumes	In absence of the F-Gas	In absence of the Regulation
development	activity data are not affected	regulation activity data	Activity data would increase.
	by the regulation and that	would increase	Main drivers are GDP
	per activity, leakage rates of	proportionate to GDP growth	growth and the phase out of
	F-gasses would remain	of the member states.	ozone depleting substances
	constant in absence of the	Leakage rates are assumed	due to Regulation (EC) No
	regulation	to remain constant.	2037/2000

Whilst no ex-post estimate of the impacts of the F-gas regulation has been possible the figure below shows the historical trend in emissions and the Commission's ex-ante estimate of the impacts of the regulation on emissions in 2010. It is clear that the regulation has the potential to have a significant impact on European emissions from these sources.

The main uncertainty with respect to the F-Gas Regulation is the availability of data required for a robust evaluation.

Table 4-16 Key uncertainties F-Gas 'Regulation

uncertainties	

Data availability for F-Gases in MS: To gain an overview of the F-gas regulation's impact on total emission reductions member states and the European Commission should focus on the creation of an adequate and cost effective way to assemble required data on sub-application level. Through reporting obligations for system operators of refrigeration, air conditioning and heat pump equipment, as well as fire protection systems containing 3 kg or more of fluorinated greenhouse gases detailed data will be available for each appliance. This data should be made available for the impact assessment. How this could work has yet to be assessed and will be a key question for the review of the regulation according to article 10

Timing issues: information on the implementation of the regulation in MS.

Key uncertainties in methodologies

Autonomous progress: assumptions made on the pre-Directive trends

No quantitative estimates were identified on the ex-post costs of implementing the F-gas regulations.

AEA 59

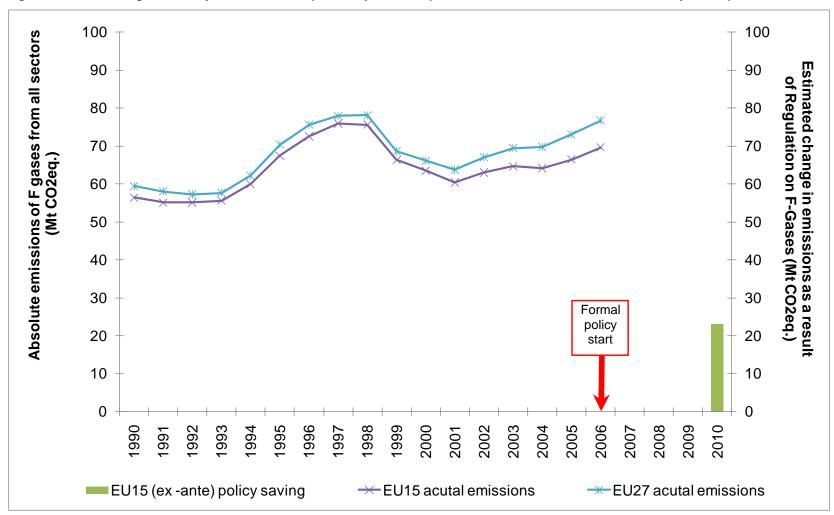
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⁵³ There is no overlap between this regulation and other EU climate policy directives. However Regulation (EC) No 2037/2000 on substances that deplete the ozone layer has a certain impact on the use of fluorinated greenhouse gases, as many of the F-Gases used are substitutes for ozone depleting substances. Before the introduction of the Regulation some Member States had already introduced national policies to stimulate the reduction of F-gases (i.e. policy to restrict the use of F-gas in certain applications, policy instruments to address containment including taxation of fluids).

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Figure 4-16 F-Gas Regulation: Key results of the ex-post analysis in comparison with ex-ante estimates and inventory development



Notes: Emission trends are shown on the primary axis while estimated policy savings are shown on the secondary axis. The final year for which ex-post estimates are available varies between policies. See Table 4-1 for further details. The geographical coverage of ex-post policy savings varies due to data constraints and is detailed in the legend above.

Sources: Policy savings for 2010 are European Commission ex-ante estimates while savings for historic years are ex-post estimates generated under this study. The source for absolute emissions is the 2006 GHG inventory (EEA, 2008).

4.4 Households and Service Sector

The decomposition analysis at the sectoral level between 2000 and 2005 for key polices with the PRIMES model shows the following main results for the residential sector (see Figure 4-17)

Both activity growth and energy intensity gains are calculated to lead to an increase of CO_2 emissions (+27.1 and +5.4 Mt CO_2 respectively). Demographic changes account for 31% of the activity growth related increase of emissions, the rest being the result of economic growth. Energy intensity in the residential sector also worsens (consumption per household increases from 1.47 toe in 2000 to 1.49 toe in 2005) as efficiency improvements in the sector occurring both in heating/cooling uses as well as in electric appliances are not enough to counterbalance the corresponding increase of energy requirements of consumers. Changes in the fuel mix account for a reduction of CO_2 emissions by -15.5 Mt CO_2 as carbon intensity in the residential sector improves. Thus, total CO_2 emissions in the residential sector increase by +17 Mt CO_2 (or +3.6%) in 2000-2005.

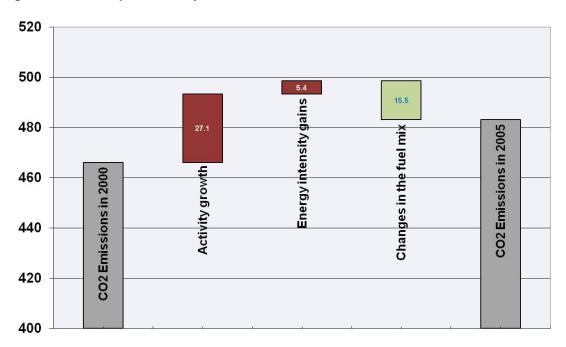


Figure 4-17 Decomposition analysis of residential sector

In the services sector CO2 emissions exhibited an increase of +12.6 Mt CO2 (+5.2%) in 2000-2005 (+14.8 Mt CO2 in services and -2.2 Mt CO2 in agriculture). As shown in Table 4-18, energy intensity gains (-8.5 Mt CO2) and to a less extend changes in the fuel mix (-1 Mt CO2) partly counterbalanced the activity growth effect (+22.1 Mt CO2, with demographic developments accounting for 20% of the increase and economic growth for 80%) in the sector.

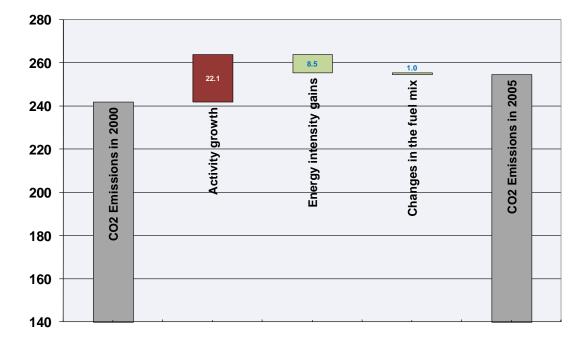


Figure 4-18 Decomposition analysis of services sector

The main policies considered in this sector in the further chapters are:

- > The Energy Performance Directive for Buildings EPBD
- > The Appliance Labelling Directive

4.4.1 Key results: Directive on Energy Performance of Buildings (2002/91/EC)

The Energy Performance of Buildings Directive obliges Member States to introduce minimum energy efficiency standards for existing, renovated and new residential and service buildings, introduce a labelling system for existing buildings, set up a system for regular boiler and air conditioning inspection.

The Directive has been evaluated using a Tier 1, Tier 2 and Tier 3 approach.

Given the fact that the application of this Directive is very recent and/or, in some parts, it is not yet implemented, it has not been possible to carry out a real ex-post evaluation of the policy impacts. The evaluation has therefore taken the form of a simulation exercises in order to illustrate the ex-post evaluation methods. The Tier 1 and 2 simulation exercises assume that impact of the EPBD, which has been issued in 2002 was immediate and that all impact observed after 2002 was triggered by the EPBD. This is clearly on overestimate although the EPBD has certainly had an influence on the development of national building regulation issued between 2002 and 2006. In the Tier 3 approach the impacts of the EPBD were simulated during the period 2004-2020 with the MURE building model. The most important hypothesis for the simulation exercise is that the newest national building regulation put in place after introduction of the EPBD is strongly influenced by the EU Directive.

Table 4-17 provides a summary of the assumptions used to generate the results illustrated in Figure 4-19.

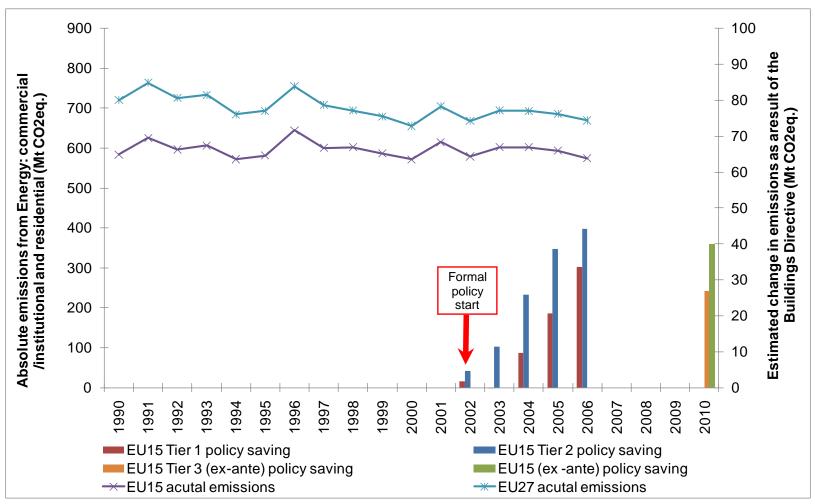
Table 4-17 Key methodological choices Energy Performance of Buildings Directive EPBD

Approach	Tier 1	Tier 2	Tier 3
Activity indicator	Number of households (Inventory 1.A.4.B.). Number of employees (Inventory 1.A.4.A.). Estimate space	Number of households and development of square metres. Estimate of space heating	In addition data on building stocks and technical characteristics of existing, new, refurbished buildings. Use of
	heat. shares.	shares.	MURE simulation model
Emission factor (g CO ₂ eq/dwelling,	Fuel specific emission factors.	Fuel specific emission factors.	Fuel specific emission factors.
square metre or employee)	Aggregate average EU emission factors for electric space heating	Emissions for el. space heating based on aggregate data reported by MS to UNFCCC	Short-term marginal emission factor (hourly model or approximation by fossil fuel plants)
Policy interaction	Combined effect of closely related national and EU policies.	Combined effect of closely related national and EU policies.	Separation of national pro- motion schemes by explicit simulation of potentially overlapping policies.
Autonomous development	Correction for autonomous progress/previous policies included in a very approximate manner by assuming a fixed rate based on the stock renewal and the period 19902002 previous to the EPBD.	Correction for autonomous progress/previous policies included in a very approximate manner by assuming a fixed rate based on the stock renewal and the period 19902002 previous to the EPBD.	Adjustment for the increase in household size, for the shift in multi/single family houses, change in age structure. No adjustment for increase in internal temperatures and length of heating period.
Structural effects	No adjustment for structural changes in the activity data	Adjustment for the increase in household size.	yes (if data allows for corrections)
Geographic factors	Adjustment for climatic influence	Adjustment for climatic influence	Adjustment for climatic influence
Timing issues / delay or announcement effects	Common implementation date at EU level, no adjustment for implementation delays or announcement effect.	MS specific implementation date, no adjustment for implementation delays or announcement effect.	Calculates policy impacts from implementation date within each MS. Adjustment for implementation delays or announcement effect.
Other exogenous factors	Non-compliance with building regulation implicit in statistical data No further adjustment for exogenous factors	Non-compliance with building regulation implicit in statistical data No further adjustment for exogenous factors	Non-compliance with building regulation explicitly modelled Adjustment for impacts of commodity prices for heating on the autonomous uptake of insulation measures.

The different tiered methodologies discussed for this policy deliver results for the sum of the residential and service sector in the EU27 which differ substantially among each other. These differences are explained by methodological differences and data issues.

In practice the Tier 1 and tier 2 results will overestimate the true impacts. Due to delays in implementation the actual impact of the Directive in the period analysed by the methodologies (up to 2006) is likely to be zero. A more realistic representation of the actual policy impacts (in 2010) is provided by the Tier 3 approach.

Figure 4-19 Energy Performance Directive for Buildings EPBD: Key results of the ex-post analysis in comparison with ex-ante estimates and inventory development



Notes: Emission trends are shown on the primary axis while estimated policy savings are shown on the secondary axis. The final year for which ex-post estimates are available varies between policies. See Table 4-1 for further details. The geographical coverage of ex-post policy savings varies due to data constraints and is detailed in the legend above.

Sources: Policy savings for 2010 are European Commission ex-ante estimates while savings for historic years are ex-post estimates generated under this study. The source for absolute emissions is the 2006 GHG inventory (EEA, 2008).

Table 4-18 Key uncertainties Energy Performance Directive for Buildings EPBD

Key uncertainties in data

Building type data: Insufficient data on the penetration of more efficient building types (distribution of energy performance certificates)

Policy overlap: Overlap with national support policies for buildings

Exogenous factors:

Inclusion of comfort factors such as increased square metres per building (Tier 1 approach), in difference to Tier 2 and 3 approaches which make the comfort increase explicit and do not include them into the impact estimate.

Non-compliance issues are included automatically in Tier 1 and 2 approaches while non-compliance with building regulation is made explicit in the Tier 3 approach.

Emissions and emissions factors for this sector. For the purpose of this analysis we have used, for consistency the data reported by Member States to the UNFCCC. However, there is large uncertainty in both the activity data and the emissions factors themselves. Whilst this does not necessarily impact upon the current analysis, for future evaluations, the methodologies will need to be updated to reflect future advancement in this area.

Key uncertainties in methods

Autonomous progress/previous policies:

In the Tier 3 approach autonomous progress/previous policies is modelled explicitly by considering the penetration of buildings obeying to the previous building regulation. For Tier 1 or 2 approaches this is included by assuming a progress factor. For the residential sector for example 0.5% annual improvement was chosen in agreement with the period 1990-2002.

Assumptions on the start of the policy impacts: while Tier 1 and 2 approaches assume an immediate start of the impacts in 2002, the year when the EPBD has been accepted (there are some arguments for this: the EPBD as an important EU policy had some effects on national legislation before it was translated in all MS to national regulation). The Tier 3 approach looks on the contrary on the implementation delays and thus models the EPBD impacts only in the period 2004-2020, assuming that the main impacts of the EPBD are still in the future.

Imperfection of climatic correction: In the Tier 1 and 2 approach, given that this is a statistical approach, without averaging over several years, for smaller countries and in early stages, when savings are still small, the fluctuations in the impact results may reach quite considerable levels.

Differences in **emission factors for electric heating:** only important for countries with high shares of electric space heating or high shares of district heating

The figure below shows the impact of using specific methodological assumptions, and the influence of data uncertainties, upon the overall results. The arrows show the relative variability in the results depending upon the particular assumptions that are used. The results represent the historic importance of the different factors. This does not necessarily mean that the factors will have the same importance in the future.

It can be seen that a variety of factors may have substantial impacts on the results. Of particular importance is the approach that is used for climate correction and the influence of national policies. Also key methodological assumptions with respect to the start date of the policy (i.e. implementation delays) and compliance/enforcement can also influence strongly the final results.

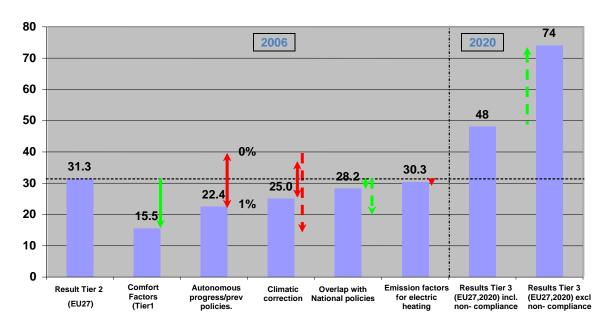


Figure 4-20 Energy Performance for Buildings Directive EPBD: Sensitivity analysis for the different factors affecting the cumulated GHG savings (2006/2020)

Notes: Variations due to methodological choices are in red. Variations due to data issues are in green. Solid arrows represent an absolute assessment of the variation, as calculated in the current analysis. Dashed arrows show an estimate of the variation, but the absolute value is much more uncertain. ¹⁾ e.g. increase m2/dwelling included

In terms of cost-effectiveness then, in general, savings on buildings envelopes belong to the most cost effective options to avoid CO_2 emissions, although very high performing buildings may still come at a positive cost. The ex-post costs of the EPBD to date have not been examined further in this study.

67

4.4.2 **Key results Appliance Labelling Directive (92/75/EEC)**

The Appliance Labelling Directive introduces a common format for the labelling of energy consumption information concerning household appliances such as refrigerators, freezers and their combinations, washing machines, driers and their combinations, dishwashers, ovens, water heaters and hot-water storage appliances, lighting sources, air-conditioning appliances

The Directive has been evaluated using a Tier 1, Tier 2 and Tier 3 approach.

Table 4-19 Key methodological choices Appliance Labelling Directive

Approach	Tier 1	Tier 2	Tier 3
Activity indicator	Number of households. ⁵⁴	Number of households and appliance ownership.	Number of appli- ances. ⁵⁵
Emission factor (g CO ₂ eq/kWh saved)	EU average	MS average	MS average fossil park/ hourly short- term marginal
Policy interaction (in particular synergy with national promotion schemes)	no	no	yes
Autonomous development (i.e. improvement of appliances in the pre-Directive period))	yes (at aggregated level)	yes (at appliance level)	yes (at appliance level)
Structural effects (e.g. adjustment for structural changes due to changes in ownership)	no	yes (if data allows for corrections)	yes (if data allows for corrections)
Geographic factors (e.g. adjustment for climatic variation for electric heating)	no	yes	yes
Timing issues / delay or announcement effects	Same start date	MS specific	MS specific
Other exogenous factors: impacts of commodity prices (electricity prices) but impact small	no	no	yes

The results derived are reasonably close for each of the tiered methodologies, providing confidence in the results from the more simplistic approaches. The size of the CO₂ savings indicates that the Labelling Directive has a "medium size impact" compared to for example the RES-E Directive.

A key factor that influenced the results derived was the assumed level of autonomous progress. Autonomous improvements in the efficiency of appliances are potentially important, so if uncorrected the evaluation results are likely to represent an upper limit for the quantitative impact estimate.

Autonomous progress can be estimated by extrapolating pre-Directive trends in appliance efficiency. However, this was limited because appliance data before 1994, the start of the first implementing Directive to the Labelling Directive (for cooling appliances), are relatively scarce. In addition, the progress in this pre-Directive period might not necessarily be representative of the later progress (i.e. if the earlier efficiency improvements were easier to achieve). It was found that autonomous progress should not be estimated over a long period, if at all, otherwise the policy impact calculated will be close to zero.

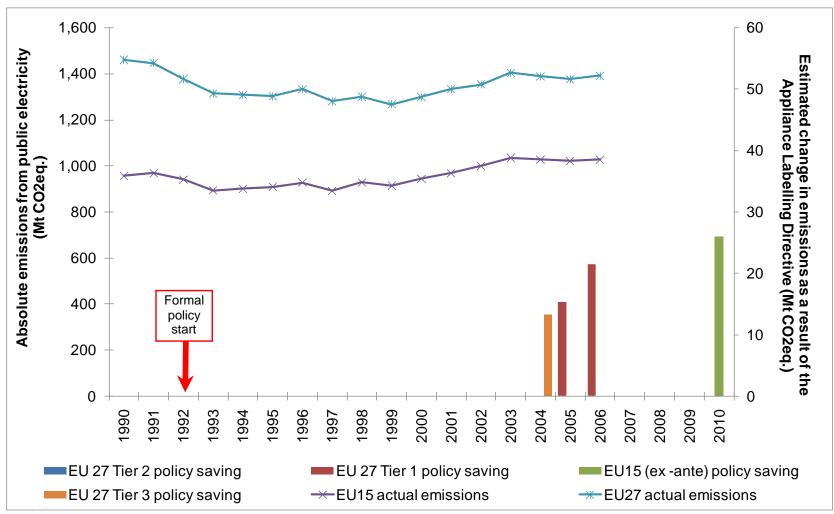
The choice of the emission factor for electricity savings (average versus marginal emission factor) was also found to have a significant influence on the impact evaluation. Emission factors differ significantly between the countries depending on the conventional power system in each country. Therefore, the result from using an EU average factor was very different from applying a member state specific factor.

A further adjustment was the separation of the impacts of the Directive from national support policies. This was done by comparing countries or set of countries with and without supporting policies.

 $^{^{54}}$ Appliances not treated individually. No separation of appliances not subject to labelling.

has Tier 2 but including sales data per appliance and data on split by efficiency class. Use of a stock model.

Figure 4-21 Appliance Labelling Directive: Key results of the ex-post analysis in comparison with ex-ante estimates and inventory development



Notes: Emission trends are shown on the primary axis while estimated policy savings are shown on the secondary axis. The final year for which ex-post estimates are available varies between policies. See Table 4-1 for further details. The geographical coverage of ex-post policy savings varies due to data constraints and is detailed in the legend above.

Sources: Policy savings for 2010 are European Commission ex-ante estimates while savings for historic years are ex-post estimates generated under this study. The source for absolute emissions is the 2006 GHG inventory (EEA, 2008).

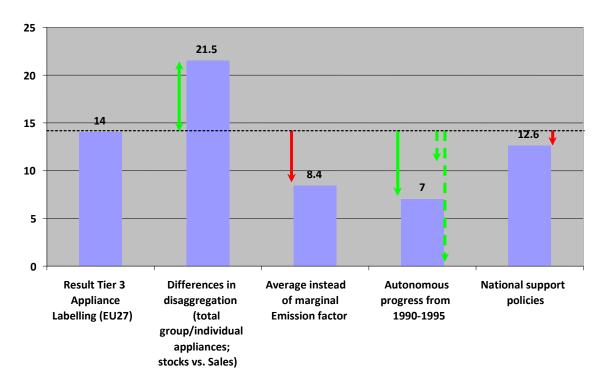
Table 4-20 Key uncertainties Appliance Labelling Directive

Key uncertainties in data
Emission factors: Use of average emission factors versus hourly calculations.
Data availability: Tier 3 analysis can only be carried out on the basis of un-official data that have to
be purchased from market actors
Key uncertainties in methods
Autonomous progress: Evaluation of the autonomous progress/impact of previous national policies
in the pre-Directive period.
Policy interaction: National support policies enhancing the impacts of the Labelling Directive

The figure below shows the impact of using specific methodological assumptions, and the influence of data uncertainties, upon the overall results. The arrows show the relative variability in the results depending upon the particular assumptions that are used. The results represent the historic importance of the different factors. This does not necessarily mean that the factors will have the same importance in the future.

It can be seen that a variety of factors may have substantial impact on the overall results. These relate to data uncertainties, for example, the differentiation of sales and stocks, and the differentiation of labelling classes. Other factors are linked to methodological choices, such as the choice of emission factor (average EU/MS or MS marginal), and the correction for national support policies. The parameter with the largest overall influence on the results is autonomous progress.

