INCLUSION OF ADDITIONAL ACTIVITIES AND GASES INTO THE EU-EMISSIONS TRADING SCHEME

Report under the project
"Review of EU Emissions Trading Scheme"

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Ecofys

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TABLE OF CONTENTS

ACKNOWLEDGEMENTS

This paper builds upon earlier work conducted by Ecofys in different projects. First, it builds upon an earlier paper on expansion of activities and gases written in the scope of the same project. Second, it integrates work on the interpretation of combustion installations conducted as ad-hoc support to the Commission in the same project. Moreover, it uses results obtained by Ecofys UK and AEA Technology Environment under the LETS UPDATE Project, conducted for the Environment Agency (UK), Umweltbundesamt (Austria), the Danish Environmental Protection Agency, DEHSt (German Emissions Trading Authority) and APAT (Italy).

1 INTRODUCTION

The EU Emissions Trading Scheme (EU ETS) was launched in January 2005. It is the largest cap-and-trade scheme in the world and the core instrument for Kyoto compliance in the EU. This first environmental market established in the EU involves thousands of operators who have obligations for limiting the carbon dioxide emissions from their plants. In an average week more than 10 million allowances are traded, resulting in a market worth several billion Euro already in the first year of operation.

Article 30 of the Directive implementing the EU ETS requires the Commission to review the application of the EU Emissions Trading Scheme and report to the European Parliament and to the Council. The report may be accompanied by proposals for amendments to the scheme.

The European Commission's DG Environment appointed McKinsey & Company and Ecofys to support it in developing the review. Amongst other things, they were asked to develop an understanding of the impact of the scheme on the competitive position of participants and to analyse possibilities for the design of the scheme after the second trading period.

Their work deals with a number of the issues listed in Article 30 as ones that should be addressed in the Commission's report, as well as other relevant issues. Each report discusses approaches taken in the first phase and important lessons learnt. The analyses focus on the post-2012 design. For each design element, future options are investigated. This involves discussion of the advantages and disadvantages of design options, harmonization opportunities, and impact on competitiveness.

The work conducted in the period June 2005–July 2006 consists of a web survey to consult stakeholders on their views on the EU ETS, as well as extensive topical analyses.

This report reflects the views of McKinsey & Company and of Ecofys and does not constitute official views or policy of the European Commission.

Other reports delivered in the scope of this work are available at http://ec.europa.eu/environment/climat/emission/review_EN.htm.

Currently, the European emissions trading system (ETS) only covers CO_2 emissions from a limited set of activities, as laid out in Annex I of the Directive. According to the most recent analysis between 46% and 51%[1] of total greenhouse gas emissions in the EU-25 are covered by the ETS. Article 24 of the Directive does allow for the unilateral inclusion ('opt-in') of other activities and gases as from 2008.

Article 30 of the Directive on "Review and further development" requires the Commission to draw up a report exploring whether inclusion of further activities or gases in Annex I of the Directive could enhance the cost-efficiency of the EU-ETS. Three activities emitting CO_2 are directly referred to in the Directive: the chemical industry, the aluminium industry and the transport sectors. Other activities emitting CH_4, N_2O or the fluorinated gases are discussed as potential candidates for future inclusion.

Besides an inclusion of new activities and gases via an amended Annex I of the Directive there are discussions on the interpretation of combustion installation in the current form of Annex I. At present, Member States apply differing interpretations of the category combustion installation, leading to a differing installation coverage.

This paper discusses the consistent inclusion of activities in the EU-ETS as well as the potential for an addition of new activities and gases. This is done by analysing the differences between the different interpretations of the combustion installation as well be assessing the suitability for full inclusion of all installations covered under the broader interpretation. Because of the present difficulties connected to a consistent interpretation of combustion installations to be included in the EU-ETS, this analysis provides proposals for improved definitions.

In addition, a two step assessment of potential activities for inclusion is carried out. Emissions of CO_2 as well as of non-CO_2 greenhouse gases are covered. The assessment is based on criteria of relevance, monitorability, costs and availability of reduction options.

[1] 46% represents the average cap/yr compared to current (2002) emissions (UNFCCC website).
51% represents the average cap/yr compared to average BAU emissions in 2005-2007 (Ecofys NAP evaluation draft, 2005)

2 Interpretation of "Combustion Installations"

2.1 Background

The current interpretation of the term combustion as introduced by the European Commission is based on how a combustion installations is characterised by the Large Combustion Plants Directive (LCP-Directive). In the LCP-Directive "*combustion plant"* is defined as "*any technical apparatus in which fuels are oxidised in order to use the heat thus generated*" (Article 1(7)).

The LCP directive further in article 1(7) states that it is to apply to "*combustion plants designed for production of energy with the exception of those which make direct use of the products of combustion in manufacturing processes*" and names a number of installations not falling under the definition (e.g. regeneration of catalytic cracking catalysts, direct process heating in general).

The European Commission has stressed at several occasions that such exceptions are not made in the EU-ETS Directive and therefore also installations supplying direct process heat are included under the EU-ETS. This interpretation is generally addressed as the "broad interpretation" which has been described in the NAP evaluation report[2] by Ecofys as follows:

"*All combustion installations that produce electricity, heat or steam, even if their main purpose is not energy production, but e.g. the production of ethylene or ammonia (e.g. naphtha crackers or ammonia plants).*"

In the preparation of the NAPs, Member States have interpreted the term "combustion installation" differently. Besides the broad interpretation, two further interpretations ("medium" and "small") were used:

- Medium interpretation: *All combustion installations that produce electricity, heat or steam, with the purpose of energy production, including those that are process-integrated, e.g. a steam plant integrated in e.g. chemical industry is included, but process furnaces such as crackers in the petrochemical industry are excluded.*
- Narrow interpretation: *Only combustion installations that produce electricity, heat or steam and supply that to third parties.*

These interpretations can be based on Article 1(7) of the LCP depending on the interpretation of "products of combustion".

[2] A. Gilbert, J-W. Bode, D. Phylipsen; M. Voogt; Analysis of the national allocation plans for the EU Emissions Trading Scheme; on behalf of the Departments of Trade and Industry (DTI) and Environment, Food and Rural Affairs (DEFRA)

At present no Member State consistently applies the narrow interpretation. This is due to the fact that the Commission required the countries applying the narrow interpretation (Italy, France, Spain) in their NAPs to adopt the medium interpretation. Most MS currently apply different versions of the medium interpretation, only few the broad one (e.g. The Netherlands, Belgium (Wallonia), Ireland).

Comparing medium and broad interpretation, the medium interpretation includes all installations combusting fuel, regardless whether the energy is supplied to third parties or is used in a production process. Looking at production processes, only installations providing energy to a production process through an intermediate, e.g. hot oil, steam, hot air, water, are included (indirect process heating), installations providing energy directly to a production process, are not (direct heating). The broad interpretation in contrast covers both direct and indirect process heating.

In Member States applying the medium interpretation, installations with direct process heating may obtain a competitive advantage compared to comparable installations in Member States that use the broad interpretation. Looking at emissions on a technical level, there is no reason for a differentiation between indirect and direct process heating. In both cases, emissions from fuel combustion occur. Using the broad interpretation of combustion installation leads to the inclusion of a larger share of emissions in the EU ETS.

The use of a harmonized definition within the EU-ETS scheme could bring an end to the considerable differences regarding emissions and installations covered in the various Member States. Direct process heating could be explicitly included via Annex I, albeit requiring a change of the EU-ETS directive. At the same time it can be argued that they are implicitly included via the broad interpretation.

2.2 Emission Pattern under the Broad Interpretation

A list of those types installations covered by the broad and exceeding the medium interpretation was developed by Ecofys. Under the project "Review of the EU-Emissions trading scheme" an inquiry was sent to Member States by the Commission, asking which of the listed installations were included and which not. The inquiry was answered by 15 Member States, with nine Member States sending installation lists. Accordingly, three Member States apply a broad interpretation (The Netherlands, Ireland, Belgium – Walloon Region) and twelve apply the medium one. The answers given by Finland suggest that a narrow rather than a medium interpretation is used. An overview table is included in Annex I of this paper.

The Member States' answers regarding the list of installation showed that even for countries which state to apply the medium interpretation, there are considerable differences regarding the inclusion of specific types of installations, e.g. for paint drying in the automobile industry and units of integrated steelworks not yet included like rolling mills, re-heaters, annealing furnaces, pickling. Many more examples exist. Several member states expressed their preference for a medium interpretation or highlighted potential negative effects of the broad interpretation (UK, Germany, Spain).

Table 1 gives an overview of the most common magnitude of emission level for the various installations. It shows that the majority of installations are smaller installations with less than 25,000 t CO_2 p.a.. During the review process for the EU-Monitoring and Reporting Guidelines, a number of stakeholders as well as Member States have called for reduced requirements for smaller installations, due to the disproportionally high costs they have to bear for participation in the scheme. Several approaches for defining "small installation" have been discussed. A separate paper ("Small emission sources in the EU ETS") under this project discusses this matter in greater detail.

Considering only types of installations which are generally above 25,000 t CO_2 p.a., the following types remain (shaded grey in Table 1):

- In building materials: gypsum board/plaster drying, mineral fibres/mineral wool, glass – annealing, heating, drying;
- In the chemical industry: Ethylene plants (LPG/naphtha/fuel oil crackers), aromates furnace (BTX furnace), steam reformers (production of ammonia, methanol, hydrogen, synthesis gas), partial oxidation of fuel oil for production of ammonia, salt production: evaporation, drying and refining, titanium oxide furnace, carbon anode furnaces, blast furnace for phosphorus production, soda ash production: lime kilns, carbon black installations;
- In metal production: smelting furnace, secondary aluminium furnace;
- Flaring (offshore).

