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Assessment of different approaches to implementation of the IPPC Directive and their impacts on competitiveness – Some evidence from the steel and glass industry

Study on behalf of the European Commission, DG Environment

by

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ENVIRONMENT, REGIONS AND TRANSPORT

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The report does not necessarily represent the position and views of the Commission.

Executive summary

Aim and scope

This study aims at assessing the impacts of different approaches to IPPC implementation on competitiveness of companies in two industrial sectors (electric steelmaking and domestic glass production). As the provisions of the IPPC Directive allow a certain flexibility for Member States to set permit conditions and to apply the concept of Best Available Techniques (BAT), the implementation of the IPPC Directive is likely to differ across the EU. Furthermore, the Directive does not contain any detailed requirements concerning later stages of the "regulatory cycle" like monitoring and inspections which also may influence competitiveness. Therefore, while differences in implementation of the IPPC Directive across the EU might be justified due to specific circumstances, this may result in distortion of competition and an influence on the competitiveness of certain production sites and industry sectors within and across Member States. There may also be competitiveness impacts relative to non-EU competitors.

The implementation of the IPPC Directive can conceptually be separated into three successive steps: the legal transposition into MS' law, the application of national regulatory regimes and the delivery of the permitting process. The main focus of this study is on the potential economic implications of the permitting process from the point of view of individual plants, but knowledge about the other two steps is of course a prerequisite for carrying out the study. In particular the institutional context is of relevance in exploring the wider impact of IPPC implementation on competitiveness.

The concept of competitiveness is approximated in the study using a bundle of different indicators representing influencing factors on the input and output side of plants and companies (e.g. physical and human capital, productivity, profitability, plant growth etc.). As it is challenging to link competitiveness indicators and measures of environmental regulation, the study highlights risks and opportunities having a (hypothetical) influence on competitiveness (indicators) and identifies various competitive advantages and disadvantages from one plant or country to the next.

It should also be stressed that the study shows a largely qualitative character, does not trigger any statistical generalisations and does not aim at extrapolations from the specific sector level (electric steelmaking and domestic glass production) to the overall sector level (all glass or steel) or to other industries.

Methodology

In this study, any potential impact on competitiveness arising from IPPC implementation is measured through a study of particular sectors.

The study builds on a predecessor study by Hitchens et al. (2001) which also focussed on the impact of applying BAT on the economic performance and viability of existing plants in three different industrial sectors in the EU (cement, pulp and paper, non-ferrous metals). However, at that time the implementation process had not really started and the study was carried out on the basis of the assumption that IPPC would be implemented stringently, i.e. plants would be required to meet all the BAT conclusions as stated in the relevant background reference documents (BREFs) which determine what is considered BAT at EU level for a particular sector. The study found hardly any negative impacts on competitiveness (see section 2.3 for further details on the concept of competitiveness), but pointed out that the eventual impact would depend on the type and pace of implementation of the IPPC Directive.

Like the Hitchens study, the approach used for this study operates on multiple levels: Firstly, a sector review of electric steelmaking and domestic glass production based on the existing literature is presented (see chapters 5 and 6). Secondly - and this is a novel approach - the institutional context of (some) survey countries is explored in detail and linked, in particular, to the electric steel part of the study (chapter 4; chapter 7). Thirdly, in addition to the interview-based approach of the Hitchens study, a survey among electric steelmakers and domestic glass producers was carried out, the results of which are presented in chapters 7 and 8. Comparative conclusions and overall concluding remarks are presented in chapter 9.

All data and information received are processed in an anonymous format so that full confidentiality of individual company data is guaranteed.

Results

Various potential economic impacts on competitiveness have been found in the analysis of the institutional context of IPPC implementation. There is reason to believe, given the lack of assessment methodologies, that many competent authorities assess economic viability at the level of individual companies rather than at sector level as the Directive requires. It has also been found that competitive distortions can result from different levels of stringencies and regulatory quality, e.g. more stringent regulations typically negatively affect competitiveness of those companies immediately affected by them. Furthermore, the analysis of the institutional context shows that competitiveness impacts may arise in countries where the previous permitting regime displayed a low degree of similarity to the IPPC regime and where the regime therefore needed to be fundamentally restructured to implement the Directive. Moreover, competitive distortions can be due to differences in the frequency, regularity, consistency and quality of inspections across countries. Available evidence suggests that these differences are indeed present. This is even clearer in the comparison with some non-EU countries (e.g. Russia). Other differences in IPPC implementation that have been found relate to variations in permitting fees, different schemes of financing permit-related activities of competent authorities and variations in the length of permitting. These latter differences may be relatively unimportant quantitatively, so that one may speak about irregularities rather than competitive distortions.

The analysis of the electric steelmaking and domestic glass sectors follows two different research avenues. In domestic glassmaking the available survey data were classified according to whether the respondents themselves reported a competitiveness impact from IPPC implementation. This self-estimation was cross-checked with other data provided by the respondents in order to make sure that it was plausible. Furthermore, the data were analysed by product group and not by country of origin of the respondents (in particular to ensure confidentiality in light of the limited number of respondents per country), which means that no detailed link to the institutional context was established. In contrast, an analysis of survey data by country was possible, to some extent, for the electric steel sector and a stronger link with the institutional context of environmental regulation could therefore be provided. The results for this sector are largely qualitative due to the data made available and obtained by face-to-face interviews both with plants, regulators and other stakeholders in the area. The self-estimation of any potential competitiveness impact provided by the respondents was used to a lower degree than in the domestic glass sample.

In the electric steelmaking part of this study some convergence to more stringent regulation and an attempt to achieve a partially more level playing field were identified across sample sites. It should be stressed that several of the environmentally high performing plants explicitly stated that their competitive position would improve (in the sense of a more level playing) if the stringency of regulation in previously more leniently regulated countries were to increase. Furthermore, a transitory cost-induced competitiveness impact was found in some sample plants in one Member States producing electric steel (in general this would be expected in all countries with a substantial change in permitting regimes). Most likely this impact is a short-term competitiveness effect for strong exporters competing exclusively on price with producers in countries with more lenient environmental policies. However, no longer-term impact has been identified for in relation to EU and non-EU competitors.

In the analysis of competitiveness impacts arising from IPPC implementation, other intervening plant specific factors have also been considered in the electric steelmaking sample. These are inter alia plant age, management style, general environmental management of plant, the position of a specific plant in particular steel markets (e.g. quasi-monopoly position more likely in specific niche markets), or relationship to customers etc. For example, young plant age was found to be a factor facilitating the economically efficient adoption of IPPC. There was no evidence in the steelmaking part of the study that small plants would suffer disproportionately more from costs related to IPPC implementation than large plants. Although investment in BAT represented an additional cost for the electric steelmaking sample plants with relatively long pay-back periods (if any), there were some cases where BAT investment was reported to trigger positive impacts on e.g. process efficiency and labour productivity.

Helpful factors on the institutional level which facilitate IPPC implementation for electric steelmaking sample plants are, among others, a co-operative relationship with authorities, the availability of the BREF as a reference manual, one-stop-shop permitting and very importantly the coincidence of IPPC implementation with the operator's own efforts to improve the environmental performance of a plant.

The study also demonstrated that environmental costs induced by regulation are only one among many factors influencing competitiveness of the electric steel industry. Especially looking at the cost structure of steel plants it is evident that costs and availability of raw materials, labour costs and electricity costs are clearly more important and decisive than costs induced by environmental regulation.

With regard to the domestic glass part of the study, it should be stressed that domestic glass making represents a special sub-segment of the glass industry and accounts for only 4% of the output of the entire glass industry. Its results cannot be applied to any other market segment of the glass industry. The two main market segments studied in this report are crystal glass and soda-lime glass.

Overall, the market for crystal glass is in general decline due to changing trends in style and a reduction in consumption. The survey results for the sample of crystal glass producers suggest that IPPC is not found to be a major factor affecting competitiveness of this market segment.

In contrast, the segment of soda-lime glass is very price sensitive, and exposed to fierce international competition. Therefore, any competitiveness impacts arising from IPPC implementation have been found to be more likely. However, the analysis of plant specific factors such as profitability, investment ratio and R&D capacity yielded evidence that sample plants with a higher performance in these areas experienced less or no competitiveness impacts arising from IPPC implementation. Even when a negative competitiveness impact was identified, it was only short-term and had no impact on long term company development.

As in the electric steelmaking part of the study, there was no evidence that small plants in the domestic glass sample would suffer disproportionately more from costs related to IPPC implementation than large plants. Domestic glass sample plants which have made early investments in BAT experience more favourable economic impacts, reporting no competitiveness impacts from IPPC implementation.

At the institutional level, several supportive factors facilitated IPPC implementation for the sample of domestic glass producers (e.g. a co-operative relationship with authorities, the availability of the BREF as a reference manual, the coincidence of IPPC implementation with the operator's own efforts to improve the environmental performance of a plant etc.).

Generally, the domestic glass sample results suggest that any increases of production costs for EU producers acting in the low priced end of the market are difficult to absorb. However, it was also found that environmental regulation was one of many competitive pressures faced by the domestic glass industry. Other competitive factors, like lower labour costs in major non-EU competitor countries such as China and Turkey, exert a higher degree of pressure on the EU domestic glass producers than costs following IPPC implementation. Overall, no significant impact of IPPC implementation on competitiveness and long term growth and/or company development of high quality segments of the domestic glass industry in the EU could be traced. This was the case across all product groups and also across different types of implementation approaches.

PART I: General introduction

1 Aim and scope of the study

Council Directive 96/61/EC concerning integrated pollution prevention and control (also known as the IPPC Directive) aims to minimise pollution and achieve a high level of protection of the environment as a whole. It lays down a framework for setting common permitting and controlling rules for about 50.000 industrial installations in the EU.

Article 9(4) of the IPPC Directive states that emission limit values in permits "shall be based on best available techniques (BAT), without prescribing the use of any technique or specific technology, but taking into account the technical characteristics of the installation concerned, its geographical location and the local environmental conditions." Moreover, recital 18 of the Directive states that "it is for Member States to determine how the technical characteristics of the installation concerned, its geographical location and local environmental conditions can, where appropriate, be taken into consideration". As a result, certain flexibility for Member States is anchored in the provisions of the Directive concerning the setting of permit conditions, as well as in the notion of BAT itself. Also, the Directive does not contain any detailed requirements concerning later stages of the "regulatory cycle" like monitoring and inspections.

Therefore the implementation of the IPPC Directive is likely to differ across the EU. While this may be justified in some cases[1], it may also distort competition and influence the competitiveness of certain production sites and industry sectors within and across Member States and also in relation to non-EU competitors. It is these competitiveness impacts arising from differences in implementation of the IPPC Directive which this study addresses both within the EU and in relation to the EU's competitors. The immediate focus of the study is on plant competitiveness, but there will also be conclusions on a sector- and/or country-level.

Choice of sectors and Member States

The terms of reference for this study required that this assessment would be carried out for two to four industrial sectors within a case study framework. Their selection should be based on the methodological problems to be expected in analysing the sector, the economic significance of the sector, its vulnerability to competitiveness pressures, the presence of small and medium enterprises (SMEs) in the sector, the environmental impacts of the sector as well as date of finalisation of the BREF[2] and the extent of IPPC permitting. Furthermore, the study should cover at least six Member States representing a wide range of approaches to implementation of the IPPC Directive, a balanced geographical coverage (with at least one new Member State) and a significant proportion of industrial activity in the selected industries.

At the beginning of the project it turned out to be important to assure co-operation on behalf of industry. While industry is usually strongly interested in assessing impacts on costs and competitiveness of new environmental regulation, co-operation was not self-evident for this study. Their quite cautious reaction may seem surprising to some. Yet, industry most frequently argued that the time for undertaking such a study has not been well chosen (see table 1).

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[1] It is not the intention of the Directive to lead to a complete harmonisation of environmental standards. Also in the light of possible distortions of the level playing field the need for differentiations of environmental standards is discussed (see for a longer discussion e.g. Faure, 2001).

[2] BREFs are BAT reference documents acting as a guidance for Member States. They result from the exchange of information on BAT according to Article 16 of the IPPCD.

Table 1: **Industry contacted or considered for this study**

Industry sectors contacted / considered	**Reasons for not choosing the sector**
Pulp and paper industry	Industry argued mainly that the study would bring hardly any new insights, since the industry was already included in Hitchens et al. (2001). Other concerns were also raised (e.g. chosen segment, workload for companies).
Textile industry	Industry supported the study in principle and was very interested, but argued that the study comes too late to influence the IPPC implementation process (and too early to review it given the limited amount of permitting so far).
Chemical industry	Closer contact to industry was established and industry supported the study with its own ideas. The segment of ethylene crackers was considered as a potential good candidate but in the end not found suitable for the study, mainly because it was difficult to draw up the possible boundaries of the analysis[3]. It was therefore considered by industry that any competitiveness impacts from the IPPC Directive would be difficult to measure.
Foundry industry	Industry argued that the BREF has only been finalised very recently and that any assessment would be premature.
Pig farming	Sector considered too heterogeneous with too many installations.

Finally, two sectors where the IPPC permitting process is relatively advanced and industry associations agreed to support the project could be found. In both sectors two relatively homogeneous segments exposed to international competition were chosen. Concerning the iron and steel industry, electric steelmaking based on the electric arc furnace route is at the centre of our study. There are about 190 installations of this kind in the EU. Within the glass sector the investigation is focussed on domestic glass; there are about 50 installations producing domestic glass in the EU. While electric steelmaking represents an economically significant part of the iron and steel sector, domestic glass accounts for a small share of the entire glass industry. Both segments can be clearly distinguished from other parts of the respective industry sectors. Also, there is a significant amount of SMEs in particular in domestic glass production (less so in electric steelmaking).

Approaches to the implementation of IPPC

The implementation of the IPPC Directive can conceptually be separated in three subsequent steps: the legal transposition and anchoring in MS' law, the application in national regulatory regimes and the delivery of the permitting process. The main focus of this study is on potential economic implications of the permitting process from the point of view of individual plants, but knowledge about the other two steps is of course a prerequisite for carrying out the study.

Concerning the first step, *legal transposition,* Member States have adapted their existing permitting systems to the IPPC regime or adopted new legislation transposing the Directive. Thus, some Member States already had an integrated permitting system in place previously so that only minor legal changes were necessary. By contrast other Member States had to restructure their permitting system more fundamentally. These differences explain in part why the transpo-

[3] Industry argued that there are some stand alone plants, but generally crackers are integrated with downstream users such as polyethylene producers or refineries. Studying the impacts of BAT on ethylene crackers only would not be enough, since substantial knock on effects are likely to occur on the level of the downstream user (the polyethylene producer for instance). One would then have to take a larger sector (ethylene producers + polyethylene producers for instance) with the problem of the BREF on polymer just being finalised. The competitiveness issue seems mainly to be linked to the delocalisation of the downstream users. Spot markets do not seem to be a big issue.

sition of the Directive has been delayed in some countries or why some MS have transposed the Directive only partially in the first years after the IPPCD entered into force (e.g. Italy up until last year). Moreover, Member States have used the legal flexibility of the Directive to a different extent (e.g. the possibility laid down in Article 9(8) to prescribe certain requirements for certain categories of installations in general binding rules, instead of including them in individual permit conditions).

The second step, the *application in a body of national, regional and local regulations, procedures and guidance documents*, is an important indication on whether there is any change in permitting practices or whether previous procedures are maintained.[4] By asking whether Member States formally comply with the IPPCD it is also linked to the first step. European requirements in pollution prevention and control may resemble certain national arrangements, but also impose significant changes upon other Member States. Clearly, Member States have started from different positions with some national arrangements prior to the entry into force of IPPC legislation being already broadly in line with the IPPC "philosophy" and some others in need of more fundamental restructuring. On the other hand, implementation will depend on the degree of adaptation pressure exerted by supranational policies and the way this is received by national administrative traditions (Knill, 1998). Factors affecting such adaptation are policy characteristics and contents (i.e. primarily the nature of requirements set in a EU Directive, but also, and maybe more importantly, preferences, capabilities and resources of subordinate administrative actors dealing with practical enforcement, as well as societal actors addressed by the policy in question.

The third step, the actual *delivery of the permitting*, is closely related to the way IPPC requirements are anchored in national and local regulations and procedures. A broad examination of the link between step two and step three will to some degree allow to assess practical compliance, i.e. whether the objectives of legislation are actually met in practice. But there may still be a discrepancy between legal and administrative compliance on one hand and practical compliance on the other hand. The latter do not completely (i.e. only to a certain extent) determine the result of individual permitting processes. Not only across countries, but even within one country with similar administrative traditions and procedures actual permitting is also a matter of discretion and varies from one local or regional permitting authority to the next and from one industry sector to the next. Also, a further distinction between the practical application and enforcement could be made here (Glachant et al., 2001, p. 15): The former relates primarily to the way permits are issued (including the necessary infrastructure for this task), whereas the latter encompass all approaches of the authorities to encourage or compel others to comply with existing regulation (e.g. monitoring, on-the-spot controls, sanctions).

It is eventually the process and the result of individual permitting that allows to assess the economic consequences for the affected plants. In terms of process, it matters i.a. what the timing in permit application and permit granting looks like, whereas, in terms of contents, the level of environmental stringency is most relevant. Thus, it is of interest how regulator and operator interact and which procedures and criteria are actually applied "on the ground". At the same time, it matters from an economic point of view to characterise the site and its (IPPC-) installations and to assess its framework conditions (sector, market and political environment).