Figure 4-22 Labelling Directive: Sensitivity analysis for the different factors affecting the cumulated GHG savings (Mt CO2 equ. in 2006 for EU27)



Notes: Variations due to methodological choices are in red. Variations due to data issues are in green. Solid arrows represent an absolute assessment of the variation, as calculated in the current analysis. Dashed arrows show an estimate of the variation, but the absolute value is much more uncertain.

In terms of the **cost-effectiveness**, in general electricity savings from electric appliances belong to the most cost effective options to avoid CO_2 emissions. In addition, due to the relatively small difference between the most efficient appliances and the average of the market, as well as due to the fact that with market penetration a rapid decrease in the differential costs occurred in the past, the consumers face less important investment barriers to energy efficiency than in other sectors.

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The IEA (2003) estimated that "savings can be achieved at negative cost to society, since the extra costs of improving energy efficiency are more than offset by savings in running costs over the appliance's life. In the US, each tonne of CO₂ avoided in this way in 2020 will save consumers \$65; while in Europe, each tonne of CO₂ avoided will save consumers €169 (reflecting higher electricity costs and currently lower efficiency standards in Europe)."

4.5 Waste

4.5.1 Key results: Landfill Directive (1999/31/EC)

The Landfill Directive sets out legislation for the reduction of Municipal Solid Waste disposed to landfill and sets targets to reduce biodegradable waste to landfill progressively by 25%, 50%, 65% compared to 1995 levels.

Two approaches, a Tier 1 and a Tier 2, have been developed to estimate the impact on GHGs of the Landfill Directive (Table 4-21). The approaches are based on the IPCC recommended methodology for quantifying GHG emissions from solid waste disposal on land. The Tier 1 approach assumes that all changes in mass of Municipal Solid Waste (MSW) disposed to landfill since 2001 are the result of the Directive, hence this implies that there were no policies in place prior to the Landfill Directive and also that there have been no other drivers of changes to the activity. The assumption is implemented by freezing the proportion of total MSW disposed to landfill at pre-Directive levels. Under Tier 1, the composition of the MSW is taken as the EU average waste composition derived from IPCC guidance values.

The Tier 2 approach incorporates a number of refinements over Tier 1. An attempt has been made to take autonomous progress into account by considering the historic trend in the mass of MSW disposed to landfill and by extrapolating this trend. This assumes that autonomous behaviour and the influence of previous national policies to discourage landfilling MSW, would continue to deliver reductions in emissions in the absence of the Directive. In addition, the Tier 2 approach takes into account Member States specific data on the key emissions characteristics.

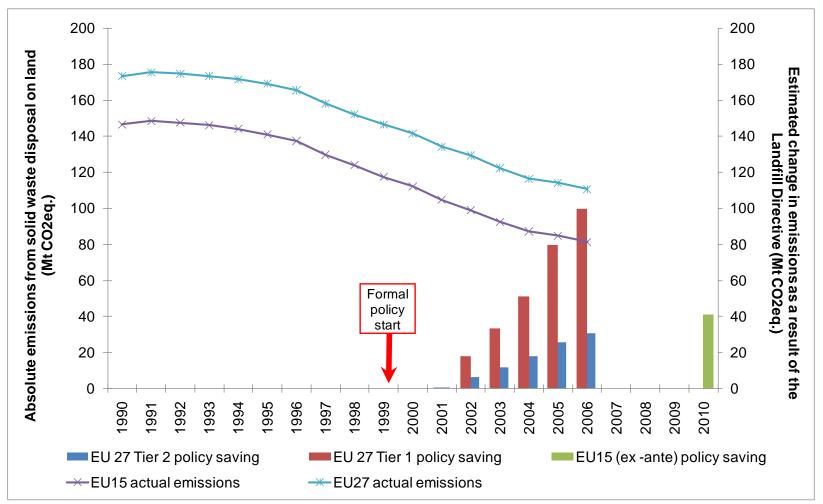
Table 4-21 Key methodological choices Landfill Directive

Approach	Tier 1	Tier 2	Tier 3 *
Activity indicator (MSW = Municipal Solid Waste)	Mass of MSW disposed	Mass of MSW disposed	Mass of MSW disposed
Further parameters	- Composition of MSW; - Default parameters for 1 st order decay (IPCC, 2006)	- Landfill gas recovery rates; - Incineration of MSW - MS specific parameters for 1st order decay	Detailed bottom up statistics
Emission factor (g CO ₂ eq/mass of MSW)	EU average	MS average	MS average
Policy interaction	no	no	yes
Autonomous development (previous trend in disposed wastes)	no	yes	yes
Structural effects	no	no	yes (if data allows for corrections)
Geographic factors	no	no	no
Timing issues / delay or an- nouncement effects	Same start date	Same start date	MS specific
Other exogenous factors (e.g. adjustment for impacts of profitability of landfill gas recovery or of incineration)	no	no	yes

^{*} The Tier 3 approach could not be further elaborated in the course of this study.

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Figure 4-23 Landfill Directive: Key results of the ex-post analysis in comparison with ex-ante estimates and inventory development



Notes: Emission trends are shown on the primary axis while estimated policy savings are shown on the secondary axis. The final year for which ex-post estimates are available varies between policies. See Table 4-1 for further details. The geographical coverage of ex-post policy savings varies due to data constraints and is detailed in the legend above.

Sources: Policy savings for 2010 are European Commission ex-ante estimates while savings for historic years are ex-post estimates generated under this study. The source for absolute emissions is the 2006 GHG inventory (EEA, 2008).

The Tier 1 analysis gives rise to savings of 93 Mt CO₂eq. for the EU15 in 2006. However, under the assumptions of the Tier 2 approach the impacts attributed to the Directive are considerably reduced to around 25 Mt CO₂eq. Overall, the Directive has the most impact for Member States generating large quantities of MSW and that also incinerate a reasonable fraction of that waste. As is to be expected, those Member States that had reduced landfilling of MSW prior to the implementation of the Directive, give rise to a lower impact. This highlights the importance of methodological choices with respect to policy overlaps and pre-Directive trends in emissions. The key uncertainties in the evaluation of the Landfill Directive are summarised below.

Table 4-22 Key uncertainties Landfill Directive

Key uncertainties in data

Emissions and emissions factors for this sector: The IPCC first order decay model requires an assumption about the proportion of the waste in landfill sites that will decay anaerobically, and therefore generate methane. Additionally, the model needs the fraction of methane in the landfill gas generated. For each of these assumptions, the standard Tier 1 methodology uses the IPCC default values.

Key uncertainties in methods

Policy overlap, specifically, the overlap with other policies that act upon the available waste (Directives for Waste Incineration, Framework on Waste, Packaging, Integrated Pollution Prevention and Control)

Influence of other exogenous factors on the profitability of the different streams for waste treatment. **Issue of structural changes**: the amount of waste processed by recycling and biological treatment as compared to disposal or incineration.

Autonomous progress: assumptions made on the pre-Directive trends

An ex-post assessment of the **cost effectiveness** of the EU Landfill Directive was conducted by Golder Europe. The report, which was submitted to the European Commission (EC) in October 2005, used a governmental questionnaire and an individual landfill site operator interview in each Member State.

Overall, the implementation of the EU Landfill Directive was generally followed by a cost increase of waste disposal in every EU member state. While this result corresponds to what is to be expected in reaction to the implementation of the EU Landfill Directive there are several potential limitations:

- The costs are only approximations as actual costs are often due to the exact type of waste to be disposed of, the location of the facility in respect of local competition and internal business processes of the operating organisation.
- A cross country comparison of costs, i.e. an assessment of whether the cost per tonne of waste disposal converge across countries, is difficult to impossible as to the following reasons:
 - There is a large variation in the costs per tonne of waste disposal across countries.
 - There are a large variations in the cost changes, which probably correspond to the very different observed time periods across countries.
- Several data are unknown or not available. The poor data result from the fact that it is often
 difficult to obtain representative costs, as government representatives may not be aware of the
 operational details at landfills. Also, organisations operating landfills are reticent about revealing
 their disposal charges since they regard this as commercially sensitive information.

4.5.2 Key results: Waste Incineration Directive WID (2000/76/EC)

This Waste Incineration Directive aims to regulate the incineration of hazardous waste in order to prevent excessive pollution to air, water and soil. Incineration and co-incineration plants must be authorised, implement measurement and monitoring systems and maximise energy recovery

The Directive has been evaluated using a Tier 1 and Tier 2 approach.

Important assumptions in the analysis are: The approach considers only the effect of the Directive on recovery of energy from incineration and subsequent displacement of energy from other sources. However, WID in itself does not affect the mass of MSW disposed through the incineration stream. Therefore, the absolute impacts of the Directive on greenhouse gas emissions are strongly influenced by other factors (i.e. the levels of waste incineration) which can fluctuate greatly. The WID interacts with Landfill Directive in terms of composition of waste to be incinerated (although does not affect the total quantity incinerated).

The Tier 1 approach to quantifying the greenhouse gas impact of WID assumes that if WID had not come into force in 2005 for all incineration plant, the energy recovered per unit mass of waste incinerated would have remained 'frozen' at 2005 levels. The energy recovered from waste incineration subsequent to 2005 is therefore assumed to displace heat and electricity from other sources. However other policies and measures may have influenced this metric:

- Framework Directive on Waste (75/442/EEC) requires national competent authorities to draw up a
 waste management plan. One element of the plan encourages recovery of waste including for its
 use as a source of energy;
- Directives on air pollution from MSW incineration plants (89/369/EEC & 89/429/EEC) regulate the permitting, design, equipment, operation and reporting of waste incineration;
- The Combined Heat and Power (CHP) Directive (not yet fully implemented) aims to indirectly support the advancement of CHP which is commonly used to capture the energy generated through the incineration of MSW.

The Tier 2 approach takes some account of autonomous developments and policy interactions.

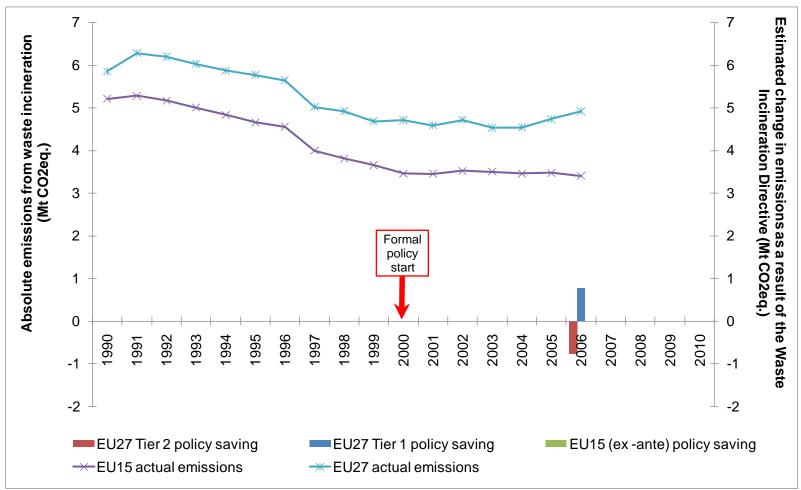
Table 4-23 Key methodological choices Waste Incineration Directive

Approach	Tier 1	Tier 2	Tier 3 *
Activity indicator (MSW = Municipal Solid Waste)	Mass of MSW disposed	Mass of MSW disposed	Mass of MSW disposed. Detailed bottom up statistics.
Emission factor (g CO ₂ eq/mass of MSW)	EU average	MS average	MS average
Policy interaction (in particular interaction with the Common Agricultural Policy CAP)	no	no	yes
Autonomous development (i.e. energy available per unit mass of MSW incinerated; waste composition)	no	yes	yes
Structural effects	no	no	yes (if data allows for corrections)
Geographic factors	no	no	no
Timing issues / delay or announcement effects	Same start date	Same start date	MS specific
Other exogenous factors (Adjustment for impacts of profitability of waste incineration)	no	no	yes

^{*} The Tier 3 approach could not be further elaborated in the course of this study.

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Figure 4-24 Waste Incineration Directive: Key results of the ex-post analysis in comparison with ex-ante estimates and inventory development



Notes: Emission trends are shown on the primary axis while estimated policy savings are shown on the secondary axis. The final year for which ex-post estimates are available varies between policies. See Table 4-1 for further details. The geographical coverage of ex-post policy savings varies due to data constraints and is detailed in the legend above. Emissions from waste incineration are split in UNFCCC reporting between category 6.C for waste oil, incineration of corpses and hospital waste, and category 1.A for MSW incineration. There currently no data on the emissions arising from MSW incineration under category 1.A.

Sources: Policy savings for 2010 are European Commission ex-ante estimates while savings for historic years are ex-post estimates generated under this study. The source for absolute emissions is the 2006 GHG inventory (EEA, 2008).

The principal conclusion form the analysis is the WID is not fully suited to a Tier 1/2 indicator based approach: for the EU 27 as a whole and a number of individual MS, 2006 saw an anomalous fall in energy recovery from MSW incineration set in the context of a trend towards increasing recovery. For this reason negative savings associated with WID have been calculated here for Tier 2. Primary this is because of the large variability in the time series of energy recovery rates and the lack of a strong trend over the 1995 - 2004 period for some MS.

The key data and methodological uncertainties for the evaluation of the WID are summarised below.

Table 4-24 Key uncertainties Waste Incineration Directive (WID)

Key uncertainties in data

Emissions and emissions factors for this sector. MS specific versus average emission factors for heat and electricity.

Key uncertainties in methods

Influence of other exogenous factors e.g. profitability of waste incineration.

Autonomous progress: assumptions made on the pre-Directive trends

Policy overlap, specifically, the overlap with the Landfill Directive and other policies that act upon the available waste. Also the Combined Heat and Power (CHP) Directive (not yet implemented) that aims to indirectly support the advancement of CHP which is commonly used to capture the energy generated through the incineration of MSW.

No quantitative estimates were identified on the ex-post costs of implementing the Waste Incineration Directive.

4.6 Agriculture

4.6.1 Key results: Nitrate Directive (91/676/EEC)

The Nitrates Directive concerns the protection of waters against pollution caused by nitrates from agricultural sources. The main goal is to prevent nitrogen loading of water bodies stemming from agricultural waste and the excessive use of fertilisers. However, there is a close link between N_2O emissions from agricultural soils and nitrate losses resulting in water pollution. Therefore, measures introduced under the Nitrates Directive may also result in declining N_2O emissions to the atmosphere.

The Nitrate Directive has not been designed specifically as a GHG mitigation policy. This has an important bearing on the amount and type of monitoring data that is currently collected, and available for the ex-post evaluation of the impacts of the Directive on GHG emissions.

The Nitrates Directive has been evaluated using a Tier 1 and Tier 2 approach. Application of the Tier 1 and Tier 2 methodologies (Table 4 26) enabled an initial assessment of the potential GHG savings that may have been delivered by the Nitrates Directive.

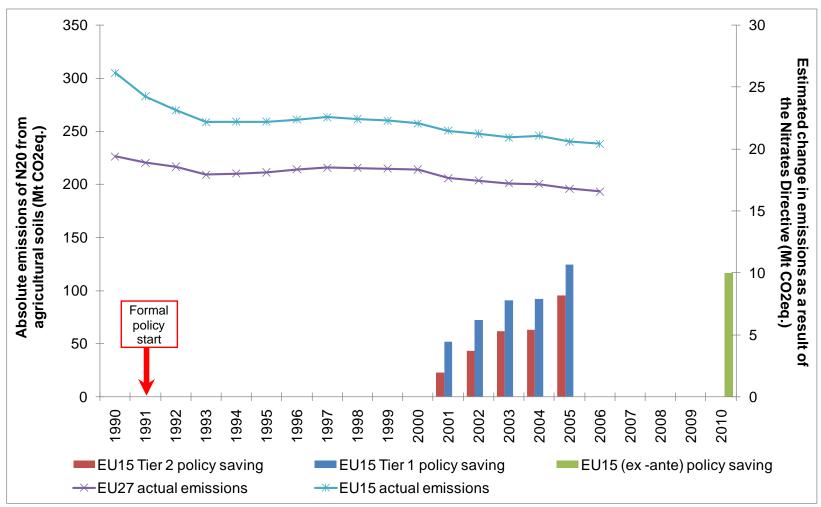
Table 4-25 Key methodological choices Nitrate Directive

Approach	Tier 1	Tier 2	Tier 3 *
Activity indicator	Agricultural land area	Agricultural land area	Agricultural land area. MS data on land use and crop type
Emission factor (g CO ₂ eq/area)	MS average	MS average	MS average
Policy interaction (in particular interaction with the Common Agricultural Policy CAP)	no	no	yes
Autonomous development (i.e. number of animals fixed at pre policy levels)	no	no	yes
Structural effects (e.g. adjustment for structural changes in the activity data)	no	no	yes (if data allows for corrections)
Geographic factors (e.g.			
- adjustment for soil type or moisture,	no	no	no
annual variation in fertiliser application rates due to weather variability.)	no	yes	yes
Timing issues / delay or announcement effects	Same start date	MS specific	MS specific
Other exogenous factors (adjustment for impacts of fertiliser prices and commodity prices; adjustment for availability of animal manures)	no	no	yes

^{*} The Tier 3 approach could not be further elaborated in the course of this study.

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Figure 4-25 Nitrate Directive: Key results of the ex-post analysis in comparison with ex-ante estimates and inventory development



Notes: Emission trends are shown on the primary axis while estimated policy savings are shown on the secondary axis. The final year for which ex-post estimates are available varies between policies. See Table 4-1 for further details. The geographical coverage of ex-post policy savings varies due to data constraints and is detailed in the legend above.

Sources: Policy savings for 2010 are European Commission ex-ante estimates while savings for historic years are ex-post estimates generated under this study. The source for absolute emissions is the 2006 GHG inventory (EEA, 2008).

The analysis, using a top-down indicator of emissions per unit of agricultural land, does show a decline in emissions of N2O from soils, as would be expected under the Nitrates Directive. For the EU15 as a whole the reduction in emissions, as estimated by applying the Tier 1 approach, is 11.5 MtCO₂ eq in 2005. This compares favourably to the estimated ex-ante savings of 10 MtCO₂eq.in 2010 estimated in the first ECCP for savings from N₂O emission from soils. However, whilst these results are encouraging, similar reductions in emissions are shown in those Member States that have not implemented the Directive. This suggests other important factors are influencing the estimated savings in addition to the Directive. Therefore assuming that all of the reduction in emissions can be attributed to the Nitrates Directive is likely to overestimate the true policy impacts.

Overall, taking into account the complexity of the sectors and the overall uncertainties we consider that the Tier 1 and Tier 2 results should not be considered an accurate representation of the greenhouse gas impacts that can be attributed to the Nitrates Directive. The results do provide an indication of the overall magnitude of the potential policy savings, and the savings from N_2O emission from soils more generally. However, further analysis is required to isolated the true policy impacts, and identify the level of influence of the other main drivers of emissions.

The main uncertainties with respect to the evaluation of the Nitrates Directive are summarised in the Table below.

Table 4-26 Key uncertainties Nitrate Directive

Key uncertainties in data

Emissions and emissions factors for this sector. For the purpose of this analysis we have used, for consistency the data reported by Member States to the UNFCCC. However, there is large uncertainty in both the activity data and the emissions factors themselves. Whilst this does not necessarily impact upon the current analysis, for future evaluations, the methodologies will need to be updated to reflect future advancements in this area.

Key uncertainties in methods

Policy overlap, specifically, the overlap between the Nitrates Directive and the Common Agricultural Policy CAP. It is recommendation that the greenhouse gas impacts of the policies be evaluated as a package rather than in isolation.

Issue of structural changes, which relates to the resolution of the data used in the analysis. The current indicator does not differentiate between changes in N_2O emissions that arise as a result of reduced N application rates, and those associated with changes in the farming or land use type.

Influence of other exogenous factors on the application of nitrogenous fertiliser (influence of changes in commodity prices on the behaviour of farmers). Using econometric techniques these impacts can potentially be isolated in a Tier 3 approach.

In terms of the **cost-effectiveness** of the Nitrates Directive in delivering emissions reductions a study by Kuik (2006) for DG Environment of the European Commission provided an analysis of the difference in ex ante and ex post estimates of the costs to farmers of the implementation of the Nitrates Directives.

The study found that the (ex-ante) costs of the Nitrates Directive differ across Member States. The costs range from \in 6 to \in 236 per hectare affected, and from \in 0.4 to \in 3.5 per kg N. The authors identified a number of factors that influenced the range in estimates, including differences in industry structure, livestock intensity, historical rates of fertiliser application, and the vulnerability of soils to nitrate leaching. Different assumptions and methodological differences were also identified as important factors in explaining the variation. Overall, the authors stated it is impossible to relate the cost differences to differences in the application of more or less efficient policy instruments across Member States.

For the two Member States (Denmark and the Netherlands) where it was possible to compare ex ante and ex-post cost estimates, the authors found that the ex-ante estimate is at least as large as the expost estimate and usually larger. When expressed as cost-per-kg N, the ex-ante estimates were found to be between 1.2 and 1.9 times as large as the ex-post estimate (Kuik 2006). For Denmark, the major reasons for this difference were that the stricter requirements on the utilisation of the N content of animal manure turned out to be much cheaper than expected at the time of the ex-ante estimate. For the Netherlands, the major difference was that the expected costs for dairy farms to dispose of their surplus manure were much smaller than expected, largely because of a more rational management of fertilisers at these farms. Both for Denmark and the Netherlands, the costs of nitrate measures at the farm level were lower than expected because of improved fertiliser management.

4.6.2 Key results: 2003 CAP Reform

The central aim of the 2003 CAP reform was to ensure, through the 'decoupling' of support payments, that farmers need no longer manage their businesses with the aim of maximising their subsidies from the CAP, but can gear their production and management practices to market demand. The vast majority of support payments under the reformed CAP are independent of production.

The 2003 CAP Reform has been evaluated using a Tier 1 and Tier 2 approach. In both cases, the availability of data and the complexity of the policy have limited the extent of the analysis possible. Furthermore, since the outcomes of the 2003 reforms will only be reflected within emissions data from 2005 at the earliest, the extent to which the policy can be evaluated to date was limited.

The evaluation considered two elements of the coupled Common Agricultural Policy: the sheep and goat meat regime and the beef sector premia. Specifically, the change in livestock numbers arising from the reform in these sectors. In practice, the impacts of the CAP reform on greenhouse emissions from the sector are far more wide-ranging than these two elements, so the analysis represents a subset of the total potential impacts of the reform.

A number of other factors, alongside the CAP and other legislation, will affect the size and structure, and thus environmental impact, of the livestock sectors in Member States, and these must all be taken into consideration when developing a counterfactual. These additional variables are not isolated and corrected for within the current Tier 1 or the Tier 2 approaches (Table 4-27).