Table 1 Activities left out in the medium interpretation and their annual emissions. Activities generally above 25,000 tons of CO_2 per year are shaded in grey[3]

Classes	Definitely Low	Usually Low	Could be Either	Usually High	Definite-ly High
Emission Range	<10 $ktCO_2$	<10 $ktCO_2$	>10 $ktCO_2$	>25 $ktCO_2$	>25 $ktCO_2$
AUTOMOBILE					
– Foundry furnace			X		
– Paint drying for bottom layer		X			
– Paint drying for the top layer		X			
– Post combustion (incl. Steam boilers)			X		
– Engine test-bench	X				
BREWERIES					
– Malt kilns			X		
– Wort boiling			X		
- Optional on-site combustion process: brewers grain drier		X			
BUILDING MATERIALS					
– Gypsum drying			X		
– Gypsum board/plaster board drying				X	
– Mineral fibres/mineral wool				X	
– Glass: heating, annealing, dryers				X	
CHEMICALS					
– Ethylene plants (LPG/naphtha/fuel oil crackers)					X
– Aromates furnace (BTX furnace)					X
- Steam reformers (production of ammonia, methanol, hydrogen, synthesis gas)					X
- Partial oxidation of fuel oil for production of ammonia					X
– Salt production: evaporation, drying and refining					X
– Titanium oxide furnace					X
– Carbon anode furnaces					X
– Blast furnace for phosphorus production					X
– Soda ash production: lime kilns				X	
– Carbon black installations					X
DAIRY					
– Pasteurizing		X			
– Spray drying (creameries)			X		

[3] This table was developed by Ecofys under the project "Review of the EU Emissions Trading Scheme".

Classes	Definitely Low	Usually Low	Could be Either	Usually High	Definite-ly High
Emission Range	**<10 $ktCO_2$**	**<10 $ktCO_2$**	**>10 $ktCO_2$**	**>25 $ktCO_2$**	**>25 $ktCO_2$**
– Whey powder, milk powder drying			X		
METALS (ferrous metal processing and non-ferrous metals)					
– Reheating and heat treatment furnaces			X		
- Ferrous metals: foundries, casting, smelting furnaces			X		
– Smitheries		X			
- Integrated steelworks: rolling mills, re-heaters, annealing furnaces, pickling					X
– Smelting furnaces (primary copper, zinc, lead)					X
– Secondary aluminium furnace				X	
– Casting			X		
– Galvanising			X		
OTHER METAL PROCESSING AND METAL-BASED EQUIPMENT PRODUCTION					
– Casting		X			
– Paint drying		X			
SUGAR					
– Evaporator	X				
– Boiling station	X				
– Optional on-site combustion process: lime kiln			X		
TEXTILE					
– Fabric drying			X		
– Stock drying			X		
TIMBER					
– Saw milling: kiln drying			X		
– Saw milling – incinerator (burning residues off-site)	?				
– Particle board production: flake drying		X			
– Particle board production: hot presses					
- Medium density fiber board production – plugging and heating					
- Veneer and plywood production – log steaming and/or soaking					
– Veneer and plywood production – veneer drying					
OTHER SECTORS					
– Compressor stations (transport of natural gas)			X		
– Flaring (in the off-shore industry)				X	
GENERAL OR SEVERAL SECTORS CONCERNED –					
– Steam boilers and turbines (CHP)				X	

Classes	**Definitely Low**	**Usually Low**	**Could be Either**	**Usually High**	**Definite-ly High**
Emission Range	**<10 $ktCO_2$**	**<10 $ktCO_2$**	**>10 $ktCO_2$**	**>25 $ktCO_2$**	**>25 $ktCO_2$**
– Hot water or heat transfer oil boilers			**X**		
– Boilers for heating purposes			**X**		
– Emergency power generators		**X**			
– Auxiliary boilers/secondary equipment		**X**			
– Post combustion installations			**X**		
– Evaporators			**X**		
– Dryers (e.g. grass, animal feed, fertiliser)			**X**		
– Roasting (coffee beans, cocoa beans, nuts, seeds)		**X**			
– Pasteurizers (food production)		**X**			
– Cooking vessels and fryers in the food industry		**X**			

Generally the application of the broad interpretation would imply the inclusion of a large number of additional smaller installations. There would be cases in which this could enhance the competitiveness where at present an installation with indirect process heating is included, while another installation producing the same product but applying direct process heating is not.

On the other hand, the consistent application of the medium interpretation would lead to the exclusion of a number of installations already part the EUETS. Emission sources with fuel combustion in the form of direct process heating would remain excluded.

2.3 Pragmatic definitions of combustion installation

Short but still pragmatic definitions of the broad and medium interpretations could be as follows:

- Medium interpretation: *All installations combusting fuel to produce electricity, heat or steam, including those that are process-integrated and supply production processes with energy via an energy transfer medium (e.g. air, water, steam, oil). Combustion installations directly supplying production processes with energy (e.g. by radiation or heat conduction) without using an energy transfer medium are not included.*
- Broad interpretation*: All installations combusting fuel are included, irrespective of the purpose of fuel combustion. This means that both energy production for third parties, as well as the supply of energy for a production process with and without using an energy transfer medium are included.*

Regardless of which interpretation of Annex I and the term combustion installation is applied, the pattern of installation sizes as shown in table 1 suggests that only a selective inclusion of installation types improves the cost-effectiveness of the scheme based on direct compliance costs independent of the size of the installations.

3 SECTORAL ASSESSMENT

3.1 Assessment Criteria

The EU-ETS is an instrument aiming to achieve emission reductions at low costs. The inclusion of additional activities thus has to maintain the environmental effectiveness as well as cost-effectiveness of the scheme. These issues are closely interlinked.

Environmental effectiveness of an EU-ETS scheme relates to the amount of emissions covered by the scheme as well as to the fact that it is ensured that an allowance will always correspond to one ton of CO_2 equivalents of emissions in the greenhouse gas inventory of one of the Member States. This implies that emission relevant data can be monitored with low uncertainty and enforcement of monitoring requirements is possible.

At the same time, inclusion of sectors can only enhance cost-effectiveness for the overall scheme, if technical reduction potentials exist and can be accessed at a reasonable price by proven abatement options. Besides the costs for compliance, transaction costs occur, i.e. the costs for participation in the scheme occur for the installations. At the same time costs for administration occur at the national competent authorities. The cost-effectiveness of the scheme is among other things affected by the number and size of installations of a sector. As costs for data collection and verification are not proportional to the emissions of an installation, small participants have to bear disproportionally high costs. A large number of small participants thus means high relative costs for monitoring and verification on the side of operators and absolute high costs on the side of the competent authorities, while potentially only adding little reduction potential to the scheme. Similar problems apply for sectors having a very low contribution to total GHG-emissions in the EU-ETS, where the additional costs for inclusion could outweigh the benefits of available reduction potentials.

Furthermore, competitiveness is an issue. If competing sectors are not consistently included into or excluded from the scheme, distortions of competition can be expected. A detailed consideration of competitiveness issues is necessary for the individual sectors, given that competition can occur on several levels, e.g. on a regional level, for products traded on the global market between installations inside and outside the EU-borders, but also on a sectoral level, for competing materials or products, with one sector included, but the other not (e.g. glass wool production (included) and stone-wool production (not included))

The specific assessment criteria and respective indicators are detailed in the following.

Monitorability

In order to ensure that the environmental integrity of the scheme is maintained, a low uncertainty of the emission levels has to be achieved. At the same time costs for monitoring need to be limited to a reasonable level.

For the assessed sectors the achievable levels of uncertainty are shown. In the MRG, generally levels of uncertainty with less than 7.5% are required. Exemptions include flares, where 12.5% is allowed, and certain process emissions in the mineral industry. By analogy, uncertainties for the monitoring of new activities are categorized as low (<10%) medium (10% < x < 20%) and high (>20%.).
As a very basic requirement, emission data must be available at reasonable cost. This can be a problem with fugitive emissions, diffuse emission sources or irregular processes which are not continuously measured. This also includes that an installation – and thus what has to be measured - can be clearly defined

The following indicators were used:

- Achievable uncertainty in monitoring (environmental integrity)
- Feasibility of data collection
- Feasibility to define clear installation boundaries

Enforcement

For enforcement, it is important that an operator, who can be held responsible for the emissions, exist. The latter might be a problem where emissions stem from products but cannot be controlled by the user, as the emissions are a functional part of the product. Verification is the main element of enforcement. For verification, raw data, to which the emission data can be tracked back, are required as well as further data for cross-checking (e.g. from previous years or from additional production data which has not been used for emission determination).

The following indicators were thus used: Achievable uncertainty in monitoring (environmental integrity)

- Feasibility to define an operator responsible for the installation (cost-effectiveness)
- Feasibility of verification (environmental integrity, cost-effectiveness)

The following ranking was used for the indicators emission determination, definition of installation boundaries, defining an operator and verification:

++ Feasible at low cost
+ Feasible at reasonable cost
0 Feasible but requires some effort

- Difficult and costly
-- Feasible only at high costs

Relevance

In order to determine the relevance of sectors, their share in total non-CO_2-GHGs (for non CO_2-gases) in the EU-25 in 2003 and in total CO_2-GHGs for CO_2 respectively together with the emission trend were considered. Sectors with less than 0.5% and no upwards trend, were in most cases considered not relevant. In certain cases, where sectors had very favourable characteristics, e.g. regarding monitorability and enforcement, the criterion of relevance was given some flexibility.