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4 The study will not investigate the different approaches to the implementation of the IPPC Directive in regulatory bodies in isolation. This latter aspect is covered by another study informing the IPPC review which is fed into this study as much as necessary (see ENTEC, 2006).

The study also builds upon a predecessor study by Hitchens et al. (2001) which was carried out between 1999 and 2001 when even fewer experience had been made concerning the implementation of IPPC in Member States. Based on some analytical simplifications to account for the unknown “real” level of BAT the study dealt with the impact of applying BAT on competitiveness of individual plants in the cement industry, the pulp and paper sector and in non-ferrous metals. Inter alia the study found no evidence that BAT prevented those companies using them and achieving good environmental performance from remaining competitive both nationally and internationally. However, the study also emphasised in its conclusions that the impact of BAT on competitiveness in other and maybe less competitive plants would depend on the way the IPPC Directive would be implemented in Member States. Therefore, in the current more advanced state of implementation of the IPPC Directive, this study will build on the Hitchens study, apply it to industry sectors not studied previously and check whether the conclusion of Hitchens et al. (2001) still hold or need to be modified. The study builds upon the experiences already gained on the implementation of the Directive since 1999. Such types of analysis could of course also be carried out after the deadline for the full implementation of the IPPC Directive by October 2007.

This study will also be used as a source of information to inform the IPPC review process.

Yet, as explained in the next section (and reiterated throughout the following chapters), the study faces considerable methodological and data constraints. Other than Hitchens et al. (2001) the institutional complexity and ambiguity of a still quite uncomplete and often unsatisfactory process of IPPC implementation (application, delivery) is taken seriously in this study.

2 Methodology

2.1 Basic approach

In principle, this study will assess the impacts of different approaches of IPPC implementation on competitiveness through a case study. The case study approach examines the actual experience of plants in implementing the IPPC Directive and represents one of a number of possible approaches to the measurement of the competitive implications of IPPC implementation. An alternative approach might, for example, involve modelling the impact of BAT on costs of production. Given price elasticity of demand the effect on industry output and employment could then be estimated in a model. Econometric models are certainly a powerful tool, since they allow to construct different scenarios in an internally consistent way, in particular one in which an (IPPC) intervention takes place (policy scenario) and one in which the intervention is absent (the counterfactual situation or reference/baseline scenario). Comparing the results in relative terms allows to estimate the net effects of a particular policy (or set of policies), and only that policy (that set of policies). However, given the limited experience with IPPC permitting until today, the case study approach was preferred and stronger emphasis was put on describing, understanding and explaining actual plant performance in the context of IPPC implementation. Yet, by abstracting from single cases as much as possible the study tries to come closer to model-based results. This will be done by comparing relevant influential factors between cases or by drawing analogies. Below we therefore try to construct our own "model" to a certain extent.[5]

The case study approach chosen here operates on multiple levels: It will consist of sector reviews, a postal/electronic survey and interviews. The sector reviews for domestic glass and electric arc furnaces will present the background to be able to better frame the analysis of both the survey and interview data. Apart from describing and delineating the sector the reviews will contain an analysis of a number of quantitative factors which help to approximate the competitiveness of the respective industry in selected EU countries, over time and in relation to other industries and competitors from non-EU countries. Yet, given the paucity of data and the lack of conclusive evidence at the sector level, the reviews will analyse the impact of environmental variables and environmental regulations (i.a. IPPC-related regulations) on competitiveness to a limited extent only. While this "phenomenological approach" is insufficient in itself, it will allow to better contextualise the micro-level analysis at a later stage of the project.

Below the sector level this study uses, other than Hitchens et al. (2001), a postal/electronic survey in order to capture the different impacts of IPPC. As a result, the study intends to cover a broader spectrum of electric steelmaking and domestic glass making installations (for the geographical distribution of the survey installations across Member States see table 2).

The study primarily asks for information from those sites that have already undergone the IPPC permitting process. However, attention was also be paid on whether there are certain patterns in the permitting process that may result in distortions of competition or other irregularities (e.g. between existing and new installations, between different regions etc.). In addition, it was of interest to ask whether there are distortions between IPPC and non-IPPC installations (resulting e.g. from the thresholds foreseen in the IPPC Directive).

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5 Note that "with and without" analysis applied in model studies is different from "before and after" analysis, requiring not only what the world was like before the regulation was imposed, but what would have happened in its absence. This "baseline" problem is more than a data problem; it is also a modelling problem. The world will either be observed with the regulation or without it; but one cannot rewind the tape of life and play it again.

Table 2: **Distribution of sites* included in survey for electric steelmaking and domestic glass production**

Country	**Sites for electric steelmaking**	**Sites for domestic glass production****
Austria		4
Belgium	5	1
Czech Republic		4
Finland		1
France	19	9
Germany	20	9
Greece		1
Italy	27	6
Luxembourg	3	
Netherlands		1
Norway		1
Poland	9	1
Portugal	1	1
Slovakia		2
Slovenia		2
Spain	21	3
Sweden	8	2
UK	7	3
Total	120	51

Notes: * A site can comprise several installations. * * The total of 51 sites refers to the original list of targeted sites. During the process of the survey the targeted sample diminished to a size of 47 installations which are presumably subject to IPPC (see also chapter 8 of this report).

The survey asks for information about IPPC requirements at the level of individual production sites, the environmental situation at these sites and combines this with data on the competitive position of plants/sites. In particular managers are asked:

- to indicate the state of IPPC implementation and to illustrate any changes due to IPPC implementation compared to the previous environmental regime incl. compliance costs, any change in emission limit values as well as obstacles and helpful factors in the IPPC permitting process;

- to give data on the competitive performance of plants incl. productivity, markets and profit ratios;

- to specify the competitive advantages and disadvantages they face for their main product segments in comparison both to EU and non-EU competitors, including those arising from environmental regulation and costs;

- to indicate the impact of (expected) IPPC related compliance costs and/or the adoption of BAT on overall firm performance and profit;

- the individual economic effects of adopting new environmental techniques at plant level. For a number of these techniques managers are asked a series of quantitative and qualitative questions on the impact of that initiative on plant performance (asked in an annex to the survey questionnaire).

A list of installations in the two selected sectors was prepared in collaboration with the respective European and in the case of electric steelmaking also with national industry associations. The list includes in total 171 sites for the 2 sectors concerned (see table 2 above) and was also distributed to Member States. In early May two different questionnaires for electric steelmaking and domestic glass production focusing on the impacts of different approaches of IPPC implementation on competitiveness were sent out to industrial installations in the EU. The planned deadline for answering originally was 30th of May 2006. However, due to some difficulties explained in the next paragraph, response was delayed until late June/early July.

One of the difficulties of conducting a written survey is that no face-to-face contact with competent respondents can be established and that it is sometimes impossible to find out who the competent person(s) would be. In addition, operators and managers need to take care of their main business and cannot be expected to spend an excessive amount of time on filling out a survey. As a result, surveys on inherently complex matters (like the economic impacts of IPPC regulation) meet easily either with ignorance and uncertainty or get discarded due to time or other business constraints.

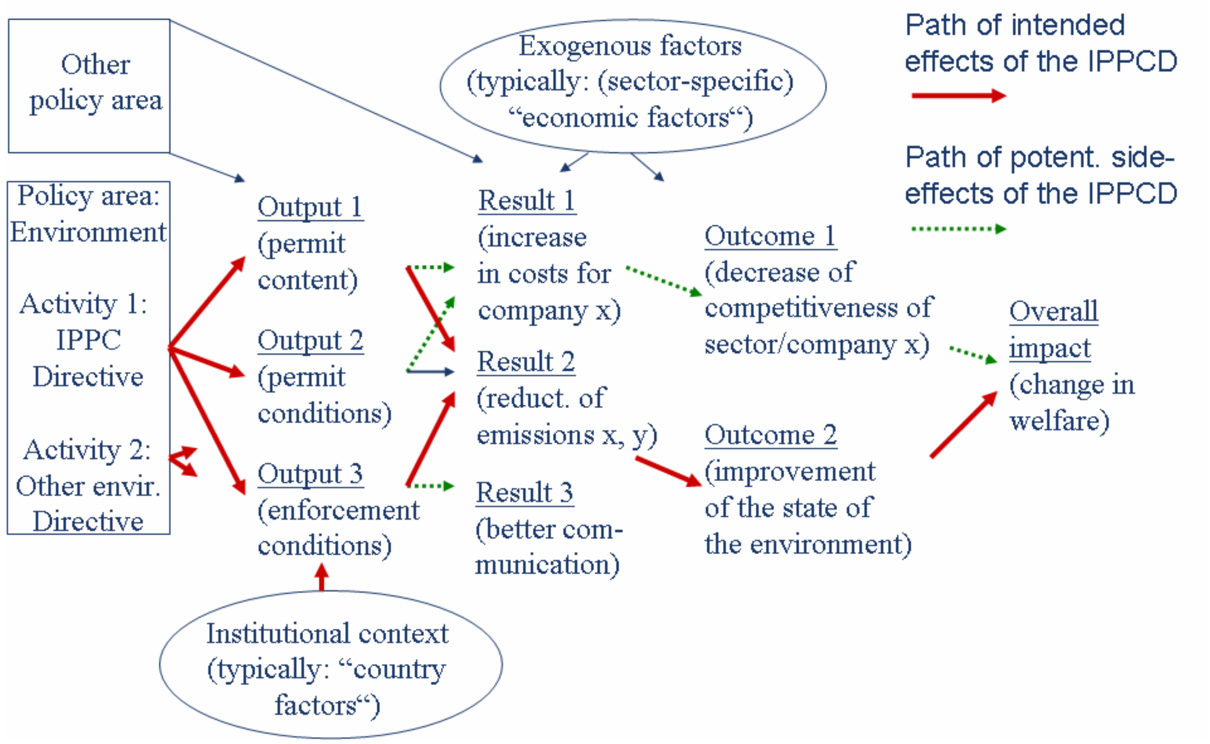
For this reason, it was aimed to carry out additional interviews both in individual sites and headquarters as well as with authorities and other stakeholders (e.g. industry associations) in each of the two selected sectors. These interviews were either based on the (partial) results of the postal/electronic survey or facilitated eventual filling-in of survey questionnaires. The latter was especially the case in the electric steelmaking case study. On one hand, personal interviews helped to establish a greater amount of trust to the concerned plant/environment managers. On the other hand they serve to investigate any implementation issues and potential competitiveness impacts in greater depth, fully accounting for the potentially large amount of site- and context-specific factors coming into play. Site visits and interviews helped to deal with the methodological challenges we were facing in this study (baseline problem, separation of cause and effect etc., see below).

2.2 Conceptualising links between the IPPCD, IPPC implementation and competitiveness

How can we conceptualise the role of the implementation process when assessing the impacts of IPPC on competitiveness? Graph 1 helps to illustrate the complex linkages in a simplified way. The IPPC Directive aims to achieve a high level of protection of the environment as a whole (outcome) through the prevention or reduction of pollution from industrial sources (result). This is done by setting common rules for permitting and controlling these industrial activities and by formulating other principles and requirements Member States have to adhere to (more direct “outputs” of the policy intervention). However, what these outputs are at the level of individual production sites (e.g. emission limit value (ELV) set) depends strongly on the institutional context which will differ from one Member State to the next (and possibly along other dimensions, see below).

Apart from environmental results and outcomes the IPPCD produces potentially important economic results (first impacts) and outcomes (wider or longer-term impacts).[6] These economic impacts are also, and possibly more directly, induced by other policy areas (e.g. attempts to liberalise energy markets at the EU level). These policy processes interact with IPPC based permitting at different governance levels and (mostly) in different policy arenas (see also Glachant et al., 2001, p. 4f.). In addition, a potentially large amount of exogenous factors needs to be accounted for at the level of results and outcomes (e.g. geographical, socio-economical, sector-specific). They "co-produce" these impacts, but are not or only indirectly related to the IPPCD. It is thus useful to think of the institutional context primarily intervening at the level of outputs and other exogenous factors interacting with the effects of the Directive mainly at the level of results and outcomes (see also European Commission, 2004, p. 93).

Graph 1: **Conceptualising links between the IPPCD, its implementation and competitiveness**
(stylised examples in brackets illustrating key terms*)



*Note: The decrease of competitiveness in outcome 1 is only a potential and exemplary impact. A priori the extent and the direction of any competitiveness impact are not clear. Eventually. this will depend on the industry, the price elasticity of demand etc.

Various stages in the implementation process can now be distinguished conceptually.

[6] These can be framed using the concept of competitiveness (see below 2.3).

Along these stages hypothetical linkages to economic implications and eventually the impacts on competitiveness of the IPPCD (level of results and outcomes in the graph) can be explored. As indicated above these linkages are typically quite indirect, so that no immediate conclusions can be drawn. In addition, some of the potential economic impacts may be temporary whereas others may be permanent or longer lasting. The first stage of “implementation” refers to the legal transposition and anchoring of IPPC in Member States’ law[7]. The starting positions of Member States clearly differ: some Member States need to adapt while others need to more fundamentally restructure their current system of regulating emissions from industrial sources. The additional impact of IPPC may therefore be more or less pronounced, and in some cases it may be negligible or not discernible. Also, IPPC requirements may be in harmony or in conflict with other regulations companies (still) have to face.

This leads us to the first hypothesis: The more similar the pre-IPPC country/regional regime to the spirit and the letter of the IPPCD and the higher the level of consistency with related (environmental) regulations the less influence on competitiveness is to be expected.

The second stage of implementation relates to the application of the IPPCD in national/regional/local regulations. The main focus is on Member States’ characteristics facilitating or impeding the application of the directive given the pressure from the EU level to adapt the current national permitting and enforcement system. While the number of influential factors is potentially large we propose to concentrate on two main characteristics: administrative structure and administrative resources. The first refers to the level and distribution of competencies as well as the establishment and functioning of suitable co-ordination mechanisms (see explanations in chapter 4.2), the second entails the level and quality of financial, technical and human resources. We propose the following hypothesis here: A clear distribution of competencies without frictions and proper co-ordination among competent authorities is less likely to impose a burden on companies subject to permitting and negatively affect competitiveness. A high level of professionalism, integrity and training is less likely to lead to unequal treatment and competitive distortions.

The third stage of implementation refers to the delivery of permitting and enforcement “on the ground”. Permits differ in the number of requirements (e.g. monitoring, reporting) and the level of stringency (especially of the ELV) imposed on the operator. The permitting process varies i.a. in terms of the time required and the flexibility granted to the operator (e.g. early take-up of production). The enforcement of the permit conditions from one site to other varies i.a. by the frequency and type of inspections and monitoring and the level of co-operation and trust between operator and competent authorities. On this quite general level we hypothesize that c.p. the impact on costs and effort of the operator (and eventually plant competitiveness) is the less important

- the lower the level of stringency and the more transparent and coherent the relevant regulatory requirements
- the less strict the enforcement regime and the less frequent the number of inspections
- the faster the permitting process and the more co-operative the relationship with competent authorities
- the higher the consistency in the permitting and enforcement approach (i.e with regard to the above elements) from one site/region/country to the next (e.g. same level of ELV for “identical” process in “identical” plant in neighbouring region)

[7] In legal terms the transposition of EU law in Member States’ law does strictly speaking not qualify as part of the implementation process.

This more general set of hypotheses needs to be fine-tuned and contextualised in light of the evidence found in the case-studies and during stakeholder interviews (e.g. regarding the interpretation of BAT) (see chapter 4.3).

As indicated in graph 1 the various stages/levels and impacts of IPPC implementation interrelate with (sector-specific) economic factors (exogenous factors) that operate more directly on the level of results and outcomes. These economic factors can be looked at starting from the position and history of individual companies/plants or at a broader sector level. Yet, it is unclear, if and how these factors (e.g. typical competitiveness indicators) interact with IPPC requirements and whether they should (to some degree) be endogenised into the explanatory framework.

While there may be numerous potential linkages between IPPC and "general" competitiveness indicators that need to be looked at on a case-by-case basis, a relatively close relationship is typically apparent when considering a company's investment motives. At a more general level we hypothesize that IPPC is less likely to have a negative impact on competitiveness the more synergies between IPPC investment requirements and other company (environmental) investment strategies.

These conceptual linkages between the IPPC Directive itself, the IPPC implementation and competitiveness illustrate the need to look at multiple baselines. Specifying a baseline helps to think about what would happen in the absence of a policy measure, and hence what precise difference the policy measure makes. This is essential, as we should in principle only include those additional (economic) impacts that are due to the introduction of the new IPPC regime.

A baseline may be looked at from the perspective of a single Member State only or for several Member States in conjunction. Again, it is often more straightforward to study the evolution of permitting in single Member States only. By contrast, creating a valid baseline across countries is inherently difficult given the in-built flexibility of the IPPCD (with a number of specific permitting requirements only determined at national, regional or local level) and the similarity of the IPPCD and IPPC philosophy with some national permitting policies. As a result, only partial cross-country comparisons can be made and care needs to be taken in drawing conclusions.

2.3 Competition, competitive distortion, competitiveness and environmental stringency – Some clarifications on key terms

Some hypotheses have been brought forward on potential economic impacts of the IPPC Directive, but further clarification is needed on what this implies in a market environment and with respect to fundamental principles of EU legislation.