Table 4-27 Key methodological choices Common Agricultural Policy (CAP)

Approach	Tier 1	Tier 2	Tier 3 *
Activity indicator	Number of animals	Number of animals	Number of animals
Emission factor (g CO ₂ eq/animal)	MS average	MS average	MS average
			(Supplemented by
			bottom up or more
			refined statistics)
Policy interaction (in particular interaction	no	no	yes
with the Nitrate Directive)			
Autonomous development (i.e. number of	no	no	yes
animals fixed at pre policy levels)			
Structural effects (e.g. adjustment for	no	no	yes (if data allows for
structural changes in the activity data)			corrections)
Geographic factors (e.g. local markets for	no	no	no
certain products)			
Timing issues / delay or announcement	Same start date	MS specific	MS specific
effects			
Other exogenous factors (adjustment for	no	no	yes
impacts of commodity prices)			

^{*} The Tier 3 approach could not be further elaborated in the course of this study.

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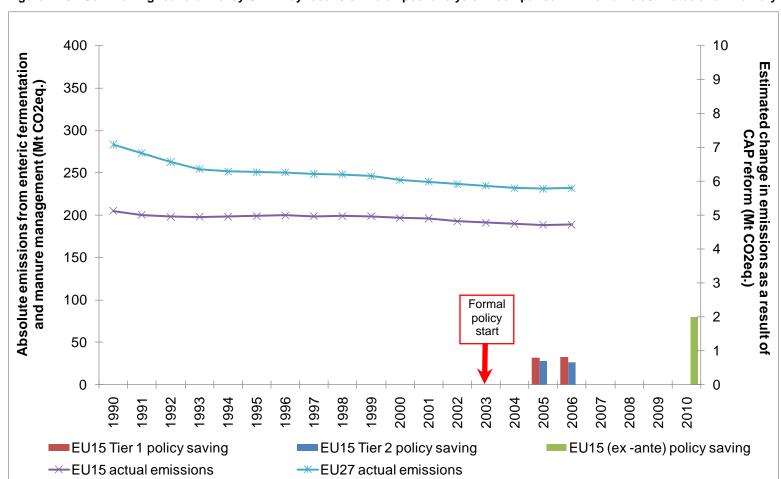


Figure 4-26 Common Agricultural Policy CAP: Key results of the ex-post analysis in comparison with ex-ante estimates and inventory development

Notes: Emission trends are shown on the primary axis while estimated policy savings are shown on the secondary axis. The final year for which ex-post estimates are available varies between policies. See Table 4-1 for further details. The geographical coverage of ex-post policy savings varies due to data constraints and is detailed in the legend above. Only 4A/B category emissions investigated. In general, the following categories are relevant: 4A - Enteric fermentation, 4B - Manure management, 4D - Emission from soils (see Nitrate Directive), 5B - Cropland – sequestration in soils and vegetation, 1A4c - Emissions from energy use in agriculture/forestry/fisheries.

Sources: Policy savings for 2010 are European Commission ex-ante estimates while savings for historic years are ex-post estimates generated under this study. The source for absolute emissions is the 2006 GHG inventory (EEA, 2008).

Overall, we consider that the results presented in Figure 4-26 should be treated with caution. Whilst the results are useful in showing the values that are achieved by implementing the Tier 1 approach, as it currently stands, we do not consider the results sufficiently robust to recommend the use of a Tier 1 or Tier 2 approach to quantify the impacts of the CAP Reform. This statement is supported by the views of the stakeholders who commented on the draft guidance for the policy.

However, the Tier 1/2 approaches do show the overall magnitude of the change in emissions in the sector that could be in part driven by the policy, but the results derived are likely to overestimate the true impacts of the policy. Further analysis, is required to isolate the policy impacts further, and identify the level of influence of the other influencing factors – and the overall level of accuracy of the results derived from a Tier 1/2 approach.

The key uncertainties associated with the methodologies applied to evaluate the 2003 CAP Reforms are summarised below. Of particular importance is the influence of market factors on production levels. Since the reforms effectively aim to influence the sensitivity of production to market conditions, then the impacts associated with CAP and impacts associated with market conditions (e.g. commodity prices) are fundamentally linked. However, even using econometric relationships and detailed information on the supply and demand characteristics of the market, there is still likely to be significant uncertainty in the results of such analysis. Faced with such uncertainty, the Tier 1/2 approach at least provides a transparent, if oversimplified, assessment of the impacts of the policy (and other factors).

Table 4-28 Key uncertainties Common Agricultural Policy (CAP)

Key uncertainties in data

Emissions and emissions factors: By using the Tier 1 IPCC methodology to estimate emissions from the sector, only the impacts of changes to livestock numbers will be accounted for; the impacts of more subtle changes, such as improved manure management, would go un-noticed.

Key uncertainties in methods

Policy overlaps specifically, the overlap between the Common Agricultural Policy CAP and the Nitrates Directive. It is recommendation that the greenhouse gas impacts of the policies be evaluated as a package rather than in isolation.

Structural changes: Structural changes, whilst not necessarily changing the overall numbers of animals, can change the average emissions per head, and hence the overall emissions.

Other exogenous factors: A particular challenge is in understanding how market factors impact upon agricultural production under the CAP reform – especially since the policy may in this case have had strong influence over the developments. Livestock disease is another factor that is unrelated to the CAP, but has influenced emissions from the sector.

No quantitative estimates were identified on the ex-post costs of implementing the 2003 CAP reforms.

4.7 Key findings from the application of the methodologies

This section highlights some of the findings that have emerged from the development and application of the evaluation methodologies. In particular the section discusses the current strengths and weaknesses of the methodologies and the factors that influence their ability to deliver robust estimates of the ex-post impacts on greenhouse gas emissions.

4.7.1 Tier 1 and Tier 2 approach

For certain policies we consider that the results derived from the application of a Tier 1 or Tier 2 approach provide a reasonable approximation of the policy impacts: see Table 4-29. Whilst the results derived for these policies are not without uncertainties, we consider that these uncertainties are within a reasonable bound that the Tier 1 or Tier 2⁵⁶ results can be used to provide an approximate estimate of the policy impact to date. This conclusion is supported by the fact that the results from the Tier 1 and Tier 2 approach are similar to those derived from a more comprehensive Tier 3 approach, where one was developed. Often, the uncertainties in this group of policies are motivated by methodological

⁵⁶ Whilst the Tier 1 and Tier 2 are not identical in their approach, they are sufficient similar in their methodology, and level of sophistication that they can be treated together, for the purposes of drawing broad conclusions

choices which may, once made, e.g. through further expert interaction, narrow down the range in the results.

However, for certain other of the ECCP policies that were analysed, we do not consider that the results achieved by applying a simple Tier 1 or Tier 2 approach provide an accurate representation of the policy impacts. For these policies, the uncertainties in the estimates that are derived from applying a Tier 1 or Tier 2 approach are too great, and we recommend that a Tier 3 approach is required in order to quantify the policy impacts within an acceptable bound of accuracy - see Table 4-29.

For a third group of policies, we consider it may be possible in the future to evaluate the policies using a Tier 1 or 2 approach. However, current limitations in the availability of data provide a barrier to the use of a more simplistic approach for the policy evaluation. Until additional data is made routinely available, a more extensive Tier 3 approach will be required for the evaluation of these policies, which will itself require additional data collection.

Table 4-29: Suitability of the tiered methodologies for evaluating the impacts of individual policies

Policies for which a Tier 1 and 2 methodology can be currently used to produce reasonable estimates of policy impact	Policies for which a Tier 1 and 2 methodology could in the future be used to produce reasonable estimates of policy impact	Policies for which a Tier 3 methodology is required due to the complexity of methodology or high resolution of data required
RES-E Directive Labelling Directive ACEA agreement Landfill Directive Biofuels Directive ⁵⁷	Nitrates Directive* CHP Directive* Energy Performance of Buildings Directive*	EU ETS* IPPC* Common Agricultural Policy (CAP) reform* F-gas Regulations* Waste incineration Directive*

^{*} At present there is insufficient data available for most of those policies to perform a complete evaluation. For the EU ETS, in principle most of the data is available but some important parameters such as elasticises for the demand of industrial products as a reaction to carbon pricing or the pass through behaviour for carbon prices of industrial and energy companies are insufficiently supported by empirical evidence.

Even for those policies where a Tier 1 or Tier 2 approach is not considered sufficiently robust for a policy impact assessment currently, the application of the methodologies still provides useful information for policy makers. Specifically, it:

- identifies the overall trends in emissions from the sector/target in question;
- provides a screening of the overall magnitude of emissions from the target/sector in question;
- provides a foundation for more detailed evaluation as part of a Tier 3 approach.

The Tier 1 and Tier 2 methodologies therefore provide a useful starting point for the ex-post evaluation of certain climate policies and measures. Furthermore, since the Tier 1 and Tier 2 methodologies utilise top-down statistics to represent the policy impacts they can also be used as **indicators** of policy progress; whilst not representing the full policy impacts they do show the direction of travel in the sectors influenced by the policy.

As data and expertise grows then the Tier 1 and Tier 2 methodologies can be further refined in order to improve the accuracy of the estimates. Likewise, in the light of a more complex Tier 3 analysis it may also be possible to revisit the Tier 1 and 2 approaches with a better understanding of the influence of key parameters (see below). However, for certain other policies, the wide range of influencing parameters that need to be considered as part of the ex-post evaluation make it unlikely that a more simplistic Tier 1 or Tier 2 approach will ever be suitable. For these polices, a more extensive Tier 3 approach is required.

In addition, policies and their context will change over time. As such, a policy for which a Tier 1 or 2 methodology is deemed to produce reasonable estimates of the policy impact at present, may not continue to do so in the future. For example, if certain renewable technologies become cost competitive in the future, the methodologies will need to be adapted. Also, an increasing overlap of policies due to a higher policy activity may require more refined approaches in the future. Given these

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⁵⁷ Excluding any impacts associated with land use change

fluctuations it is important that the methodologies are underpinned by a consistent set of methodological principles. This is discussed further in the Methodologies Report.

4.7.2 Tier 3 approach

For those policies where it has been possible to test a Tier 3 approach, we have a greater understanding of the key parameters that have influenced GHG emissions within the target sector. Furthermore, the application of a Tier 3 approach has allowed some further data collection, which has allowed the Tier 1 and Tier 2 methods to be refined. For example, as part of the Tier 3 approach more detailed data on biofuel feedstocks was collected and subsequently used to define 'average EU conditions' within the more simplistic Tier 1 approach.

The Tier 3 analysis has also provided valuable information on the robustness of the Tier 1 and Tier 2 results. For example, the application of the ASTRA model as part of a Tier 3 methodology for the ACEA agreement enabled the examination of other factors (e.g. national policies), that were not captured within the Tier 1 or Tier 2 approach. In this particular example, these additional factors were found not to be significant – hence the Tier 1 and Tier 2 results, which did not adjust for these factors, gave similar results to the Tier 3 approach. Clearly if these other factors were more important, then the variation in results would be much greater.

This may advocate for certain polices a combined approach, where a more simplified evaluation is carried out on a regular basis (e.g. on an annual basis) while being gauged at less frequent intervals, e.g. every three years, with an in-depth Tier 3 approach. This could form part of a continual improvement process for the methodologies.

The piloting of a Tier 3 approach has also identified areas where a more simplistic Tier 1 and Tier 2 approach is unlikely to provide a robust estimate of the policy impacts. For example, the development and testing of a Tier 3 approach for the EU ETS highlighted the large methodological complexities associated with the ex-post evaluation of this policy, which cannot adequately be captured within a simplified Tier 1 or Tier 2 approach.

Clearly, if resources where unlimited then a Tier 3 approach would be the recommended approach for evaluating all policies. However, this is not the case, and one of the wider aims of this study has been to examine what level of evaluation is possible without additional data collection or extensive model development. It is therefore useful to consider under what circumstances the results from a Tier 1 or Tier 2 approach would deliver a reasonable estimate of the policy impacts, without the need for a more resource intensive Tier 3 approach.

4.7.3 Factors that influence the robustness of the Tiered approaches

On the basis of our experience developing and testing the evaluations methodologies, two key factors were found to be critical in determining whether a more simplistic (Tier 1 or 2) approach is likely to provide a reasonable approximation of the policy impacts. These are:

- Data related issues (availability, quality and resolution)
- Complexity (number of influencing parameters, heterogeneity of the target sector, type of instrument, level of policy interaction)

Whilst issues associated with 'data' and issues associated with 'complexity' have been defined separately, in practice they are closely related. For example, the more complex the policy space, e.g. a large number of policies acting upon the same activity indicator, the more data is required to isolate these competing factors. Indeed those policies that were found to be most difficult to evaluate suffered from both data issues and complexity.

A third area that influences the robustness of the overall approaches, but is less specifically related to the choice of approach is the methodological assumptions (e.g. emission factors). Sometimes these methodological assumptions also link to data issues (e.g. information on indirect land-use change for biofuels or on hourly development of the power sector). These assumptions are discussed further in Section 5.3.

Data related issues

The methodologies that have been developed during the study have been based upon existing data sets with limited additional primary data collection. This was a necessary restriction placed upon the methodology to enable an initial assessment of the policy impacts within the scope of the study. This means that with further data collection, the methodologies that have been developed can be refined further, and the overall accuracy of the methods improved.

The following factors were found to be important in determining the applicability of a given methodology:

- Data availability i.e. data on the specific emissions causing activities that are influenced by the
 policy in question. Since the Tier 1 and tier 2 methodologies were largely based upon existing
 data sets then the availability of data was a key determinant of what was possible under these
 approaches.
- Data quality i.e. the level of uncertainty in the emissions and/or activity data. This will affect all
 methodologies. Where the uncertainties can be resolved by additional data collection then this
 would suggest a Tier 3 approach. However, where uncertainties are very large, this may
 advocate a more simplistic approach since the benefits of a more refined Tier 3 approach
 might be outweighed by the overall uncertainty in the basic data.
- Data resolution i.e. data on the specific sub-sectors, or technologies that are influenced by the
 policy. The Tier 1 and Tier 2 approaches are typically more reliant upon top down statistics. If
 these statistics are not sufficiently disaggregated to isolate the activities influenced by the
 policy, then this will introduce greater error to the results.
- Timeliness of data i.e. the extent to which data is available to evaluate the most recent impacts of the policy

The importance of each of these issues for each of the policies considered is discussed in more detail in the next chapter.

Issues of complexity

For certain policies the complexity of the policy areas, sector or instrument meant that it was difficult to determine an accurate estimate of the policy impact without a more refined approach. Three main sources of complexity encountered in the development application of the methodologies are discussed below:

- 1. multiple emission sources potentially affected by the policy
- 2. multiple policies acting upon the target sector
- 3. multiple non-policy influences on emissions in the target sector

Multiple emissions sources

Since the simple Tier 1 and Tier 2 methods tend to use a top down approach, assessing policy impacts using aggregate statistics, an important issue is whether the policies act upon a sector that is homogenous in nature or one that is heterogeneous in nature.

Where the coverage of the policy instrument is heterogeneous in nature (either in terms of the emissions, or the emissions-causing activities) the Tier 1 and Tier 2 approach are less well suited. Where the activities can be dis-aggregated by sub-sector, and adequate data is available at this more disaggregated level then a Tier 1 or Tier 2 approach be applicable. However, this may require additional (bottom up) data collection.

In the absence of detailed sub-sectoral data then the alternative is to take 'average' assumptions, which if the sectors are extremely heterogeneous will result in a large uncertainty in the outcome. This is highlighted to some extent in the difference between the Tier 1 and Tier 2 results, where 'EU average' conditions are used in Tier 1, whereas in Tier 2 member state specific data is used where possible. The key issue, when using average data of this kind is what is the range that contributes to the average, and what is the impact on the overall results. For those sectors where the range is potentially very large, a more disaggregated or sub-sectoral approach is recommended. Likewise, a Tier 2 (member state specific) approach is generally preferred to a Tier 1 (EU average) approach.

Multiple policies acting upon the target sector

Where a large number of different policies are acting upon the target in questions, it becomes increasingly difficult to isolate the impacts of a particular policy using a simplistic top-down approach. Since the Tier 1 and Tier 2 tend to use aggregate indicators, then a key issue for the evaluation is to what extent do other policies impacts upon the activity indicator in question. If several policies act upon the indicator then it will be necessary to employ a more refined approach, or alternatively evaluate the policies as a package.

Multiple non-policy influences on emissions in the target sector

Where there are a large number of non-policy factors which influence the emissions in the sectors in question, then it becomes increasing difficult to isolate the policy impacts from the counter-factual emissions. To some extent this may relate to the nature of the policy instrument. For example, market based mechanism are driven by the market dynamics, and therefore the supply and demand characteristics of the target sector. In contrast, regulations place specific limits on the market, which may be more easily distinguished from the counter-factual scenario.

Other factors

For a number of the policies considered, the abatement of GHG emissions is not the primary objective of the policy, or one of several objectives. Consequently, the monitoring arrangements have been put in place to evaluate the effectiveness of the policy focus on different aspects, which may not be related to the greenhouse gas impacts. For example, under the Nitrates Directive Member States are required to put in place extensive monitoring of nitrate levels within water bodies.

Overall, for those policies where the primary focus is not the abatement of GHG emissions, the level and quality of data available is less well suited to a Tier 1 and Tier 2 approach. Furthermore, since the primary focus of the policy is not the abatement of GHG emissions, then it is likely that in order to explain any changes in GHG emissions is it necessary to understand how the policy is responding to the other drivers. This is likely to necessitate a more complex methodology.

Conclusions

On the basis of the above discussion, it is possible to draw some broad conclusions with respect to those policies where a more simplistic Tier 1 or Tier 2 methodology might be applicable, and those policy areas where a top down approach may be less well suited. Whilst the list should not be considered definitive, and there will be certain exceptions, it does provide a potential guide for future ex-post evaluations.

Factors in favour of a more simplistic Tier 1 or Tier 2 approach	Factors against a more simplistic Tier 1 or Tier 2 approach
Activities targeted by policy are homogeneous	Activities targeted by policy are heterogeneous
Policy acting upon a whole sector	Policy acting upon sub-sectors
Policy acting upon a single target sector	Policy acting upon multiple sectors
GHG mitigation (or energy objectives) is the primary focus of the policy	GHG mitigation (or energy objectives) are not the primary focus of the policy
Policy instrument (sectoral agreements, regulations, subsidies)	Policy instrument (Market based mechanism, taxes)
Small number of policies acting upon the target sector	Large number of policies acting upon the target sector
Policy influences new activities (e.g. activities that are not cost-effective without policy support)	Policy influences existing activities

4.7.4 Future development of the methodologies

The existing methodologies reflect the current policy frameworks, data availability and expertise in policy evaluation at a member state level. All these variables will change over time as technologies develop, directives undergo revisions and new data sets become available. In parallel, Member States will become more familiar with ex-post policy evaluation methodologies. The methodologies will need to be developed accordingly. For example, the RES-E guidelines currently assume that the only cost-

effective technology is large-scale hydro and hence only this technology would form part of the autonomous improvement and not the impact of the Directive. This assumption is currently reasonable given the current level of maturity of RES technologies, but may not hold in future when other renewable technologies may become cost-effective.

The methodologies should therefore be considered as 'work in progress', still providing potential for refinement, and improvement over time. It is advisable that the existing guidelines should regularly undergo an updating process to reflect changes in policy, socio-economic and technological factors. A first evaluation and revision exercise may take place after two years from the initial implementation of the methodologies. This initial review may be extremely valuable as it would provide the first feedback based on the actual experience of individual Member States with the evaluation guidelines. Such feedback would therefore help to improve the methodologies and the guidelines. Subsequent reviews and revisions may be spaced more broadly over time (e.g. every 3-4 years) as they would mostly focus on updating the guidelines to reflect changes in policies and data sources. Additionally, revision of specific guidelines may be triggered by relevant changes in the policy under evaluation.

4.7.5 Key conclusions from the application of the methodologies

The large variability in the complexity of the policies means that the Tier 1 and 2 methods may be more applicable to some policies than others.

Ideally, a detailed Tier 3 methodology would be employed to evaluate each of the individual resources. However, resources and expertise are limited, so it is useful to understand those policies where a Tier 1 or Tier 2 approach may be appropriate for a policy estimate and those where a more complex (Tier 3) approach is necessary.

A range of factors have been identified that influence the extent to which a more simplistic top-down approach may provide a reasonable estimate of the policy impacts. This included the homogeneity of the target sector, the level of uncertainty in the emissions and emission factors and the number of competing policy instruments.

However, the overall methodological issues and the potential options for addressing them are common for all polices, and can inform the evaluation of similar types of policies or policies in the same sector

The ability to develop robust methodologies using existing statistical data is highly dependent upon the collection of good quality policy relevant statistics already. It is much easier to evaluate policies if consideration is given to the data that is required to evaluate the policies at the policy design stage.

However, even where processes are put in place to collect detailed data on the sectors/activities influenced by the policies this does not guarantee that sufficient data is available to enable a robust evaluation of the policy impacts. Specifically, sufficient empirical data is also required to isolate the change in emissions that arises from the policy, from the impacts of other contributory variables.

Furthermore, for policies where the abatement of greenhouse gas emissions is not the primary objective of the policy, then the monitoring performed in accordance with the regulations is focused on other objectives. There is therefore a balance required in terms of the appropriate level of monitoring and the quality of the impacts assessment.

Looking forward, it is important that the methodologies are able to anticipate future changes in the policies e.g. expansion of the sectors covered by the EUETS.

5 Overall conclusions and recommendations

The previous chapter provided a synthesis of the key quantitative and qualitative results from the analysis. It presented our estimates of the changes in emissions of greenhouse gases as a result of each of the ECCP policies and measures examined.

This chapter outlines the main conclusions and recommendations from the study. It includes a number of concrete recommendations for the future evaluation of climate policies at the EU level. The findings are of relevance to any new work to appraise future impacts (ex ante) or evaluate past impact (expost) of greenhouse gas mitigation polices.

The main findings cover a range of issues, but can be broadly categorised into 3 areas:

- Experience and capacity
- Data requirements and availability
- Methodologies and methodological parameters

These issues are then drawn together into specific recommendations for different types of policy instruments.

5.1 Experience and capacity

The initial phase of the study reviewed current experiences in the ex-post evaluation of greenhouse gas mitigation policies, both within Member State and at an EU level.

The review found a large variation in the level of experience between different Member States. Member States were classified into three groups: those with well developed capacity and expertise in ex-post evaluation (for example, they had undertaken ex-post impacts of their climate change strategy); those with some expertise in ex-post evaluation but in a more ad-hoc way (for example, had experience in evaluating a few individual policies); and those with limited or no experience in ex-post evaluation of climate change policies. In broad terms the EU15 Member States tend to have more experience in ex-post evaluations and more often have formalised monitoring and evaluation systems in place than the EU12 Member States, although not in all cases.

From a sectoral perspective, experience in ex-post evaluation of GHG emissions was greatest for policies acting upon the energy demand sector. This included policies targeting emissions from the road transport sector, and also policies targeting emissions from buildings. Experience was also strong in the evaluation of emissions from the electricity generation sector. Fewer studies were found for the waste sector, and fewer still for the agricultural sector and for emissions associated with industrial gasses. In the energy demand sector, the future requirements of the Energy Service Directive (ESD) were cited as an important stimulus for Member States to evaluate the impacts of their policies addressing energy consumption. However, the ESD is focussed on energy savings and not greenhouse gas emissions, although the latter can be calculated from the former.