The following indicators were used:

- Emissions relative to total EU-25 Emissions in 2003
- Emissions relative to non-CO_2-GHG in EU-25 in 2003
- Emission trend 2010-2020

Transaction costs

As a detailed cost assessment was not possible in the scope of this working paper, sectors were assigned to three categories: low, medium and high. The assessment of costs was based on the following considerations:

- Upfront and recurring costs exist which are not proportional to the installation size, i.e. smaller installations have to bear disproportionately higher costs . This applies to obtaining a basic understanding of the legal framework, applying for a greenhouse gas emissions permit, developing and implementing a monitoring plan, installing and operating reporting software, verification and finding market access.
- The more complex an installation is, the more effort is required in the preparation of the monitoring plan, the monitoring itself and the verification.
- Where sophisticated process control measures are required (e.g. in processes of the chemical industry) and several process parameters are already measured (i.e. amount and composition of input material, composition of exhaust air and product) emission data might be already available or might be made available with less effort. Existing knowledge on data collection and accuracy is also considered to be higher.

The following indicators were used:

- Installation size and number
- Complexity of production process
- Existing process control measures

Availability and costs of emission reduction options

This gives an indication on the cost-effectiveness of reaching emission reductions in the scheme, i.e. the effects of including a sector on the overall reduction price in the scheme. The following indicators were used:

- Reduction potential
- Reduction options
- Cost specifics

Costs compared to other instruments

An indication is given, whether other environmental instruments aiming at GHG reduction would be more cost effective than the EU-ETS for a specific sector. Generally, this requires are very detailed cost assessment, including detailed reduction options and costs as well as transaction costs, which depend very much on the specific design of an instrument. Therefore only a very general indication can be given. The instruments taken into consideration and their main advantages regarding cost-effectiveness are briefly described in the following:

- Integrated Pollution Prevention and Control (IPPC): Can be of advantage when there is no extensive choice regarding technical reduction options
- Voluntary commitments: Of advantage when the sector is highly self-organized and availability of emission reductions is medium-high. Voluntary commitments are generally considered to work better with a small to medium number of participants, as this facilitates a high level of self-organization
- Taxes: Compared to EU-ETS generally not in advantage as transaction costs for monitoring and enforcement also occur, but the flexibility regarding reduction costs does not exist.
- Incentive schemes: Of advantage where little knowledge about reduction options exist, e.g. in small installations with low capacity regarding technical staff, but reduction potential is available at low costs.

It has to be kept in mind that results regarding emission reductions cannot be compared, as emissions trading schemes allow for a concrete reduction targets, while reductions can only be estimated for other instruments. For this working paper, instruments are compared to the EU-ETS regarding costs if they seem appropriate to access the existing reduction potential. Instruments which are not considered as appropriate are marked as "not suitable".

Competitiveness:

Competitiveness issues are addressed on a general level in this working paper, i.e. whether significant competition with non-EU-sectors generally existed and should be further addressed or whether competing sectors were already included in the EU-ETS, with the inclusion of candidate sectors potentially enhancing competition.

The following indicator was used:

- Existence of competition situations with non-EU-producers or with activities already included in the EU-ETS

3.2 Assessment procedure

The first selection of sectors to be generally considered, was carried out as follows:

- For CO_2 sectors were chosen from the three-digit ISIC-Code and the UK-Report on CO_2-sources. Sources with various levels of aggregation were chosen with regard to their homogeneity for the criteria to be addressed and specific issues of interest, e.g. sectors not included clearly competing with included sectors (e.g. stone wool)
- For non-CO_2-GHGs main contributing sources were selected.

Sectors have been considered in two assessment steps. In the first step the criteria relevance, monitorability and enforcement were considered.
In the second step, the selected sectors were assessed regarding reduction costs, transaction costs, competitiveness issues, coverage by other schemes also addressing reduction of GHGs. Furthermore, costs for addressing the sectors via the EU-ETS and other environmental instruments are compared.

3.3 Assessment Step I - CO_2-Sectors

The following sectors were addressed:

- Offshore / onshore oil and gas flaring
- Foundries, rolling and other activities in the production of ferrous metals not covered by Annex I
- Primary aluminium production
- Gypsum production
- Stone wool production
- Fertilisers and ammonia production
- Petrochemicals
- Other chemicals
- Food/Drink products
- Textiles and leather
- Wood product
- Plastic rubber products
- Agricultural sector
- Residential sector
- Commercial sector
- Waste incineration
- Road transport
- Railways
- Navigation

Generally, for the CO_2-sectors chosen both installation boundaries and operators can be clearly identified.
Due to the specifically large number of medium to small installations in the subsequent ferrous metals processing were not taken forward to the second assessment step. Inclusion of such activities at least for installations located at integrated steel plants has advantages as it provides increased cost-effectiveness for these plants as a whole. Most secondary manufacturing industries (except food/drink) were not included, due to the very large amount of small emitters and low emission shares. The agriculture, residential and commercial sectors show problems with data collection and verification due to the large number of small emitters.
Road transport accounts for 21% of total EU-25 emissions in 2003, with considerable increases for the various sub-sectors expected between 2010-2020, e.g. 19% for trucks. Emissions occur during use, but potential for emission reduction is not only on the side of car producers, i.e. through using hybrid motors, increased efficiency, fuel-cells, etc. but also on the side of the user, by driving less and more efficiently. The sector has a very large number of small emitters considerably varying in size, making monitorability low and costs high: data on the amount of gas combusted could of course be provided by the car holder, but verification and administration of such a large number of emitters seems virtually impossible. Approaching car manufacturers would be a way to reduce the number of players, but at the same time monitorability would be even lower, as emissions could only be estimated with high uncertainty. The sector is thus not considered for the second assessment step.

The railway sector shows a considerable downwards trend and is thus also not considered for the next assessment step. Navigation is not taken forward due to the large number of small emitters and problems of assigning emissions in case of international navigation.

Sectoral data is shown in Table 2 below, sectors taken forward to the next assessment step are marked yellow.

Table 2 Characteristics of CO_2-Sectors (Assessment Step I)[4]

Sector	Source	% of gas emissions in 2003 EU25 1.Combustion emissions, 2. process emissions	Trend, EU25 ST-Short term, LT - Long term	Uncertainty in emissions	Number & size of emitters	Installation boundaries	Data collection	Identification of operator	Verification
Fuel Production	Offshore oil & gas - flaring	0.1%	Stabilisation in the ST;	MH	average number / large emitters	**+**	**0**	**+**	**0**
	Onshore oil & gas - flaring		Possible decrease in the LT	MH	average number / large emitters	**+**	**0**	**+**	**0**
Ferrous Metals	Foundries, rolling and others not covered in Phase I	1.1%	Stabilisation	L	large number / small to average emitters	0	0	+	0
Non-Ferrous Metals	Primary Aluminium	0.2%	Stabilisation in the ST; possible decrease in LT	L	small number / average emitters	**+**	**+**	**+**	**+**
	Other	0.3 & 0.1%	Stabilisation in the ST; possible decrease in LT	L	small number / average emitters				
Non-Metallic Minerals	Gypsum	n.d & < 0.15% 2/	Stable emission level	L	small number / small emitters	**+**	**+**	**+**	**+**

[4] Colums 1 and 3-6 taken from the LETS UPDATE Report, column 2 based on information in the LETS UPDATE Report

Sector	Source	% of gas emissions in 2003 EU25 1.Combustion emissions 2. process emissions	Trend, EU25 ST- Short term, LT - Long term	Uncertainty in emissions	Number & size of emitters	Installation boundaries	Data collection	Identification of operator	Verification
	Rock Wool			L	small number / average emitters	**+**	**+**	**+**	**+**
Chemicals	Fertilisers & ammonia	0.2 & 0.4%	Slightly increasing trend in the ST & LT	L	small number / large emitters	**+**	**+**	**+**	**+**
	Petrochemicals	0.9 & 0.0%		MH	small number / large emitters	**0**	**+**	**+**	**+**
	Other Chemicals	0.9 & 0.0%		M	large number / small to large emitters	**0**	**+**	**+**	**+**
Secondary manufacturing industries including	Food/Drink products	1.5 & 0.0%	Slightly increasing the ST trend and stabilisation in the LT	L	large number / small to medium emitters	**0**	**-**	**+**	**0**
	Textiles & leather	0.4%	Slightly increasing trend	L	large number / small emitters	0	-	+	0
	Wood products	0.10%	Slightly increasing trend	L	large number / small emitters	0	-	+	0
	Plastic/rubber products	n.av.	Slightly increasing trend	L	large number / small emitters	0	-	+	0

Sector	Source	% of gas emissions in 2003 EU25	Trend, EU25 ST- Short term, LT - Long term	Uncertainty in emissions	Number & size of emitters	Installation boundaries	Data collection	Identification of operator	Verification
	Transport equipment Machinery	transp eq: 0.3% machinery: 0.7%	Slightly increasing trend	L	large number / small to medium emitters	0	-	+	0
Agriculture	Food production (combustion of fuels)	1.5 & 0.5%	Slightly increasing trend	ML	very large number / small emitters	0	-	+	0
Residential	Space heating/Warm water, Cooking,	11.9%	Decreasing the LT trend	ML	very large number / small emitters	-	--	+	--
Commercial	Space heating/Warm water	4.4%	Increasing trend	L	very large number / small emitters	-	--	+	--
Waste incineration	Combustion processes	0.1%	Stable trend	MH	average number / average emitters	**+**	**+**	**+**	**+**
Transport									
Road Transport		21.1%	Trucks 19%, Private cars -2%, Motorcycles 6%, Buses -4%	M	Very large number of small emitters for all subsectors	0	--	0	--
Railways		0.2%	-82%	L		0	-	+	-
Navigation		0.5%	14%	11%	Large number of small emitters.	+	-	+	-

3.4 Assessment Step I - Non-CO_2 GHG

At present non-CO_2-GHGs make up for around 18% of total GHG-emissions in the EU-25. Figure 1 shows the percentage shares of the individual non-CO_2-GHGs for the EU-25 in 2003. CH_4 and N_2O clearly dominate with 92% of total emissions.