One of the key objectives of establishing the European Economic Community (and later the European Community) was the creation of a common market with undistorted competition. The establishment of a common market where firms "freely" compete against each other is believed to enhance social welfare. The principal instrument to prevent or eliminate distortions of competition mentioned in the Treaty is harmonisation, i.e. the deliberate equalisation of policy instruments and norms in different countries or, at least, the procedures that lead to norms and regulations. While this approach has (to a different extent) been applied to policy areas such as safety, health or environment, it often remains unclear what a distortion of competition entails and what, if at all, should be done to reduce or eliminate it.

Van der Laan and Nentjes (2001) propose to distinguish (conceptually) between two different views on what constitutes a distortion of competition. The first one, brought forward primarily by economic theory, interprets a competitive distortion as an inefficiency leading to welfare losses. The second view, regards distortion of competition as a situation where firms do not operate under equal starting conditions giving rise to inequalities.

Competitive distortion as inefficiency

More precisely, the first view defines a competitive distortion as a measure which entails a price deviation from a (hypothetical) welfare optimum under perfect competition, thereby reducing the efficiency of the allocation of resources and in particular (inter-)national trade. Gains from trade would be diminished, since free trade results in an international distribution of industries where countries (regions) specialise in industries producing products which require for their production inputs which are relatively abundant in that country (region) (e.g. with countries relatively abundant in labour specialising in labour-intensive products). This trade pattern based on the principle of comparative advantage is *a priori* more efficient ("Pareto-superior") than an alternative one putting deliberate restrictions on exports and imports.

It is well known from environmental economics, however, that this pattern does not (easily) emerge when considering the environment and the utilisation and consumption of natural resources. Due to its public good characteristics a market for environmental inputs does not develop spontaneously. In order not to change relative prices to the disadvantage of ecologically beneficial processes and goods, it is generally emphasised that policy interventions (like environmental regulations) are needed to create artificial prices and correct for the deficiencies of the market. In other words: Without environmental regulations – be it standards, norms, ecotaxes or other instruments – that make the polluter "pay" for the ecological costs he induces, inter-firm competition for scarce factors is biased, and thereby the whole market outcome is distorted.

Neoclassical economists have proposed to internalise external effects and further social costs of economic activities associated with the environment on the basis of the "polluter pays" principle. Unfortunately, this is far from easy in practice and for the purpose of specific policy analyses (like the analysis of the IPPCD) given important informational, methodological and normative constraints. The decisive questions are again: Which environmental policy is compatible with undistorted competition? How restrictive or stringent should environmental policy be? What are and wherein lie the distortions of competition before and after the use of environmental policy instruments?

The most popular conclusions that are based on economic theory, but consider the practical unfeasibility of "proper" internalisation might be the following:

- On the level of instruments, economists mostly propose to impose on all firms the *same costs* per pollution unit, for instance by use of taxes and levies. Instead of expecting the *same efforts* in environmental protection from all firms, as is typically the case in what is termed "command-and-control" legislation, this is likely to be statically and dynamically more efficient. In particular, such an approach is more sensitive to differences in the abatement cost curves between firms/plants.

- Regarding in particular the (inter-)national trade implications, the restrictiveness of environmental policy should depend, on one hand, on the availability (scarcity) of environmental resources. Clearly, there are potentially large differences in the environmental endowment from one country (region) to the next: in the physical availability of raw materials and resources, the geographical and natural conditions of the environment, the assimilative capacity of this environment, and in the level of pollution reached so far. Due to these "endowment" effects which in turn imply cost differentials it is economically efficient that countries with relative environmental abundance and lax environmental standards will exist next to countries with relative environmental scarcity and strict standards. Accordingly, it is to be expected that countries relatively abundant in environment will specialise in relatively pollution/resource-intensive products and/or produce them in a relatively polluting way. Whenever pollution does not cross borders or other reasons justify a more unified environmental policy (see below) each Member State in the EU should therefore decide for itself how stringent national environmental emission standards should be, since a set of uniform standards would only prevent – a politically "controlled" – specialisation based on differences in environmental scarcity, prevent the realisation of gains from trade and thus create competitive distortions (i.e. inefficiencies) in themselves.

- On the other hand, it is also argued that the stringency of environmental policy should take into account national environmental preferences and consider trade-offs with other policy goals. Since demand for environmental quality increases with income, there is an argument that poorer countries prefer to opt for laxer environmental policies, avoiding the investment in environmental protection of an unduly high share of their income. In addition it is argued that these preferences will be further diversified in an enlarged European Union. These national environmental preferences are also reflected in national legislation. Differences in national regulations can result in different cost conditions for firms from one country to the next. Again, there is no a priori case for EU wide harmonisation. Yet, a co-ordinated EU policy to fight imperfections in competition e.g. arising from transborder pollution or strategic national standard setting to change the terms of trade in favour of national industry is usually supported. However, international or inter-EU agreements on emission ceiling per country are not identical with harmonisation of national environmental standards to uniform levels.

Competitive distortion as inequality

The second view of the concept of distortion of competition does not focus on results, i.e. the efficient allocation of resources (or more narrowly, production) in the EU, but on equitable or fair starting conditions. Usually this approach is accompanied by demands for a "level playing field" which requires that "identical" producers should operate under a uniform regulatory regime. Thus, the distortion of competition as inequality arises when firms face different laws and, more importantly, when these laws have different financial consequences for firms and affect their competitive relations (Woerdman, 2001). As a result, the level playing field approach does not object to the fact that the competitive positions of firms can be unequal because they have different market shares and that their relations may change, both before and after an environmental policy intervention, because of their economic activities and strategies. It only demands that the competitive and (relative) financial position of firms must not change due to the political process of regulation (i.e. permitting). If foreign producers do not have to conform to environmental legislation equally strict or demanding as the one faced by local producers, a distortion of competition is therefore usually assumed.

From this perspective, some kind of harmonisation could provide the desired level playing field. Implicitly it is also evident that differences in factor scarcity and national preferences between states should not play a role in designing policies.

In practice there may be different ideas about the level of equalisation. In extremis, supporters of this approach would not even accept cost differences arising from differences in natural endowments. Basically, emissions standards should then be identical in all EU Member States and reflect a strong interpretation of the precautionary principle. One of the more moderate views is to counter only cost conditions created by differences in national legislation that arise out of divergent national preferences rather than endowments. Supporters argue that the harmonisation consensus is sufficiently advanced and should be "enforced". Thus, the European Union is seen as a political subject having the welfare of its citizens at the centre of its concerns. It therefore takes an active stand towards countries that are lagging behind in defending the interest of its citizens. In the worst case a more proactive environmental policy may be hindered in some countries by domestic corruption and poor domestic institutions (Pellegrini and Gerlagh, 2005).

There are also some concerns whether the term endowment can be made operational in practical environmental policy. For example, Lübbe-Wolf (2001) argues that it makes a difference whether the environment is treated as a sink for pollution or as a resource. It may be inadequate to differentiate environmental policies by the capacity of the environment to assimilate pollution: pollution easily accumulates or becomes persistent having long range and far reaching effects that cannot be anticipated today (precautionary principle). Other than the supporters of the inefficiency view, Lübbe-Wolf (2001) argues that local pollution and trans-boundary pollution cannot easily be separated. The distinction depends on the amount and the persistence of the emitted substance and not on the level of regulation. A strong degree of decentralization of competencies in environmental policies may therefore transfer polluting production activities from countries with more stringent policies to countries with looser environmental policies (pollution leakage) and constrain the ability of countries with a high level of environmental preferences in their pollution abatement activities.

In addition, the argument is also used by some industry groups. Environment-intensive industries operating in countries with strict environmental standards may use the level playing field argument to lobby for protection and for the creation of market entry barriers ("disguised equity").[8]

Van der Laan and Nentjes (2001) trace the evolution of EU environmental legislation to find out whether the inefficiency or the inequality perspective is more prevalent. Regarding emission standards from stationary sources the inequality seems to have been the primary motive for (partly) harmonising source emission legislation. However, actual harmonisation policies also partly reflect the inefficiency view. For example, there are forms of "minimum legislation" (maximum to emissions or minimum environmental quality standard) which allow countries to impose stricter environmental norms (but not lower standards). Van der Laan and Nentjes (2001) suggest, that implicitly harmonisation policies of the EU trade off efficiency and equity.

Based on these different concepts of competitive distortion it will be necessary to analyse more closely the implementation and permitting process following the 1996 IPPC Directive to increase our understanding of whether the efficiency or equity interpretation prevails. The political implementation process may "objectively" lead to competitive distortions according to one of the above mentioned viewpoints. Yet, it is also of interest which perception stakeholders hold "subjectively" on such complex issues as IPPC implementation and competitiveness impacts (Woerdman, 2001).

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[8] In practice, it is difficult to draw a clear distinction between these viewpoints.

Competitive distortions may affect the competitiveness of certain industry sectors or specific firms/plants. At the same time, a range of other factors not (directly) related to environmental regulations affect competitiveness. Thus, any study about the competitiveness impacts of environmental regulation necessarily needs a definition and appropriate indicators both of competitiveness and environmental stringency.

Competitiveness

The concept of competitiveness implies an international dimension and it refers to different levels of aggregation, i.e. it refers to the ability with which a country, a sector or industry, and/or a firm or an individual plant competes against foreign counterparts. For instance, the OECD (1992) understands competitiveness as "the degree to which (a country) can, under free and fair market conditions, produce goods and services which meet the test of international markets, while simultaneously maintaining and expanding the real incomes of people over the longer term". Simultaneously, a nation´s competitiveness will be the result of a disparate array of performance at sector, firm and plant level and the responsiveness to wider economic factors such as the exchange rate, real wages and other factor prices. Similarly, sectoral competitiveness will reflect a wide range of different performances of which the industry consists and individual plants within the same firm may show considerably varying competitive performance relative to the average of the firm (SQW, 2006).

In terms of indicators, competitiveness is often linked to long run increases in living standards on the national level, for example The World Economic Forum defines competitiveness as 'the ability of a country to sustain high rates of growth in GDP per capita'. However, GDP per capita is often thought to be a too generic (and in itself problematic) measure in order to explore the environmental regulation-competitiveness link (see a meta-analysis of Mulatu et al., 2003) and is attended by severe problems in understanding the distinct impact of environmental regulation on competitiveness. Therefore it is suggested to investigate this relationship at a more disaggregated level – either at sectoral or at firm level.

On a sectoral and firm level, most commentators would emphasize the need to judge the impact of environmental regulation on competitiveness by measuring the effect on productivity since long run increases in overall living standards come only about through the achievement of higher productivity levels on a sectoral level (see Baumol/Blackman/Wolff, 1989; Dertouzous/Lester/Solow, 1989; Krugman, 1991).

However, according to Jacobson and Andréosso-O'Callaghan (1996) there are additional indicators available for the measurement of competitiveness. The authors list factors related to the input and output side. Concerning the input side (the likely explanations and drivers of competitiveness) these factors are physical and human capital, research and development spending, rate of innovative capacity etc.; on the output side (illustrating the consequences of the relative competitiveness of a firm) the essential factors are profitability, market share and productivity.

Given this background, also in this study, a bundle of different competitiveness indicators with labour productivity and profitability being the most important ones, has been chosen for the measurement of competitiveness and firm performance (see case studies presented in chapters 7 and 8).

Approximating environmental stringency

Usually the stringency of environmental regulation is judged by the environmental standards in place and the rigour of their implementation. These two elements can be broadly approximated by pollution intensity (for instance level of SO_2 emissions), private environmental expenditures or proxies of public regulatory stringency. Each of these measures has its specific advantages and disadvantages (see Jeppesen et al., 2002). Looking at available measures of pollution intensity, on one hand, typically requires strong assumptions between regulation and enforcement as well as actual performance (e.g. if SO_2 emissions are relatively high then environmental regulation is lax and/or not enforced). On the other hand, indicators may very well reflect differences in endowment with natural resources between countries which would not be captured by performance data alone. Private abatement costs as e.g. collected in the US PACE database give a broad picture of polluting and less polluting industries. Yet, it remains unclear whether abatement efforts are induced by regulatory policies or other factors. Other major shortcomings of PACE data as proxies for regulatory stringency are that data do not control for the mix of old vs. new plants (old source bias) and that data are not very disaggregated. Finally, various indices for public regulatory stringency may be helpful. They may include items such as public monitoring expenditures, number of persons employed in enforcing environmental policies, but also include broader characteristics of the (environmental) regulatory regime in place. Also, qualitative rankings about the perceived strictness, consistency and transparency of regulatory activities in certain sectors or countries (typically on the basis of industry or expert surveys) are used.

Due to the multidimensional nature of the regulatory process the use of multiple measures of environmental stringency may be most appropriate (List and Co, 2000). The newer studies take this into account. Also this study uses several variables for the measurement of environmental regulation as implemented by the IPPC Directive. These variables need to be tailored to the specific context (see chapters 4, 7 and 8).

Linking competitiveness indicators and measures of environmental regulation

Having clarified some key terms it is important to stress that it is often challenging to link competitiveness indicators and measures of environmental regulation. To meet this challenge in a satisfactory way much depends on data and information input. The lower this input the more it will only be possible to highlight risks and opportunities having a (hypothetical) influence on competitiveness (indicators) and to identify various competitive advantages and disadvantages from one plant or country to the next.

3 Previous literature

In this section the existing literature on the competitiveness implications of the IPPC Directive is reviewed. On a sector level there are still not many studies available.

The section starts with a general overview of the relationship between environmental regulation and competitiveness.

3.1 The relationship between environmental regulation and competitiveness

Essentially, there are two opposite views on the impact of environmental legislation on competitiveness. The conventional view fears that the private costs imposed by stringent environmental policy impair competitiveness and productivity (Palmer/Oates/ Portney, 1995). Conversely in the so-called “Porter hypothesis” or revisionist view it is argued that environmental regulation spurs innovation in a number of ways and that there are “win-win” opportunities available through environmental regulation, where simultaneously pollution is reduced and productivity increased (Porter and van der Linde, 1995). In the maybe most well-known variant of the revisionist view firms can create a type of first mover advantage by the development of environmental technology from which they can benefit in later times when other countries also have to adopt stricter environmental regulations (Sorsa, 1994; OECD, 1996). Porter and van der Linde (1995) have also stressed that innovation caused by regulation can directly benefit the user sector of environmental technology and its wider network of suppliers and customer.

Whether the traditional or the revisionist view holds true can only be measured empirically. A useful typology of available empirical studies on the positive and negative impacts of environmental regulation is undertaken by Stewart (1993). He separates the studies in research on productivity, location and trade.

Empirical studies taking labour productivity as the main indicator of competitiveness and firm performance come to at least mixed findings concerning the relationship between environmental regulation and competitiveness for various industries (see for US studies of the last decade Stewart, 1993; Gray and Shadbegian, 1995; Repetto, 1995; Boyd and McClelland, 1999; see Conrad and Wastl, 1995 for an example of a German study). Gray and Shadbegian (2003) find in their estimation of a production function including abatement costs that paper mills with higher pollution abatement costs have significantly lower productivity levels, with older and newer plants showing similar impacts. In a refined production function approach of 2005 Shadbegian and Gray show for pulp and paper mills, oil refineries and steel mills that pollution abatement investment does not have significant negative effects on the productivity of non-abatement inputs. There was no evidence for significant differences across the sample plants when production technology and the types of pollution investment (clean vs. end-of-pipe) were examined. For the European Union Hitchens et al. (1998 and 2000) as well as Clausen et al. (2004) find in their case study approach no significant impact of environmental measures on competitiveness of small and medium firms in a variety of countries and sectors in the European Union. Neither was competitiveness influenced by a positive environmental management culture. Clear proof of the Porter hypothesis is scarcely found (one example would be Murty and Kumar (2001) who examine upgrading of waste water technology in India). A shortcoming of most studies is that no systematic search for the impact of the type of environmental abatement measure was undertaken. In most cases the impacts of end-of-pipe technologies were measured, but not those of process-integrated or clean technologies.

Studies on the locational impact of environmental regulation examine whether a movement from nations with stringent standards to those with lower standards is observable. US and also international studies from the mid 1990ies have found out that the costs of environmental regulation are only of minor importance in the decision making process concerning the siting of new production facilities (see e.g. Ferrantino, 1995; Eskeland and Harrison, 1997). According to a literature survey by Jeppesen et al. (2002) newer studies which have used both more recent data and more refined estimation techniques have found much stronger evidence that capital flows respond to heterogeneous environmental regulations.

Another focus of the research literature has been on the effects of environmental regulation on trade to test for a loss of comparative advantage in environmentally sensitive industries. The question addressed is whether highly regulated industries suffer in terms of exports, whether production moves abroad and whether there is increasing investment by firms to less regulated countries. The older trade studies are mainly based on data from the 1960´s and 70´s and show that there are no significant effects for most industries (see Kalt,1988). The newer studies from the 1990ies find even less evidence to suggest that stringent environmental standards lead to a loss of competitiveness (see Ratnayake, 1996; Albrecht, 1998).