Most MS have no formal rules for the ex-post evaluation of climate policies. This meant that the methodological assumptions and data sources frequently varied between different studies. Likewise, where cost effectiveness analysis had been performed as a part of the evaluation, the analytical basis frequently varied. Taken together, these factors reduce the comparability of the results from different evaluations, and therefore the usefulness of the results for policy makers.

This project is the first study of its kind to develop harmonised methodologies for the ex-post evaluation of policies under the European Climate Change Programme. Whilst a large amount of work has been carried out, and progress has been made in a number of areas, a number of research gaps and areas of further development remain. Of greatest importance is the need for a continued coordinated approach from the European Commission, or similar organisation. In the absence of such co-ordination then it is likely that certain Member States will continue to perform ex-post evaluations, but others may not. For the evaluations that are performed, differences in the data and methodologies

used will continue to make it difficult to quantify, in a consistent manner, the overall impacts of the ECCP policies and measures at an EU wide level.

Recommendations:

- The European Commission should consider facilitating the development of and collaboration on national systems for policy monitoring and evaluation. This remit may include the further development of the guidelines and evaluation tools developed in this study (see Methodologies Report). Specific activities may include:
 - Agreement of a harmonised set of methodological assumptions and parameters (see later).
 - Development of simple spreadsheet tools to facilitate the development of experience and sharing of best practise in ex-post evaluation.
 - Co-ordinating research to address gaps in knowledge and/or data. For example, the impacts of indirect land use change associated with biofuels.
 - Co-ordinating common data collection including with both statistical agencies and private sector organisation. Through a common approach the cost of the data collection could be significantly reduced. This may be the case with policies such as the appliance labelling directive where comprehensive private data collection exists for market research purposes.
 - Co-ordinating activities to evaluate large and complex EU wide policies, including the EU Emissions Trading Scheme and the regulations of the Common Agricultural Policy.
- Learn from the recent experiences of the EMEES project, which aimed to develop harmonised methodology for the evaluation of energy efficiency policies in accordance with the Energy Services Directive.
- In the short term, Member States could be encouraged to voluntarily use the existing guidelines developed during this project. This could then feed in to Member States' next review of their exante scenarios and ensure that policies are re-appraised in light of actual developments.

5.2 Data requirements and availability

The availability of accurate, relevant and timely data is a prerequisite for the robust evaluation of policies and measures. However, the amount of data required in order to perform a robust evaluation of the impacts varies greatly between policies, depending on the complexity of the mechanisms involved and the coverage of the instrument.

The data required in order to perform an ex-post evaluation of a given policy can be broadly categorised into two areas:

- Data required in order to quantify the change in emissions, or emissions causing activity, in
 the sectors that are targeted by the policies (i.e. the "with policy" emissions). For example, for
 a policy that stimulates a new technology then data is required on the number of devices
 installed, their usage or activity levels, and the associated emissions.
- Data required in order to isolate the impact of the policy, upon emissions in the sectors targeted by the policy, from the influence of other contributing variables (i.e. the counterfactual emissions). For example, this would require data on the emission factors and activity levels of the reference technologies being replaced.

5.2.1 Availability of data

For the case study polices analysed, the **availability of sufficient data** was a key factor in whether the policy could be evaluated with a reasonable degree of accuracy. Some examples are:

- For the ACEA agreement data was available on the specific emissions (i.e. g CO₂ per km of the average vehicle stock) and the emissions causing activities (i.e. number and type of vehicle, km travelled) including data to determine the counterfactual before the start of the policy. Furthermore, data was available for most Member States and disaggregated by vehicle type. This allowed emission impacts to be estimated to a high degree of accuracy. Uncertainties were mainly introduced by methodological decisions to be taken (e.g. concerning the length of the period to be considered to determine the counterfactual.
- For the RES-E Directive the existing reporting of progress by MS against the Directive
 provided information on the activity (i.e. total electricity generated), with the counter-factual
 emissions calculated relatively easily using existing Eurostat statistics. The main uncertainty
 was again methodological (i.e. the emission factors for the off-set emissions) rather than data
 related. However, the evaluation of this policy was affected by the timeliness of official
 statistics (see below).
- For the Labelling Directive the availability of data on the performance of appliances was readily available. However, the quality of the data may need to be scrutinised further. Data on the uptake of efficient appliances was more limited, and the methodology relied upon data collected by the private sector. However, with this data a relatively simple approach could be used to determine a reasonable estimate of the policy impact. The main problem for this directive was that no similar data was available for the pre-directive period that could be used to evaluate autonomous progress.
- For the Biofuels Directive, existing statistical sources provided data on the production and
 consumption of biofuels. Data was also readily available on the fuel consumption and
 associated emissions from conventional fuels in the counter-factual. However, additional data
 collection was required to refine the estimates (e.g. by providing data on EU average
 conditions). One area where the current data was insufficient was data on imports of biofuels
 separated by feedstock and on land-use impacts.
- For the Landfill Directive, information was available on the total volumes of Municipal Solid
 Waste sent to Landfill, but additional data collection was required to estimate the composition
 of MSW within different Member States. The emissions estimation was based upon
 established methodologies for reporting emissions with GHG emissions inventories.
- For the Co-generation Directive the data collection requirements will, once implemented fully, allow the activities influenced by the Directive to be assessed. However, in order to assess the impacts of the policy against the counter-factual, this data is also required for the period prior to the implementation of the Directive which will not be available.

Whilst some of the evaluations were informed by data that was provided by Member States, in accordance with their monitoring requirements under the respective Directives, others used additional data sources. In general, for most the policies additional supplementary data was required, over and above the current monitoring requirements, in order to perform a robust evaluation of the policy impacts.

Importantly, for certain policies the isolation of the counter-factual emissions required data on the emissions-causing activities for a period prior to the policy implementation. This was necessary in order to isolate the policy impacts from ongoing trends. Since data collection activities frequently only begin once the policy has been implemented then this can create problems for any subsequent evaluations of the policies.

Recommendation:

- It is important that during the design of future climate policies, and as part of their initial **ex-ante appraisal**, consideration is given to the future monitoring requirements to ensure appropriate monitoring data is collected over the lifetime of the policy to enable its future (ex-post) evaluation.
- Likewise, it is necessary that when performing an **ex-post evaluation** that consideration is given to the data that is currently available to inform the evaluation. Ideally, the two processes should be joined up, so that the monitoring requirements are precisely defined to enable the future ex-post evaluation.
- In defining data needs, policy makers should consider requirements to a) monitor emissions in the sectors influenced and b) isolate the impact of the policy itself (as influenced by the complexity of

the policy mechanism and exogenous factors). These requirements are equally applicable to the determination of robust **ex-ante projections** as to **ex-post evaluations**.

- For certain policies e.g. where the policy stimulates a change in a current activity, it may be necessary to begin the collection of data prior to the policy being implemented. This is important for determining the counter-factual trend. Such data is also likely to be useful for the original exante appraisal, and may have been used in the original impact assessment. Where a policy is stimulating a new (e.g. currently not cost-effective) activity, this is less applicable.
- In practice, it is difficult to specify exactly what is required to be monitored until the policy has been precisely specified. If no data has been collected to inform the ex-ante projection or if data was found to be limited as part of the initial appraisal, then a process of data collection could be commissioned once the Directive comes into force. This may involve the collection of historical data (or estimates) on the key emissions causing activities, as well as the development of systems for future policy monitoring.

5.2.2 Resolution of data

For certain policies the **resolution**, **or granularity**, **of the data** was an important factor in determining the extent to which the policy could be evaluated without detailed modelling. This was particularly an issue for those policies that either acted upon a sub sector or where the emissions performance varied significantly within sub sectors. For example:

- F-gas regulations act upon a range of emissions causing activities with different leakage rates
 applicable to the different sectors. In order to evaluate the F-gas regulations it is therefore
 necessary to collect detailed sub application data. Such data is not currently available for most
 applications.
- For the Nitrates Directive more refined data would have enabled structural changes in land use and crop type to be better isolated from changes in nitrate application rates induced by the Directive.
- In the evaluation of the ACEA agreement, the policy acts upon a single sector (passenger cars) and the resolution of the data is sufficient to understand variations in emission by subsector and isolate the impacts of structural changes (e.g. changes in the size of vehicle, switching from petrol to diesel cars).
- Likewise, in evaluating the impacts of the RES-E Directive, statistics on the types of renewable technologies allowed emissions arising from certain technologies to be isolated to correct for autonomous development (e.g. generation from large hydro that would have taken place in the absence of the RES-E Directive).
- The IPPC Directive relates to specific industrial processes and energy industries reaching
 particular emissions thresholds. Disaggregated data is therefore required to determine which
 emission variations over time result from the Directive and which variations result from other
 autonomous developments.
- The Labelling Directive acts upon energy using products. Whilst the impacts of the Directive
 will vary according to the different product types, data was available (although from private
 sources) to assess the individual products separately.
- The Landfill Directive has been evaluated based upon aggregate data on the total quantities of biodegradable waste sent to landfill. To allow a more accurate evaluation of the impacts the biodegradable waste statistics needed to be broken down by waste type.
- The lifecycle impacts of biofuels can vary widely depending upon the feedstock type. Therefore, further dis-aggregation of the biofuel statistics to differentiate between feedstock data is required in order to for the impacts on emissions to be accurately reflected.

These case study examples highlight the importance of developing monitoring and data collection strategies that reflect the characteristics of the target sector(s), and their respective heterogeneity. Whilst current environmental and energy statistics (such as those currently collected under the Monitoring Mechanism) are useful, they seldom have sufficient resolution for use in a robust ex-post evaluation.

The collection of more refined data is important for ensuring the robustness of the emissions estimates, but is also important for isolating policy impacts from other contributory variables (e.g. structural changes in the activity data that are unrelated to the policy impacts). This may require substantially more data to be collected for certain policies than for others.

Recommendation:

- The recommendations below relate to the ex-post evaluation of policies and measures, though the issues are equally relevant to improving ex-ante appraisals.
- In the design of new climate policies it is recommended that provision is made for the design of an appropriate monitoring framework.
- In designing the monitoring framework for a given policy, it is useful to map out the specific sectors, and emissions causing activities, that will be influenced by the policy. Importantly, the monitoring framework needs to be designed in such a way that data is collected at a sufficient resolution to account for sectoral or sub-sectoral impacts, particularly where the target sector is heterogeneous in nature. It will then be necessary to determine the most appropriate way to monitor the changes in these sub-sectors over time.
- It might be appropriate to clearly identify the data requirements for a full policy impact assessment and the intermediate data requirements for a partial assessment or an assessment with greater uncertainty. Policy makers then have to decide what level of assessment is to be carried out and set up data collection accordingly.
- This should consider what is most appropriate for a given sector e.g. if the activities/emissions are relatively homogeneous in nature then a high level monitoring may be appropriate, if the policy only acts upon a sub-sector then only data for this sub sector needs to be collected. It is recommended that to inform this decision, it is useful to look at the data, methodologies and approaches that are already in place to compile national emissions inventories. These can give an indication of the types of data that can be readily collated, and the simplifying assumptions that may need to be used. Taking this sub-sectoral approach to monitoring will also help to isolate structural changes in the activity data that are not obvious in the high-level statistics.

5.2.3 Quality of data

In addition to the availability of data, the **quality of the data** was found to be an important consideration in the development of the evaluation methodologies. Whilst emissions from energy consumption can be calculated with a reasonable degree of accuracy, emissions on non-CO₂ greenhouse gases, for example emissions from agriculture, are generally subject to a higher level of uncertainty. Whilst these uncertainties are well known, and work is underway to improve the accuracy of the factors, this does have implication for the methodologies that are developed to quantify emissions reductions in these sectors. Specifically, where default emissions factors are applied, these may not adequately reflect the influence of the policies on the overall emissions. For example:

- For CAP the use of default IPCC tier 1 value (e.g. emissions per head of cattle) will not capture the impact of the impacts of certain management measures on emissions.
- For Biofuels there are considerable uncertainties in country-related feedstock composition and feedstock composition of imports; uncertainties in N₂O emissions from the use of fertilisers; and uncertainties in the occurrence of indirect Land Use Change. All of these factors have a significant influence upon the potential emission impacts.
- For the Nitrates Directive, significant uncertainties in the emissions factors for N₂O releases from soils, limits the robustness of any evaluation.
- For the Landfill Directive, the assumptions that are made with respect to methane capture and leakage rates can have a significant impact on the overall results. However, this is also an area of large uncertainty.
- For the Labelling Directive the quality of energy consumption data for individual appliances may need to be improved further by representative sampling. Alternatively there are data

available on a commercial basis but this data needs to be reconciled with the general statistics on energy consumption by appliances.

Recommendation:

- The key data uncertainties, e.g. uncertainties in the emission factors, should be identified as part of the original **ex-ante appraisal**. This can then be used to inform any additional research that may be required to inform the future evaluation.
- Subsequent **ex-post evaluation** should be designed to reflect the overall uncertainty in the underlying datasets. This may mean for example, that where uncertainty in the underlying emissions is very high (e.g. N₂O emissions from the soil) a more simplistic evaluation approach should be adopted since the benefits of a more refined approach might be outweighed by the uncertainties in the emissions data. Where uncertainties can be resolved by additional data collection, then this should be factored into the evaluation programme of work.
- It is important that both ex-ante and ex-post evaluations, draw upon and make reference to data
 within national emissions inventories. Whilst the inventories have not been designed for policy
 assessment, and the data is not always structured in a way that aids policy evaluation, they do
 provide a rich source of information. Furthermore, this will ensure that any developments that take
 place to improve the data in the inventory can be used to inform the policy evaluation and viceversa.
- However, as illustrated by the evaluation of the biofuels directive, not all impacts are captured by the inventories. Therefore, consideration may also need to be given to the induced emissions arising beyond national boundaries. This creates issues of both data availability and methodological uncertainty, hence these estimates are often subject of greater uncertainty. This may present a role for the European Commission in helping to raise capacity in developing countries with emissions reporting, monitoring and verification. This will improve the quality and robustness of data that can be used to inform this analysis.
- The potential uncertainty in the policy impact, and the influence of data related issues, could be characterised using sensitivity analysis. This will demonstrate the influence of the issue on the overall results derived.

5.2.4 Timeliness of data

A further consideration is the **timeliness of the data**. For example delays in reporting may mean that the impacts of recent activities may not be considered by the evaluation. For measures that have the potential to deliver savings over a relatively short period of time e.g. renewable energy, the impacts can increase significantly from one year to the next.

In some cases this also raises the question of the origin of the data. Official public statistics tend to have some delay; in some cases public data are simply not available (e.g. for the distribution of labelling classes for electric appliances, or in the future for buildings or cars). The use of private sector sources for the evaluation could then greatly enhance the quantity and quality of data available. For renewables, for example, with the help of data from sector associations it is possible to carry out an evaluation for the most recent years.

Recommendation:

- When presenting the results of an ex-post evaluation, consideration should be given to the
 timeliness of the data. It may be preferable to include data available from non-official sources to
 undertake a meaningful assessment. This could include agreements with private data providers on
 the timeliness and price of the required data.
- In specifying monitoring requirement within new directives, consideration should be given to the reporting timescales, and how these integrate with any future ex-post evaluation requirements

5.2.5 Access to data

Another data related barrier that was identified for certain policies was the **access to data**. In some cases, data may be restricted e.g. commercially confidential data on output or eco efficiency or price data from industry. In other cases the data required for the evaluation may be collected already by private sector organisations, but may not be accessible without payment. One example of a policy where it is clear that a data collection would greatly improve the knowledge on impacts is the energy performance certification of buildings. For the moment no such information is available on buildings which clearly will hamper the future evaluation on the EPBD.

Recommendation:

- The monitoring framework should consider the practicalities of collecting the required data
 including any issues associated with data access. It may be necessary at this point to define any
 additional research (such as primary data collection) that may be required to inform the future
 evaluation.
- For certain datasets verification through inquiries on limited samples may be a cost-effective approach(e.g. for determining the evolution of temperature levels in buildings or the compliance with building regulation which both are relevant to determine the impacts of the EPBD). In some cases, it may be more efficient for the European Commission to organise the sampling if EU wide technologies are concerned (e.g. in the case of appliance labelling or CO₂ labelling of cars). This could reduce the overall cost of data collection as compared to an individual data collection by country. Split financing of such data collection between EU Commission and Member States may also be envisaged.

5.2.6 Data to determine the counter-factual emissions

Even where sufficient data is collected on the main emissions causing activity targeted by the policy or regulation in question this may not be sufficient to isolate the full policy impacts. Further information is frequently required in order to disentangle the influence of other important drivers on emissions. For example:

- Whilst the quality of data on the actual emissions from the installations is perhaps more detailed for the EU ETS than for any other policies, information required to determine a robust counter-factual was less readily available. In particular, empirical data on the main economic parameters of each installation was lacking. In order to effectively evaluate the policy impacts in the case of a market based mechanism, it is necessary to replicate the market characteristics. Given the broad scope of the instrument in terms of emitting sectors (around 10,500 installations), and the variations in the (grand fathered, or more recently auctioned/benchmarked) allocations by sector and by Member State, this requires a large amount of market data. Since much of this data is not currently collated, and is potentially commercially sensitive e.g. the ability of sectors to pass through the cost of carbon, then significant difficulties arise in collecting this data.
- Similar issue were encountered with the CAP reform. Whilst data was available on the key
 activities (i.e. animal numbers) and the associated emissions, less information was available
 on the market factors (e.g. commodity prices, input prices) in a way that enables the simplistic
 assessment of the policy impacts.
- The Co-generation Directive will influence the take up of CHP across range of sectors, including residential, commercial and industrial uses. However, a certain level of take up would have occurred in the absence of the Directive in response to existing national policies and other drivers. Data is therefore required on the level of uptake prior to the Directive, in order to fully account for the counter-factual level of uptake.
- In evaluating the impacts of the Nitrates Directive data is available from national emissions inventories on the total emissions of N₂O from agricultural land. However, emissions of N₂O will vary according to factors influenced by the Directive (e.g. N fertiliser application rates) but also structural changes (e.g. changes in land use or crop type) and geographical/climatic

- factors (e.g. soil type, rainfall). Current data sets are not sufficiently detailed to enable these other influencing factors to be isolated and corrected for.
- For the IPPC Directive certain data was available on the emissions arising from the
 installations. However, the IPPC Directive covers a large number of industrial installations
 including the energy and mineral industries, production and processing of metals, chemical
 industries and waste management. These sectors are regulated by a range of other
 instruments for their other environmental burdens. Consequently, it is necessary to
 understand the many drivers of output and emissions performance in each sub-sector.
- The impacts of the Waste Incineration Directive are strongly related to assumptions about the
 levels of energy recovery from incineration in the absence of the Directive. Since the level of
 energy recovery are likely to be influenced by the economics returns from energy recovery,
 and the economics of alternative energy sources within the respective years, amongst other
 things, then the modelling of the counterfactual scenario is much more complex.

Recommendation:

- When specifying the monitoring requirements for a given policy this needs to include the non-policy parameters that will influence the emissions from the sector in question. The non-policy parameters will vary from one policy to the next. However, the following list of parameters, can provide an initial checklist of the areas for consideration:
 - Other policies drivers i.e. are other policies in place to encourage (or discourage) the emissions causing activity
 - Technological innovation i.e. what innovation in technology are likely to have occurred anyway and what would be the impact on emissions.
 - Behavioural change i.e. what changes in behaviour are likely to have occurred anyway and what would be the impact on emissions.
 - Market factors i.e. what economic incentives exist to carry out the activity and how have these incentives changed over time (e.g. developments of energy prices).
- When commissioning new research to inform the development of new policies, in particular
 modelling or data collecting, consideration should be given to future evaluation requirements.
 For example, so that the model can be used for the ex-post evaluation of the policy in the
 future. This is particularly important for the evaluation of large and complex EU policies.

A further finding from the case study analysis is that evaluation is more difficult where a large number of different policies are acting upon the activity or emissions in question. In such cases it becomes increasingly difficult to isolate the impacts of a particular policy using a simplistic approach. For example:

- For CHP overlaps exist with the EPBD, RES-E, EU ETS Directive, the LCP and the IPPC Directives.
- The IPPC directive has strong overlaps with the LCP, WI, EU ETS, and Landfill Directives, amongst other.

Recommendation:

 As part of the ex-ante evaluation it is important that all policy linkages are clearly identified and accounted for as far as possible in the projections. A particular challenge exists where national policies are in place to support to EC regulations.

5.3 Methodologies and methodological parameters

Independent of any issues relating to the quality of monitoring data, there a number of key methodological assumptions that can have a major impact upon the outcome of the evaluation. These

are described in detail in the accompanying methodologies report. The influence of key methodological decisions on the quantitative results was also described in the previous chapter.

A key finding from this study is that there are currently <u>no fixed rules</u> for what methodological assumptions should be made when carrying out an ex-post evaluation. Consequently, there is an element of subjectivity involved in the process. This leads to inconsistencies in the results of separate studies. It also makes it difficult to isolate the impact of key methodological decision on the overall results. Ultimately, this reduces the usefulness of the ex-post evaluation results to policy makers.

As part of this study we have identified the main issues that are relevant to the ex-post evaluation of climate policies, but how these issues should be reflected in the evaluation is the subject of debate.

The main methodological choices that influence the results are as follows:

5.3.1 Autonomous (pre-policy) developments

Autonomous development (or rather pre-policy developments which may also include the impacts of previous policies, see the discussion on previous policies below) can potentially describe a range of inter-related factors that influence the counter-factual trend in emissions, but cannot easily be isolated as part of the evaluation. It may include, for example, technological improvements (i.e. innovation in technology) but also existing behaviour (where an activity would have occurred anyway, but has instead occurred in relation to a specific policy). Overall, the extent to which autonomous development is an issue, and can be corrected for, may vary considerably from policy to policy and from sector to sector. For example:

- Technological innovation, was an important consideration for the ACEA agreement. Historical data was available for the activity indicator (emissions from passenger cars) which allowed autonomous development to be estimated on the basis of historical trends.
- In the RES-E Directive it was assumed that large scale hydro would have been installed anyway in the absence of the Directive. This behaviour was therefore considered an autonomous development so the impacts were excluded from the overall results.

It may be possible, by examining statistical trends (e.g. linear extrapolation) prior to the implementation of the policy, to estimate the level of savings associated with autonomous developments. However, this is only applicable where the effects can be clearly defined and isolated.

The recommendation made above with respect to collecting data as early as possible, including the collection of data prior to the implementation of the policy, is relevant to the correction of pre-policy development.

5.3.2 Structural changes

Other variations in the apparent effectiveness of policies within given Member States can relate to the compositions and structure of the particular emissions causing activities. These may arise from political or economic factors that are unrelated to the policy It is therefore important to isolate these structural changes from those induced by the policy. For example:

- The impact of the RES-E Directive across the Member States examined differed significantly
 and scaled directly with the induced growth of renewable electricity in the Member States and
 with the carbon intensity of the power system. Countries which have introduced successful
 instruments like Denmark, Germany, Spain and the UK, and have a coal based generation
 systems, show significant emission reductions arising as a result of the RES-E Directive.
- The impacts of the Waste Incineration Directive are strongly related to what is assumed about the rates of energy recovery in the counter-factual scenario within different Member States. Since these rates varied significantly from one Member State to the next then this had a consequential impact on the estimated level of policy effectiveness.
- Structural changes in the agricultural sector in Germany, following its reunification, and in the new Member States of the European Union following accession, is one potential explanation for emissions of N₂O from the agricultural soils not following the expected trend.