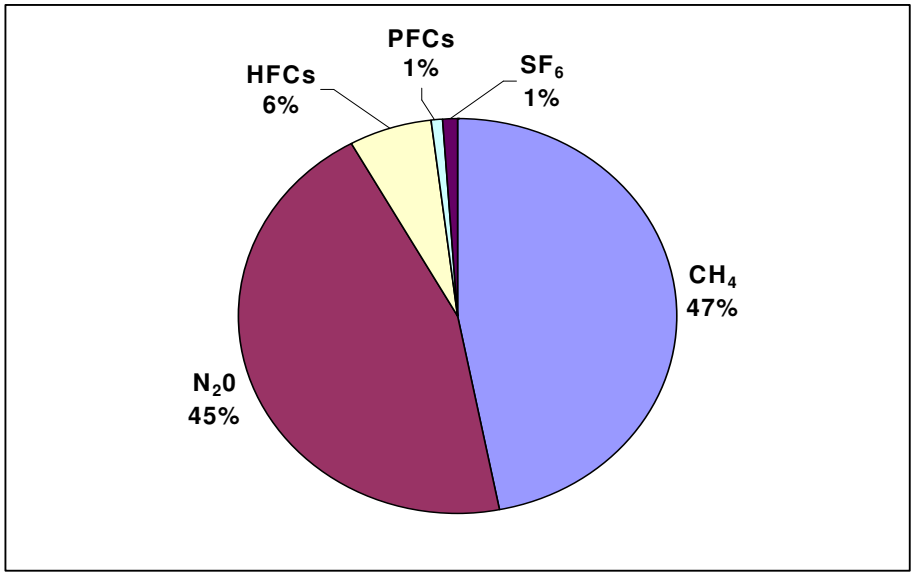

Figure 1 Percentage shares of single non-CO_2 –GHGs to total non-CO_2-GHG emissions

Altogether 32 sectors were assessed. In the following the five non-CO_2 greenhouse gases with their major sources of emission are briefly described and the reasons for not considering specific sources for the second assessment step, are given.

Methane - Emitting Sources

Methane results from fermentation, e.g. in agricultural activities (cattle), waste disposal, but also in trace amounts from certain combustion processes. Eight processes leading to methane emissions were assessed:

- Enteric fermentation from cattle, sheep, etc.
- Landfill sites
- Transport fuel combustion
- Manure management
- Emissions from natural gas distribution
- Emissions from coal mining
- Wastewater handling (domestic/commercial)
- Stationary fuel combustion

Enteric fermentation, manure management and, fuel combustion from energy use and transport have low monitorability and enforcement as emissions are diffuse and a large number of small emitters exist. Landfill sites are above the relevance threshold and have a considerable share of methane emissions (23%), but show a clear downward trend in emissions. Monitorability is low, mainly due to the high uncertainty in emission determination. Natural gas distribution shows problems in the definition of installation as well as an operator, as the distribution network is interlinked across MS and between companies. Furthermore the uncertainty in emission determination is estimated to be around 50%. The sector is thus not taken forward to the next assessment step, but remains a candidate for later stages of the review because of its significant contribution to non-CO_2-GHG emissions. The achievable uncertainty should be checked again at a later point in time. N_2O emissions from waste-water handling are also excluded because of severe problems in respect to the monitorability of emissions. Only coal mining is going to be assessed further.

Sectoral data is shown in **Table 3** below, sectors taken forward to the next assessment step are marked yellow.

Table 3 Characteristics of selected CH_4-emitting sectors[5]

	Source	% of non CO2 GHG in EU-25 in 2003	Trend, EU25 (annual % change 2010 to 2020)	Uncertainty in emissions	Number & size of emitters	Installation boundaries	Data collection	Identification of Operator	Verification
CH4									
	Enteric fermentation from cattle, sheep etc.	16.89%	0.3%	high	High number of emitters, size of installation (farm) varies significantly	--	--	0	--
	Waste disposal on land - Landfill sites.	11.01%	-1.9%	Usually high. Uncertainty nearer +/-10% for MS with good quality data e.g. NL.	Medium number of large emitters	0	-	-+	--
	Manure management, agricultural.	7.48%	0.7%	High	High number of emitters, size of installation (farm) varies significantly	0	-	-+	--
	Fugitive emissions from coal mining. Deep underground mines and some open cast mines.	3.72%	-1.4	medium	Small number of large emitters. Only relevant for some member states.	0	0	+	-
	Fugitive emissions from natural gas. Predominantly leakage of gas from distribution system	3.43%	1.2%	Generally high, for individual source sectors could be medium to low	1000's of km of pipework for each MS natural gas distribution network. Often one organisation per MS responsible for network.	0	0	-	0

* Colums 2 and 4-6 taken from the LETS UPDATE Report, column 2 based on information in the LETS UPDATE Report

	Source	% of non CO2 GHG in EU-25 in 2003	Trend, EU25 (annual % change 2010 to 2020)	Uncertainty in emissions	Number & size of emitters	Installation boundaries	Data collection	Identification of Operator	
	Fuel combustion from energy use. Released in trace amounts when fuels combusted	1.60%	0.0%	High	Very large number of small emitters.	-	0	+	-
	Domestic and commercial wastewater handling	1.55%	Likely to increase	High	Large number of installations of varying size.	0	0	+	0
	Transport fuel combustion. Released in trace amounts when fuels combusted (road, aviation, rail, navigation).	0.33%	1.4%	High	Diverse sources. Mobile emitters, low concentrations.	0	-	--	--

N_2O - Emitting Sources

N_2O results from agricultural activities (fertilising of soils, manure management) but also from certain combustion processes. Eight processes leading to N_2O emissions were assessed:

- Emissions from agricultural soils (fertilizers)
- Fuel combustion in transport
- Production of adipic and nitric acid
- Agricultural manure management
- Fuel combustion – Energy industries
- Fuel combustion – other sectors
- Waste-water handling (domestic/commercial)
- Fuel Combustion – Manufacturing industries and construction

Agricultural soils and manure management show a low monitorability due to their high uncertainty in emission determination. All fuel combustion activities also have low monitorability and enforcement due to their large numbers of small emitters and have low relevance for the most part. Waste-water handling also shows a low monitorability as emissions from the various sources (digester, lagoon, reactor, etc) varying also in size can be monitored and verified only with difficulty due to a lack of data and high uncertainty.
Only the production of adipic and nitric acid shows a high monitorability, enforcement and relevance and is considered for the next assessment step.

Sectoral data is shown in **Table 4** below, sectors taken forward to the next assessment step are marked yellow.

Table 4 Characteristics of selected N_2O emitting sectors[6]

	Source	% of non CO2 GHG in EU-25 in 2003	Trend, EU25 (annual % change 2010 to 2020)	Uncertainty in emissions	Number & size of emitters	Installation boundaries	Data collection	Identification of Operator	Verification
N2O									
Agricultural Soils	Application of mineral nitrogenous fertilisers and organic fertilisers (manures).	26.04%	-0.5%	High	Large number of emitters (farms) of widely varying size.	--	--	+	--
Transport	Fuel combustion in road vehicles, rail, air, and ship.	3.10%	-1.1%	High	Large and diverse number of small emitters.	0	-	--	--
*Industrial Processes - Chemical Industry	adipic and nitric acid manufacture (69% from nitric acid production and 28% from adipic acid production).	6.12%	0.1%	Low	Small no. of point sources (major adipic acid manufacturers already installed abatement equipment).	+	+	+	+
Manure Management	Agricultural manure management	3.46%	-0.7%	High	Large number of sources of widely varying size	0	-	+	--
Fuel Combustion - Energy Industries	Fuel combustion in power stations and other large energy supply facilities.	2.11%	-0.3%	Low to medium	Small to medium number of point sources.	+	+	+	+
Fuel Combustion - Other Sectors	Fuel combustion in domestic, and tertiary sectors.	1.30%	?	Low to medium	Very large number of emitters, many very small.	-	-	+	-
Waste-water Handling	Domestic and commercial waste water treatment	1.21%	?	High	Diverse sources. Emissions at digester, lagoon, reactor and direct release to sea.	0	0	+	0
Fuel Combustion - Manufacturing Industries and Construction		0.90%	?	Low to medium	Large number of emitters.	0	0	0	0

[6] Columns 2 and 4-6 taken from the LETS UPDATE Report, column 2 based on information in the LETS UPDATE Report.

HFC – Emitting Sources

HFCs are in most cases man-made and are mostly used in production processes or as functional part of the product (e.g. as cooling agent in refrigeration and air conditioning or as aerosols in sprays). Only in specific cases as in the production of HCFC-22 HFC by-product emissions occur.