More recent studies examine the impact of environmental policy on foreign direct investment (FDI). Keller and Levinson (1999) as well as List and Co (2000) find a strong negative impact of pollution abatement costs on the total inward stock of US foreign direct investment. Xing and Kolstad (2002) find for pollution-intensive industries that weaker regulations do tend to attract capital. For less-polluting industries these results are not confirmed. An exception within these studies are the results suggested by Cole et al. (2002) and Fredriksson et al. (2003) which confirm a negative relationship, but a weaker one as in the other studies. A further specification in the newer literature is to examine whether domestic vs. foreign plant location decisions are dependent on variation in local environmental stringency. One study using a comprehensive data set that includes observations on both foreign and domestic plants has been carried out by List et al. (2004). They find the striking result that only new openings of domestic plants are influenced by environmental standards, confirming the results of List et al. (2003). Foreign owned firms are not deterred by stringent environmental regulations. This suggests a sort of double dividend: Foreign owned firms provide an economic stimulus for the host country (e.g. creating additional jobs, increasing local wages) and are not unduly influenced by stringent environmental regulation. Dean et al. (2003) suggest as a further explanation for this result that foreign direct investment is more likely to embody new technology and therefore adaptation to more stringent environmental standards might be easier for foreign than for domestic firms. A recent econometric study by Egger/Rave/Triebswetter (2006) show for Germany that a hypothetical harmonization of environmental standards in the major partner countries would lead to a net increase in German inward foreign direct investment.

In terms of methodologies the above has shown that there is an increased use of econometric and trade models in order to perform a sectoral analysis of the question at hand. On the firm-level, results are frequently based on case studies which can offer good data quality incl. information on cost savings, but they are by nature limited in the extent of data coverage. The mixed results from studies with different methodologies presented in the section above demonstrate that there is no coherent distribution of evidence across the various hypotheses in the environment-competitiveness debate. Evidence suggests that the impact of environmental regulation does indeed depend on the individual sectors of the economy and that model specification and study design do play a decisive role. One important further direction of research would be to further improve data quality at the micro level (e.g. data collection not only through interviews, but also through supplementary survey work) and feed this into the wider sectoral analysis. Also, the newer studies in the field concentrate on the issue of specific types of regulation, e.g. the impact of market based instruments like a carbon tax (see e.g. OECD, 2003).

Still, all in all, from an empirical point of view, a negative impact of environmental regulation on the output and employment of firms will be the larger the greater the rise in costs following compliance, the greater the differential cost penalty relative to domestic and foreign competitors, the more significant the compliance costs are in total costs and the greater the degree of price competition between firms and the greater the sensitivity of demand to price increases (OECD, 1993).

3.2 Existing literature on IPPC and competitiveness

The literature on the competitiveness impacts of the IPPC Directive on a sector level is still insufficient. The most comprehensive international study is the already mentioned Hitchens study of 2001 on the cement, pulp and paper as well as non-ferrous metals sector. Another, however, much smaller international case study on eco-efficiency in the dairy sector was carried out by Honkasalo et al. (2005). A feasibility study by Rave (2006) addresses the methodological problems in estimating the competitiveness impacts of the IPPC Directive. There are also a few, more local studies available (e.g. Clinch/Kerins (2002) on the efficiency of IPC licensing in Ireland; Pellini/Morris (2001) on the impact of IPPC implementation on the environmental and financial situation of the pig rearing industry in the UK using a life cycle assessment perspective and Larsson/Telle (2005) on BAT requirements in several Norwegian industries). Since the Hitchens study is regarded to be a role model for this study, it is presented in greater length than the other studies in the following paragraphs.

The Hitchens study focussed in a case study approach the impact of BAT on the economic performance and viability of existing plants in three different industrial sectors. More than 100 interviews were carried out in EU Member States, e.g. France, Italy, Spain, Germany, UK, Poland, Sweden, but also in Canada and Brazil (only in the pulp and paper segment). The study was carried out on the basis of the stringent assumption that plants were required to meet all the BAT conclusions as stated in the respective BREFs. The study asked two questions:

a) Is a BAT plant viable?
b) Is the application of BAT to existing plants likely to lead to a significant number of closures?

Furthermore the study tested a set of hypotheses of which the following two are central (see box 1 below for the detailed set of hypotheses):

“The adoption of BAT could place firms at a competitive disadvantage and lead to the loss of markets, particularly vis-a-vis countries with less stringent regulation. The regulated firm needs to redirect resources from other profitable opportunities, costs and prices rise, and markets and customers may be lost.

On the other hand the adoption of BAT although it may represent a short-term cost and burden to the firm, could push firms on to a higher growth path by forcing them to make product and process changes which yield higher competitiveness. The relationship between BAT and competitiveness is likely to be two way: the fact that the firm is competitive may lead to the early adoption of environmental initiatives while at the same time environmental initiatives are expected to have consequences for the competitiveness of firms” (Hitchens et al., 2001).

Box 1: **The detailed hypotheses of the Hitchens study**

(i.) The implementation of Best Available Techniques (BAT) could place firms at a competitive disadvantage and could be reflected in the loss of markets to imports from countries with less stringent environmental regulation.

(ii.) High environmental standards and strict enforcement, although they may represent a short term cost and burden to the firm, could in the medium and longer term push firms on to a higher growth path by forcing them to make product and process changes which yield higher competitiveness. If this happened it would represent part of the so-called "double dividend", i.e. gains in environmental performance would also be accompanied by increased economic performance.

(iii.)The proportional cost of compliance (relative to turnover) by the firms is likely to be a negative function of the productivity level (i.e. firms which in general have the management and other capabilities to produce high productivity and competitiveness also find it easiest to adapt to the specific challenge posed by environmental measures)

(iv.) The proportional cost of compliance is also likely to be a negative function of the size of plants/firms.

(v.) The age of the plant and machinery in each firm is likely to impact on environmental outcomes, costs of compliance and the number of clean technology initiatives undertaken. The younger the capital stock the better the environmental outcomes. Plants with very old capital stock may also be at the point of replacement investment

(vi.) Plants with a higher proportion of skills, or those with strong R and D efforts, are more likely to introduce a large number of clean technology initiatives and be more successful in reducing environmental costs.

(vii.) Where multinational branch plants are sampled in those parts of the EU with the lower environmental standards/enforcement, they will generally have higher environmental standards than indigenously owned plants making similar products.

(viii.) Relations within the supply/production chain are likely to be both an influence upon, as well as being influenced by, the level of environmental standards, e.g. a manufacturer may find it easier to increase the environmental standards of its products if it has a reliable and competent base of suppliers to draw on. A manufacturer may be forced to upgrade product and process environmental standards by pressure coming from the customers of plants in the three sectors under study.

(ix.) Location can affect the cost of compliance and adoption of clean technology. There are important competitiveness differences between countries in the Community, and underlying these differences are differences in productivity and skills, the capacity for advanced research and development and differences in cost of capital (i.e. amount of supportive subsidies among other things) , and since these may be important factors influencing the ability of a firm to efficiently adapt to regulations, then there is the potential for environmental policy to differentially influence the competitiveness of firms between regions and countries.

Source: Hitchens et al., 2001, p. 28.

The study captured both these negative and positive factors which influence the costs or benefits arising from an adjustment to the adoption of BAT. The sample comprised so-called "BAT plants" with many or all BATs as specified in the respective industry BREF document and also "non-BAT" plants with only a few BATs in place. Furthermore the classification "BAT plants" and "non-BAT plants" was also undertaken on the basis of the actual emission levels reached with respective BATs. While this classification turned out to be useful for analytical purposes, it was not based on a detailed examination of the institutional and legal framework conditions for industrial permitting in different countries or regions. As the transposition and implementation of IPPC was still at an early stage when the study was undertaken, it remained unclear how BAT would eventually be interpreted by local authorities and what possible (other) requirements permitting would entail.

The three main results of the case study applied to pulp and paper manufacture, cement and lime production and non-ferrous metals processes are as follows:

1. Primary measures (process-integrated measures) had a generally positive impact on productivity and plant performance. Secondary (i.e. end-of pipe) measures had a mixed impact on plant performance: some had a positive impact, others were neutral and others had a negative effect.

2. When BAT measures as a whole were related to plant performance, strong BAT/environmental performers were not economically disadvantaged, i.e. they were not doing any worse than any other plants with less BATs in place and still having higher emissions. In many cases there were special circumstances which facilitated good environmental performance at minimum compliance cost. These facilitating factors comprised:

- high physical productivity (this illustrated the strong competitive position of a plant),

- modern or technically up to date machinery (this ensured efficient production both in economic and natural resource terms),

- plant growth (both in terms of turnover and physical output)

- high quality human capital inputs (including skills, management and R&D),

- continuous investment in environmental initiatives (was found to be important with respect to the size of investment required for the adoption of BAT; this investment could be related to location and the history of regulation in a particular Member State).

- ownership (was found to be important due to reasons of economies of scale in multinational enterprises, use of human capital, experience and, where necessary, plant rationalization).

3. Many plants with a strong environmental performance were able to use this as a competitive strength. Infrequently was environmental performance considered a competitive disadvantage.

In addition, based on an analysis of investment needs by non BAT-plants sampled, further competitiveness implications for the three sectors under concern were found. In the cement case, for those plants producing cement with dry technology competitive risks were minimal provided that implementation would be undertaken appropriately, i.e. with sufficient time for planning investments. In the semi wet/semi dry area of the cement sector there were many concerns about the likelihood of closure following a stringent implementation of BAT. In non ferrous metals there were many fewer competitiveness problems associated with the introduction of BAT, although there were different levels of investment required by different plants. Only few plants risked closure. In the paper and pulp sector Jaakko Pöyry (a sub consultant for the Hitchens study) estimated the percentage of capacity and number of plants requiring different levels of investment to meet 80% of the required BATs. According to the Jaakko Pöyry estimates the number of mills at risk of closure following a sharp implementation of BAT was supposed to be 20% or less.

Overall, the Hitchens study concluded that the understanding of how IPPC may be implemented was an essential backdrop to a judgement of economic implications as indicated in the study. This had been a continuous problem in discussing the question of the impact of BAT on competitiveness with industry members while carrying out the study. The study concludes that the principal requirement is for realistic timescales and the recognition by authorities and the plants themselves of the opportunity for implementation of BAT in a sustainable or competitive way.

Strengths and weaknesses of the Hitchens study

From a methodological point of view the Hitchens study implies certain strengths and weaknesses.

The strengths of a micro study is that it recognizes differences existing between plants. These are also important when considering the implementation of BAT. Furthermore, a micro study allows for the possibility of measuring and ranking factors which influence the adoption of BAT and compliance costs. In the interviews managers could answer the detailed questions about the impact of specific environmental initiatives on firm performance. Overseas visits facilitated an understanding of environmental performance by competitor plants.

However, a micro approach also has its weaknesses. Naturally, it is difficult to achieve statistical representativeness with a case study approach. Sometimes it was difficult to achieve co-operation from particular Member States. In some cases there was an undue dependence on ‘expert opinion’ and ‘professional judgement’. Also, there can be problems identifying plants with the full range of BATs and plants which also reach strong environmental performance standards. Knowledge about the emission reduction associated with a particular BAT is required in order to show which BATs are sensitive.

Further studies on the IPPC Directive in relation to competitiveness aspects

Based on the work of Hitchens et al. (2002) a number of recent studies look at the economic implication of IPPC implementation for specific sectors or specific countries. For the UK, Pellini and Morris (2002) conduct a case study on IPPC implementation in the pig industry at the level of individual installations using a range of environmental and economic performance indicators and comparing various with and without IPPC scenarios. Their “affordability analysis” finds that, given the current depressed state of the sector and depending on size and location of plants, IPPC compliance could threaten the viability of the existing production units. Yet, IPPC is also likely to drive innovation and structural change in the industry. Pellini and Morris (2002) suggest that considerable management resources will be needed to meet IPPC permit requirements for planning, monitoring, control and record keeping.

In a broader assessment for the UK as a whole Atkins (2006) examines the additional costs and benefits as well as the regulatory burden and the likely competitiveness impacts of the new Pollution Prevention and Control (PPC) regulation using a survey of relevant sites. They suggest that there's little evidence of the competitive impact of IPPC on business, even though some survey respondents claim the contrary. Atkins (2006) also finds that many companies are improving resource efficiency as a direct consequence of the regulations, which may assist in bringing about cost savings. However, the survey results also indicate that small and medium-sized companies feel at a relative disadvantage compared with larger sites.

In a cross-country perspective, Honkasalo et al. (2005) examine the role of the IPPCD as a driver for eco-efficiency in the dairy industry in Finland, Sweden and the UK given the current stage of the national implementation process. Eco-efficiency is defined as economic efficiency combined with environmental benefits. The study solely focuses on resource efficiency as part of eco-efficiency[9] and shows that the success of the IPPC Directive as a driver for eco-efficiency will heavily depend on two factors: On the one hand, the BREF documents have to provide adequate information on preventive environmental solutions and challenging BAT associated emission limit levels. On the other hand, the national permitting process following the transposition of the Directive where national authorities use the BREF as a basis for discus-

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[9] Other aspects of eco-efficiency include reduction of environmental impacts and the higher value of goods and services (World Business Council for Sustainable Development, 2000).

sions with companies will play a decisive role. For the dairy industry it is found that the BREF is not very specific and not of great help to regulators because it is woven into the food processing industry. Given the stage of the national implementation process at the time of the study it appeared that the IPPC Directive would not significantly influence eco-efficiency – and also (although not researched in detail) as an indirect consequence competitiveness - in the dairy industry. Both in Sweden and Finland this was due to low expectations from the involved parties. In the UK, the specific application forms outlining BAT for the sector seemed to be more promising

The VITO BAT-centre in Flanders (Belgium) is quite advanced in incorporating economic aspects in BAT-analyses for specific sectors using a quantitative framework of three interconnected building blocks - industry analysis, an investment calculation and a feasibility assessment (Vercaemst and Dijkmans, 2002). Especially the latter allows to decide whether costs of candidate-BAT are excessive or not for the industry and whether the cost of a candidate BAT are excessive or not compared to the environmental benefits obtained. For this purpose, VITO uses a partial equilibrium model and financial ratios to compare the financial strength of an industry with or without investment in candidate-BAT. In a recent analysis for the ceramic industry in the Flemish region of Belgium the viability (feasibility) analysis reveals, for example, that in comparison with other industrial sectors the ceramic industry in Flanders remains one of the poor performing sectors and that the relatively weak financial position could be partly explained by the investments in BAT (Vercaemst et al., 2005).

Finally, Larsson and Telle (2005) calculate in an economic modelling approach the cost of BAT implementation for four of the most energy intensive industries in Norway (pulp and paper, primary aluminium, ferro alloy and inorganic chemistry) where IPPC implementation is also underway. They show that the requirement of implementation of BAT for all plants at a given point in time may trigger the danger of economic inefficiency, i.e. an emission reduction could be achieved at lower costs, or alternatively that emissions could be further reduced at the same costs. This result also reflects the conclusions of the Hitchens study where the need for sufficient timing of BAT investment was stressed.

3.3 Basic hypotheses and considerations for data analysis

In order to assess the competitiveness impacts of different approaches to the implementation of IPPC some hypotheses were developed. In principle, we follow the approach by Hitchens et al. (2001) and extend it by adding research questions concerning the pace of implementation.

First of all, we take up the central consideration of Hitchens et al. (2001) that the relationship between BAT (or here rather the approach to implementation of BAT) and competitiveness is likely to be two way: the fact that the firm is competitive may lead to the early adoption of environmental initiatives while at the same time environmental initiatives are expected to have consequences for the competitiveness of firms. Therefore we expect both positive and negative competitiveness effects of IPPC implementation at company/site level.

Positive effects could follow an IPPC implementation which stimulates innovation, improves efficiency or creates comparative advantages and spin-offs in terms of new production activities and advantages.

Negative impacts on competitiveness from IPPC implementation on the plant level will be greater where environmental compliance costs rise and the differential cost penalty relative to domestic and external competitors is growing. Also, when prices increase due to environmental costs and demand is sensitive to price, a loss of competitive strength is to be expected. Negative impacts can also be foreseen where margins and profits are tight and where environmental costs rank high among the threats facing the firm. Moreover, when firms face strong competition from countries where regulation is less stringent, negative impacts are likely.

The survey and interviews attempt to collect data on these possible positive and negative effects from IPPC implementation. The data analysis will particularly focus on the question whether plants already having an IPPC permit are any different from those not yet possessing a permit, i.e. whether they have special conditions facilitating early IPPC implementation. This of course will depend on the regulation in the respective Member State prior to IPPC and the specific approach to implementation, but also on plant specific items like size, age of equipment, environmental and competitive performance.

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PART II: Broader analysis of the institutional context and potential competitiveness impacts

4 Institutional and country-level analysis

The IPPCD implementation approach of MS - or more broadly, the institutional context of individual MS - heavily influences the regulatory conditions under which individual companies with IPPC installations operate. An economic impact assessment that does not take this variety seriously and does not appreciate the influence of the national and sub-national level on permitting and enforcement systems would be incomplete and could easily be misleading. The aim of this chapter is therefore to shed some light on how selected MS go about integrated pollution prevention and control and compare the approach across countries. This is not done for its own sake, but as a means to better frame the subsequent case studies (see chapters 7 and 8). For this purpose we draw and elaborate on the framework and the hypotheses of chapter 2.2.

There are many reasons why such an institutional analysis is necessarily incomplete and potentially one-sided. Firstly, there is a lack of sufficiently detailed and systematically collected information on the implementation and application of environmental law in the EU (and beyond). Secondly, it is very difficult to provide a common frame of reference to be able to compare (available) data and information across countries. Thirdly, information needs to be pertinent to the subject of this study. Beyond data availability the usefulness of these data may be debateable given the indirect link between IPPC and competitiveness.