 Emissions from passenger cars were related to changes in the structural composition of the sector, with an increase in the proportion of diesel cars, and an increase in the proportion of large vehicles.

In order to isolate these structural changes it is useful to collect data at a more refined level (e.g. for passengers cars, type and size of vehicle). Therefore the recommendations made above with respect to the collection of more refined data are equally applicable here.

5.3.3 Policy implementation

For some of the policies examined the implementation of the policy or regulation varied significantly from one Member State to the next. This included both the timing of the policy implementation, but also the nature in which the requirements were met. For example:

- The Nitrates Directive is a particular example where the implementation of the Directive showed significant variability between Member States. This included both the scope of the implementation (e.g. coverage of Action Programme measures), but also the timing of the implementation of the requirements.
- In contrast, the ACEA agreement was agreed at an EU level so the variability of impacts between Member States was much smaller in relative terms, and related more to behavioural factors (e.g. demand for different size vehicles across Member States).
- Likewise, for the Labelling Directive the main variation in effectiveness across Member States related to the type of appliance and the ownership rates. However, another important factor for the policy implementation was the existence of accompanying national policy schemes to promote the energy labels.
- For the implementation of the Energy Performance Directive of Buildings EPBD a largely unknown, but potentially very important factor is the compliance of the buildings with the requirements of the Directive. This implies more efforts to verify through inquiries on limited samples the compliance level.
- For the Biofuels Directive, the variation in impacts between Member States, in relative terms, can be largely put down to different promotion schemes introduced in the different countries for encouraging the take up of biofuels. However, this only takes into account the direct emissions from fuel consumption.
- For the IPPC Directive, there have been several inconsistencies in implementation including timing, the extent to which pre-IPPC national permitting schemes were in place and to what extent BAT has been applied.

Recommendations:

- When preparing ex-ante appraisals of policy impacts consideration should be given to the
 potential for variations in policy implementation to influence the overall results. This may include,
 for example, including illustrative scenarios to reflect the range of potential implementation
 options.
- The revisions to the **Monitoring Mechanism** could include a requirement for Member States to state the date of implementation of each of the CCPMs. In this way future **ex-post evaluations** would have a consistent, central, data source that can be used to inform the evaluation.
- When performing **ex-post evaluations** of policies implemented across a range of countries, variations in implementation should be taken into account. This should include:
 - o Scale i.e. has the policy been implemented at a larger/smaller scale.
 - o Timing i.e. has the policy been implemented sooner/later.
 - Supporting instruments i.e. have supporting policies been put in place in certain member states but not others.
 - Enforcement i.e. is the level of enforcement/compliance greater in one country than another.
 - Market factors i.e. does the nature of the market mean that the policy has been implemented differently in one country to the next e.g. planning laws.

5.3.4 Policy interaction

Another factor that had an important influence upon the apparent effectiveness of the EU policies within a given Member State was the incidence of national policies. This included both complementary national policies that supported the EU Directive, but also the national policies that were in place prior to the Directive and were subsequently superseded by the EU regulations. For example:

- The decline in disposal of municipal solid waste (MSW) to landfills within the EU 27, prior to
 the implementation of the Landfill Directive, can largely be attributed to national policies that
 were in place prior to the Directive. For example, MSW to landfill has declined almost linearly
 in Germany since 1995 four years prior to the deadline for implementing the Landfill
 Directive.
- The RES-E Directive is another area where the influence of national policies is potentially
 important, where a number of Member States had support policies in place prior to the
 implementation of the Directive. A similar issue arises with the Co-generation Directive.
- National policies were also put in place to support the ACEA agreement. However, the limited impact of the national polices in this example meant that the overall influence of this factor on the results within different Member States was not large.
- The influence of national policies was also potentially important for the effectiveness of the Labelling Directive in certain Member States (e.g. information campaigns in Denmark, subsidies in the Netherlands).

There is a methodological issue about how national policies should be accounted for when appraising EU policies. For example, it could be argued that certain national policies were implemented in preparation for the subsequent EU measures (so should be included within the scope of the analysis). Conversely, an argument can be made that the national policies would have continued, potentially at a more stringent level, in the absence of the EU Directive (so the impact of the Directive should allow for this underlying level of development). How the evaluation methodologies deal with national policies can therefore significantly affect the overall results. The impacts of these choices could be demonstrated as part of a sensitivity analysis.

The influence of national policies can also help to explain apparent variations in policy effectiveness between Member States. For example, measures implemented at a national level may have had a large impact upon greenhouse gas emissions prior to the implementation of the Directive. This may therefore reduce the potential (or most cost-effective potential) savings that remain to be delivered under the Directive. A good evaluation should therefore also show absolute progress towards a desired policy goal e.g. installed capacity or emissions intensity levels.

Recommendations:

- Ex-ante appraisals of future policies are frequently informed by evidence on the effectiveness of existing national policies. This practice should continue. However, it is also important that future ex-ante appraisals reflect the influence of any early actions as a result of national potential, which may reduce the overall potential for further savings arising from the EU regulations.
- The revisions to the **Monitoring Mechanism** could include a requirement for Member States to state more clearly whether the European policy has replaced an existing national policy.
- Future **ex-post evaluations** should clearly spell out the assumptions that are made with respect to national policies, as with any of the main methodological assumptions.

5.3.5 Emission factors

The choice of emission factor has an important influence on the overall results. This is particularly relevant for those policies that deliver savings in the electricity generation sector (RES-E, CHP, WID, Labelling). An important issue of debate is also whether to use average or marginal emission factors (i.e. to consider which technologies have really been displaced by the new technologies in the day-to-day operation). However, this also includes the use of 'default' emission factors, particularly where the potential range in the uncertainty is large (e.g. Indirect Land Use Change).

Recommendations:

- These variation highlight the importance, as far as possible, of using Member State specific characteristics in both **ex-ante** and **ex-post evaluations**. Whilst EU average conditions are reasonable, where data is limited; the use of more detailed country specific data should be advocated where the variations in the parameter is likely to be large between Member States. This is particular an issue for average emission factors from electricity generation⁵⁸.
- Furthermore, debate should continue on whether policy impacts associated with electricity
 consumption should be assessed using marginal emission factors or average factors. This may
 lead to a different factor being used for ex-post evaluation and for ex ante. In any case more
 data collection is necessary on day-to-day operation of power plants in order to be able to
 calculate the marginal emission factors. With the increasing penetration of renewables in the
 future this issue will become more relevant.
- Finally, since these methodological choices, such as emissions factors, can lead to discrepancies between Member States policy estimates and those derived at an EC level. As part of the Monitoring Mechanism provision should be made to collect data on the key methodological issues used in MS projections.

5.3.6 Other factors

There are a range of other factors that can be potentially important for given policies which may or may not be corrected for with additional data. For example:

- Temperature correction of savings from policies targeting energy demand of buildings
- Correction for wind intermittency on renewable energy generation

Adjustments can be made with the evaluation methodology to 'normalise' these variations, and isolate the influence of these variables on the overall outcome.

5.3.7 Sensitivity analysis

As far as possible we have aimed to demonstrate the influence of the methodological assumptions on the overall results in sensitivity analyses. This shows the relative impacts of taking one set of assumptions over another.

Recommendations:

- To ensure the consistency and comparability of results future ex-post evaluations should include an explanation of how the results have bee derived and the main methodological assumptions that were. This should include a sensitivities analysis of the main methodological assumptions where there is uncertainty. The main methodological assumptions may include:
 - Autonomous development
 - o Structural changes
 - Policy implementation
 - Policy interactions
 - o Emission factors
 - Boundary issues
 - Timing (announcement and delay effects)
 - Geographical factors
- Consideration should be given, as part of the update of the Monitoring Mechanism, of the
 requirement for Member States to specify the methodological assumptions and parameter that
 have been applied in their policy evaluations.

⁵⁸ There may be an argument in favour of using a unique EU-wide emission factor when a perfect common market for electricity can be argued (however, this is currently not the case).

5.3.8 Cost effectiveness

One of the major limitations of the methodology, as it current stands, is that the focus is upon the effectiveness of policies (i.e. the reduction in emissions arising), but no consideration of the efficiency of the policy (i.e. the resources expended in delivering the agreed target). From a policy makers perspective, whilst an understanding of the effectiveness of the policy is important, of equal importance is an understanding of the costs associated with delivering the given impacts. Within the scope of this project it has not been possible to look at the issue in detail, other than to review existing estimates. It is clear that this is an area that would warrant further examination.

Whilst the impact of GHG policies can be compared, in emissions terms, on a relatively straightforward basis i.e. the reduction in emissions over the period that the policy has been in place that can be attributed to the policy (absolute emissions in GWP terms), this is not necessarily the case for the cost estimates. Not only are estimates of the costs of policies more scarce, they are also much less consistent in terms of how the costs are presented – often for good reasons.

For the studies that we have reviewed as part of this study, the main factors that have resulted in the cost estimates being presented on an inconsistent basis are as follows:

- Cost components Some cost estimates included the direct resource costs to government (e.g. costs associated with the implementation, enforcement and administration of the regulations), whereas others included just the costs to industry and consumers (e.g. cost of the equipment installed, cost of lower/higher energy bills, cost savings from reduced energy consumption). Some evaluations included externals costs (see below) and in some cases the treatment of transfer payments (e.g. tax revenues) was also subject to variation between studies.
- External costs Some of the evaluations included an assessment of the external costs associated with the policies. This included, for example a 'shadow price' to reflect estimated the marginal damage cost of the carbon abated (as part of a cost-benefit analysis). Other studies included external costs associated with emissions of air quality pollutants.
- Distributional impacts In some studies a distinction was made between the costs accruing to the government and those costs/benefits that fall on end users. A further distinction was made in some evaluations to account for leakage from the national economy associated with imports/exports. For example, where national policies reduced electricity imports, so influenced emissions from the importing countries, but not the emissions within the country where the electricity is consumed.
- Time basis A further distinction is the time basis for the cost assessment. Some evaluations calculated the costs (ex-post) over the period that the policy has been in place, however, other 'ex-post' estimates assessed the costs (and cost savings) over a longer period - the lifetime of the measures implemented as a result of the policy. The rationale for this lifetime assessment is that the impact associated with certain expenditure (e.g. in a new technologies) will extend beyond the period of the initial investment, so the cost-effectiveness analysis should consider the costs and benefits over the lifetime of the measures implemented as a results of the policy (during the evaluation period).

As a result of the above factors the cost estimates from different studies, and across different polices, cannot be compared as directly as the GHG emission savings.

Furthermore, even where cost data is available, this may not be sufficient to evaluate the policy fully. In some countries, e.g. in Germany, promoting renewables is considered as part of the industrial policy. Likewise in the UK energy efficiency policies have benefits in reducing fuel poverty. An another important consideration is the impact on other environmental outcomes, for example, climate change mitigation measures are often related to impacts on air quality⁵⁹. In these cases, a multi-criteria approach is often advocated for the evaluation rather than a simple cost efficiency approach, which may provide only a limited picture.

⁵⁹ Indeed, air quality and climate change policies are frequently evaluated in a harmonised manner. See for example, http://www.ec4macs.eu/home/index.html

Whilst some recent studies have examined the ex-post costs for selected EU policies⁶⁰ in a more comprehensive way, there is no systematic process in place to collect his data or to ensure that the estimates are harmonised. The studies that are available suggest that, as with the emissions estimates, there are frequently large differences in the projected costs (ex-ante) of a policy, and those estimated ex-post. The discrepancies can be explained by a number of factors, including:

- the concept of costs (issues such as the definition, attribution, calculation and measurement of costs, including the availability, quality and reliability of data, and total costs versus unit costs);
- the role of assumptions in cost estimates e.g. on the context, the baseline (counterfactual scenarios) and the expected policy response by market parties;
- differences between planned, adopted and implemented policies (including differences in interpretation of targets and measures; in policy instruments; and in the extent of compliance or objectives achievement);
- the potential for innovation, economies of scale and other cost reducing dynamics.

It is clear that a number of the issues that were identified for the ex-post evaluation of policy impacts on emissions (e.g. data quality, methodological assumptions, policy implementation) are equally applicable to the evaluation of policy costs. It is therefore recommended that further work to developed ex-post evaluation methodologies consider both emissions performance and cost.

Recommendation:

- For the EU Commission to take the initiative in driving forward work to develop more consistent and harmonised systems for collection and collation of data on the ex-post costs of EU policies. This may involve the following activities:
 - To identify a lead organisation to promote the systematic collection of economic data for use during the formulation and review of environmental policies.
 - To develop an open-access database of ex-post studies for sharing methodologies and cost estimates.
 - To evaluate the value of further guidance on ex-post cost assessments and on the application of the findings of such assessments. This could complement the guidance developed in this study.
 - Consult more fully with stakeholders on the potential methods.

5.4 Recommendations for the evaluation of different types of policy instrument

In bringing the recommendations together it is useful to consider under what circumstances some issues are more important than for others. From a policy making perspective it is therefore useful to examine how the requirements relate to different policy instruments.

5.4.1 Research and /spending programmes to support new technologies

Common policy mechanisms include those which act as a 'carrot' or 'push' to encourage low carbon technologies. These include investment grants such as infant industry support of renewables and publicly funded R&D, technology diffusion measures, operating subsidies or grants, and infrastructure (industrial or otherwise) policies. These programmes are intended to encourage innovation, overcome market failures leading to under-investment in R&D, support the diffusion/adoption of new technologies, and mitigate the effects of policy uncertainty.

Such programmes should, in most instances, only support technologies which would not otherwise have come onto the market. As a result, it is reasonable to assume causality between increased use of the technology and the resultant emissions benefits. As technologies become competitive,

⁶⁰ For example, (IVM, 2006) Ex-post estimates of costs to business of EU environmental legislation, AEA (2007) Assessing how the costs and benefits of environmental policy change over time.

programme support should be removed. If support remains for competitive technologies, causality cannot be assumed.

Recommendation:

- For policies that subsidise low carbon technologies it is important as part of both ex-ante appraisals and ex-post evaluations to consider the relative economics of the technologies in questions⁶¹.
- For policies that target technologies that are already in the market it is beneficial to begin to collect data on the products or technologies prior to the implementation of the policy. As part of the exante evaluation this data may have been collected/utilised already.
- For the EU Commission to consider the development of a consistent economic framework for the design, and evaluation of climate policies. This may take a sectoral approach, outlining the key market failures and potential policy instruments that might be considered. This might build upon recent work in the UK in this area

5.4.2 Information provision, education and public engagement

This includes awareness campaigns, education programmes, community engagement programmes, and product labelling requirements. They are important for bringing about behaviour change by increasing awareness and overcoming informational market failures. When used in conjunction with other instruments, such programmes have been shown to be effective in bringing about cost effective emissions reductions and in improving the effectiveness of the climate change policy. This therefore includes:

- Energy labelling of household appliances Directives
- CO₂ labelling of cars
- Energy performance certificates for buildings

For these policies, it may be difficult to establish causality between the policy and emission trends since other factors may influence behaviour. In particular, since these policies are often implemented in conjunction will other instruments it might be easiest to evaluate the policies as part of a package. If evaluated in isolation then more detailed information would be required on other factors affecting consumer behaviour such as pricing issues. Surveys of consumer behaviour and the relative influence of information and education campaigns are often used to elicit the additionality.

5.4.3 Voluntary or incentivised negotiated agreements

These are agreements between the government and one or more private parties to reduce emissions beyond compliance with existing regulations. They can be useful in raising awareness, realising cost effective emission reductions not targeted elsewhere, and exemplifying best practice. This would include:

> Voluntary agreement with car manufacturers to reduce CO₂ emissions (ACEA, KAMA, JAMA)

One of the benefits of these types of instruments, from an evaluation perspective, is that they are typically target based e.g. they aim to achieve a given emissions performance. It is therefore relatively easy to monitor the overall scope of emissions that have been influenced by the policy. However, for these policies, it may be difficult to establish causality between the policy and emission trends since other factors may influence the market such as the economic climate or changing consumer preferences. The main consideration in appraisal of these types of policies is therefore the isolation of the policy impacts from the influence of other factors.

⁶¹ However, short-term economics may not be the only optimising element. For example Germany, through the promotion of renewable energy sources and energy efficiency also tries to set up an industrial policy which is more difficult to put in figures. This requires additional analysis such as the investigation of macro-economic effects (e.g. on employment) and of the competitive position of a country for a given technology (e.g. through the analysis of foreign trade patterns and of patents).

62 Making the right choices for our future: An economic framework for designing policies to reduce carbon emissions. Defra/DECC, March 2009.

5.4.4 Market-based (economic or fiscal) instruments

Market based instruments include mechanisms that target the price of emissions (e.g. taxes, subsidies directly related to emissions and indirect emissions pricing such as fuel charges) and mechanisms that target the quantity of emissions (and hence indirectly the price of emissions) include trading regimes such as cap-and-trade systems. Market-based instruments are effective tools for internalising the carbon externality, with higher emissions prices also creating a greater incentive for R&D investment and for overcoming barriers to behaviour change and diffusion of low carbon technologies. Such instruments can help achieve emissions reductions in an efficient and cost effective manner, without requiring the policy-maker to have this information beforehand (Defra/DECC 2009). However, this very fact makes the evaluation of the instruments difficult.

These instruments include:

- o EU Emissions trading scheme
- RES-E

For fiscal instruments it is necessary to understand how the tax or subsidy has impacted upon the behaviours of the agents involved. For example, for technology policies (e.g. renewables) it is necessary to collect data on the economics of the technologies in order to assess the extent to which the behaviours have been influenced by the policies and the extent to which the activities would have happened anyway. For novel technologies, or those that are clearly uncompetitive in the market place then it is reasonable to assume that all of the uptake can be attributed to the policy (as has been the case historically for renewables). However, the challenge arises when the market changes and the technologies begin to become competitive in their own right, or where the policy is only acting upon the sub-sector of the market (such as with the promotion of Co-generation). Further complications arise, where additional market failures restrict the take up of technologies that are already cost-effective. This may include hidden costs (transaction costs, cross-subsidies to fossil fuels), access to capital, split incentives or information failures providing a barrier to the take up of energy efficiency measures.

For trading mechanisms, additional information is required on the market conditions. This requires information on the relative costs of abatement. Difficulties arise (such as with the EU ETS) where the measures interact with other instruments or where policies cover a range of sectors. Since the costs of abatement may vary considerably from one sector to the next then this information may be required on a sectoral basis – as with the emissions data described above.

5.4.5 Direct regulations

These include the more traditional regulations that set prescriptive technology-based standards specifying the use of particular equipment, processes, or procedures, permitting regimes that set performance standards, and product bans. Direct regulation put an indirect price on emissions, and internalise some or all of the carbon externality. Examples of this type of instrument include:

- Integrated pollution prevention and control
- o Energy performance of buildings
- Landfill Directive
- Nitrates Directive
- o Biofuels Directive
- o Common rules for direct support schemes under CAP
- F-gas regulation
- Waste incineration Directive

In the case of regulations, such as minimum standards, information is required to estimate the level of efficiency achieved prior to the regulation and how that level would have developed in the absence the regulation being evaluated.

Inevitably there will be issues that change over time that may not be considered at the policy design stage e.g. consideration of lifecycle impacts, changes in product usage or consumer behaviour.

With regard to EU policy, difficulties arise where the Directive does not stipulate the nature of the mechanism, just the overall target. If a MS meets such a target, it would be misleading to assign all savings to the policy, other factors may have contributed. Some EU policies leave Member States free to select the quantitative level of emissions standards to be applied e.g. in the case of the IPPC and EPBD. Here knowledge is required of former standards in order to judge any improvements resulting from national implementation.

6 Detailed recommendations for the Monitoring Mechanism Decision

6.1 Introduction

The Monitoring Mechanism Decision is currently under review. The revised Monitoring Mechanism Decision could contribute to the increased coordination of action on policy evaluation at the MS and EU level. Building on the analysis presented in the previous sections of the report, this chapter outlines specific recommendations for updates to the current MM.

The recommendations are specific to the current MM, however, it must be recognised that the MM is just one mechanism that is available to facilitate the collection and collation of policy impacts. For certain data it may be more practical or efficient to utilise alternative data collection mechanisms. This may include, for example, the centralised collection or procurement of data by the EU Commission rather than the provision of data by individual Member States.

6.1.1 Monitoring Mechanism Decision

Decisions 280/2004/EC and 2005/166/EC – the Monitoring Mechanism and its Implementing Provisions (hereinafter the "MM") – monitor all anthropogenic greenhouse gas emissions not controlled by the Montreal Protocol in the EC Member States, to transpose related requirements under the Kyoto Protocol (KP) into EC Law and to evaluate progress towards meeting greenhouse gas reduction commitments under the UNFCCC and the Kyoto Protocol.

The current Decisions also set a number of biennial reporting requirements with regard to policy monitoring and evaluation, including:

- Quantification of policy impact between base year and 2005, 2010, 2015
- Quantification of economic impacts to the extent possible
- Description of actual and expected interaction with other relevant policies and with relevant Community policies
- Indicators to monitor and evaluate progress with policies over time (Annex II and III to DECISION No 280/2004/EC)
- Underlying assumptions and key input and output parameters (Annex IV to DECISION No 280/2004/EC)

Figure 6-1 Articles related to monitoring and evaluation in Decisions 280/2004/EC and 166/2005/EC

DECISION No 280/2004/EC

Article 3.1.j

1. Member States shall, for the assessment of actual progress and to enable the preparation of annual reports by the Community, in accordance with obligations under the UNFCCC and the Kyoto Protocol, determine and report to the Commission by 15 January each year (year X):

(j) information on indicators for the year before last (year X-2); and

Article 3.2.a

(iv) indicators to monitor and evaluate progress with policies and measures over time, including, *inter alia*, those indicators specified in the implementing provisions adopted pursuant to paragraph 3; (v) quantitative estimates of the effect of policies and measures on emissions by sources and removals by sinks of greenhouse gases between the base year and subsequent years, including 2005, 2010 and 2015, including their economic impacts to the extent feasible; and

Article 3.2.b

national projections of greenhouse gas emissions by sources and their removal by sinks as a minimum for the years 2005, 2010, 2015 and 2020, organised by gas and by sector, including: (iv) descriptions of methodologies, models, underlying assumptions and key input and output parameters.

DECISION No 166/2005/EC

Article 7

The information on indicators referred to in Article 3(1)(j) of Decision No 280/2004/EC:

- (a) shall include, by 15 January 2005 and each year thereafter, the values for the priority indicators listed in table II-1 in Annex II:
- (b) should include, by 15 January 2005, and shall include, by 15 January 2006 and each year thereafter, the values for the additional priority indicators listed in table II-2 in Annex II;
- (c) should include, by 15 January 2005 and each year thereafter, the values for the supplementary indicators listed in table II-3 in Annex II.