- Refrigeration and air conditioning
- Aerosols/Metered Dose Inhalers
- Foam blowing
- HCFC-22 production
- Fire extinguishers
- Production of Halocarbons

Refrigeration and air conditioning has a share of 60% in HFC emission, but only of 3.6% in total non-CO_2-emissions. Installation sizes vary considerably depending on the field of application. Experiences from national reporting show that due to the structure of the sector, data collection for national reporting is very onerous and still shows considerable uncertainty. While monitoring can be done quite easily by the staff responsible for maintenance as the amount of refrigerant to be refilled is considered to equal the emissions, verification would be tedious and extremely costly due to the large number of (partly very small) installations.
In the case of aerosols and metered dose inhalers HFCs occur both during production and during product use, with the major share being emitted during use. While a reasonable number of production sites exist, enforcement would be confronted with an extensive number of very small products to be controlled.
With emissions being part of the functionality of the product, identification of operators needs some thought. In foam blowing HFCs are used as blowing agents. A relatively small share of emissions occurs during production, a larger share during the lifetime, the most part at the end of life. Again, a small number of production sites exist, but for the end-of-life phase definition of an installation with a responsible operator allowing to track the product at the end of life seems extremely difficult. Monitorability and enforcement are thus rated low. The same applies in the case of fire extinguishers. Emission occur mainly from leakage and during use in case of fire. Besides the large number of applications, use is of course unexpected and irregular, making monitorability and enforcement very difficult. Production of halocarbons is only practiced by one country with a strong downward trend. Its relevance is thus considered to be low.
Only the production of HCFC-22 is considered for the next assessment step.

Sectoral data is shown in **Table 5** below, sectors taken forward to the next assessment step are marked yellow.

Table 5 Characteristics of selected HFC emitting sectors[7]

	Source	% of non CO2 GHG in EU-25 in 2003	Trend, EU25 (yr % change 2010 to 2020)	Uncertainty in emissions	Number & size of emitters	Installation boundaries	Data collection	Identification of operator	Verification
HFC						+	+		+
*Consumption - Refrigeration and Air Conditioning Equipment (including mobile sources which account for about 60% of total)	Predominantly from leakage from systems during operation and servicing.	3.64%	1.3%	Low to medium	Large number of diverse sources	-	--	-	--
Consumption - Aerosols/ Metered Dose Inhalers	Almost all released at point of use. Mostly from aerosols.	0.67%	Aerosols 3.7% MDI 3.7%	Aerosols: High MDI: Low	Very large number of small aerosols.	--	--	--	--
*Consumption - Foam Blowing	Some emissions during manufacture. Will rise as use of HCFCs now banned. End of product life will trigger the most emissions.	0.47%	10.9%	High	Small number of foam blowing sites - e.g. ten sites in UK.	+	+	0	+
*Production of HCFC-22	Production of HCFC-22	1.08%	-5.5%	Low	Small number of point sources.	+	+	+	+
Consumption - Fire Extinguishers	Emissions due to leakage (during servicing) and on use of systems. Leakage rates being reduced on a voluntary basis.	0.21%	1.8%	Low	1000's of F-gas fire protection systems per MS. Small number of manufacturers.	--	--	--	--
Production of Halocarbons - Other (please specify)	Netherlands is the only emitter.	0.01%	-5.5%	Low	Small number of point sources.	0	0	+	0

[7] Colums 2 and 4-6 taken from the LETS UPDATE Report, column 2 based on information in the LETS UPDATE Report.

PFC-Emitting Sources

PFC is also manmade and mainly used in production processes, e.g. for etching and cleaning. In some cases also used as functional part of product, e.g. in refrigeration and air conditioning equipment and in fire extinguishers.

- Aluminium production
- Semiconductor manufacture
- Refrigeration and air conditioning equipment
- Production of halocarbons (fugitive emissions, by-product emissions)
- Use as detergent
- Fire-extinguishers

For PFCs in refrigeration and air conditioning equipment the same as for HFCs applies: monitorability as well as enforcement is rated low due to the large number of installations varying strongly in size. HFC emissions from production of halocarbons have low relevance, due to their low share in EU-25 emissions and a considerable downwards trend between 2010-2020. PFC used as detergent also shows low relevance. For fire extinguishers the same applies as in the case of these applications using HFCs. Only aluminium production and semiconductor manufacture are taken forward to the second assessment step.

Sectoral data is shown in Table 6 below, sectors taken forward to the next assessment step are marked yellow.

Table 6 Characteristics of selected PFC emitting sectors[8]

	Source	% of non CO2 GHG in EU-25 in 2003	Trend, EU25 (%/yr change 2010 to 2020)	Uncertainty in emissions	Number & size of emitters	Installation boundaries	Data collection	Identifi-cation of operator	Verifi-cation
PFC									
*Aluminium Production	Released when normal operating conditions are disturbed. Reduced significantly during 1990s due to installation of new technology.	0.45%	-0.7%	Low uncertainty	Small number of point sources.	+	+	+	+
*Consumption - Semiconductor Manufacture	Used in semiconductor industry for chamber cleaning.	0.14%	4.5%	Low uncertainty	Small number of point sources.	+	+	+	+
Consumption - Other (no spec allocation)		0.04%	?			-	--	0	--
Consumption - Refrigeration and Air Conditioning Equipment	Predominantly from leakage from systems. Large sources are supermarket systems and industrial systems.	0.02%	1.3%	High	Large number of diverse sources.	0	--	-	--
Production of halocarbons - Fugitive emissions	Diverse sources from production plants. BE main emitter.	0.02%	-5.5%			+	0	+	0

[8] Colums 2 and 4-6 taken from the LETS UPDATE Report, column 2 based on information in the LETS UPDATE Report.

	Source	% of non CO2 GHG in EU-25 in 2003	Trend, EU25 (annual % change 2010 to 2020)	Uncertainty in emissions	Number & size of emitters	Installation boundaries	Data collection	Identification of operator	Verification
Consumption - Semiconductors, Electrical and production of trainers	Main emitter is UK. Likely source from semiconductor manufacture (check).	0.01%	4.5%	Low uncertainty of data should be technically feasible.	Small number of point sources.	0	+	0	+
Production of halocarbons - By-product emissions	Diverse sources from halocarbon production plants. BE and UK main emitters.	0.01%	-5.5%			0	+	+	+
Consumption - PFC used as detergent		0.00%	?			--	--	0	--
Consumption - fire extinguishers	Emissions due to leakage and on use of systems. Leakage rates being reduced on a voluntary basis.	0.00%	1.8%			0	-	--	--

SF_6 Emitting Sources

Also SF_6 is mainly manmade and is used in production processes (e.g. as cover gas in magnesium foundries) as well as functional part of the product.

- Electrical equipment
- Aluminium and Magnesium Foundries
- Semiconductor manufacture
- Use of SF_6 in glazing and running shoes

SF_6 is used for insulation and arc-quenching in electrical equipment with emissions occurring mainly during production, use-phase and at the end of life. Monitoring and reporting of emissions already takes place under voluntary agreements in a number of member States. Significant emission reductions, regarding all life-cycle phases have taken place since 1995, limiting cost-effective reduction options to predominantly to the end-of-life. A large number of pieces of equipment exists, making verification onerous. Sectoral emissions amount only to 0.3% of total non-CO_2-GHG in the EU-25 in 2003 with a downward trend. The sector is thus not considered for the next assessment step.

Emissions from sound insulating glazing and running shoes only make up for 0.1% of non CO_2-GHG emissions and show a downward trend. The latter is also due to the fact that the use of SF_6 in running shoes as well as in sound insulating glazing is restricted by the draft EU-F-Gas directive from 2006.
Aluminium and magnesium foundries and semiconductor manufacture are taken forward to the next assessment step.

Sectoral data is shown in Table 7 below, sectors taken forward to the next assessment step are marked yellow.

Table 7 Characteristics of selected SF_6 emitting sectors[9]

	Source	% of non CO2 GHG in EU-25 in 2003	Trend, EU25 (annual % change 2010 to 2020)	Uncertainty in emissions	Number & size of emitters	Installation boundaries	Data collection	Identification of operator	Verification
SF6									
*Consumption - Electrical Equipment	Used to insulate high voltage switchgear. Emissions mostly from leakage e.g. during maintenance.	0.30%	-0.7%	Low uncertainty	Large number of single sources (single pieces of equipment, e.g. switchgear applications)	-	-	+	-
*Metal Production - SF6 Used in Magnesium Foundries	SF6 used as cover gas in magnesium smelters	0.37%	9.5%	Low uncertainty	Very small number of large point sources.	+	+	+	+
*Consumption - Semiconductor Manufacture	Emitted during use for etching and cleaning semiconductors.	0.07%	4.5%	Low uncertainty.	Limited number of plants.	+	+	+	+
Consumption - Emissions of SF6 from (1) window plate production and (2) running shoes	Mostly from disposal of old trainers with SF6 as air cushioning in sole. Use has now been phased out.	0.01%	Decline		Many very small emissions on disposal of trainers.	--	--	-	--

[9] Colums 2 and 4-6 taken from the LETS UPDATE Report, column 2 based on information in the LETS UPDATE Report.

3.5 Assessment Step II

In the following, the sectors identified in the previous chapter are assessed regarding the following criteria:

- Transaction costs
- Availability and costs of emission reductions
- Competitiveness issues
- Inclusion in other schemes
- Compared costs for other schemes (only addressed where specific statements can be made)

An overview table on the sectoral assessment is given in Annex II.

Coal minining (CH_4)

Transaction Costs: Low uncertainty can only be achieved through continuous emission monitoring systems (CEMS). The achievable uncertainty should be further explored. In summary medium transaction costs are expected.
Availability and costs of emission reductions: No extensive emission reduction measures have been carried out so far and extensive reduction potential is available. Reduction technology through recovery and utilisation of gas as well as through flaring is available at moderate costs.
Competitiveness issues: Competition with non-EU-producers is unlikely to be a serious issue despite the fact the product is widely traded, as relative incremental costs of abatement systems are minor.
Other schemes: UK ETS.
Compared costs for other schemes: The high reduction potential which should be available at moderate costs as well as medium transaction costs, indicates that the EU-ETS will be more cost-effective than voluntary agreements, taxation, IPPC and subsidies/Incentive programmes
Summary: The sector seems generally well suited for inclusion into the EU-ETS, but issues like uncertainty and competitiveness have to be further explored.