To meet these challenges this chapter heavily draws on a quite up-to-date and comprehensive empirical study by Bohne (2006). Based on 138 expert interviews with public and private actors, a survey of 178 public authorities and document analyses the author undertakes a comparative analysis for 8 MS of the degree of procedural, organisational and substantive integration of the national permitting and inspection systems. Out of this study we use selected indicators (or sets of indicators) for 5 MS (Germany, France, Great Britain, Italy and Spain). These indicators seem to be most relevant to better appreciate the potential economic impacts of the IPPCD. In addition, we employ other available cross-country indicators from the Global Competitiveness Report, other studies informing the IPPC review and available literature (also for some other MS). The information provided by ENTEC (2006) and the MS implementation reports to the Commission were also considered for this study in particular for the description of the institutional context. These quantitative indicators are put in context by providing (as much as necessary) country-specific information and by interpreting or qualifying indicators through additional interviews. For this purpose and to complement the interviews of Bohne (2006) own interviews with national or regional authorities will also be incorporated into this chapter[10].

[10] Some of the information (especially with regard to the two case-study sectors) can also be found in chapters 7 and 8; see cross references).

4.1 The similarity of national to the IPPC permitting regime

All EU Member States had a permitting system for industrial installations in place, prior to the entry into force of the IPPC Directive in 1996. The permitting system of Member States had to change to various degrees due to the legal requirements of the IPPC Directive. Some Member States had to make few adaptations, for example by including additional sectors into the permitting systems. Some other Member States had to adopt completely new legislation and some even had to more fundamentally restructure the current sectoral permitting system to comply with the integrated philosophy of the IPPC Directive. These differences explain in part why the transposition of the Directive has been delayed in some countries, or why some countries have transposed the Directive only partially in the first years after the IPPC Directive entered into force. Table 3a) gives an overview about national environmental regulations and statutory orders transposing the IPPC Directive. The table 3b) below lists up the main changes of the permitting system due to IPPC and broadly ranks Member States by the degree of similarity between the pre-IPPC permitting regime and the new IPPC-compatible permitting regime. It is evident that starting positions of Member States were quite different (e.g. between Poland and Germany)[11]. Among Member States with a high degree of similarity to the IPPC regime it also needs to be taken into account whether countries have opted to undergo a complete re-permitting (for example the UK), or whether the old permit is more or less automatically updated by small alterations in national regulations (Germany).

Table 3: a) **Overview of the transposition of the IPPC Directive into national environmental regulations in selected Member States**

Member States	**Environmental regulations**
Belgium	Flanders: Order of 6 Febuary 1991 concerning environmental licenses (Vlarem I), Order of June 1 1995 concerning general and sectoral conditions to environmental safety (Vlarem II); Walloon: l'arrêté du 4 juillet 2002 fixant les conditions générales d'exploitation des établissements visés par le décret du 11 mars 1999 relatif au permis d'environnement
France	Environmental Code (fifth book) ; arrêté du 2 février 1998 relatif aux prélèvements et la consommation d'eau et les émissions de toute nature des installations classées
Germany	BImSchG of 26 September 2002, 9th BimSchV (procedure), TA Luft of 24 July 2002, TA Lärm of 26 August 1998, annex of waste water order of 15 October 2002
Italy	Dlgs 372/99 of 4 August 1999, Dlgs 59/2005
Luxembourg	Loi du 10 juin 1999 relative aux établissement classés et loi du 19 novembre 2003 (modification)
Poland	Environmental Protection Law of 27 April 2001 Environmental Protection Law of 27 April 2001 (Dz. U. 2001 Nr 62, poz. 627 z pózn. zm.), Regulation of 26 July 2002 concerning types of installations which may cause significant pollution of environmental components or the environment as a whole (Dz. U. Nr 177, poz. 1055)
Spain	Ley 16/2002 de 1/7/2002 (Ley de Prevención y Control Integrados de la Contaminación)
UK	Pollution and Prevention Control Act of 27 July 1999, Pollution and Prevention Control Regulations of 23 June, Statutory Instrument 2000 No. 1973

[11] It is difficult to clearly pin down the notion of similarity. In principle it would make sense to also include the level of stringency or the relative regulatory intensity of Member States before the IPPC came into force. However, the IPPCD does hardly proscribe any measurable benchmarks, and it is only the Sevilla process (BREFS) that give some indication about the level of changes necessary in special industry sectors of Member States. Part of what falls under "similarity" is therefore treated in section 4.2 and chapter 7.

b) **The national permitting regimes and their similarity to the IPPC regime**

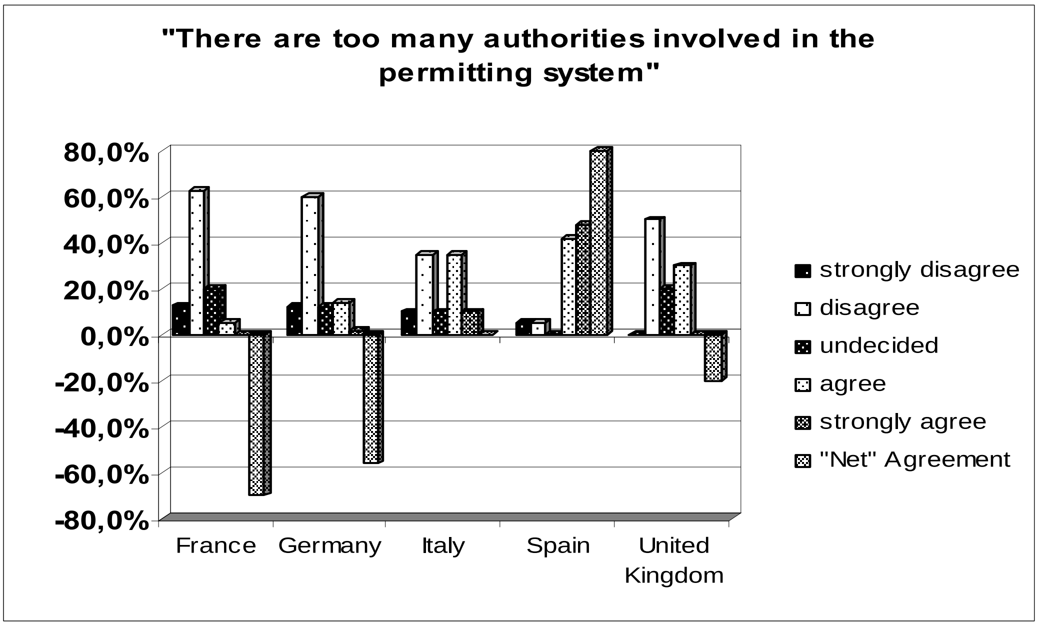
Country	**Main changes of the permitting system due to IPPC**	**Degree of similarity between pre-IPPC permitting regime and current IPPC regime**
France	Few changes in secondary environmental regulations	high
Germany	Stronger procedural coordination of the permitting process (water, other media); few adaptations in the German imission protection law (BImSchG) and secondary regulations (e.g. inclusion of EIA in permitting application forms, need for efficient energy use)	high
Italy	Transition from a sectoral and media-specific permitting and inspection system to a more integrated regulatory system; Integrated environmental permits replace the sectoral permits for air, waste-water discharges, waste and the municipal activity permit; Partial integration of EIA into the permit procedure; Some changes in the competences distribution and the coordination activities between national, regional and provincial permitting authorities.	low
Spain	Transition from a sectoral and media-specific permitting and inspection system to a more integrated regulatory system; revocation of previous national environmental and sectoral authorisations (for IPPC affected installations); only Autonomous Communities have the competence to give the Integrated Environmental Authorisation.	low
UK	Minor changes to legally comply with the IPPCD; inclusion of some new sectors into IPPC, consideration of a wider range of environmental impacts	high
Luxembourg	Marginal changes to legally comply with the IPPCD, no discernible "material" or conceptual changes in permitting regime	high
Belgium (Wallonia)	Streamlining, stronger co-ordination among competent authorities, systematic collection of (previously dispersed) permitting information, creation of an IPPC centre as expert and contact point, delivery of one permit only/ check-up of validity of permits for existing installations	medium
Poland	Transition from a permitting regime which used to be comprehensive, but relatively fragmented (among sectors and media, between permitting authorities); stronger focus on pollution prevention and not only pollution control, introduction of technical considerations (no BAT in previous Polish system)	low

4.2 Differing administrative structures and resources

Industrial permitting is based on certain decision-making structures which are similar across countries (permit application, consultation, permit decision, inspection, etc.). Specific procedural and substantive requirements of EC Directives allow -in principal- a high degree of comparability among regulatory systems of EU MS. Yet, there are significant structural differences between national regulatory systems which reflect different historical experiences, different political priorities and different attitudes towards environmental protection. Apart from more fundamental differences (e.g. the forms of state) administrative structures and practices of implementation of environmental law remain diverse and show distinct national characteristics despite a certain degree of regulatory convergence in EU MS. This section gives a (necessarily rough) impression about the importance of differences of administrative structures and resources in industrial permitting, mainly by drawing on the empirical study of Bohne (2006). Some indicators have been selected that we think have the closest potential link to the subject of competitiveness.

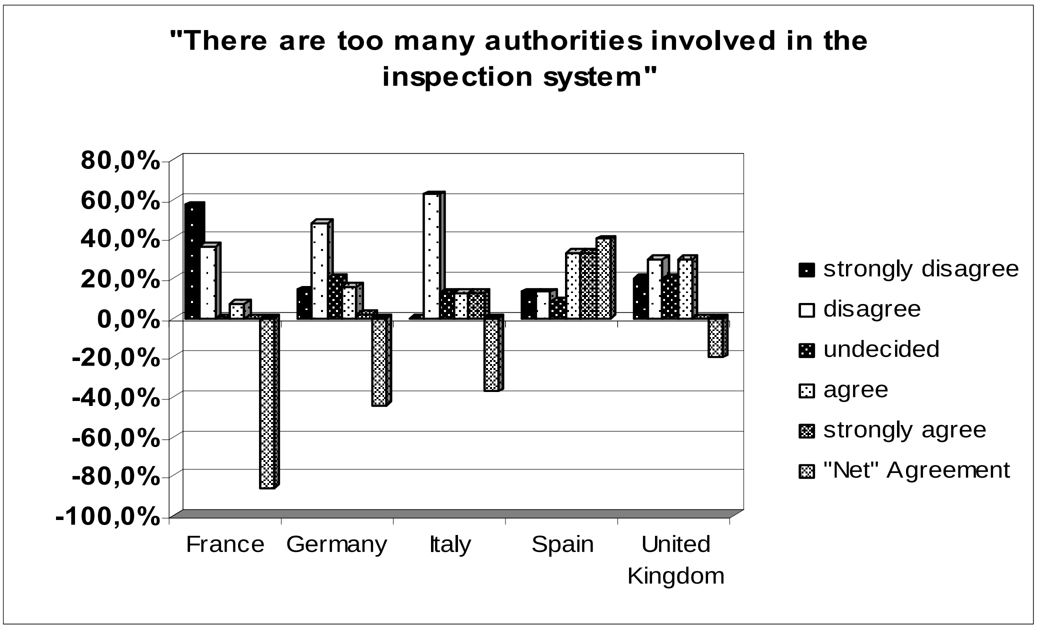
The permitting and inspection system may place a burden on operators of IPPC installations, if there are too many authorities involved, the distribution of competencies is unclear and the coordination among competent authorities is not well-established. Graphs 2-5 show considerable variation in the self-perception of surveyed competent authorities in the five MS.

Graph 2:



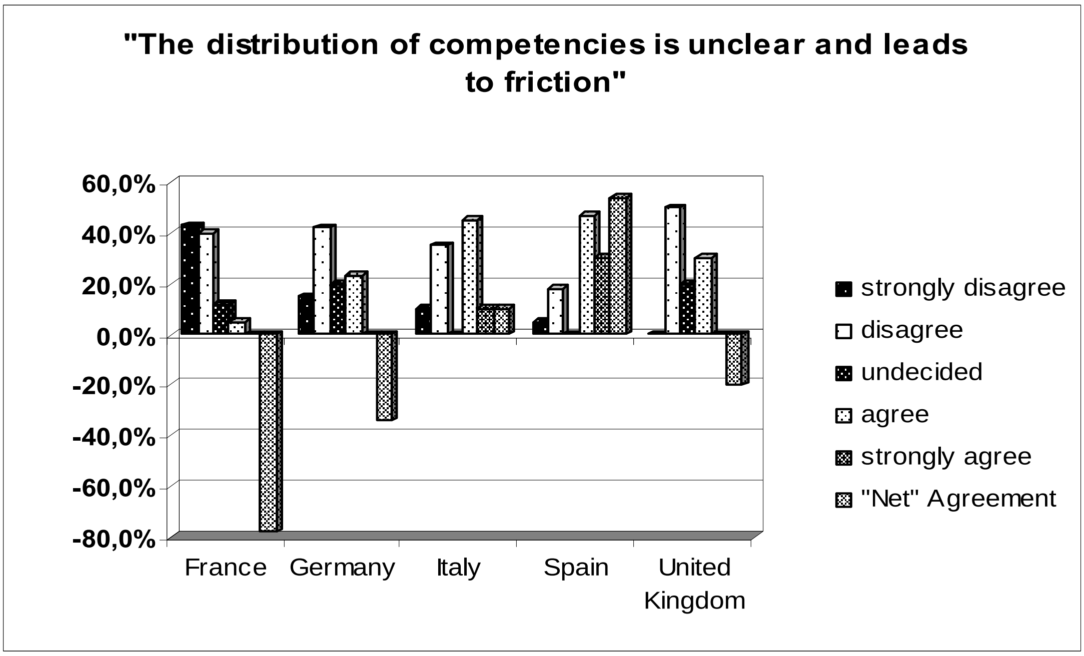
Notes: The column “net” agreement is calculated by subtracting “strongly disagree” and “disagree” from “strongly agree” and “agree”.
Number of respondents: FR: N=16, DE: N=51, IT: N=9, ES: N=17; UK: N=6.
Source: Bohne (2006).

Graph 3:



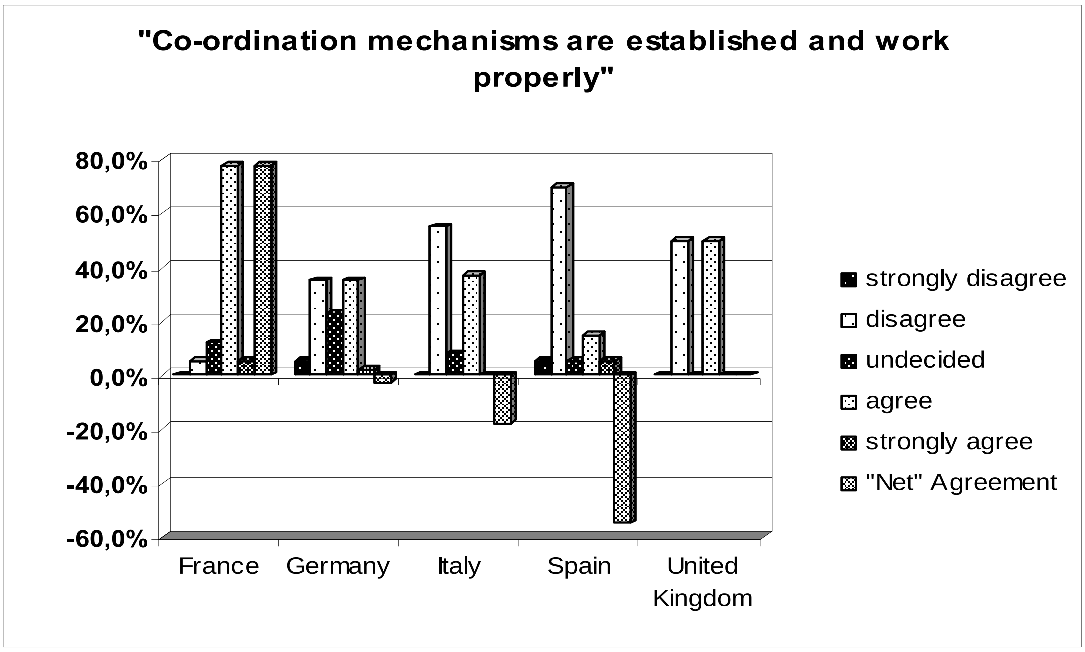
Notes: The column "net" agreement is calculated by subtracting "strongly disagree" and "disagree" from "strongly agree" and "agree".
Number of respondents: FR: N=16, DE: N=51, IT: N=9, ES: N=17; UK: N=6.
Source: Bohne (2006).

Graph 4:



Notes: The column "net" agreement is calculated by subtracting "strongly disagree" and "disagree" from "strongly agree" and "agree".
Number of respondents: FR: N=16, DE: N=51, IT: N=9, ES: N=17; UK: N=6.
Source: Bohne (2006).

Graph 5a):



Notes: The column "net" agreement is calculated by subtracting "strongly disagree" and "disagree" from "strongly agree" and "agree".
Number of respondents: FR: N=16, DE: N=51, IT: N=9, ES: N=17; UK: N=6.
Source: Bohne (2006).

French authorities turn out to be most satisfied with their administrative structures and interviews with industry and NGO seem to confirm this (Bohne 2006, p.172). This may be explained by the relatively straightforward institutional design of a "deconcentrated" permitting and inspection system: the prefect as the representative of the national government at the regional level fulfils primarily administrative-regulatory functions whereas the so-called DRIRE serves as an agency with clearly defined technical-scientific functions.