Article 9

The information on national policies and measures referred to in Article 3(2)(a) of Decision No 280/2004/EC shall include:

- (b) a description of the actual and expected interaction with other relevant policies and measures and with relevant Community policies and legislation;
- (c) indicators for projections for the years 2005, 2010, 2015 and 2020 as listed in Annex III to this Decision.

Article 10

2. The descriptions of methodologies, models, underlying assumptions and key input and output parameters referred to in Article 3(2)(b)(iv) of Decision No 280/2004/EC, shall include, if used, the mandatory parameters set out in point 1 of Annex IV to this Decision. Member States are encouraged to report the parameters on projections included in the list of recommended parameters set out in point 2 of Annex IV to this Decision.

6.2 Recommendations for the revision of the MM

To support improved policy appraisal, monitoring and evaluation, we recommend that a number of specific requirements are considered for inclusion in the revised MM. Each of the recommendations is described briefly. This is then followed by a more detailed description later in the chapter.

1. Under the current MM Member States are required to provide "quantitative estimates of the effect of policies and measures on emissions by sources and removals by sinks of greenhouse gases between the base year and subsequent years, including 2005, 2010 and 2015, including their economic impacts to the extent feasible". Consideration should be given to extending this requirement to consider impacts in future years: 2020, 2025 and 2030. In addition, consideration should be given to the requirement for Member States to provide quantitative estimates of the impacts of their most important measures to date, indicating the estimated impact in the latest year for which data is available. In light of the results from the ex-post evaluation, Member States should then re-appraise the future impact of those policies

One the findings from this study was that current capacity in ex-post evaluation within Member States was mixed, with a number of Member States having only limited experience in the systematic evaluation of GHG policies and measures. A further finding from this study is that, for certain key EU

policies, there are limitations in the reliability of evaluation methodologies that draw upon currently available aggregate statistics. Taking these factors into account it is clear that further work is required to build capacity in ex-post evaluation (both in terms of data sets, and practical experience). On this basis it is important to be realistic about what might be achieve from the inclusion of a specific requirement for Member States to provide quantitative results of ex-post policy impacts, and what further work is required in order to support Member States in meeting any requirement. In the short term, it may be expected that only a limited range of information may be provided (for example, from a limited number of Member States, or for a limited number of policies). However, even in these circumstances this still represents an improvement on the current situation. It is also important to recognise that the inclusion of a specific requirement will provide a stimulus for further action, and in the absence of a requirement ex-post evaluation activities are likely to remain inconsistent.

If a requirement was introduced into the Monitoring Mechanism for MS to prepare ex-post estimates for selected policies, it may be necessary to specify exactly which policies MS are required to report against. This list could be drawn from the list of Common and Co-ordinated Policies and Measures (CCPMs). In the short term this may focus on those policies with the most significant impact and also, potentially, those that can be evaluated relatively easily on the basis of currently available data. The following policies would be good first candidates:

- Voluntary agreement with car manufacturers to reduce CO₂ emissions (ACEA, KAMA, JAMA)
- Biofuels Directive (Dir 2003/30/EC)
- RES-E Electricity production from renewable energy sources (Dir 2001/77/EC)
- Energy labelling of household appliances (Dir 2003/66/EC, 2002/40/EC, 2002/31/EC, 99/9/EC, 98/11/EC, 96/89/EC, 96/60/EC)
- Landfill Directive (Dir 1999/31/EC)

Whilst reporting against a short list of CCPMs could be mandatory, since national policies are closely related and often evaluated in combination with the EU policies, the requirement should allow national policies to be reported also.

The methodologies and guidance documents produced as part of this study provide a useful starting point to assist Member States in the evaluation of selected key policies. However, further work is required to refine and develop the methods further to improve the accuracy of the results. In particular, the methodologies should be refined as additional data sets or models become available, and as policy understanding grows. In addition, there is still a great deal of debate on certain methodological assumptions, which can have a large influence on the estimated impacts. In the future the Commission may wish to consider introducing requirements to use harmonised methodological assumptions where policy impacts are well understood and methodologies well developed. In the short term further discussion and debate on these issues is required. Expert working groups would be a useful way to agree these issues and to ensure that the latest knowledge on data and methodologies is shared between Member States.

2. The requirement for Member States to report progress in terms of policy impacts could be formalised in terms of a regular National Climate Change Policy Evaluation and Appraisal Report. This could include the results of the policy appraisals and evaluations, as well as a description of the associated methodological approaches. The report could also include a description of Member States planned evaluation activities.

The National Climate Change Policy Evaluation and Appraisal (NCCPEA) Report could be submitted on a regular basis, at the same time as the projections reports, to the EC. The NCCPEA report would ideally take a standardised format so that the results and methods can easily be compared between Member States. Given the potential variations in data and methodologies utilised in the evaluation of the policies it will necessary to capture this information in a simplified way. This will also minimise the burden on Member States. Further details and a suggested questionnaire are provided below. It is recommended that the reporting format is specified in an Annex to the Decision which can therefore be amended if necessary through comitology.

3. In addition to Member States reporting progress it is important that the EC is able to monitor and evaluate the impacts of EU wide policies and measures. We therefore recommend that the EC carry out an ex-ante appraisal of all their policies impacting on GHG emissions,

quantifying the expected future impact on GHG emissions in the years 2015, 2020, 2025, 2030. We also recommend that the EC carry out an ex-post evaluation of their most important measures, indicating the estimated impact in the latest year for which data is available. In light of the ex-post evaluation, the future impact of those policies should be reappraised.

When commissioning research to inform the development of new policies, in particular modelling or data collection, consideration should be given to future evaluation requirements. For example, ensuring that the model, if appropriate, can be used for the ex-post evaluation of the policy in the future. This is particularly important for the evaluation of large and complex EU policies.

The Commission may also want to consider the development of a consistent economic framework for the design, appraisal and evaluation of climate policies. This may take a sectoral approach, outlining the key market failures and potential policy instruments that might be considered. This might build upon recent work in the UK in this area⁶³.

4. The requirement for European Commission to report progress in terms of policy impacts could be formalised in terms of a regular National Climate Change Policy Evaluation and Appraisal Report detailing the results of the policy appraisals and evaluations, as well as the associated methodological approaches. It could also include a description of planned evaluation activities.

The requirement for the EC to evaluate EU level policies could be included as a legal requirement in the MM.

It is important that the EC demonstrates that the effectiveness and efficiency of the European Climate Change Programme is continually reviewed, and the findings are used to inform the development of new policies. Whilst this is justifiable in its own right, it also demonstrates the leadership position of the EU with regards to 'good' climate change policy making. A centralised evaluation of EU level policies is also advantageous as:

- policies are evaluated transparently and consistently;
- the EC is engaged in developing and applying a national system for policy evaluation:
- the EC may more efficiently organise the data collection for certain policies.

The National Climate Change Policy Evaluation and Appraisal (NCCPEA) Report should be updated on a regular basis, at the same time as the projections or progress reports. The EC should make public the NCCPEA Report. The Report could take the format of a standard table for results supplemented by a description of the data source and methodologies employed to derive the results. The data and methodologies could be presented on a sectoral basis. Further details on the suggested content of the report is provided below. It is recommended that the reporting format is specified in an Annex to the Decision which can therefore be amended if necessary through comitology.

5. Consideration should be given to the requirement for Member States to provide additional specified statistical data sets to support EU policy appraisal and evaluation.

In order to carry out a robust evaluation of the policies and measures that make up the European Climate Change Programme it is clear that in most cases, data is required at a more detailed level of resolution than is currently collected by established EU or international statistical agencies. In particular, a greater level of granularity is likely to be important for policies that act on:

- a range different types of emissions causing activities (e.g. different technologies)
- a range of sectors, or subsectors (e.g. cross sectoral policies)
- activities influenced by a range of different policy instruments.

However, it is not possible to prescribe a default list of data that will be applicable to all policies. The data requirements will vary from one policy to the next, and may also vary between Member States. It is therefore important that consideration is given to the monitoring requirements on a policy-by-policy basis.

108 AEA

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⁶³ Making the right choices for our future: An economic framework for designing policies to reduce carbon emissions. Defra/DECC, March 2009.

The EC can play an important role in helping to identify the data required to evaluate individual ECCP policies, and in ensuring that the data is efficiently collected and organised. This report plays an important role in helping to identify the data requirements for those policies that have been considered as case studies. However, where new policies are introduced the Commission has a role in defining the monitoring requirements to ensure that the necessary monitoring data is collected and collated efficiently.

A detailed list of data required to evaluate each of the policies studied during this project is provided below. Compared to the current MM requirements, additional and more disaggregated data is required in order to implement the methodologies developed under this project. Some such data is readily available from other statistical sources or is provided by Member States, in accordance with their monitoring requirements under the respective Directives but in other cases is not. Such data could be requested centrally under the revised MM, although this is not the only mechanism. It is also important to strike a balance between the cost and administrative burden associated with additional data collection and the benefits of improved accuracy in policy evaluation. This is one of the reasons why a tiered approach was developed during this study.

Where the benefits of additional data collection are justified, and the MM is the preferred mechanism for collecting the data, it is recommended that requested data sets are specified in an Annex to the Decision which can therefore be amended if necessary through comitology.

- 6. Consideration should be given to a requirement for Member States to provide the following information on the implementation of each of the CCPMs in their national context:
 - i. Description of related national legislation in place before the arrival of the CCPM
 - ii. Description of expected additional effects of implementing the CCPM, beyond the effects that would have resulted from the national legislation
 - iii. Description of measures introduced to implement or support the policy
 - iv. Date of implementation of the CCPM into national legislation
 - v. Description of compliance and enforcement activities
 - vi. Description of factors influencing the effectiveness of the policy in the national context e.g. local market factors or planning laws

At present, the MM and its IP request "information on measures being taken or planned for the implementation of relevant Community legislation and policies" and "a description of the actual and expected interaction with other relevant policies and measures and with relevant Community policies and legislation". In addition, an informal consultation process as part of the annual EEA GHG Trends and Projections report provides information on the interaction between national policies and CCPMS. More specific requirements such as those outlined above should provide a more consistent, central, data source which will help to inform appraisals and evaluations carried out at the EU level.

6.2.1 Policy Evaluation and Appraisal Reporting and Planning

Further details regarding the recommendation outlined above for MS and the EU to prepare a National Climate Change Policy Evaluation and Appraisal Report is provided below.

Upscaling evaluation activity

To encourage Member States to perform regular and integrated policy evaluations and (re)appraisals, we recommend that the EC introduce a reporting requirement for MS to prepare a National Climate Change Policy Evaluation and Appraisal Report on a regular basis covering their most important measures or a specified set of EU policies.

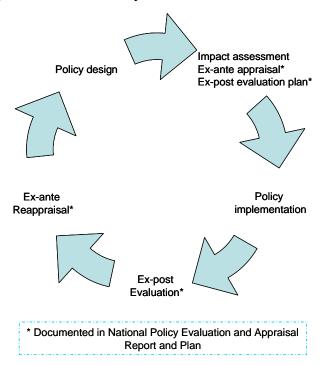
Without reporting requirements set in legislation, policy evaluation and appraisal will continue to be ad hoc, unless required by national legislation, and methods may not be transparent. Reporting would stimulate evaluation activity by encouraging MS to report on their evaluation plans and activities.

Importantly, this study has shown that a successful evaluation can only be performed where suitable data is available. The NCCPEA Report would encourage Member States to identify what data will be required to evaluate the policy in the future before the policy is implemented and to put in place plans to collect the required data. In addition, the NCCPEA Report would encourage a cyclical approach to

appraisal and evaluation of the policy (see **Error! Reference source not found.**), whereby policies are re-appraised in the light of findings from the ex-post evaluation.

Furthermore, reporting would make MS evaluation methods more transparent. This in turn allows the EC to compare and contrast MS results, to understand why results vary and to inform EC level evaluations. The information also provides a platform for MS to work together to overcome common difficulties and share best practice.

Figure 6-2 Policy appraisal and evaluation cycle



The National Climate Change Policy Evaluation and Appraisal Report

The National Climate Change Policy Evaluation and Appraisal (NCCPEA) Report should contain the results of policy appraisals and evaluations. Results should be presented in a common format using a standard reporting template. This may build upon the current 'Monitoring Mechanism Reporting Template' with an expanded element to capture the results from any ex-post assessments. This excel template could be submitted alongside the main report.

The NCCPEA Report should be submitted on a regular basis. This report could be submitted alongside the projections report i.e. every other year: 2011, 2013, 2015. However, a less frequent interval may be more appropriate to limit the additional burden on Member States.

Whilst the NCCPEA report should, ideally, contain the latest evaluation evidence available, it should not necessarily mandate an evaluation of all policies and measures. It may be more appropriate to evaluate certain policies less frequently than others, particularly where the costs of additional data collection are large. Reporting within the NCCPEA could therefore take into account existing policy evaluation cycles within Member States.

Likewise, MS should be given flexibility, at least initially, to choose the evaluation methodologies that they employ. There is an argument for including a requirement in the MM for MS to report impacts in accordance with a harmonised methodology and default set of methodological assumptions, since this will allow the full consistency of the results. However, it is clear from the work undertaken as part of this project (and similar work undertaken elsewhere e.g. under the EMEES project) that there is still debate on the most appropriate methodologies and methodological assumptions.

The work undertaken as part of this study provides a useful starting point to guide Member States in the most appropriate evaluation methodologies, and the key methodological issues. However, further

debate and discussion is required before harmonised methodologies or assumptions can be prescribed. We therefore recommend that the MM does not prescribe the evaluation methodologies to be used. However, it could require MS to report on the methodologies that they have used, the key data sources, methodological assumptions and main uncertainties in the estimates.

The NCCPEA report should, ideally, follow a consistent structure and format so as to enable a comparison of results from different member states. The report could include the following information:

g) List of policies evaluated

The report should include a list of the policies and measures that have been evaluated and are considered within the report. These should be identified as CCPMs or supporting national policies.

h) Quantitative estimates

The report should include a concise summary of the quantitative estimates of the policy impacts. The estimates should be provided in accordance with an agreed template, which could be based upon the results table presented in Section **4.1.1** of this report. The template should allow key differences in the evaluation period, and the relative uncertainties of the methods, to be identified.

i) Scope of the policy evaluations

The report should include a clear description of the scope of the evaluation performed for each of the individual policies.

A description should be provided of the **evaluation period** i.e. what is the assumed start data of the policy, and up to what point in time have the impacts been evaluated to. This should include any assumptions with respect to announcement effects or delay effects.

The report should include a description of the implementation of the policy in the respective MS. This should also include a qualitative description of the potential influence of key implementation assumption of the evaluation results. This may include assumptions with respect to non-compliance in respect to regulatory measures. The evidence that is used to underpin the assumption should be clearly stated.

The Monitoring Mechanism could specify the evaluation period for the CCPMs, for example, the data the regulations came into force to a recent date e.g. 2005. This would ensure greater consistency and comparability between estimates. However, it is important that any differences in policy implementation between Member States are taken into account, and that data for the most recent years is utilised.

The revisions to the Monitoring Mechanism could include a requirement for Member States to provide more **structured information on the implementation** of each of the CCPMs. In this way future EU ex-post evaluations would have a consistent, central, data source that can be used to inform the evaluation. Requested information should include:

- i. Scale i.e. has the policy been implemented at a larger/smaller scale?
- ii. Timing i.e. has the policy been implemented sooner/later?
- iii. Supporting instruments i.e. have supporting policies been put in place in certain member states but not others?
- iv. Enforcement i.e. the assumed level of enforcement/compliance?
- v. Market factors i.e. does the nature of the market mean that the policy has been implemented differently in one country to the next e.g. planning laws?

For measures that will deliver savings beyond the lifetime of the policies (e.g. insulation measures will deliver emissions reductions in households beyond the lifetime of the subsidy that was used to support the installation), these assumptions should be clearly stated. Ideally, results should be reported on an annual (e.g. annual savings in the latest year for which results are available) and cumulative (i.e. sum of annual impacts to data) to enable a comparison of estimates between different MS.

The report may also provide a description of important time lags in data provision they may influence the overall outcome of the evaluations. For example, where recent years' activities are not reflected in the assessment and may materially influence the overall findings from the evaluation.

The report should also describe any **boundary conditions** relevant to the policies evaluated. For example, for certain policies it may be appropriate to consider indirect or life-cycle emissions.

i) Description of the data

The report should include a clear description of the data that has been used to underpin the policy evaluations reported. This may include the following information:

- Activity data
- Emissions factors (and their impact on the counterfactual)
- Data used to isolate the counter-factual
- Key data uncertainties
- Consistency with inventory data

The report should include a clear description of the **activity data** used to inform the ex-post estimate. This would describe the main emissions causing activities that have been influenced by the policy, including the key sectors or sub-sectors influenced. This is important for linking the estimated policy impacts to the data captured within the national emissions inventories. It should also describe the source of the data e.g. is it based upon existing statistical sources, or his primary survey data been collected for the purposes of the evaluation.

The choice of **emission factor** can have an important influence on the comparability of results from different evaluations. It is therefore important that the source of emission factors is clearly stated. Whilst EU average conditions are reasonable, where data is limited; the use of more detailed country specific data should be advocated where the variations in the parameter is likely to be large between Member States. This is particular an issue for average emission factors from electricity generation⁶⁴.

It is useful to understand what additional data has been used in order to isolate the policy impacts from the **counterfactual scenario**. For certain policy evaluations it may be assumed that the activity would not have happened in the absence of the policies (e.g. it was not cost effective) so the counterfactual is no activity. However, for other policies the case is less straightforward, particularly where the policy leads to a change in existing activity. This is likely to involve more refined analysis, which in turn, may require additional data – for example relating to economic drivers. These additional data sources should be described.

A description should also be provided of the main **uncertainties** relating to the data. These uncertainties may relate to the activity data or the emissions factor, or both. The report should include the results of any uncertainty analysis that has been carried out. This should clearly show what parameters have been examined, and what influence this has in comparison to the main result. It would also be useful to include a description of how uncertainties in data have informed the choice of evaluation methodology, although this should be an optional element.

The reporting should also make reference to data reported within (or used to compile) **national emission inventories**. Whilst the inventories have not been designed for policy assessment, and the data is not always structured in a way that aids policy evaluation, they do provide a rich source of information. Furthermore, this will ensure that any developments that take place to improve the data in the inventory can be used to inform the policy evaluation and vice-versa. Linkages, and discrepancies, with data reported in national emissions inventories should therefore be described.

Finally, the report should include a description data issues relating to the **boundary conditions.** For example, where the emissions factors take into account life cycle emissions, or emissions arising outside of territorial emissions inventories (e.g. as illustrated by the evaluation of the biofuels directive, not all impacts are captured by the inventories). This may present a role for the European Commission in helping to raise capacity in developing countries with emissions reporting, monitoring and verification. This will improve the quality and robustness of data that can be used to inform this analysis.

⁶⁴ There may be an argument in favour of using a unique EU-wide emission factor when a perfect common market for electricity can be argued (however, this is currently not the case).

k) Description of the methodologies

Methodological choices, such as emissions factors, can lead to discrepancies between Member States policy estimates and those derived at an EC level. To ensure the consistency and comparability of results, appraisals and evaluations should include an explanation of how the results have been derived and the main methodological assumptions used. This would also include a description of any adjustment factors that have been applied.

For each of the policies that have been evaluated it would be useful to understand the methodologies that have been applied. The report could include a short description of the methodologies and a classification of the methodologies. This could draw upon the **classification** used within the methodologies report: Top-down, Bottom-up, Integrated methods.

The methodology report should outline, for a given policy, how the policy impacts have been **isolated** from other factors influencing. The non-policy parameters will vary from one policy to the next. However, the following list of parameters, can provide an initial checklist of the areas for consideration:

• Policy interaction

The report should describe how policy interactions have been accounted for. This would include interactions with National policies, but also interactions with other EU policies. The revisions to the Monitoring Mechanism could include a requirement for Member States to state more clearly whether the European policy has replaced or strengthened an existing national policy, which policies and how the policies interact. This is currently done through an informal consultation process as part of the annual EEA GHG Trends and Projections report.

It should be made clear if the policy has been evaluation in isolation, or as part of a policy package i.e. to what extent attempts have been made to isolate the policy impacts.

• Autonomous developments

The report should include a description of what has been assumed in terms of autonomous development. This specifically relates to behaviour i.e. what behavioural trends are likely to have occurred anyway and what would be the impact on emissions, and technological innovation i.e. what innovation in technology are likely to have occurred anyway and what would be the impact on emissions. The report should include a description of what assumptions have been used, and what evidence these are based upon.

Other correction factors

The individual policy evaluations may have included a number of other corrections factors to enable a more robust evaluation of the policy impacts. These may include corrections for climatic factors (e.g. degree days correction) or weather (e.g. on renewables production, or agricultural output). They may also include correction for rebound effects (e.g. comfort taking), or for structural effects (e.g. non-policy changes in the structure of the sectors affected). Where possible, these correction factors should be described, including details of the evidence that has been used to inform the correction.

Other exogenous factors such as price impacts

Other exogenous factors can influence upon all of the above parameters. For example, increases in energy prices will influence the level of autonomous energy savings behaviour whilst at the same time making subsidies for energy saving measures more attractive – so increasing the policy impacts. Where these factors have been taken into account they should be stated.

It is important to note that each of the above drivers seldom work in isolation and are often interrelated, for example policy intervention can induce behavioural change.

I) Future evaluations activities

It is also important that monitoring and evaluation requirements are planned in advance of policy implementation to ensure appropriate monitoring data is collected over the lifetime of the policy to enable its future evaluation. The NCCPEA Report could therefore also include:

- a timeline of planned appraisal and evaluation activities for individual policies;
- details of the methodologies and data sets to be used;
- details of any primary data collection activities;
- details of any difficulties foreseen and how those difficulties will be overcome.

In designing the monitoring framework for a given policy, it is useful to map out the specific sectors, and emission causing activities, that will be influenced by the policy. Importantly, the monitoring framework needs to be designed in such a way that data is collected at a sufficient resolution to account for sectoral or sub-sectoral impacts, e.g. if the activities/emissions are relatively homogeneous in nature then high level monitoring may be appropriate, if the policy only acts upon a sub-sector then data for this sub sector needs to be collected. For certain datasets verification through inquiries on limited samples may be a cost-effective approach. In some cases, it may be more efficient for the European Commission to organise the sampling if EU wide technologies are concerned (e.g. in the case of appliance labelling or CO₂ labelling of cars). This could reduce the overall cost of data collection as compared to an individual data collection by country. Split financing of such data collection between EU Commission and Member States may also be envisaged.

National system for policy evaluation and appraisal

The requirements described above could be further expanded to require MS to set up and report details of responsible institutions, processes, data flows and data management, QA processes etc for policy evaluation and appraisal. This would be akin to the requirements placed on Member States with respect to the setting up national systems for inventories in accordance with the UNFCCC. In this case, the requirement would extend beyond simply reporting policy impacts and the associated methodologies to setting up the institutional architecture to support such activities.

In this case, the national system would comprise the institutional, legal and procedural requirements necessary for monitoring and evaluating the effectiveness of climate change policies over time. Experiences from the setting up of national systems for emissions inventories suggest that this supporting framework is important for ensuring the quality of the inventories. It could therefore be argued that a similar system is necessary for ensuring the quality of data reported on policy impacts.