Production of adipic and nitric acid (N_2O)

Transaction Costs: Monitorability is very good as both processes are already highly monitored and controlled. Additional costs for preparation, monitoring and verification should thus be low to medium.
Availability and costs of emission reductions: Reduction of process N20 can be achieved both by end-of-pipe technologies and by using catalysts. In adipic acid plants a number of reduction measures have already been carried out, in N_2O production sites, a considerable fraction of the reduction potential is still available. Specific reduction costs per t CO_2-eq. are generally low.

Competitiveness Issues: Competition with non-EU-producers is a potentially serious issue as the products are widely traded.
Other schemes: Both processes are covered under the IPPC-Directive.
Compared costs for other schemes: With the high reduction potential, low reduction costs and low transaction costs, the EU-ETS could be more cost-effective than voluntary agreements, taxation, IPPC and subsidies/Incentive programmes
Summary: The sectors seem suitable for inclusion in the EU-ETS. Effects of inclusion on competitiveness compared to sectors located outside EU should be explored.

HCFC-22 Production (HFCs)

Transaction Costs: Monitorability is very good as the process is already highly monitored and controlled. Additional costs for preparation, monitoring and verification are expected to be low to medium.
Availability and costs of emission reductions: HCFC-22 is currently being phased out in developed countries as required by the Montreal Protocol, except for HCFC-22 feedstock production. In the EU HCFC-22 use (but not consumption as feedstock) is forbidden from 2010 onwards. A strong downward trend in emissions is thus expected. Most of the production sites within the EU have already implemented HFC-23 incineration equipment, reducing emissions considerably. Exceptions can still be found in Greece and Spain. Specific reduction costs are low for plants without abatement equipment.
Competitiveness: Competition with non-EU-producers is unlikely to be a serious issue despite the fact the product is widely traded, as relative incremental costs of abatement systems are minor.
Summary: The sector seems sufficiently regulated to explore the reduction potential. The few plants without abatement could be covered under IPPC.

Semiconductor Manufacture (PFCs and SF_6)

Transaction Costs: Costs are expected to be low as installations are large and the process is already highly controlled.
Availability and costs of emission reductions: Reduction action with view to the World Wide Voluntary Agreement of the semiconductor manufacturers has already been carried out, but reductions beyond the reduction target of the agreement seem feasible in principle. Specific reduction costs are typically significant and vary strongly among sites.
Other schemes: Semiconductor manufacture is covered under the World Wide Voluntary Agreement for the semiconductor manufacturers (WWVA).
Competitiveness: Competition with non-EU producers
Cost comparison with other schemes: The potential for an EU-wide voluntary agreement aiming to access the reduction potential beyond the WWVA target

should be explored. As a voluntary agreement already exists and seems to function, an extension regarding emission targets might be more cost-effective than participation in the EU-ETS. Of course this depends heavily on the exact amount of remaining reduction potential and the respective costs and on competitiveness issues, if the additional target only applies to manufacturers within the EU.
Further issues: Confidentiality of data is a problem, as manufacturers currently only report emissions, but no further data allowing emission determination. This is mainly due to the fact that emissions depend largely on chemical conversion in the plasma reactor as well as on the technology used for the treatment of exhaust gas which are considered sensible information by the manufacturers.
Summary: The sectors seems generally well suited for the EU-ETS, but as a functioning voluntary agreement already exists, the potential to proceed on this path should be explored first.

Magnesium Foundries (SF_6)

Transaction Cost: Installation sizes vary and emissions are generally equal to consumption (open process), so they can be easily monitored and verified. Transactions costs are thus expected to be low except for small casting facilities.
Availability and costs of emission reductions: Generally a considerable reduction potential exists, as HFC-134a or SO_2 can be used as substitutes for SF_6. In case of HFC-134a this would mean changing from a high GWP greenhouse gas to a low GWP greenhouse gas, so a scope for inclusion into the EU-ETS would remain. Specific reduction costs are generally low.
Competitiveness issues: Competition with producers in non-EU-ETS countries.
Other schemes: The draft EU-F-Gas Directive will cover SF_6 emissions from magnesium smelters and casting facilitieswith a consumption of more than 850 kg SF_6 p.a. This will cover most of the sector and thus leaves only little reduction potential.
Summary: The development in the sector should be followed closely in order to decide whether the sectors should be included into the EU-ETS at a later stage.

Offshore/onshore gas flaring (CO_2

Transaction Costs: These installations are partly already included as combustion installations if they are above 20 MW for a number of offshore flares and most onshore flares which are commonly part of larger installations covered under the ETS. Costs tend to be medium to high, as flaring is intended as a means for security and for disposing of waste gases or liquids, e.g. from the refinery or chemical sector, meaning that process control equipment does not exist for a large part of the applications. In most cases even flares above 20MW account only for a very small fraction of installation emissions e.g. commonly below 2% in refineries.

Availability and costs of reduction options: Considerable reduction potential is available, but might not be fully accessible, e.g. for flares as security equipment. Specific reduction costs range from low to high depending on site specifics like size.
Competitiveness: Respective producers (offshore, refineries, chemical industry, etc.) in non-EU-countries
Cost comparison with other schemes: In many cases flares will be part of larger installations already taking part in the EU-ETS. From this point of view taking the same approach promises economies of scale. In general, approaches allowing for a high uncertainty might be more appropriate and less costly, e.g. voluntary agreements.
Summary: Given the problems with uncertainty even the larger flares face and given the low amount in total EU-ETS emissions, it seems reasonable to not include even the larger flares unless they are part of a larger installation under the EU-ETS.

Aluminium production (CO_2, PFCs)

Transaction Costs: Basically only large installations exist in this industry. As the smelting process is complex but highly controlled, costs are considered to be medium. The monitoring of PFC emissions is fairly well developed applying proxies like anode effect duration and thus does not necessarily require the use of CEMS. The monitoring of CO_2 can be based on the consumption of fossil fuels.
Availability and costs of emission reductions: Existing abatement options for PFCs are rather small, as retrofitting to better production systems, the main abatement measure, has already been implemented in a large number of plants. Limited CO_2-reduction potentials both for combustion and process emissions exist. Several reduction options are available, but cover only a small amount of the existing potential. Specific reduction costs tend to be negative to low if size and electricity prices justify mid-term investments.
Other schemes: Aluminium production is covered by the IPPC directive.
Competitiveness issues: Aluminium production competes with several other materials in transportation, the construction sector and as packaging material. As most installation in the three sectors are already included in the scheme inclusion of the aluminium sector could bring an end to distortion of competition. At the same time competition with producers of aluminium and other material outside the EU might occur.
Cost comparison with other schemes: Regarding PFC emissions, costs for coverage under the IPPC are considered lower, due to the little reduction potential remaining.
Summary: Regarding PFCs and CO_2 little reduction potential is left in the EU, so the sector does seem only suitable for inclusion in the EU-ETS in the longer term, when additional reduction potential can be accessed.

Gypsum production (CO_2)

Transaction Costs: Installations are small and the process is straightforward but not highly controlled so far, costs are expected to be medium – high.
Availability and costs of emission reductions: Reduction measures exist, but reduction potential is quite small. Specific reduction costs tend to be low to medium depending on existing corporate and national approaches on energy efficiency.
Competitiveness issues: Gypsum competes with sectors like cement and lime, already included in the scheme. Including gypsum could enhance the competition between the sectors.
Other schemes: If not under the EU-ETS, gypsum producing industry will be covered by the energy services directive.
Summary: The sector seems generally suitable for inclusion to the EU-ETS. Potential transaction costs due to the small size of installations should be explored. Furthermore the available reduction potential and reduction costs should be explored.

Stone wool production (CO_2)

Transaction Costs: Installations are medium to large, the process is not highly controlled so far. Costs are expected to be medium – low.
Availability and costs of emission reductions: Reduction options exist, but mainly for combustion emissions and the existing reduction potential is quite small. Specific reduction costs tend to be low to medium depending on existing corporate and national approaches on energy efficiency.
Competitiveness issues: Stone wool competes directly with glass wool, which is included in the EU-ETS under the subheading of glass production. Including the sector of stone wool could enhance competition between the sectors.
Other schemes: Would be covered by the energy service directive if not covered under the EU-ETS.
Summary: The sector seems generally suitable for inclusion to the EU-ETS.

Fertilisers and ammonia production (CO_2)

Transaction Costs: Installations are usually large, the processes are complex, but highly controlled. Costs are therefore assumed to be low.
Availability and costs of reduction options: Considerable reduction potential is available. With existing reduction options 15% of combustion and 20% of process emissions could be reduced. Specific reduction costs vary but tend to be medium to high as energy is a key cost factor.
Competitiveness issues: Inclusion will enhance competition, which is currently influenced bythe medium interpretation of combustion installation. Competition

with non-EU-producers is a potentially serious issue as the products are widely traded.
Other schemes: Are covered by the IPPC- and LCP-Directive, but only limited results on emission reduction are expected.
Summary: The sector seems well suitable for inclusion in the EU-ETS scheme. Competitiveness issues with non-EU producers is a serious issue warranting further consideration.