The overall situation in Germany seems to be similarly positive. The fact that the permitting process is largely canvassed by the German immission protection law (concentration impact of the BImSchG) facilitates the procedure for the operator. As suggested by the study of Rauscher (2001, p.168) some problems may still result from the fact that regulatory decisions need to be co-ordinated between the municipal water authority and the state environment authority. Also, Bohne (2006, p.219) cites an industry representative complaining about the amount of necessary inter-agency consultation. Representatives of the German Environmental Protection Agency feel more positive about the functioning of the formal co-ordination obligation (in the sense of §7 IPPCD) and suggest that a further impetus to streamline permitting is likely to occur, if the plan to subsume major parts of environmental legislation in one Environmental Code will eventually be realised (permitting of IPPC and non-IPPC installations, co-ordination among media) (own interview).

UK authorities are also by and large content with their administrative structure. IPPC has not brought about major change in the competence distribution and power balance between the Environmental Agency and local authorities. According to own interviews at the Environmental Ministry co-ordination mechanisms are well-established and generally work properly. The more negative picture of Bohne (2006, p. 451) results from the potentially unclear relationship between the environmental permit and the planning permission (political nature of the latter and technical nature of the former, different issues decided upon separately).

The situation in Italy and especially in Spain is much more critical according to Bohne (2006) highlighting the administrative difficulties in setting up an integrated permitting and inspection system. Regarding Italy reform efforts in the latest years suggest that co-ordination efforts have at times improved whereas competence and power structures remained essentially unchanged (Bohne, p. 254). The new integrated environmental permit replaces the sectoral permits for air, waste water discharges and waste as well the municipal activity permit and permitting competence for Annex 1 installations of Dlgs 59/05 (i.e. not those in Annex V) is assigned to the authorities designated by the regions or autonomous provinces (i.e. regions, provinces or municipalities). While this is in line with the spirit of IPPC, the decision competency of the competent authorities remains limited making the overall decision structure still quite fragmented: Firstly, the former “sectoral” permitting authorities have veto power in the conference of services. Secondly, municipalities may impose additional prescriptions for classified “unhealthy Installations” concerning the protection of local public health. While this may give rise to conflict or cause delay, own interviews at ARPA Lombardia reveal that some improvements in the co-ordination mechanisms have taken place (e.g. early pre-tests of permitting processes, strong position of ARPA in co-ordinating activities, set-up of databases to facilitate communication). At the same time, interviewed representatives of the Lombardian authorities had very mixed feelings about progress in other regions of Italy (lack of procedural guidelines, unstable organisational framework, etc.).

In Spain only the Autonomous Communities have the competence to authorise the Integrated Environmental Permit. Law 16/2002 on Integrated Prevention and Control drastically changed the air, water and waste control system by replacing previous decisions on air pollution control in the municipal activity permit as well as the waste permit and the permit for wastewater discharges into regional surface waters.[12] According to a study conducted by Ramboll Management (2005) Spain faced several challenges during the transposition of the IPPC Directive. Under Spanish constitutional law the power to enact environmental legislation is shared between the national institutions and the Autonomous Communities. This made both political and judicial co-ordination necessary. The basic legislation is applied across the country, but regions can apply more stringent environmental standards. So far most of the Autonomous Communities have not used this right to further develop the law.

According to own interviews with authorities in Spain the integration aspect of the Law 16/2002 has significantly simplified the permitting process. In particular, the integration of the previously different proceedings for different permits into just one permit application is seen as simplifying step. Also the previous dispersion of responsibilities providing different permits is avoided by the integrated approach. In the new system just one administration has the final responsibility for granting the permit. At the same time - and despite the reduction of the number of permitting procedures - the number of regulatory decisions on various administrative levels seems to remain high which may lead to conflicts (as suggested by the survey of Bohne, see p. 344, 357). However, there are also examples where the role of one person acting as negotiator between administration and regulated companies was perceived in a very positive way by business because the number of contacts between industry and authorities could be drastically reduced. This makes the permitting system more efficient (experience in the Basque country, own interview).

There are two levels of competent authorities in Poland, voivods at the regional level and poviats or starosts at the county level. An important concern is currently that the quality of permits differs substantially due to the high number of authorities involved in permitting (400 powiats 16 voivods). This can easily give rise to inconsistencies.

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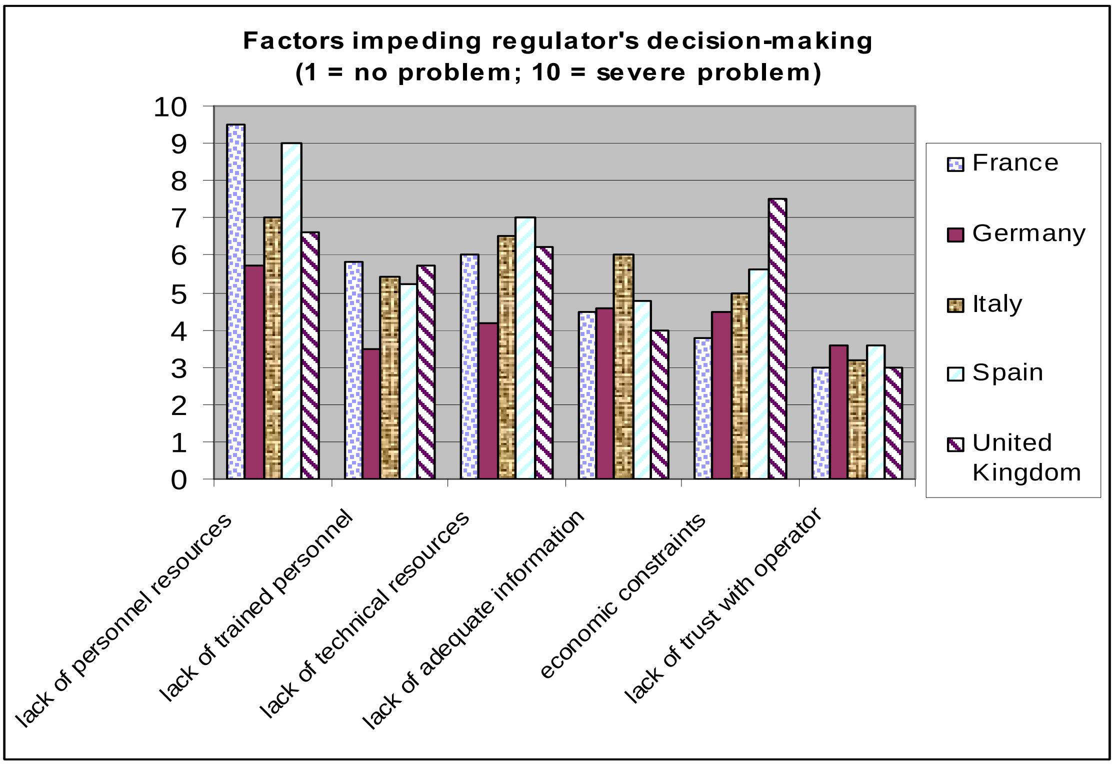
[12] If waste water is discharged to a river flowing through different Autonomous Communities (interregional basin), the Autonomous Communities will coordinate the preparation of a report on discharges with the Hydrographical Confederation.

Apart from the structural features, competent authorities have been asked to name factors impeding regulatory decision-making. These factors relate mainly to the level and quality of financial, technical and human resources. As mentioned in chapter 2 we suspect a high level of administrative resources and a high level of professionalism, integrity and training to less likely lead to unequal treatment and competitive distortions.

Major problems result in all countries from a lack of staff resources or trained personnel. Complementary interviews help to put these findings into context on a country-by-country basis. In France interviews of Bohne (2006) revealed that there is a particularly low number of inspectors given the number of installations to be inspected. However this has become better after the accident in Toulouse. In Germany the situation is relatively favourable. Own interviews at the German environmental protection agency, however, show that budgetary pressures can have an impact on the capacities of authorities to effectively perform their duties. For example, concerns have been raised about negative implications resulting form the devolution of authorities at the regional level (Landesumweltämter) and a trend towards "municipalisation" of permitting (for example in Lower Saxony). Typically, local authorities lack expertise necessary for high quality permitting. In Spain the lack of personnel of some Autonomous Communities and the concentration of applications are overcome subcontracting some aspects of the permitting process to independent experts. The main implication of this lack of personnel is a possible delay in the permitting process. Discussions with Polish authorities suggest that there may be some important differences in IPPC permitting between voivods and powiats both with respect to the general approach and the level of resources. On one hand, elected starosta (powiat level) fulfil a broader mandate vis-à-vis the interest of the local public, whereas the voivod acts as a more "distant" state representative executing and enforcing national law. On the other hand, it may be easier for the voivods to obtain the necessary information and assure a high level of human and technical resources. Some concerns about lack of resources to carry out all the necessary enforcement tasks are also stressed by representatives from the inspectorate. The situation is not likely to improve since the competence for IPPC permitting in the regions will move from January 2008 to the representative of the national government in the regions to the regional governments, making the coordination even more difficult. In addition only very few guidance documents on specific legislation have been drawn up to support consistency in implementation (see also section 4.3).

Graph 5b)



Source: Bohne (2006)

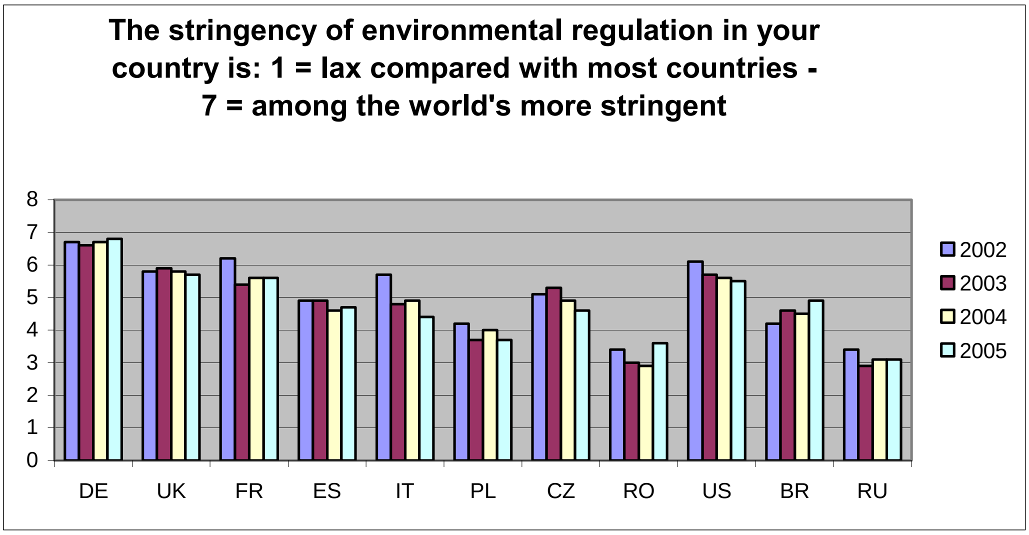
4.3 Differences in the delivery of permitting and enforcement "on the ground"

The requirements and conditions imposed on operators in their permits and during permitting usually have a more direct impact on competitiveness. They will be discussed in the following chapter.

The economic literature discusses primarily the impact of stringency of environmental regulations on economic competitiveness. However, the quality, quantity and stability of regulations may as well have the same importance as their stringency. Since there is no overall picture about the importance of these parameters for setting permit conditions we discuss here some more general insights from the World Competitiveness Report and contrast them, if possible, with results from Bohne (2006). Chapters 7 and 8 will then present some more sector-specific findings (especially on the stringency of ELVs across countries).

Graph 6 displays the perceived stringency of environmental regulations in different countries. (Note: Graphs on stringency are also available for different environmental media (e.g. stringency of wastewater regulations), but there is not much of a difference to the overall picture presented here). Environmental regulations are perceived the most stringent in Germany. With some distance this is followed by countries like the UK, France or the US. A similar level of stringency is then accorded to countries like Italy (with a somewhat surprising downward trend), Spain and the Czech Republic. Poland and Brazil follow suit, but Brazil is apparently catching up in its level of stringency. Finally, Romania and Russia are perceived as the least stringent of the countries shown.

Graph 6:

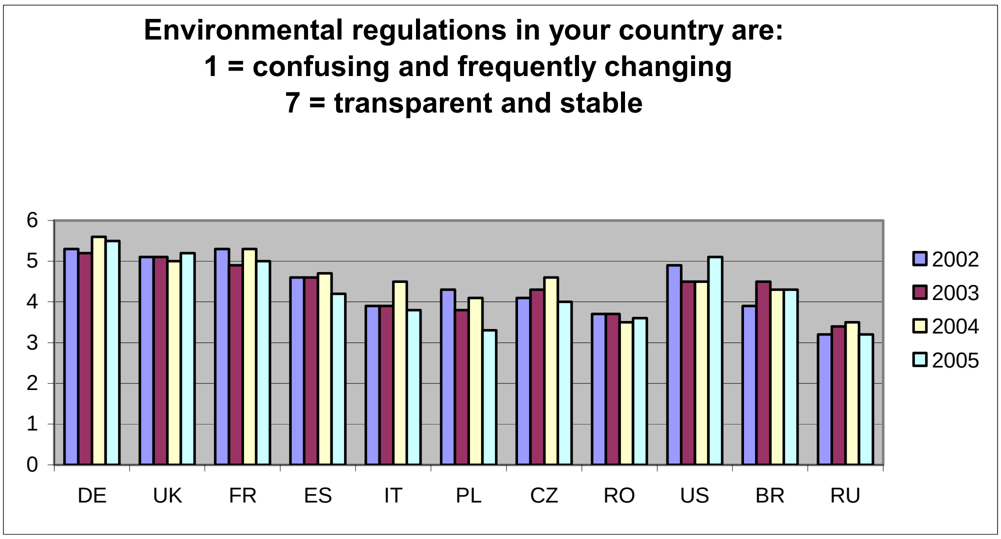


Source: World Economic Forum (various years). Average N = 84, ~ 1/3 from industry

The following graph 7 from the World Economic Forum on the transparency and stability of regulations show a similar ranking between countries. However, when contrasted with the results of Bohne, these results are not always confirmed. Thus, the perception of executive managers (WEF) and the authorities surveyed by Bohne may differ. This is most notable for France and Germany. Both countries take a top position regarding the transparency and stability of regulation asked for in the World Competitiveness Report. In Graph 8 the situation seems to be more ambivalent. Interviews of Bohne in Germany have shown, for example, that it has to be differentiated between the various laws. Whereas the federal air pollution control and noise abatement act (BImSchG) is considered, by and large, to be clearly structured, public authorities and industry complain more often about the waste and water laws. The number of regulations and the frequency of their amendments are also seen as problematic in both countries. The problem in France, as explained during an interview with authorities, lies within the numerous application orders and the frequent amendments that the authorities have to keep up with to make permit decisions compliant with existing law.

Italy and Spain score still relatively favourable in the World Competitiveness Report, but less so in Bohne (2006). For Italy, for example, there is quite a strong disagreement with regard to the clarity and precision of regulations. Authorities expressed their frustration about the fact that Italian regulations are complicated and fairly fragmented (Bohne, 2006, p. 268). Regulations also change very frequently. In Spain the major concerns result from the fact that legislative overlap makes Spanish environmental law extremely complex and diverse. Regulations may potentially duplicate or contradict each other (Bohne, 2006, p. 342). The situation in the UK seems to be most favourable. Specially, primary environmental legislation is perceived as clear, transparent and precise. Some concerns were raised during interviews about secondary legislation, especially about the diversity of interpretation of guidance material and possible inconsistencies resulting thereof.