6.2.2 Revised MS reporting requirements

<u>In the context of the recommendations outlined above, Article 3.2.a</u> (v) of the current MM should be revised. Suggested wording is provided below:

1. Member States should:

- i. Carry out an ex-ante appraisal of all their policies impacting on GHG emissions.
- ii. Carry out an ex-post evaluation of their most important measures
- iii. In both cases, use the available EC guidance, except where more advanced Member State approaches are available.
- iv. Regularly review ex-ante scenarios and re-appraise policies in light of actual developments and ex-post evaluation activities.
- v. Prepare a National Policy Evaluation and Appraisal Report including:
 - The results of the policy appraisals and evaluations, in accordance with the template provided in Annex X. The results should include quantitative estimates of the effect of policies and measures on emissions by sources and removals and quantitative estimates of the economic impacts of policies and measures, to the extent possible.

Member States should quantify the impact of existing policies and measures on emissions to date (ex-post) for a historic period starting from the date of policy

implementation up the most recent historic year available (annual expected reduction). The impacts should be assessed against a counter factual and should be derived from an ex-post evaluation (making use of historical data).

Member States should quantify the projected (ex-ante) impacts of policies and measures on emissions in the years (ex-ante) 2015, 2020, 2025, 2030 (annual expected reduction compared to a 'without policy' scenario). Future year estimates should be derived from an ex-ante evaluation (making use of projected data).

Member States should also provide quantitative estimates of the total effect of policies and measures on emissions by sources and removals, taking account of any policy overlaps, for both the WEM and WAM scenarios.

Member States should also provide an explanation of any changes in the estimates compared to previous years and a list of policies not quantified and the reason why a quantification was not possible.

- Associated methodological approaches in accordance with the template provided in Annex Y.
- 3. The planned approach for future evaluations of those policies, in accordance with the template provided in Annex Z.
- vi. Implement a national system for policy evaluation and appraisal.

6.2.3 MS data reporting in support of EU policy appraisal and evaluation

Further details regarding the recommendations outlined above for MS to provide specified statistical data sets to support EU policy appraisal and evaluation are provided below.

Annexes II, III and IV of the current MM Implementing Provisions specify a number of historic and projected indicators and parameters to be reported by Member States "to monitor and evaluate progress with policies and measures over time". Projected indicators and projected parameters requested in the current MM and IP can, in certain cases, be used to explain expected activities impacted by GHG policies and measures and therefore facilitate the first step in a policy appraisal or evaluation.

However, a rationalisation of the requested data sets is required to ensure that the data is indeed of use for policy evaluation or other purposes.

At present the MM and IP do not clearly state whether projected indicators and parameters should be provided for the WEM, WAM and/or WOM scenarios. The current MM and IP clearly request indicators for projections for the years 2005, 2010, 2015 and 2020 but do not specify the years for which parameter data should be reported. We recommend that the same data sets are requested for both historic and future years. The relevant articles and annexes should therefore be clarified to request:

• data sets for all historic years up to the latest year for which data is available and 2015, 2020, 2025, 2030 for the WEM, WAM and WOM scenarios

It is recommended that the revised MM encourages reporting of data required for the appraisal or evaluation of EU level policies only. This data can then be used by the European Commission to appraise and evaluate its policies. Interactions between EC policies and national policies should be taken into account in this request. It is recommended that requested data sets are specified in an Annex to the Decision which can therefore be amended if necessary through comitology. The EC should review and amend the list of required data when legislation is introduced, amended or phased out.

The tables below outline the data required to implement the methodologies developed under this project and some suggestions on the additional data requirement for improvements in the analysis. Associated data sources are also provided. Clearly there is no definitive list of data requirements with different policies requiring different amounts and resolution of data. Likewise the data and

methodologies are closely entwined, so the choice and level of sophistication of the methodologies that can be employed is dependent upon the data available.

For each policy, a policy effectiveness indicator is described. This is not meant to provide an accurate representation of the policy impacts, or replace the results from the policy evaluation. However, in accordance with the Tier 1 methodology it does provide a quick overview of the emissions causing activity that the policy acts upon, and the overall trend in emissions since the policy has been in place.

Where data is currently provided only through the existing MM, we recommend that the reporting requirement is carried through to the revised MM Decision. Where data is currently unavailable or only available through private sources, we recommend that the Commission considers including requirements for MS to report this data under the revised MM Decision. However, we recognise that other data collections mechanisms exist, and may be more appropriate for certain policies. Furthermore, the costs of any additional data collection need to be balanced against the associated benefits.

In the tables below data that is currently required in the existing MM decision is highlighted in bold.

6.2.4 ACEA agreement

The simplified policy effectiveness indicator that underpins the Tier 1 methodology for the evaluation of the ACEA agreement is the **average emission rate of new vehicles** relative to the pre-agreement levels.

Table 6-1 Data used in our current analysis

Tier	Data requirement	Data source
1	Number of passenger vehicles (stock)	Decision 1753/2000/EC; Odyssee Database, Eurostat
1	Number of new passenger vehicle registrations	Decision 1753/2000/EC; Odyssee Database, Eurostat
1	Emission rate of new vehicles	European Automobile Manufacturers Association
2	Number of passenger vehicles (stock) (split by fuel: petrol/diesel/)	Decision 1753/2000/EC; Odyssee Database; European Automobile Manufacturers Association, Eurostat
2	Number of new passenger vehicle registrations (split by fuel: petrol/diesel/)	Decision 1753/2000/EC; Odyssee Database; European Automobile Manufacturers Association, Eurostat
2	Emission rate of new vehicles (split by fuel: petrol/diesel/)	European Automobile Manufacturers Association, Eurostat
3	Vehicle stock and new registrations by size class	ASTRA Model (from various sources), European Automobile Manufacturers Association, Eurostat
3	Fuel taxation	ASTRA Model (from various sources), Eurostat
3	Fuel prices	ASTRA Model (from various sources), Eurostat
3	Use of low emission fuels (biofuels, electric cars)	ASTRA Model (from various sources), Eurostat

For the ACEA agreement, there is currently detailed data available on emissions performance and numbers purchased of cars, reported by Member States. More refined data on the vehicle kilometres and CO₂ emissions from passenger cars, and data on improvements in energy efficiency of vehicles by type, would improve the analysis. Some of this data is required under the existing MM.

Table 6-2 Suggested data requirements for further refinement of the methodology

Tier	Data requirement	Data source
3	Number of kilometres by passenger cars,	MM Decision - Historic Indicators / UNFCCC, EU
	Mkm	Projections from ASTRA or TRANSTOOLS models
	(supplementary: split by diesel and petrol)	
3	CO ₂ emissions from passenger cars, kt	MM Decision - Historic Indicators / UNFCCC, EU
	(supplementary: split by diesel and petrol)	Projections from ASTRA or TRANSTOOLS models
3	Improvements in energy efficiency split by	MM Decision - Parameters for projections, European
	vehicle type (stock/new cars)	Automobile Manufacturers Association, EURO
	,	emissions standards and legislation

Data currently required in the existing MM highlighted in bold

6.2.5 CHP Directive

The simplified policy effectiveness indicator that underpins the Tier 1 methodology for the evaluation of the CHP Directive is the **electricity and heat production from CHP plant** relative to pre-Directive levels.

Table 6-3 Data used in our current analysis

	Tier	Data requirement	Data source
	1	CHP heat	Eurostat
	1	CHP electricity	Eurostat
ſ	1	(CHP) fuel	Eurostat

Current Eurostat CHP statistics do not split the total fuel use into CHP and non-CHP fuel. Making this refinement to the current statistics would improve the usefulness of the statistics. For example, the reporting of CHP fuel use in the statistics will eliminate the need to estimate the overall CHP efficiency. This will improve the robustness of the policy impact assessment. It is also recommended that data is reported for CHP fuel per fuel category which allows calculating the average CO₂ emission factor for the CHP fuel.

Table 6-4 Suggested data requirements for further refinement of the methodology

Tier	Data requirement	Data source
1	Total fuel split by CHP fuel and non-CHP fuel	Not currently available.
1	Electricity production split by fuel type (NG, coal, oil, RES, other)	Eurostat / MM Decision - Parameters for projections
1	Heat production split by fuel type	MM Decision - Parameters for projections
1	CHP electricity/heat production and fuel consumption by auto producers and public supply, split into high-efficiency and other CHP.	Not currently available.
1	Electricity and heat production and fuel consumption by high-efficiency CHP and non-high efficiency CHP per sector & technology	Not currently available.
2	CHP electricity/heat production by sector (large scale DH, small scale DH, refineries, chemical industry, paper, food, other industry, waste incineration, other)	Not currently available.
2	For each end use sector, production and input data split by CHP technologies (CC, ST, GT, ICE, other)	Not currently available.
2	New CHP capacity (number of installations and capacity)	Not currently available.
2	Assumptions on weather parameters, especially heating or cooling degree days	MM Decision - Parameters for projections
3	National coal, oil and gas energy prices per sector (including taxes) — suggested sectors are electricity and heat generation, industry, commercial, residential and transport. Constant prices should be quoted.	MM Decision - Parameters for projections
3	National electricity prices per sector as above	MM Decision - Parameters for projections

Data currently required in the existing MM highlighted in bold

The suggested data requirements can be considered as recommendations to improve Eurostat CHP statistics. Most of the data asked for is available at the national level (and sometimes even reported in the national statistics). Adding this level of detail would increase the possibility for a more thorough CHP policy analysis.

6.2.6 Biofuels Directive

The simplified policy effectiveness indicator that underpins the Tier 1 methodology for the evaluation of the Biofuels Directive is the **consumption of biofuels** relative to pre-Directive levels.

Table 6-5 Data used in our current analysis

Tier	Data requirement	Data source
1/2	Production biodiesel/bioethanol	Eurostat, EurObserv'ER Barometer
1	EU average emission rates biodiesel/bioethanol	IPCC, REFUEL project
2	MS average emission rates for the reference fuels Diesel/Gasoline	Concawe WTW Assessment
3	Life cycle emission factors based on MS feedstocks (net excl. LUC)	EU Commission (Energy/Climate Package December 2008)
3	Emission factors for separate electricity and heat production (co-generation uses)	CHP Directive
3	Imports/exports of biofuels	Eurostat, EurObserv'ER Barometer

The existing methodologies can be improved with additional data on the production and consumption of biodiesel and bioethanol, by feedstock type. Ideally, this data would also be provided for each individual Member State. In addition, further information of biofuel imports and exports split by feedstock and origin would also be useful, particular if data can be provided on the source country. Finally, more data (and more research generally) is required (and already initiated by the EU Commission) on the impacts of land use change.

Table 6-6 Suggested data requirements for further refinement of the methodology

Tier	Data requirement	Data source
2/3	Production biodiesel/bioethanol by feedstock	Not currently available
	type	
3	Imports/exports of biofuels by feedstock type and origin	Not currently available
3	Life cycle emission factors incl. LUC (net)	Forthcoming EU Commission Study

Data currently required in the existing MM highlighted in bold

The current MM requests data on biofuel consumption, but this is required at a more refined level for a robust assessment to be carried out. The MM could easily be modified to request data on biofuel production and/or biofuel exports, although it might be unwieldy to collect this for each of the feedstock types. Potentially, the MM could also be used to collect information to inform the analysis of land use change, but it is first necessary to work through the methodological and data collection issues in more detail, especially if the biofuels originate from countries with weak statistical systems.

6.2.7 Electricity production from renewable energy sources

The simplified policy effectiveness indicator that underpins the Tier 1 methodology for the evaluation of the RES-E Directive is the **renewable energy production** relative to pre-Directive levels. The key data used in the analysis is shown in the table below.

Table 6-7 Data used in our current analysis

Tier	Data requirement	Data source
1/2	Electricity generated by RES technology	Eurostat, MM Decision - Historic Indicators,
		EurObserv'ER Barometer
1/2	Electricity generation statistics	Eurostat
1	Emission factors power generation (European average)	Eurostat
2	Emission factors power generation (national average)	Eurostat
3	Emission factors power generation (hourly values to determine marginal emissions)	PowerACE (based on various sources) - Germany only. A reasonable approximation for EU countries may be the use of average national emission factors including fossil fuels only.

3	Most recent RES capacity figures *	EurObserv'ER Barometer; technology specific
		publications

Current data is available to enable an assessment of the impacts of the RES-E with a reasonable degree of accuracy. However, the data on installed capacities from official sources is not always the most recent (time lag of 2-3 years). In order to evaluate the actual generation technologies that will be replaced by the renewables generation information is required on short-term dispatching induced by RES-E. This requires short term (e.g. hourly or half hourly) generation data for each of the generation plants in each electricity supply market. In the future, as renewable energy sources become more competitive with conventional generation sources, it may be necessary to collect data on the levelised generation cost for these technologies, and the wholesale prices in the respective electricity markets, so that the impacts of policy-induced investments in renewables can be isolated from investment that would have happened anyway. In practice, some crude simplifying assumptions could be applied - as has been the case for large scale hydro in the current analysis or the approximation of hourly emission rates with average fossil fuel emission rates.

Table 6-8 Suggested data requirements for further refinement of the methodology

Tier	Data requirement	Data source
1/2/3	Levelised cost of renewable technologies	Technology specific publications/models/field studies on the performance of the technologies
3	National whole sale electricity prices	MM Decision - Parameters for projections

Data currently required in the existing MM highlighted in bold

6.2.8 EU Emissions trading scheme

The simplified policy effectiveness indicator that underpins the Tier 1 methodology for the evaluation of the EU ETS Directive is the **CO₂** or **GHG** emissions per unit of value added relative to pre-Directive levels. The key data used in the analysis is shown in the table below.

Table 6-9 Data used in our current analysis

Tier	Data requirement	Data source
1	GHG emissions from industry and power sector	National GHG Inventories
1	Value added of manufacturing industry and energy industry	Eurostat; Odyssee Database
2	GHG emissions from industry by branch and power sector	Eurostat; Odyssee Database for industry
2	Value added of manufacturing industry and energy industry by branch	Eurostat; Odyssee Database
3	Emissions for each installation in the EU ETS	Community Independent Transaction Log CITL
3	Physical production of products under ETS	Eurostat (Prodcom, production index); national statistics; Statistics from branch associations
3	Benchmarking curves from the industrial sector	Those curves are presently collected under the revised EU ETS Directive but it is unclear at present how and whether they will be public. They will further only be available EU-wide, i.e. they could contribute to the EU-wide evaluation but a breakdown by country will not be available. They have not been used in the present methodology but may make substantial contributions to improve the methodology.
3	Electricity production on an hourly basis by type of fuel	PowerAce Model (detailed database on power sector sector including renewables; currently only for Germany).
3	Renewables production on hourly basis	PowerAce Model (various sources)
3	Allowance prices	PowerAce Model (various sources)

Data required for the evaluation at Tier 1/2 level are available from GHG inventories and the Odyssee database and also at national level. Data requirements for the Tier 3 approach implies the use of a database on the dispatching of power plants and, for the evaluation of long-term effects of the ETS on investment decisions. Those data are presently only available for Germany but need to be collected EU-wide (but are mainly available from private sources).

Table 6-10 Suggested data requirements for further refinement of the methodology

Tier	Data requirement	Data source
1/2	CO ₂ emissions from industry, kt	MM Decision - Historic Indicators
	(supplementary: by branch)	
1/2	Gross value-added total industry, Euro	MM Decision - Historic Indicators
	(EC95)	
	(supplementary: by branch)	
1/2	CO ₂ emissions from public and autoproducer	MM Decision - Historic Indicators
	thermal power stations, kt	
1/2	CO ₂ emissions from public and autoproducer	MM Decision - Indicators for projections
	thermal power stations, kt	
1/2	Total gross electricity generation by fuel type	MM Decision - Parameters for projections
3	Benchmarking curves from the industrial	Those curves are presently collected under the revised
	sector	EU ETS Directive but it is unclear at present how and
		whether they will be public.

Data currently required in the existing MM highlighted in bold

The Odyssee project will investigate through further research in how far a Tier 2 approach based on a break-down by industrial sector is feasible. This approach will be focussed on energy savings. It is suggested before establishing further data requirements to link with this effort. Concerning the Tier 3 approach is seems difficult to define data that the MS could easily deliver. However, the benchmarking curves as currently collected under the revised EU ETS could contribute to improve the evaluation. They will, however, at best only be available EU-wide, i.e. they could contribute to the EU-wide evaluation but a breakdown by country will not be available.

6.2.9 Integrated pollution prevention and control

The simplified policy effectiveness indicator that underpins the Tier 1 methodology for the evaluation of the EU ETS Directive is the **emission rate per unit industrial production** relative to pre-Directive levels. The key data used in the analysis is shown in the table below.

Table 6-11 Data used in our current analysis

Tie	Data requirement	Data source
1	Categories 1A1, 1A2, 2 emissions and 1A1 and 1A2 fuel consumption data	UNFCCC
1	Industrial Production Index (Volume index of production)	Eurostat

The methodology developed and applied for the ex-post evaluation of the IPPC Directive is a Tier 1 methodology. The data requirements are outlined in the table above. Application of the Tier 1 methodology indicates that a much more detailed methodology is required to determine the impact of the IPPC Directive. A more detailed Tier 2 or 3 methodologies was not developed for the IPPC Directive. However, this report highlights a number of methodological issues that would need to be addressed and the table below suggests a range of possible supporting data.

Table 6-12 Suggested data requirements for further refinement of the methodology

Tier	Data requirement	Data source
3	CO ₂ emissions from the industry sector, kt	MM Decision - Historic Indicators / UNFCCC
3	Total final energy consumption from industry, PJ	MM Decision - Historic Indicators / UNFCCC
3	CO ₂ emissions from public and autoproducer thermal power stations, kt	MM Decision - Indicators for projections
3	All products –output by public and autoproducer thermal power stations, PJ	MM Decision - Indicators for projections
3	Total CO ₂ emissions from iron and steel, kt	MM Decision - Historic Indicators
3	Production of oxygen steel, kt	MM Decision - Historic Indicators

3	Gross value-added - iron and steel industry, Bio Euro (EC95)	MM Decision - Historic Indicators
3	Energy related CO ₂ emissions chemical industries, kt	MM Decision - Historic Indicators
3	Gross value-added chemical industry, Bio Euro (EC95)	MM Decision - Historic Indicators
3	Energy related CO ₂ emissions glass, pottery and building materials, kt	MM Decision - Historic Indicators
3	Gross value-added - glass, pottery and buildings materials industry, Bio Euro (EC95)	MM Decision - Historic Indicators
3	Cement production, kt	MM Decision - Historic Indicators
3	Energy related CO ₂ emissions food industries, kt	MM Decision - Historic Indicators
3	Gross value-added – food, drink and tobacco industry, Bio Euro (EC95)	MM Decision - Historic Indicators
3	Energy related CO ₂ emissions paper and printing, kt	MM Decision - Historic Indicators
3	Physical output of paper, kt	MM Decision - Historic Indicators
3	Gross value-added – paper and printing industry, Bio Euro (EC95)	MM Decision - Historic Indicators
3	Annual GHG emissions and associated activity data are required for each IPPC activity type (see 2008/1/EC Annex I).	Not currently available.

Data currently required in the existing MM highlighted in bold

Emissions inventory data includes emissions from installations not covered in the scope of the IPPC Directive or under the threshold capacity or exempt due to EU ETS requirements. Annual emissions and production data or emission factors for each industry covered by the Directive are required. Data from the E-PRTR (European Pollutant Release and Transfer Register) database will be available for 2007, but only for installations where both capacity threshold and thresholds for each gas as indicated in the E-PRTR Regulation (annex 1 and 2) are exceeded. This means that data may not be complete or comparable across years. In addition, some activities not covered by the IPPC Directive are covered by the E-PRTR Regulation ("new activities").

Consideration should also be given to the usefulness of collecting detailed data sets for the purposes of evaluating the GHG impact of IPPC given that the policy is not directly aimed at reducing GHG emissions and since other policies such as EU ETS are directly addressing GHG emissions from similar sources. In addition, even if industry level GHG emission and activity data were to become available in future, methodological issues (such as overlaps with pre-IPPC permitting policies and uncertainty over which factors – commercial or policy – drive emissions) would likely remain, meaning that a policy impact assessment may still be unsatisfactory.

Given that significant efforts would be required to collect installation specific emissions and activity data for all of the industries covered by IPPC permits, collection of annual emissions and production data or emission factors for each industry covered by IPPC permits is recommended. Industry specific GVA may also be used as a substitute for production data. Alternatively a bottom up approach could be used to estimate the impacts of individual abatement technologies.

The MM currently requests relevant data for a number of IPPC permitted industries. Data is however requested at an aggregate level and will therefore include subsectors exempt from IPPC. In addition, some IPPC permitted industries are not included e.g. industries in the mineral sector. In addition, GVA and production data is requested in some cases, but not others e.g. chemical and food industries.

Qualitative information will be required to interpret the extent to which data patterns are driven by the IPPC Directive or extraneous factors. This information will include details of MS implementation experience and will identify key factors that have driven production methods and patterns in individual industries. More detailed knowledge is also required of the history of MS permitting including dates and phasing of implementation, the stringency of conditions imposed in permits and the response of installations.

6.2.10 F-gas regulation

Since the Regulation only entered into force in 2006, and since necessary databases are not yet available a policy impact cannot be determined yet.

Data availability represents a critical factor for the implementation of a robust evaluation methodology. This will require Member States to compile a database that archives all information demanded by the regulation such as the quantity and type of fluorinated greenhouse installed, any quantities added and the quantities recovered during servicing, maintenance and final disposal as well as all information required through Article 6 (Reporting) of the regulation.

Table 6-13 Suggested data requirements for further refinement of the methodology

Tier	Data requirement	Data source
1	Basic aggregated activity data at sector level	UNFCCC NIR
1	Default emission factors (for emission factor	2006 IPCC Guidelines for National Greenhouse
	approach)	Gas Inventories
1	Equipment sales data (for mass-balance approach)	Equipment manufacturers, National associations,
		etc.
2	Disaggregated activity data at the sub-application level	For the refrigeration and air conditioning sector:
		system logbooks according to article 3 F-Gas
		regulation
		For the foam sector: Reported sales and
		production data to the Member States
		For Aerosols/MDI: Annual sales data reported to
		Member States
		For solvents: Sales data reported to Member
		States
		For SF6 from electrical equipment: The amount of SF6 filled in electrical equipment is needed and
		shall be reported by the industry
2	Default emission factors (for emission factor	2006 IPCC Guidelines for National Greenhouse
_	approach)	Gas Inventories
3	Activity data and equipment lifetime per sub-	Not currently reported
	application	The carretty repende
3	Emissions factors per sub-application during	
	operation, at servicing and at end-of-life	
3	Consideration of the increased emissions arising	
	through Montreal policies	
3	Tier 3 requires a close cooperation between policy	
	makers, industry and relevant associations, especially	
	for the collection of all relevant data that is needed	

Data currently required in the existing MM highlighted in bold

6.2.11 Energy performance of buildings

The simplified policy effectiveness indicator that underpins the Tier 1 methodology for the evaluation of the EPB Directive is the **energy consumption for space heating per household** relative to pre-Directive levels. The key data used in the analysis is shown in the table below.