Petrochemicals (CO_2)

Transaction Costs: Installations are generally large, with complex, but highly monitored processes. Costs should therefore be medium to low.
Availability and costs of reduction options: Existing reduction option allow to reduce combustion emissions by 15%. Specific reduction costs vary but tend to be medium to high as energy is a key cost factor.
Competitiveness issues: Inclusion will enhance competition, which is currently influenced bythe medium interpretation of combustion installation.. Competition with non-EU-producers should be explored.
Other schemes: Will be covered by IPPC and LCP, but only limited results on emission reduction are expected.
Summary: Despite the complex production processes, the sectors seems well suited for inclusion in the EU-ETS. Consideration has to be given to competition outside the EU-borders and the treatment of process emissions.

Other chemicals (CO_2)

Transaction Costs: Installation sizes span a very broad range from small to large, with numerous different processes being covered. Costs at installation level will thus vary greatly depending on the size of the installation, complexity of the process and existing process control measures. On the administrative side costs will be high due to the large number of installations.
Availability and costs of reduction options: Depend highly on the specific processes.
Competitiveness issues: Inclusion will enhance competition, which is currently influenced bythe medium interpretation of combustion installation. Competition with non-EU-producers is a potentially serious issue as the products are widely traded.
Other schemes: If not covered by the EU-ETS the sector will be covered by the Energy Services Directive.
Cost comparison with other schemes: Incentive schemes are considered to have lower costs than the EU-ETS. Voluntary agreements would need to be considered for homogeneous sub-sectors with not to many participants, costs might be lower then.

Summary: With also a large number of small installations costs for inclusion to the EU-ETS will be high. Other options for emission reduction should be explored. If aiming at the larger emitters, direct process heating above 20MW could be included. Thus also competition between to production processes using indirect and direct heating would be strengthened.

Food/Drink products (CO_2)

Transaction Costs: Installations vary strongly in size, but are generally small. Emissions stem from combustion processes, which are straightforward. Costs are expected to be high, due to the large number of small installations.
Availability and costs of emission reductions: Over the whole sector considerable reduction potential and a number of reduction technologies exist, allowing for cost-effective emission reductions. Specific reduction costs tend to be low to medium depending on existing corporate and national approaches on energy efficiency.
Competitiveness issues: Depending on the interpretation of combustion installation applied, certain installation types are already included, while others, though operating in comparable production processes, are not.
Other schemes: Would be covered under the Energy Services Directive, if not under the EU-ETS.
Cost comparison with other schemes: Incentive schemes are considered to have lower costs than the EU-ETS. Voluntary agreement might have lower costs for homogeneous sub-sectors with not too many participants.
Summary: The small size of most emitters is a problem, inclusion of the sector could lead to considerable costs also on the administrative side. As table 1 showed, most of the production processes in this sector have annual emissions below 25kt CO_2 and would probably qualify as "small installations". If aiming at the larger emitters, direct process heating above 20MW could be included. Thus also competition between to production processes using indirect and direct heating would be strengthened. For the smaller installations, other options to accede the reduction potential should be explored.

Waste incineration: (CO_2)

Transaction Costs: Installations are medium – large. The process is not straightforward regarding monitoring of emissions, but highly controlled, so costs are expected to be medium.
Accessibility and costs of emission reductions: The main options for emission reductions in combustion installations are increasing the efficiency as well as fuel switching. In assessing these options, a distinction between incineration of hazardous waste and municipal solid waste needs to be made. In the case of hazardous waste, corrosive and toxic gases result from the incineration. Due to this fact, comprehensive pollution control devices and many

operational constraints lead to high specific CO_2 emissions and to little or no energy recovery. Partly, this also applies to the incineration of municipal solid waste, but with less operational constraints and often significant energy recovery. Inclusion of the sector into the EU-ETS could accelerate the retrofitting or renewal of outdated municipal incinerators to enhance the level of energy recovery.
The potential for fuel switching is limited especially in the case of hazardous waste. For municipal solid waste "cherry picking" for a single incinerator is feasible. Still it has to be taken into consideration that all wastes which cannot be recycled, recovered or biodegraded and thus in the past were commonly landfilled, now generally have to be incinerated to fulfil the requirements of the EU Directive on landfill of waste.[10]**.** This means that within the EU-25 a specific overall amount of waste – leading to a respective amount of CO_2-emissions - is to be incinerated in any case.
Competitiveness issues: Competition for waste fuels exists with the cement and lime industry. A number of installations from the waste sector produce excess heat and electricity and therefore compete to some extent with energy activities covered under the ETS.
Other schemes: Waste incineration is covered by a large number of environmental schemes at the national and EU-level, mainly covering the issues of waste policy and air quality.
Summary: At first sight, finding a scope for emission reductions with the numerous legal requirements waste incineration plants face, seems rather difficult, especially in the case of hazardous waste incineration. The scope in the municipal waste sector should be further explored.

[10] Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste.

4 SUMMARY

In this paper, several issues regarding the inclusion of additional activities and gases into the EU-ETS were discussed.

Firstly, the possibility and effects of inclusion of additional installation types via a broad interpretation of "combustion installation" was discussed. It turned out that most installation types not covered by the medium, but by the broad interpretation, are smaller emitters. The inclusion of such installations is seen as problematic by many Member States due to the disproportionally high costs these installations have to face when participating in the EU-ETS. A group larger of activities was identified which is covered only by the broad interpretation and which generally exceed 25kt CO_2 p.a. comprising:

- Mineral industry: drying of gypsum board/plaster, mineral fibrrs, mineral wool, glass (annealing, heating, drying)
- Chemical industry: Ethylene plants (LPG/naphtha/fuel oil crackers), aromates furnace (BTX furnace), steam reformers (production of ammonia, methanol, hydrogen, synthesis gas), partial oxidation of fuel oil for production of ammonia, salt production (evaporation, drying and refining), titanium oxide furnaces, carbon anode furnaces, blast furnace for phosphorus production, soda ash production (lime kilns), carbon black installations
- Metal production: smelting furnaces, secondary aluminium furnaces
- Flaring (offshore)

Secondly, a number of new activities were assessed regarding their suitability for inclusion by means of a two-step procedure. The sectors identified as suitable for inclusion into the EU ETS are shown in Table 8 together with main potential barriers to implementation which should be further explored.

The main reasons for ruling out sectors comprised poor monitorability and enforcement, high costs as a result of adding a large numbers of small installations and (expected) successful coverage by other policy instruments. In certain cases, sectors with small to medium installations, which would generally have been ruled out when applying the selection criteria, were nevertheless considered for inclusion due to competitiveness issues, i.e. as competing sectors were already included (gypsum, stone wool).

Table 8 Identified sectors and potential barriers to implementation

Sector	Gas	Number of installations	Potential Main Barriers
Coal mining	CH_4	54[11]	
Aluminium production	CO_2, PFCs	25[12]	Remaining reduction potential , Competitiveness
Gypsum production	CO_2	220[13]	Smaller installations
Stone wool production	CO_2	17[14]	
Fertilisers and ammonia production	CO_2, N_2O	100[15]	Competitiveness
Production of adipic acid	N_2O	4[16]	Competitiveness
Petrochemical Processes	CO_2	17[17]	
Waste incineration	CO_2	400[18]	Availability of reduction potential due to complex environmental requirements

Although part of the data for this analysis was taken from the LETS UPDATE project, results of the assessment differ from it in respect to several sectors, especially in the assessment step 1. This resulted from the application of the additional assessment criteria monitorability and enforcement.

Several of the identified activities are also activities at least partly covered by the broad interpretation, e.g. aluminium production, gypsum production, stone wool production, fertilisers and ammonia production, petrochemicals. For these sectors inclusion to the scheme is viable both via an amendment of Annex I of the EU-

[11] Covers coal mines in the countries with the largest emissions, i.e. UK, Germany, Poland, Czech Republik.
[12] Covers primary aluminium smelters in the EU-25. See A.Gilbert et al.; LETS update: interim report working groups A&B; Jan 2005.
[13] See www.eurogypsum.org.
[14] Approximate value, personal communication with Lena Esteves (EURIMA) on Jan 30 2006.
[15] This includes 25 ammonia production sites, covering sites in the five largest emitting coutries: Belgium, France, Germany, Netherlands, UK. See A.Gilbert et al.; LETS update: interim report working groups A&B; Jan 2005. Furthermore 75 nitric acid production sites, see van Balken; N_2O emissions should be part of EU emission trading system from 2008 (Presentation); May 2005.
[16] See IPCC; Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories; 2000.
[17] Covers ethylene plants in Belgium, France, Germany, Netherlands, UK. See A.Gilbert et al.; LETS update: interim report working groups A&B; Jan 2005.
[18] This covers only municipal waste incineration plants. Personal information with Ella Stengler, CEWEB, on Jan 24 2006.

ETS Directive as well as via a selective application of the broad interpretation of a combustion installation.

Differences in respect to the political process as well as the administrative practicalities in Member States nevertheless warrant a careful consideration of the preferred route for their inclusion.

While this paper was prepared, the Commission released a guidance document on allocation plan ("Further guidance on allocation plans for the 2008 to 2012 trading period of the EU Emission Trading Scheme", dated 22.12.2005), very clearly indicating that the broad interpretation is to be applied by the Member States.

In summary, our analysis suggests that an expansion of the activities and gases covered by the EU-ETS could be based on an immediate but highly selective expansion beyond the medium interpretation of a combustion installation plus a more long term expansion by amendments of Annex I of the Directive for selected other activities and gases. Maintaining the environmental integrity and cost-effectiveness of the scheme could preclude a rapid and broad expansion of the scope of the EU-ETS beyond the proposed activities.