Graph 7:

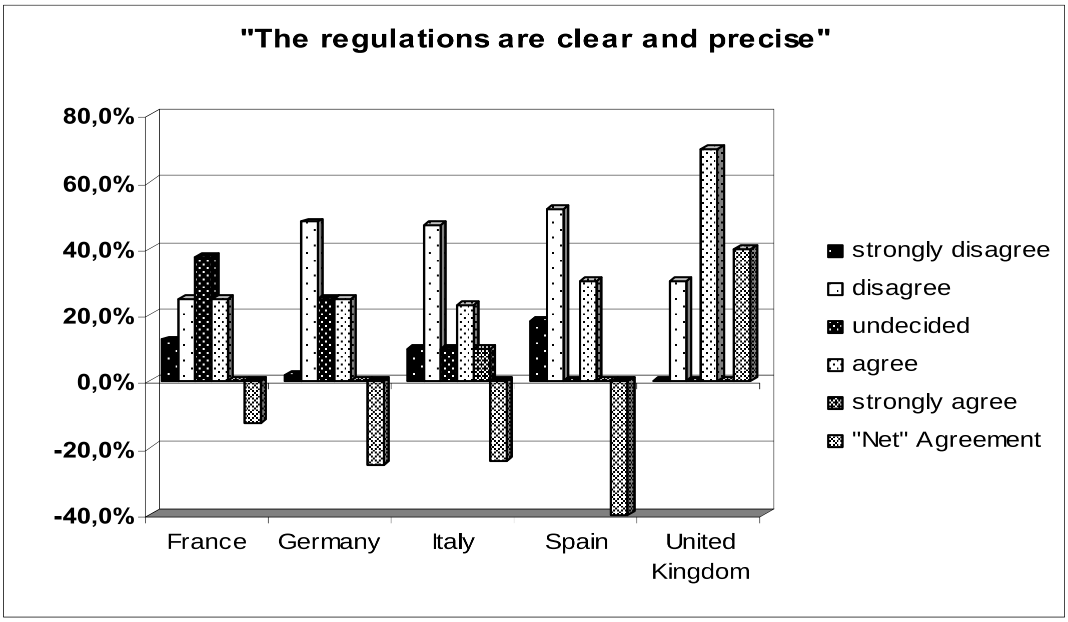


Source: World Economic Forum (various years). Average N = 84, ~ 1/3 from industry

Pre-application contacts

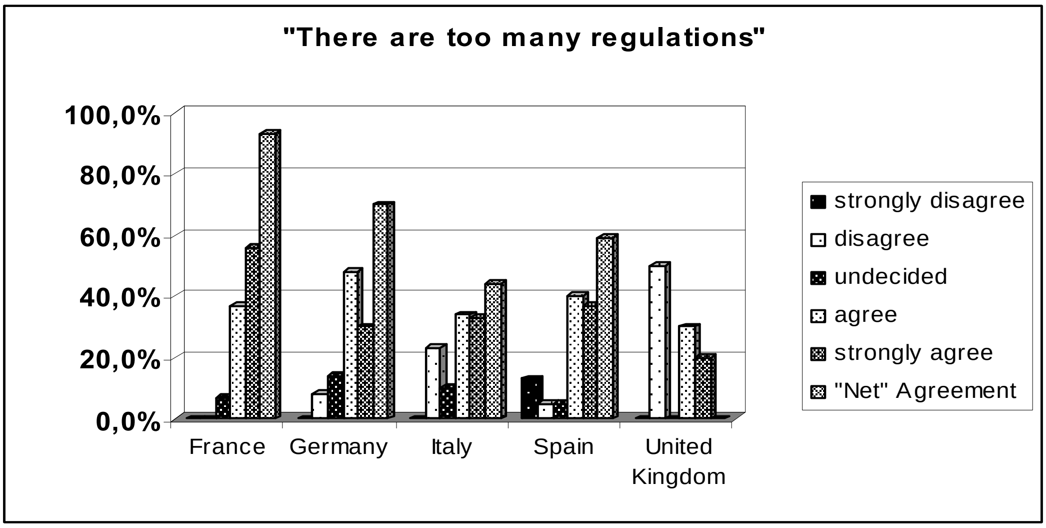
For the companies it matters whether or not they can agree with competent authorities about the contents and the requirements of the permit at an early stage. Bohne (2006) shows that practically in all countries pre-application contacts are common practice (without major variation between countries). This was confirmed in some of our own interviews conducted for this project (e.g. in Italy and Spain). For example, in the Basque Country an important number of voluntary agreements have been developed between the Basque Government and different industrial sectors as Steel, Cement, Pulp and Paper, Glass, Ceramics, Chemical, Waste Management, Foundries and Surface Treatment in order to facilitate the implementation of the IPPC Directive. These pre-application contacts may serve various purposes. While they may sometimes amount to a simple exchange of information, they may also give companies much more assurance about the kind of permit conditions they will eventually have to face. This is because pre-application contacts provide an opportunity to build trust and to avoid conflicts at a later stage of the regulatory cycle. As a result, it is reasonably to assume that most companies don't meet with major surprises when their permits are eventually granted.

Graph 8:



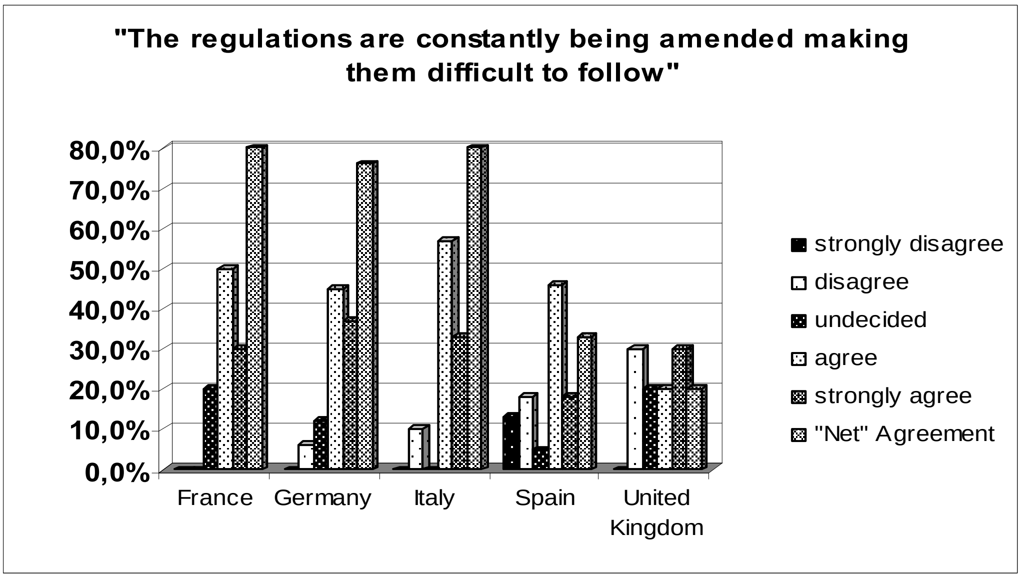
Notes: The column “net” agreement is calculated by subtracting “strongly disagree” and “disagree” from “strongly agree” and “agree”.
Number of respondents: FR: N=16, DE: N=51, IT: N=9, ES: N=17; UK: N=6.
Source: Bohne (2006).

Graph 9:



Notes: The column “net” agreement is calculated by subtracting “strongly disagree” and “disagree” from “strongly agree” and “agree”.
Number of respondents: FR: N=16, DE: N=51, IT: N=9, ES: N=17; UK: N=6.
Source: Bohne (2006).

Graph 10:



Notes: The column “net” agreement is calculated by subtracting “strongly disagree” and “disagree” from “strongly agree” and “agree”.
Number of respondents: FR: N=16, DE: N=51, IT: N=9, ES: N=17; UK: N=6.
Source: Bohne (2006).

Duration of permitting procedures

The following table 4 shows the average range of duration of permitting procedures for various types of installations (new and existing) and various procedural requirements (with environmental impact assessment (EIA) and without EIA, with and without public participation).

Table 4: **Variation in the duration of permitting procedures (in months)**

	New installations	**Existing installations**
France	10-12 (EIA, pC) 4-6 (EIA, w/o pC)	10-12 (EIA, pC) 4-6 (EIA, w/o pC)
Germany	5-8 (w/o EIA, pC) 7-9 (EIA, pC)	4-9 (pC) 1-6 (w/o pC)
Italy	3-24 (w/o EIA, pC) Av. 19 (EIA national), 4-24 (regional EIA)	3-12 (pC) 3-9 (w/o pC)
Spain	7-18 (EIA) 10 (w/o EIA)	4-9 (pC) 1-6 (w/o pC)
UK	4-24 (w/o EIA) Possibly >24 (EIA)	1-9 (w/o pC) Up to 18 (pC)

Note: EIA: Environmental Impact Assessment; pC: public consultation.

Source: Bohne (2006).

In general there is quite some variation in the duration of permitting between countries as well as some national peculiarities. In France, for example, all operators need to go through an EIA which is a potential competitive disadvantage. However, the average time of permitting is relatively short. According to the survey of Bohne (2006), the time between the submission of a permit application and the granting of the permit for new installations ranges in most regions from ten to twelve months. About the same duration is reported by the majority of respondents for the permitting of major modifications of existing installations if the public has been consulted. Without public consultation the duration of the permitting procedure falls in most regions to four to six months. In Germany most respondents indicate that it takes between five and eight months to grant an environmental permit for new installations with public consultation but no EIA. With an EIA the permitting extends to about seven to nine months. For existing installations, permitting length is typically between one to six months without public participation, and four to nine months with public participation. An interview of Bohne also suggests that the time for a water permit is shorter than the time needed for an environmental permit. Given the heated discussion in Germany about the length of permitting in the 1990s there now seems to be little reason for concerns about an excessive duration of permitting (see also RSU, 2002). Regarding Italy, there can be quite a substantial variation in the duration of permitting procedures. For new installations that need to go through public participation, but do not require EIA, permitting can range between three and twenty-four months. If operators fall under Annex I of the EIA directive and are subject to a national EIA procedure permitting tends to be longer, with an average of nineteen months but a minimum of thirteen months. By contrast, the time estimates drop considerably for new projects which only require regional EIA, with an average duration between four and twenty-four months. For existing installations, or major modifications of existing installations, the time is considerably shorter: three to twelve months with public participation and three to nine months without public participation. Own interviews at ARPA Lombardia suggest that it is sometimes hard for authorities to achieve speedy permitting given the transition to the new permitting regime. At the moment it is not easy to say how long permit procedures under the new IPPC regime will actually take. The same can be stated for Spain, but the survey data of Bohne suggests at least that integrated permitting procedures are not very likely to trigger acceleration effects compared to the previous Spanish permitting regime. However, permitting procedures in Spain seem to be fairly speedy compared to other countries. For existing installations permitting takes between four and nine months in most autonomous communities when public participation was required, and up to six months without public participation. Under article 21 (1) of the national IPPC act, the permitting procedure not considering an EIA should be completed within ten months. For new installations permitting can take much longer, up to eighteen months when an EIA is required. Substantial variation in permitting length can also occur in the UK. Survey data suggest that average duration of planning permission procedures without EIA range for new installations from four to twenty-four months. With EIA procedure it can take more than twenty-four months. As far as environmental permitting procedures for substantial changes of existing installations are concerned, the average duration however drops considerably ranging from one to nine months and up to eighteen months when public consultation is required. Regarding Belgium (Wallonia), own interviews at the "cellule IPPC" suggest that IPPC will bring about a substantial reduction in permit application times (120 days compared to previous sectoralised permitting process lasting up to two years). Thus, industry is likely to benefit from the establishement of a single IPPC contact point (see also IEEP and Ecologic, 2006, pp.89).

Reporting requirements

Monitoring and reporting can impose significant costs on businesses and regulators. Several Member States have launched initiatives to make the delivery of information from companies to regulatory authorities easier and to avoid inconsistencies and redundancies in reporting.

A good example is the REGINE initiative in Belgium (Walloon), an integrated environmental survey system, which involves the use of information technology, one-stop shops and communication between regional public authorities and companies with a view to collecting environmental data for reporting purposes (IEEP and Ecologic, 2006, pp. 34, 94; own interviews). The objective of REGINE is, among others, to lower the burden for companies in the field of environmental data collection and reporting and to ensure a better coherence between the different inventories and reports in the realm of environmental regulation. For this purpose, all required questionnaires have been reduced to one single environmental survey integrating all pertinent environment-related requirements for about 300 companies. The scheme is currently still in a pilot phase and implemented on a voluntary basis without any legal obligations for companies to participate. However, it is expected that participation will be mandatory in the future and lead to substantial benefits also for the companies. The scheme is likely to harmonise the various reporting requirements of different EU environmental directives and therefore avoid confusion due to frequent changes in legislation.

Permitting fees

The following box gives an impression about differences in permitting fees between selected Member States.

Box 2: **Permitting fees in selected Member States**

Member State	**Type of fees**	**Comments**
France	Charge for a permit or modified permit typically € 2.000, annual subsistence charges based on plant complexity (between € 300 and € 30.000	Low-medium level of fees; Substantial funding from general government revenue
Germany	One-time application fee depending on type of procedure and type of investment;	Medium level of fees; some funding from general government revenue
Italy	n.a.	n.a.
Spain	€ 1500 one-time application fee (with some variation between the Autonomous Communities)	Low level of fees; Substantial funding from general government revenue
UK	Comparatively high fees (€ 22.400 annual charge on average + one-time application fee depending on type of installation)	High level of charges; Polluter-pays-principle, fees also vary depending on environmental impact/risk (EP OPRA scheme)
Belgium (Wallonia)	One-time application fee depending on the classification of the installation	Low level of fees; Substantial funding from general government revenue
Poland	One-time application fee depending on the type of installation, on average € 2.000	Low level of fees; Substantial funding from general government revenue

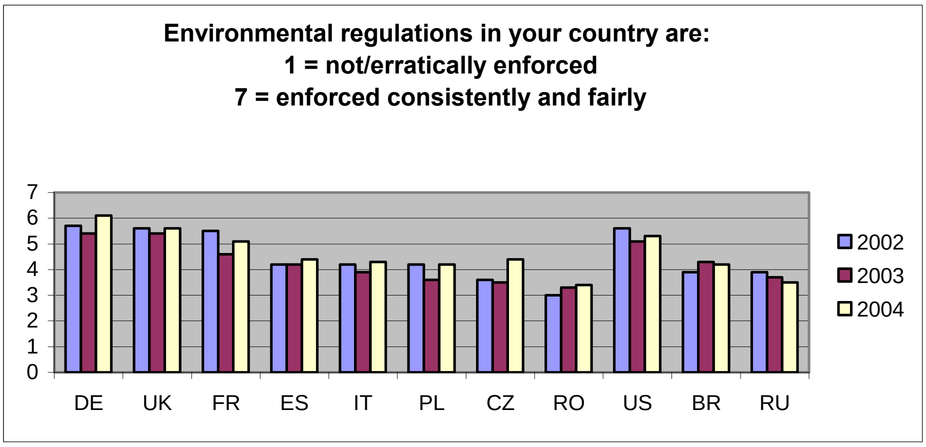
Source: IEEP et al. (2006), additional information.

Inspections and enforcement

Inspections and sanctions are important instruments which help ensure compliance with regulatory requirements and permit conditions. Stringency, quality and consistency of inspections can also have an impact on competitiveness (see chapter 2). In principle, there are two types of industrial inspections. Ordinary or preventive inspections deriving from regulatory requirements, internal inspection plans or from the routine control activity of inspectors, and reactive inspections responding to irregular events such as major accidents, incidents of malfunction or complaints coming from citizens or police authorities. The survey of Bohne gives us some idea about the frequency and the regularity of inspections (especially the preventive inspections) and also provides some information about whether or not the competency of inspectors is restricted or impeded in some way. The more authorities are involved in inspection activities, the more problems of coordination arise with possible negative consequences for the effectiveness and efficiency of inspections.

In France, inspection mainly takes place on the basis of an internal inspection plan, but only take place about once every one to two years on average. Interviews suggest that there are some concerns regarding the lack of resources for inspectors (see also chapter 4.2). However, the coordination of inspection activities does not create any problems, with inspectors being able to inspect all media at the same time. In Germany, complaints are the main cause for on-site visits, but regulatory requirements and internal inspection plans also rank quite high. About sixty percent of the survey respondents state that inspectors visit a company site on average once per year or once every two years. More frequent inspections are reported by less than twenty percent of the respondents. The competencies of inspectors in Germany, however, seem to be more restricted and integrated inspections for all environmental media take place less often. On the other hand, interviews suggest that inspections are generally perceived as effective and highly rely on a more informal cooperation between authorities and operators. In Italy inspections are the least frequent (once every two to four years). While routine is the most important trigger for inspections in Italy, this factor cannot really be interpreted as a strong indicator for the preventive orientation of inspections in Italy. Most interviewed persons by Bohne suggest that inspections are constrained by a lack of resources and that the trust between operator and authorities regarding the level of compliance is of high importance. Results of Bohne also suggest that due to the sectoral competence structure integrated cross-media inspections hardly exist. However, own interviews at ARPA Lombardia suggest that major improvements have taken place with ARPA taking over inspections and assuring consistency (at least) on the regional level. Italian authorities also mentioned that they benefit from the new EU recommendations on inspections. In Spain inspections take place more often on average (once per year). However the survey of Bohne suggests substantial variation between autonomous communities, but some of the variation may be explained by the presence of different types of plants across regions. The average frequency ranges from once per month and company to once every four years per company. The distribution of inspection competencies also varies from region to region. While some inspectors have the competence to control all environmental media, in most autonomous communities there are sectoral restrictions on inspection competencies (The Autonomous Community has the responsibility to carry out inspections except in just one case: inspection of wastewaters discharges to interregional basins being the competence of the Hydrografic confederation). In the UK inspections take place most often (several times per year) and are mainly based on internal inspection plans. The UK follows a risk-based inspection approach, trying to give companies an incentive to improve environmental performance: the better the environmental performance, the less frequent inspections take place and the lower the inspection fees that have to be paid by the company. In addition, environmental management systems (like EMAS, ISO 14000) help to establish the operator’s competence and the adequacy of the installation’s management (DEFRA, 2005 Guidance, p. 43). Some restrictions in inspection competencies are present in the UK and are likely to reflect different internal personnel situations for inspectorates.

Graph 11:



Source: World Economic Forum (various years). Average N = 84, ~ 1/3 from industry.

Apart from the fact that differences in the frequency and regularity of inspections can lead to competitive distortions, inspections also have a different, but more direct, impact on companies via the time and effort imposed on them. Some Member States have found ways to ease the potential burden of these inspections for companies. In Germany, for example, there is a possibility to differentiate the frequency of inspections in relation to the regularly reported environmental performance of the company. In particular, companies having an established environmental management system in place may be inspected less frequently and less thoroughly. A more formalised system has been introduced in the UK, the Operator and Pollution Risk Appraisal system (OPRA). Within OPRA the need for regulatory oversight is "calculated" by a quasi-quantitative measure of the risk posed by an activity to the environment.

Interpretation of BAT from an economic point of view

According to the IPPCD three key elements should be observed when determining Best Available Techniques (BAT). First, the environmental benefits of the technique should be assessed. "Best" means most effective achieving a high protection of the environment as a whole (includes the consideration of cross-media trade-offs). Second, the technical feasibility of the techniques should be assured (excluding pilot systems without proven performance, for example). The concept of technique has to be interpreted in the broader sense, indicating both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned. Third, economic feasibility is required for selecting a technique as BAT. As the following citation illustrates, the IPPCD includes economic considerations in the definition of "available": "BAT should be developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member States in question, as long as they are reasonably accessible to the operator" (Art. 2 IPPCD). This section sheds some light on how this is done in practice. Some further results can be found in the case studies (see chapter 7).