Table 6-14 Data used in our current analysis

Tier	Data requirement	Data source
1	Stock of permanently occupied dwellings	Eurostat; Odyssee Database; MM Decision - Historic Indicators
1	Number of employees in service sector	Eurostat; Odyssee Database
1	Energy consumption of households for heating per fuel	Eurostat; Odyssee Database
1	Energy consumption of services for heating per fuel	Eurostat; Odyssee Database
1	Share of electricity for heating in households and services	Eurostat; Odyssee Database
1	Heating/Cooling degree days (actual and long term average)	Eurostat; Odyssee Database; MM Decision - Parameters for projections

1	Emission factors power generation/district heating (European average)	Eurostat;
2	Square metres of permanently occupied dwellings	Odyssee Database; MM Decision - Historic Indicators
2	Square metres of service sector buildings	Odyssee Database; MM Decision - Historic Indicators
2	Emission factors power generation (national average)	Eurostat;
3	Data on building stocks and technical characteristics of existing, new and refurbished buildings.	MURE model (from various sources)
3	Non-compliance with building regulation explicitly modelled	MURE model (based on estimates)
3	Fuel-specific emission factors	IPPC; MURE model (from various sources)

A more refined bottom up analysis to assess the EPBD impact requires a variety of data not directly available from public statistics. Critical data are the refurbishment status of the buildings, and their corresponding specific energy consumption, the heating and cooling energy efficiency status and trends and, again, the compliance factors for existing and new buildings.

Table 6-15 Suggested data requirements for further refinement of the methodology

Tier	Data requirement	Data source
3	Emission factors power generation (hourly values)	PowerACE (based on various sources). A reasonable approximation for EU countries may be the use of average national emission factors including fossil fuels only.
3	Non-compliance with building regulation explicitly modelled	MURE model (based on estimates). An improvement could come from sampling.
1/2/3	CO ₂ emissions from fossil fuel consumption households, kt	MM Decision: Priority historic indicators
1/2/3	CO ₂ emissions from space heating in commercial and institutional, kt	MM Decision: Priority historic indicators
1/2/3	CO ₂ emissions from space heating in households, kt	MM Decision: Priority historic indicators
1	Electricity consumption of households	MM Decision: Indicators for projections
1	Rate of improvement of energy efficiency	MM Decision: Priority historic indicators

Data currently required in the existing MM highlighted in bold

Certain data is already requested under the MM Decision, which is relevant to the current methodology but not identical. For example, data is requested on CO_2 emissions from energy consumption, whereas in the current methodology primary energy consumption is used. The use of CO_2 emissions data is potentially simpler and ensures consistency with national inventories and emission factors, but it is less transparent than working in energy terms and reporting energy savings is also relevant for other reporting mechanisms, e.g. on energy efficiency targets. Going forward, it will be important that as a minimum emissions associated with electricity generation are reported separately to those from other energy sources since the Effort Sharing Decision requires the emissions to be reported separately.

6.2.12 Energy labelling of household appliances

The simplified policy effectiveness indicator that underpins the Tier 1 methodology for the evaluation of the Labeling of household appliances Directive is the **electricity consumption per household** relative to pre-Directive levels. The key data used in the analysis is shown in the table below.

Table 6-16 Data used in our current analysis

Tier	Data requirement	Data source
1	Stock of permanently occupied dwellings	Eurostat; Odyssee Database
1	Electricity consumption of households	Eurostat; Odyssee Database
1	Emission factors power generation (European average)	Eurostat;
2	Appliance ownership	Odyssee Database
2	Specific electricity consumption per appliance	Odyssee Database, CECED databases (not available

		from public statistics)
2	Emission factors power generation (national average)	Eurostat;
3	Sales data and data on split by efficiency class by appliance	Special studies for the labelling directive based on data by GfK (not available from public statistics)
3	Emission factors power generation (hourly values)	PowerACE (based on various sources). A reasonable approximation for EU countries may be the use of average national emission factors including fossil fuels only.

The assessment provided using the current methodology is robust but a more refined (Tier 3) analysis requires the provision of data from market surveys (like those carried out by GfK) or other private databases like those from the association CECED. Those data have to be bought or arrangements have to be found with the private associations.

Table 6-17 Suggested data requirements for further refinement of the methodology

Tier	Data requirement	Data source
1	Stock of permanently occupied dwellings	MM Decision - Priority historic indicators
1	Stock of permanently occupied dwellings	MM Decision - Indicators for projections
1	Electricity consumption of households	MM Decision - Indicators for projections
1	Rate of improvement of energy efficiency	MM Decision - Parameters for projections
2	Appliance ownership	MM Decision - Priority historic indicators
3	Sales data and data on split by efficiency class by appliance	MM Decision - Historical data (source market surveys) and projections. Such data are generally not available with the MS unless they have bought the data from private sources.
2	Specific electricity consumption per appliance	MM Decision - Historical data, source CECED databases (not available from public statistics). For a variety of major appliances collected in the Odyssee database.

Data currently required in the existing MM highlighted in bold

The main drawback in the analysis of the Appliance Labelling Directive is that such the split by efficiency class and by country is not available before the implementing directives started to be effective. It is important to collect such type of information for the products envisaged under the Ecodesign Directive which sets minimum standards for a large number of product groups. Information as far as available may presently be collected in the initial studies for each product group.

6.2.13 Landfill Directive

The simplified policy effectiveness indicator that underpins the Tier 1 methodology for the evaluation of the Landfill Directive is the **mass of biodegradable waste disposed to landfill** relative to pre-Directive levels. The key data used in the analysis is shown in the table below.

Table 6-18 Data used in our current analysis

Tier	Data requirement	Data source
1	Methane correction factor	IPCC, 2006, Guidelines for National Greenhouse Gas
		Inventories
1	Fraction of decomposable degradable organic	IPCC, 2006, Guidelines for National Greenhouse Gas
	matter (DDOC)	Inventories
1	Fraction of CH4 in landfill gas	IPCC, 2006, Guidelines for National Greenhouse Gas
		Inventories
1	Decay rate constants	IPCC, 2006, Guidelines for National Greenhouse Gas
		Inventories
1	Waste composition default values	IPCC, 2006, Guidelines for National Greenhouse Gas
		Inventories
1/2	Degradable organic carbon fraction of waste	IPCC, 2006, Guidelines for National Greenhouse Gas
		Inventories
1/2	Municipal solid waste going to landfills, kt	Eurostat / MM - Indicators for projections
1/2	Population	Eurostat / MM - parameters for projections
2	Emission factors for incineration and recycling	EEA, 2008, Municipal waste management and
		greenhouse gases

2	Emission factors for biological processing	IPCC, 2006, Guidelines for National Greenhouse Gas
		Inventories
2	Landfill gas recovery rates	UNFCCC, CRF tables

The Tier 1 and Tier 2 methodologies utilise Eurostat data on the mass of MSW disposed of to landfill. This source was chosen to align best with the Commission's definition of landfill sites under the Landfill Directive. Emissions factors and modelling assumptions drew heavily upon IPCC Guidelines for National GHG Inventories. Further refinements introduced as part of the Tier 2 methodology utilised emissions factors for incineration and recycling of MSW from the European Environment Agency's 2008 report on municipal waste management and greenhouse gases. Emissions from the biological treatment were calculated using default emission factors from the IPCC 2006 report on solid waste management.

Further improvements to the methodology would take into account more refined data on the MSW. The definition of MSW varies between MS. To inform the evaluation of the impact of the Landfill Directive, reporting on the sources of waste would be useful. Further understanding is also required on reported recovery rates of landfill gas from landfill sites. Some MS report near or complete recovery. However, the recent IPCC guidance takes issue with this level of recovery and recommends that for reporting an upper limit of 20% is used. For the current assessment the reported recovery rates are used, however, this should be reviewed for any further assessment.

Table 6-19 Suggested data requirements for further refinement of the methodology

Tier	Data requirement	Data source
	The organic fraction (DOC) of municipal solid	IPCC, 2006, Guidelines for National Greenhouse Gas
	waste	Inventories: default waste composition; degradable
		organic carbon fraction of waste. EEA, 2008, Municipal
		waste management and greenhouse gases: MS specific
		waste composition. / MM - Parameters for projections
	Municipal solid waste disposed incinerated	Eurostat. EEA, 2008, Municipal waste management and
		greenhouse gases / /MM - Parameters for projections
	Municipal solid waste disposed composted	MM - Parameters for projections
	CH ₄ emissions from landfills, kt	MM Decision - Indicators for projections
	Municipal solid waste going to landfills, kt	MM Decision - Indicators for projections
	Municipal solid waste disposed to landfills	MM Decision - Parameters for projections
	Municipal solid waste disposed incinerated	MM Decision - Parameters for projections
	Landfill gas recovery rates	UNFCCC, CRF tables

Data currently required in the existing MM highlighted in bold

6.2.14 Waste incineration Directive

The simplified policy effectiveness indicator that underpins the Tier 1 methodology for the evaluation of the EU ETS Directive is the **relative energy recovery rate per unit mass of MSW incinerated** relative to pre-Directive levels. The key data used in the analysis is shown in the table below.

Table 6-20 Data used in our current analysis

Tier	Data requirement	Data source
1	Solid fuel input to thermal power stations	Eurostat
1	Oil input to thermal power stations	Eurostat
1	Gas input to thermal power stations.	Eurostat
1	Heat and electricity generated from MSW incineration	Confederation of European Waste-to-Energy Plants (CEWEP) country profiles
1	Emission factors for coal, oil and gas combustion	IPCC, 2006, Guidelines for National Greenhouse Gas Inventories
2	n/a: Same data sources used as in Tier 1, except MS specific values used where possible	

Emissions from public thermal power stations to heat or electricity have been assigned according to the ratio of energy produced in each form. The analysis would benefit from improved data on the mass

of municipal solid waste that is incinerated, together with data on the economic conditions drving incineration activity e.g. energy prices.

Table 6-21 Suggested data requirements for further refinement of the methodology

Tier	Data requirement	Data source
	CO ₂ emissions from public and autoproducer thermal power stations, kt	UNFCCC, CRF tables / MM Indicators for projections
	Output by public and autoproducer thermal power stations, PJ	Eurostat / MM Indicators for projections
	Municipal solid waste disposed incinerated	Eurostat / MM Parameters for projections

6.2.15 Nitrates Directive

The simplified policy effectiveness indicator that underpins the Tier 1 methodology for the evaluation of the Nitrates Directive is the **emission rate of N_2O from soils per unit area of agricultural land** relative to pre-Directive levels. The key data used in the analysis is shown in the table below.

Table 6-22 Data used in our current analysis

Tier	Data requirement	Data source
1/2	Total area of agricultural land	FAO
1/2	Total emissions from agricultural soils (CRF category: 4D1.1, 4D1.2, 4D2 and 4D3.2.)	UNFCCC
2	Date of implementation of policy within	European Commission
	each Member State	

More refined statistical data is available that could potentially be used, to help isolate the influence of structural changes. For example, by examining trends in land use and crop type, and using EU or Member State average data on fertiliser application rates by land use/crop type, it may be able to isolate the influence of these changes in the underlying activity from the overall trend in emissions. Ideally, the assessment would be carried out using consistent emission factors as those used for the compilation of the emissions inventory, taking into account national circumstances and variations in application rates by land use type.

A Tier 3 approach could also consider market factors on the behaviour of farmers. Consideration of these economic factors would require a more detailed modelling of the relationships (elasticities) between agricultural inputs and outputs and the associated price of the factors of production. This is likely to require an econometric approach.

Certain data is already requested under the monitoring mechanisms - parameters for projection, which could be potentially utilised to improve the evaluation methodology.

Table 6-23 Suggested data requirements for further refinement of the methodology

Tier	Data requirement	Data source
3	N ₂ O emissions from synthetic fertiliser and	UNFCCC -CRF tables / MM Decision Indicators for
	manure use, kt	projections
3	Use of synthetic fertiliser and manure, kt	UNFCCC -CRF tables and activity data / MM Decision
	•	Indicators for projections
3	The area of crops by crop type	MM Decision - Parameters for projections
3	Fertiliser Used (Synthetic & Manure)	UNFCCC -CRF tables and activity data / Parameters for
		projections
3	Fertiliser use & Crops (tonne by crop type)	Parameters for projections
3	Agricultural trade (import/export)	MM Decision - Parameters for projections
3	Development of area of crops, grassland,	MM Decision - Parameters for projections
	arable, set-aside, conversion to forests etc	
3	Macroeconomic assumptions behind	MM Decision - Parameters for projections
	projections of agricultural activity	. ,
3	Development of farming types (e.g.	MM Decision - Parameters for projections
	intensive conventional, organic farming)	
3	Parameters of fertiliser regime:	MM Decision - Parameters for projections

3	Details of fertiliser use (type of fertiliser, timing of application, inorganic/organic ratio);	MM Decision - Parameters for projections
3	Volatilisation rate of ammonia, following spreading of manure on the soil;	MM Decision - Parameters for projections
3	Efficiency of manure use.	MM Decision - Parameters for projections
3	Parameters of manure management system:	MM Decision - Parameters for projections
3	Distribution of storage facilities (e.g. with or without cover):	MM Decision - Parameters for projections
3	Nitrogen excretion rate of manures	MM Decision - Parameters for projections
3	Methods of application of manure	MM Decision - Parameters for projections
3	Extent of introduction of control measures (storage systems, manure application), use of best available techniques	MM Decision - Parameters for projections
3	Parameters related to nitrous oxide emissions from agricultural soils (e.g., Nitrogen leaching fraction, emission factor for direct emissions, Nitrogen content in crop residues)	MM Decision - Parameters for projections
3	Amount of manure treatment	MM Decision - Parameters for projections

Data currently required in the existing MM highlighted in bold

6.2.16 Common Agricultural Policy reform

The simplified policy effectiveness indicator that underpins the Tier 1 methodology for the evaluation of the CAP reform is the **number of animals** relative to pre-Directive levels. The key data used in the analysis is shown in the table below.

Table 6-24 Data used in our current analysis

	Tier	Data requirement	Data source
I	1/2	Total number of sheep/cattle	UNFCCC -CRF tables and associated activity data
I	1/2	Total emissions from sheep/cattle	UNFCCC -CRF tables and activity data
	1/2	Date of implementation of policy within each Member State	European Commission

The (Tier 1 and Tier2) methodologies are based upon a simplified approach using data reported by MS to the UNFCCC. The methodologies are therefore limited in their ability to accurately represent the policy impacts. A more refined approach capturing, in particular, how the CAP reform interacts with the market for agricultural commodities, and in turn how this influence production, would enable a robust assessment of the impacts. This would utilise statistics on the changes in the structure of livestock enterprises both prior to and following the CAP reform, the impact of market conditions (e.g. price of farm inputs, and farm commodities) and the relationship between the key market parameters and production. This requires detailed economic data for each of the farm enterprises.

Table 6-25 Suggested data requirements for further refinement of the methodology

Tier	Data requirement	Data source
3	Disaggregated data on animal numbers and the associated emissions	Member States GHG Inventories
3	Data on emission calculation methodologies used in national inventories, including emission factors	Member States GHG Inventories
3	Data on farm management practices	Some national surveys e.g. fertliser usage
3	Economic data on agricultural commodities	FAO/Eurostat
3	Data on other relevant parameters e.g. animal disease	Not clear
3	Agricultural trade (import/export)	MM Decision - Parameters for projections
3	Domestic consumption (e.g. milk/beef consumption)	MM Decision - Parameters for projections
3	Development of area of crops, grassland,	MM Decision - Parameters for projections

	arable, set-aside, conversion to forests etc	<u> </u>
3	Macroeconomic assumptions behind projections of agricultural activity	MM Decision - Parameters for projections
3	Description of livestock (e.g. by input/nutrient balance, output/animal production, milk production quota/productivity of cattle)	MM Decision - Parameters for projections
3	Development of farming types (e.g. intensive conventional, organic farming)	MM Decision - Parameters for projections
3	Distribution of housing/grazing systems and housing/grazing period	MM Decision - Parameters for projections
3	Parameters of fertiliser regime:	MM Decision - Parameters for projections
3	Details of fertiliser use (type of fertiliser, timing of application, inorganic/organic ratio);	MM Decision - Parameters for projections
3	Volatilisation rate of ammonia, following spreading of manure on the soil;	MM Decision - Parameters for projections
3	Efficiency of manure use.	MM Decision - Parameters for projections
3	Parameters of manure management system:	MM Decision - Parameters for projections
3	Distribution of storage facilities (e.g. with or without cover):	MM Decision - Parameters for projections
3	Nitrogen excretion rate of manures	MM Decision - Parameters for projections
3	Methods of application of manure	MM Decision - Parameters for projections
3	Extent of introduction of control measures (storage systems, manure application), use of best available techniques	MM Decision - Parameters for projections
3	Parameters related to nitrous oxide emissions from agricultural soils (e.g., Nitrogen leaching fraction, emission factor for direct emissions, Nitrogen content in crop residues)	MM Decision - Parameters for projections
3	Amount of manure treatment	MM Decision - Parameters for projections

The current MM data sets provide relevant data for the Tier 1/2 approach, e.g., on animal numbers and associated emissions. However, as described, a more granular data set would ideally be required to better understand the change in emissions from the sector and the influence of the regulations. However, this in turn relates to the methodologies used by individual Member States to generate their inventories. In general, where more advanced methodologies are employed by MS, then this more refined data can be used to enable a more robust evaluation. However, it is unlikely to be available for most MS, so would restrict the scale of the analysis. Other key economic data is also required in order to assess the interactions of market forces. The current MM includes a number of these parameters for projections, which could also be relevant for evaluation.

6.3 Developing experience and capacity

Aside from the revised MM Decision, we recommend that the European Commission supports Member States to develop national systems for policy monitoring and evaluation. This support could be provided in the context of the EC Climate Change Committee working group on "Implementation of the Effort Sharing Decision, policies and measures and projections". Specific activities may include providing guidance, tools and fora, e.g.:

 Further develop the guidelines and evaluation tools developed under this study (see Methodologies Report).

This study has shown that MS experience and capacity in ex-post evaluation is variable and, in many cases, limited. Further work is therefore required to refine and develop evaluation methodologies for key policies.

In the short term, Member States should also be encouraged to use the guidance developed during this project to inform their ex-post evaluations, except where the Member States have developed a more advanced approach. Member States should also be encouraged to re-appraise ex-ante scenarios to ensure that policies are re-appraised in light of actual developments.

Guidance for ex-post evaluation should be developed and refined as methodologies are tested and improved. The guidance documents produced under this study provide a useful starting point. Any guidance document should be treated as a working document and refined following user experience and feedback. Working groups may be required to ensure latest knowledge is shared and reflected in the guidance.

Further work is required to refine and develop both generic policy evaluation guidance and guidance for key EU level policies. Such guidance should inform EC and MS level evaluation of national and EU level policies.

- Develop simple spreadsheet tools to facilitate the development of experience and best practise sharing in ex-post evaluation.
- Co-ordinate research to address gaps in knowledge and/or data. For example, the impacts of indirect land use change associated with biofuels.
- Co-ordinate with statistical agencies and private sector organisations to obtain data required for evaluations. Through a common approach the cost of the data collection could be significantly reduced. For example, it may be possible for the EU to acquire private data sets for use by MS.

EU agencies such as Eurostat or the EEA, may have a role to play to collect monitoring data to facilitate evaluation. However, in a variety of cases it may be efficient to consider cooperation with private actors that collect data anyhow for other purposes, e.g., for market research. Key benefits of this approach are:

- data is collected and available centrally
- multiple reporting of data is avoided (a situation which could occur if data monitoring requirements are defined on a policy by policy basis)
- Co-ordinate activities to evaluate large and complex EU wide policies, including the EU
 Emissions Trading Scheme and the regulations of the Common Agricultural Policy. A
 collaborative approach, making use of MS knowledge, implementation experience and data is
 recommended.

The EEA may have a role to play to assist with regular policy appraisal, monitoring, reappraisal and evaluation activities.

6.4 Future activities

As discussed above, the introduction of any legal requirement for Member States to report the ex-post impacts of climate change mitigation policies and measures will need to be supported by additional capacity raising activities. This relates to both capacity in performing ex-post evaluations, but also capacity in terms of the provision of the data required to inform the evaluations.

In terms of raising capacity in performing ex-post evaluations, further work is required to refine and develop both generic policy evaluation guidance and guidance for key EU level policies as methodologies are tested and improved. Such guidance should inform EC and MS level evaluation activities. The European Commission should therefore support Member States to develop national systems for policy monitoring and evaluation. This support could be provided in the context of the EC Climate Change Committee working group on "Implementation of the Effort Sharing Decision, policies and measures and projections". This support may include:

- Agreement of a harmonised set of methodological assumptions and parameters.
- Development of simple spreadsheet tools to facilitate the development of experience and sharing of best practise in ex-post evaluation.

- Co-ordinating research to address gaps in knowledge and/or data. For example, the impacts of indirect land use change associated with biofuels.
- Co-ordinating common data collection including with both statistical agencies and private sector organisation. Through a common approach the cost of the data collection could be significantly reduced. This may be the case with policies such as the appliance labelling directive where comprehensive private data collection exists for market research purposes.
- Co-ordinating activities to evaluate large and complex EU wide policies, including the EU
 Emissions Trading Scheme and the regulations of the Common Agricultural Policy.

Further activities with respect to data have been outlined in the previous sections and are not repeated here. However, it is worth restating the importance of giving due consideration to what data is required in order to assess the policy impact, as early in the process as possible, so that systems and mechanisms can be put in place to ensure the availability of data for future evaluations. The Commission has a role in stipulating these requirements as part of its development of new legislation.

Further work is required on the development of harmonised methodologies to quantify the economic costs of the climate change policies and measures. The Commission can play a role in driving forward work in this area. This may involve the following activities:

- identify a lead organisation to promote the systematic collection of economic data for use during the formulation and review of environmental policies.
- develop an open-access database of ex-post studies for sharing methodologies and cost estimates.
- evaluate the value of further guidance on ex-post cost assessments and on the application of the findings of such assessments. This could complement the guidance developed in this study.
- Consult more fully with stakeholders on the potential methods.

The immediate priority for further work should be the further testing and refinement of the methodologies within Member States. This may include the development of a spreadsheet tool that can be used by Member States for reporting evaluation results. This work could also be used to stimulate discussion on, and agreement of, key methodological decisions, such as how to account for national policies. The outputs could therefore be an agreed template, including a set of harmonised values, for use in reporting.

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Appendices

Appendix I Detailed policy methodology and results chapters

Appendix la Voluntary agreement with car manufacturers

Appendix 1b Biofuels Directive

Appendix Ic Electricity production from renewable energy

sources

Appendix Id Promotion of cogeneration

Appendix le EU Emissions trading scheme

Appendix If Integrated pollution prevention and control

Appendix Ig F-gas regulation

Appendix Ih Energy performance of buildings

Appendix Ii Energy labelling of household appliances

Appendix Ij Landfill Directive

Appendix Ik Waste incineration Directive

Appendix II Nitrates Directive

Appendix Im Common Agricultural Policy reform

See separate report.

Appendix II Summary of the results of the decomposition analysis performed using the PRIMES model

See separate report.



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