Annex I – Inclusion of installations covered by broad interpretation

Information presented reflects returned questionnaires sent to all 25 Member States under the LETS UPDATE project.
N.r.: Not relevant – installation type does not exist in country; X (N.r.) – Not relevant, but would be included if it existed

	UK	France	Austria	Belgium - Flemish Region	Belgium Walloon-Reg.	Germany	Ireland	Czech Republic	Finland
AUTOMOBILES									
Optional on-site combustion processes:									
– Foundry furnace - note that most plants will use an electric furnace but some may use fuel on-site to drive the furnace			N.r.	N.r.	X		X		
– Paint drying for bottom layer - most plants will use an electrostatic process, but some plants may use direct heating- however not many would be expected to use on-site combustion for this process		X	X		X (n.r.)		X		
– Paint drying for the top layer - however note that not all plants will use a combustion process for drying the top layer, some may use infrared		X	X		X		X		
– Post combustion (incl. Steam boilers) - used to treat air from the paint booths		X	X		X (n.r.)		X		
– Engine test-bench					X		X		
BREWERIES									
– Malt kilns			X	X	X (n.r.)		X		
– Wort boiling		X	X	X	X (n.r.)		X		

– Optional on-site combustion process: brewers grain drier - not all plants are expected to have this process. It is not a very energy-intensive, so may not necessarily involve on-site combustion, may just use electricity.		N.r.	X	X	X (n.r.)		X		

	UK	**France**	**Austria**	**Belgium - Flemish Region**	**Belgium Walloon-Reg.**	**Germany**	**Ireland**	**Czech Republic**	**Finland**
BUILDING MATERIALS									
– Gypsum drying	Opt-in	Answer expected		N.r.	X (n.r.)		X		
– Gypsum board/plaster board drying	Opt-in	Answer expected		N.r.	X (n.r.)		X		
– Mineral fibres/mineral wool	X	No Answer	X	N.r.	X	X	X		
– Glass: heating, annealing, dryers	Opt-in	No Answer	X	X	X	X	X	X	X
CHEMICALS									
– Ethylene plants (LPG/naphtha/fuel oil crackers)	Opt-in		X		X	X	X		
– Aromates furnace (BTX furnace)	Opt-in		N.r.		X (n.r.)	X	X		
– Steam reformers (production of ammonia, methanol, hydrogen, synthesis gas)			X		X	X	X		
– Part. oxidation of fuel oil f. production of ammonia			N.r.	N.r.	X	X	X		
– Salt production: evaporation, drying and refining			N.r.		X	X	X		
– Titanium oxide furnace			N.r.		X		X		

– Carbon anode furnaces (anodes used in the aluminium, steel production) – note that these furnaces can be located either within the metals industry or within the chemical industry.			N.r.	N.r.	X		X		
– Blast furnace for phosphorus production			N.r.	N.r.	X		X		
– Soda ash production: lime kilns		X		N.r.	X (n.r.)		X		
– Carbon black installations		Only post-combustion installations included	N.r.	N.r.	X		X		

	UK	France	Austria	Belgium - Flemish Region	Belgium Walloon-Reg.	Germany	Ireland	Czech Republic	Finland
DAIRY									
– Pasteurizing			N.r.	X	X		X		
– Spray drying (creameries)			N.r.		X (n.r.)		X		
– Whey powder, milk powder drying			N.r.		X (n.r.)		X		
METALS (ferrous metal processing and non-ferrous metals)									
– Reheating and heat treatment furnaces					X		X		
– Ferrous metals: foundries, casting, smelting furnaces					X	Smelting covered under Iron/Steel	X		
– Smitheries		N.r.		N.r.	X		X		
– Integrated steelworks: rolling mills, re-heaters, annealing furnaces, pickling	Opt-in	X		X	X	Integrated Mills included	X		
– Smelting furnaces (primary copper, zinc, lead)			N.r.		X		X		
– Secondary aluminium furnace					X		X		
– Casting					X		X		
– Galvanising – note that these may be smaller than 2 MW		No Answer		N.r.	X		X		
OTHER METAL PROCESSING AND METAL-BASED EQUIPMENT PRODUCTION									
– Casting			N.r.		X		X		
– Paint drying		No Answer	X		X		X		

	UK	France	Austria	Belgium - Flemish Region	Belgium Walloon-Reg.	Germany	Ireland	Czech Republic	Finland
SUGAR									
– Evaporator		No Answer	X		X		X		
– Boiling station		X	X	X	X		X		
– Optional on-site combustion process: lime kiln - not all plants would have this process.	X		X	N.r.	X	X	X		
TEXTILE									
– Fabric drying		No Answer	X		X		X		
– Stock drying		No Answer	X		X		X		
TIMBER									
– Saw milling: kiln drying			N.r.		No Answer		X		
– Saw milling – incinerator (burning residues off-site) – note that this process is not expected at most plants as in general these residues are sold to be used off-site		X	N.r.		No Answer		X		
– Particle board production: flake drying		No Answer	X		No Answer		X		
– Particle board production: hot presses – for smaller plants this will be powered by electricity, not by on-site combustion		No Answer	X		No Answer		X		
– Medium density fiber board production – plugging and heating		No Answer	X		No Answer		X		
– Veneer and plywood production – log steaming and/or soaking			N.r.		No Answer		X		
– Veneer and plywood production – veneer drying			N.r.		No Answer		X		

	UK	France	Austria	Belgium - Flemish Region	Belgium Walloon-Reg.	Germany	Ireland	Czech Republic	Finland
OTHER SECTORS									
– Compressor stations (transport of natural gas)	X	X		Opt-out	X	X	X	X	
– Flaring (in the off-shore industry)	Opt in	N.r.	X		X		X		
GENERAL OR SEVERAL SECTORS CONCERNED – note that some of these may be smaller, i.e. below the 2 MW threshold.									
– Steam boilers and turbines (CHP)	X	X	X	X	X	X	X	X	
– Hot water or heat transfer oil boilers	X	X	X	X	X	X	X	X	
– Boilers for heating purposes	X	X	X	X	X	X	X	X	
– Emergency power generators	X		X		X		X	X	
– Auxiliary boilers/secondary equipment	Only included if installation can be run at the same time as the main combustion plant.	X	X	X	X	X	X	X	
– Post combustion installations		X	X		X		X		
– Evaporators	X	Both included and not included	X		X (n.r.)		X		
– Dryers (e.g. grass, animal feed, fertiliser)	Excluded as combustion installation. May be included as part of		X		X (n.r.)		X		

	sectoral activity								
– Roasting (coffee beans, cocoa beans, nuts, seeds)			N.r.		X		X		
– Pasteurizers (food production)		Both included and not included	N.r.	X	X		X		
– Cooking vessels and fryers in the food industry (e.g. boiling of canned, processed foods)	X	No answer	N.r.	No answer	X (n.r.)		X		

Annex II Overview table on second assessment step

Sector	**Gas**	**Transaction costs**	**Availability of emission reduction**	**Competitiveness**	**Other schemes**	**Cost-comparison with other schemes – Schemes that might be more cost-effective than EU-ETS**
Coal Mining	CH4	Low-Medium	High	Coal mines in non-EU countries	UK-ETS	EU-ETS might be most cost-effective
Production of nitric and adipic acid	N2O	Low-medium	High		IPPC	EU-ETS might be most cost-effective
HCFC-22	HFC	Low	Low	High -Producers in non-EU countries	Phase-out under Montreal Protocol	N.a.
Aluminium Production	PFC	Low	Low	High – Producers in non-EU countries, in EU Metal, glass, packaging already included in ETS	IPPC	IPCC might be more cost-effecitve
Aluminium Production	CO2	Medium	High potential, but only small share can be accessed			N.a.

Sector	**Gas**	**Transaction costs**	**Availability of emission reduction**	**Competitiveness**	**Other schemes**	**Cost-comparison with other schemes – Schemes that might be more cost-effective than EU-ETS**
Semiconductor Manufacture	PFCs and SF_6	Low	Further reduction beyond WWVA seems feasible	High – Producers in non-EU countries	World Wide Voluntary Agreement	Voluntary agreement at EU-level might prove more cost-effective
Magnesium Foundries	SF_6	Low	Considerably lower after implementation of F-Gas-Directive		F-Gas-Directive	N.a.
Offshore/onshore oil and gas flaring	CO_2	Medium-High	High	Non-EU refineries		Voluntary agreements might prove more cost-effective
Gypsum production	CO_2	Medium-High	Low	Cement, lime already included	Energy Services Directive	N.a.
Stone wool production	CO_2	Medium-low	Low	Glass-wool already included	Energy Services Directive	N.a.
Fertilizers and ammonia production	CO_2	Low	High, but only available to a certain extent	Distorted competition within the sector reg. Interpretation of combustion installation	IPPC	N.a.
Petrochemicals	CO_2	Low	Medium	Existing distortion within sector due to interpretation of combustion installation.	IPPC and LCP	N.a.
Other chemicals	CO_2	Depending on installation	Depending on installation	Existing distortion within sector due to	Energy Services Directive	Incentive schemes and voluntary agreements for subsectors might prove more cost-

Sector	**Gas**	**Transaction costs**	**Availability of emission reduction**	**Competitiveness**	**Other schemes**	**Cost-comparison with other schemes – Schemes that might be more cost-effective than EU-ETS**
				interpretation of combustion installation.		effective
Food/Drink products	CO_2	High	Depending on installation	Existing distortion within sector due to interpretation of combustion installation.	Energy Services Directive	Incentive schemes and voluntary agreements for subsectors might prove more cost-effective
Waste incineration	CO_2	Medium	Medium – but due to complex legal requirements not fully accessible	Cement industry already included	Numerous waste and air quality legislation	N.a.