The economic evaluation is an arduous task for BREF writers, research people and policy makers alike. And as a consequence, this kind of "assessment" differs slightly from one country to the other or from one permitting process to the next". Some insights about the role of the economic assessment in individual Member States could be gained during our own interviews. The following table helps to structure the subsequent discussion by listing the main elements of an economic assessment of BAT and by highlighting differences of selected Member States.

There are relatively clear distinctions in the way Germany on the one hand, and the UK on the other hand do and perceive this economic assessment. Germany has chosen to implement the IPPCD via general binding rules, laying down emission limit values and other emission limiting requirements in a legally binding manner in a body of abstract and general regulations. Thus, the assessment of BAT (including the economic assessment) takes place, first of all, at the level of the standard setting stage. The determination of ELV can be interpreted as an implicit cost-benefit analysis, where the national environmental agency and national ministries negotiate with various industry associations on the design and stringency of standards. The German approach is sceptical about weighing costs and benefits of individual BAT on a case-by case basis in individual permitting. German competent authorities argue, among other reasons, that there is a lower danger to bring forward “irrelevant” local or regional concerns (which includes financial difficulties of a particular company) and a lower chance of potential regulatory capture at the local level. Also, national authorities assume that local permitting authorities would lack the necessary competence to assess such complicated elements as, for example, the assimilative capacity of the environment. It is difficult to generalise about what this implicit cost-benefit analysis at the national level amounts to. According to interviewed authorities the analysis cannot be carried through in a straightforward way since reliable cost data are not available or not provided by the industry in a format that allows determining viability in a quantitative way. As a result, one could say that viability is determined in a more retrospective way: the viability of a particular BAT depends on whether or not an average company using it can still succeed on the market. To know this, national authorities rely on continuous technology monitoring and retrospective assessment. This is facilitated for example by the use of R&D support for emerging technologies, by systematic benchmarking between IPPC sites, by close interactions between technology suppliers technical experts and other stakeholders from industry, by the pressure of technology suppliers trying to enter new markets, or by a general turnover of capital stock. Despite this prejudicing effect of BAT assessment at the national level (general binding rules), there is still scope for flexibility in individual permitting:

- Different transition periods may be granted in meeting ELVs. Differences in marginal abatement costs are therefore – at least to some extent – taken into account via flexibility in adjustment times (e.g. depending on investment cycles).

- Dynamisation clauses are frequently set to define a corridor in which continuous environmental improvement should take place. A target value (lower than present ELV) is to be achieved over a defined period of time.

- There are sometimes “untypical installations” for which no ELVs or specific requirements are set on the national level.

- There are some cases where environmental impacts are uncertain, but unlikely to be severe. There may then be provisions encouraging operators to approach BAT and lower ELVs step by step.

As opposed to Germany, the UK does not implement the IPPC Directive via general binding rules, although a "standard rules" approach is being taken in the permitting of some 1,200 existing intensive livestock installations, and there are proposals for a more flexible approach to the establishment of general binding rules. The UK places more emphasis on site-specific factors and case-by case decisions and case-by-case BAT-based determination of ELVs and other permit conditions. Differences in ELVs can therefore arise from one installation to another within a sector.

Economic viability is explicitly part of the BAT assessment. In line with the IPPC Directive, UK guidance is that determination of BAT requires both

- an environmental cost-benefit test: a judgement about the extent to which the benefits to the environment of using BAT outweigh the costs, and

- a sectoral affordability test: a judgement about the extent to which the cost of using BAT can be afforded without serious damage to the competitive position of a sector.

Own interviews with UK government officials suggest that there has been some capacity building in terms of economic assessment and that the build up of expertise allows them to make well balanced BAT-based permitting decisions. In contrast to interviews in Germany, UK officials were more confident that accurate cost graphs about abatement activities could be obtained. It was emphasised that much of the analysis relies on the work of consultancies and the close collaboration with in-house specialists. At the same time it was acknowledged that the assessment of affordability is inherently difficult (see also Sorrell 2002, p. 28). It was mentioned however that full-blown sectoral affordability test is not always necessary, if a well-done cost-benefit analysis justifies high investment in pollution abatement equipment, helping the authorities "to get the defences" in place. Interviewed authorities also stress the fact that BAT has to be assessed on the basis of sectoral affordability, even though that may mean individual companies/installations have to face hard choices. There was also some optimism due to the fact that the process of permitting existing installations enhances transparency (which includes more economic information). The future review of the BREFs should also bring forward further information about sectoral affordability of candidate BAT.

Giving this rather positive assessment it should be mentioned that it was not possible within the study to examine in detail to what extent capacity building in terms of economic assessment has actually taken place in the UK on a broader basis. Earlier accounts in the literature (Sorrell, 2002) suggested that there was a large gap between official government pronouncements and the practical realities of implementing IPPC at the site level, and that may have been the case at the outset of the UK's phased implementation of the Directive amongst its more than 5,000 installations. However, according to UK authorities the growth of experience which that phasing has produced both for regulators and operators has alleviated such difficulties as may have arisen.

Table 5 also tries to classify some other Member States with regard to their economic assessment of BAT. Some Member States' assessment clearly resembles more strongly the German approach. Own interviews in Luxembourg, for example, indicate that, just like in Germany, the economic dimension of BAT is hardly explicitly considered. Typically, BAT is the best technique that has been applied somewhere in the world and is technically applicable and feasible. The costs of these BATs are sometimes presented in consultancy studies, but there are hardly any big discussions about them. Information about costs serves rather as a "subjective argument" but has no influence on whether a technique will be used or not ("if plant X in country Y can apply the technique and withstand its costs, your plant can too"). However, it is still possible to agree on the time the techniques need to be put in practice and the time for the compliance with stricter ELVs. This highly technically oriented approach is also backed up by the entire government of Luxembourg (including the ministry of economics) as well as court decisions supporting the position of the environmental authorities. They may serve as a kind of "enforcement device" and as an important signal vis-à-vis foreign investors about the level of ambition of environmental protection in Luxembourg.

Italy basically follows a mixed approach. On one hand, national law allows the setting of general binding rules and establishes some requirements about how ELVs have to be set (as well as some more formal guidance about it). However, more important are informal guidance-documents established at the regional level, which are well-known amongst industry and stakeholders. The competent authorities generally use this guidance in the determination of a permit and the assessment of BAT for specific sectors and installations. Based on these guidelines (referred to as best practice guidance) competent authorities at the regional level define legal standards in close collaboration with industry. The assessment of BAT is highly technical and no explicit economic evaluation takes place due to lack of data. Own interviews revealed that it may be necessary to give industry more time to implement the BAT that was commonly agreed upon during negotiations and during the conference of services. For example, this is the case for old plants that need to be retrofitted. In addition, it was mentioned that it is often necessary to motivate companies to continuously improve environmental performance. Commonly agreed implementation plans may document future efforts expected by CA.

Other own interviews revealed that a systematic economic assessment of BAT is hampered by a lack of guidance and expertise or generally not considered of high importance. In Belgium (Wallonia) priority is given to full implementation of the IPPCD requirements rather than refinement of assessment methods or use of consultancy studies (“we have to go straight to the point”). As a result, competent authorities try to collaborate as closely as possible with industry in order to find pragmatic solutions. Cost issues may become important, for example, if the environmental improvements expected from new techniques are minor relative to the amount of necessary investment. Alternatively, implementation plans are integrated into the permit (typically by considering the course of investment cycles) specifying until when environmental improvements have to be realised. Regulatory requirements may then act, to a certain extent, as a certain investment driver. In Poland, the economic assessment of BAT is done on a case-by-case basis. Despite the availability of some national BAT guidelines (produced by technical working groups) and the recent attempt to create a network of experts the assessment doesn’t seem to be standardised at present. Any economic assessment on the sectoral level (as recommended by the European Commission) is not likely to take place and could potentially give way to prominent local and regional concerns (social and employment issues) (see e.g. Ravn et al., 2003, p. 96).

Table 5: **Tentative classification to illustrate the economic assessment of BAT of selected MS**

Elements of an economic assessment	**Approach of selected Member States**
Type of use • Explicit • Implicit	Implicit assessment prevails in most MS; Explicit assessment in the UK and Belgium (Flanders) to some extent; Some MS' CA with fairly good information about the level of environmental expenditures or even IPPC compliance costs (e.g. Belgium, Wallonia)
By whom • Consultants • National agency • Regional/local agency	Consultants: strong role in the UK and Belgium (Flanders), sometimes economic information in technical consultancy studies (LUX, Germany, Spain) National agency/ ministries: Germany, LUX, Belgium (Wallonia) Regional/local agency: UK, Italy, Poland, Spain
Characteristics of assessment • As addition to formal Cost-benefit-analysis • Retrospective and on-going monitoring of technical and market developments • Subject to negotiation, rule of thumb/ expert judgement	UK: as addition to formal Cost-benefit-analysis (at least partly) Germany, LUX, (probably) France: strongly linked to technological and market-specific monitoring Italy, Poland, Spain: still lack of experience, assessment very case-specific and determined during negotiations to a large extent, possibility to reach compromise at the "political" level
Level of analysis • Sector (with hypothetical average company as benchmark) • Individual installation/company	Sector: Germany, France, UK (to some extent) Individual installation/company: more prevalent in Poland, Italy, Spain; to some degree present in all countries (see text) No major distinction: Belgium (Wallonia), LUX (small country)
Level at which "results" are discussed and backed up • Regional/local level • National level	Regional/local level: UK (but strong role of national BAT guidelines containing some information about economic assessments), Italy (with some regional guidance available), Poland (strongly dependent on individual voivod or powiat), Spain (little use of the Economic and Cross-media BREF currently), France (level of préfet) National level: Germany No major distinction: Belgium (Wallonia), LUX (small countries)
Implications for permitting • BAT meant to support "radical innovations" ("Technological forcing") • BAT reflect latest technological improvements ("Technological signalling") • Use of flexibility clauses in the use of BAT • Use of adjustment programs to be able to introduce BAT • Consideration of broader "social" concerns in the determination of BAT	"Technological forcing": not very likely in the strict sense (all MS) "Technological signalling": Germany, LUX Use of flexibility clauses: all MS (to varying degrees) Use of adjustment programs: Poland (see text) Use of voluntary agreements with industry: Spain, Italy (partly) Consideration of broader "social" concerns: all MS to some degree, but probably more likely in Italy, Poland

Source: Interviews with CA, IPPC implementation reports of MS.

In Spain, the economic assessment of BAT is also done on a case-by-case basis, as there is currently no defined methodology to carry out this assessment and the BREF on Economics and Cross Media is not widely used. The translation of this BREF could facilitate and extend its use. Industry puts special interest in the economic aspect when defining and discussing BATs to be implemented and definition of ELVs, but as previously mentioned it is always a case by case approach. ELVs set up methodology vary from Autonomous Community to Autonomous Community. Andalusia has been the only region developing a specific methodology, most Communities use BREF documents to set up these values, taking into account current environmental legislation as minimum requirements.

As a general rule there is still a lot of uncertainty about how MS undertake the economic assessment of BAT in practice. The main reason for this is that the assessment is only done implicitly. Despite of this some differences in approach between MS are evident. Economic considerations are, to various degrees, considered at the upstream standard-setting stage and, more on a case-by-case basis, during individual permitting. One may argue that overall compliance costs are higher when economic considerations are only considered at the upstream standard-setting level if more or less uniform standards are set regardless of local or geographical conditions. On the other hand, the absence of uniform requirements (and thus more flexibility at the permitting stage on a case-by-case basis) within one country may raise concerns of “uneven” treatment and of “unfair” competition. As a result, industry may appreciate a high level of legal stability and predictability. In practice these broad distinctions are blurred, however.

4.4 Summary

Based on the conceptual outline developed in chapter 2.2, chapter 4 has emphasised that the institutional context of individual Member States influences the regulatory conditions under which individual companies with IPPC installations operate. Differing conditions and requirements from site to site and from country to country may eventually give rise to competitive distortions (inequality view). These distortions may be relatively unimportant and qualify only as irregularities. They may also be only a transitory problem related to the current restructuring of the permit system in some countries. Finally, it is not clear how to deal with these competitive distortions in view of the flexibility provided for in the IPPC Directive. Since the linkages between IPPC implementation and competitiveness are mostly quite indirect (see chapter 2.2), these competitive distortions or irregularities may, but do not have to, impact competitiveness. While differences in IPPC implementation from one European country to the next are possible, a broader perspective would compare the competitive implications of different environmental regulations and permitting regimes across the whole world (comparison of Europe with non European countries).

Given the complexity of the subject, this chapter has taken a first step to approximate potential impacts of IPPC implementation on competitiveness. While cross-country analysis is highly constrained by lack of data (especially “hard”, up-to-date and comparable data), we have proposed to use and interpret a number of indicators to characterise the environmental regulatory regime of several Member States in general, and the IPPC implementation regime in particular.

The various potential economic impacts can be grouped in the following way:

a) competitiveness impacts due to the transition to integrated permitting:

On the “system” level competitiveness impacts may result in countries where the permitting regime displays a low degree of similarity to the IPPC regime and where the regime needs to be fundamentally restructured (more so in Poland, Italy, Spain). For companies this “regime change” may lead to legal uncertainty and confusion or cause delays. Whether or not this is really the case can only be determined with more case-specific evidence.

b) Competitive distortions resulting from different administrative structures and resources:

The distribution of legal and administrative competencies and the coordination among various authorities is – to a large extent – country-specific. The introduction of the IPPC regime may be more or less challenging from one country (with its specific legal and administrative structures) to the next. This may lead to frictions, delays or inconsistent permitting within a country with potentially negative implications for companies. Lack of financial, technical and human resources among CA may also add to these delays or inconsistencies. Again, this should be looked at in more detail, but competitive distortions / irregularities may be more pronounced in Poland and Italy than in the other countries (but may also be a transitory phenomenon) (Bohne, 2006 and own interview).

c) Competitive distortions resulting from different levels of stringencies and regulatory quality:

More stringent as well as confusing or frequently changing regulations typically negatively affect competitiveness of those companies immediately affected. Regarding stringency there are notable differences between e.g. Germany and some non-European countries (e.g. Russia, Brazil) and – to a lesser degree – some other European countries. However, countries with a high level of stringency score often better in terms of the quality of regulation. Yet, it is necessary to substantiate this finding with more detailed evidence.

d) Competitive distortions due to the different frequency and regularity of inspections:

Competitive distortions can result from differences in the frequency, regularity, consistency and quality of inspections across countries. Available evidence suggests that these differences are indeed present, even if there may be a certain convergence of practices within the EU. The most notable differences among the Member States analysed seem to be between the UK and Italy, with a more lenient approach in (parts of) Italy benefiting potentially Italian companies (Bohne, 2006).

e) Competitiveness effects of various flexibility and adjustment clauses in the application of BAT:

There are few signs of negative effects on competitiveness resulting from insufficient flexibility or lack of cooperation on behalf of authorities. In most countries pre-application contacts and continuous interaction between operators and CA is standard practice avoiding “surprises” for companies.

f) Competitiveness effects of the different interpretation of BAT from an economic point of view:

As mentioned in e), there are few signs of CA unduly imposing or forcing BAT on companies. However, the economic assessment of BAT varies from country to country. There is little evidence to suggest that countries following an approach of

IPPC implementation based on general binding rules impose a higher burden on companies than countries following a case-by-case approach. However, there is reason to believe that many CA assess economic viability at the level of individual companies rather than the “average” company of the sector as a whole given the lack of suitable assessment methodologies.

g) Other competitive distortions (amount of reporting and other requirements, permitting fees, duration of permitting, quality and consistency of secondary regulations):

Various other differences in IPPC implementation take place. Differences may be relatively unimportant quantitatively, so that one may speak about irregularities rather than competitive distortions. The most apparent examples are variations in permitting fees and different schemes of financing permit-related activities of CA. There are also notable differences in the length of permitting. Again, there is a need for more case-specific evidence.

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5 Review and analysis of the electric steelmaking sector in the EU

5.1 Introduction

In accordance with the steel industry association EUROFER it was agreed to focus this case study on electric steelmaking, excluding integrated steelworks partly covered by ENTEC (2006). The next paragraph briefly depicts the environmental implications of producing steel and electric steelmaking in particular. In the following section 5.3 a more detailed analysis of EAF steelmaking will be provided. Starting with a more general overview, we will discuss in more detail demand and supply characteristics and explain current trends in production and consumption. Based on this a range of indicators about the competitiveness of the European iron and steel industry in general and electric steelmaking in particular are presented. Section 5.4 concludes linking the analysis to the previous and future chapters of this study.

5.2 Steel: The material, its production process and its applications

5.2.1 The material

Steel is a material which helped to set off the industrial revolution in the Western world. It is an iron-based material containing low amounts of carbon (in general less than 2%) and various alloys that can be made into thousands of different compositions to meet a wide range of needs. While there is no clear-cut single end use dominating the demand for steel, a large amount of steel is consumed by the automotive and construction industries. Yet, given its versatile character steel is also used in mining, energy production and transmission, in packaging, in containers, in office furniture, in industrial machinery, in transformers and electric motors, in domestic appliances, in radiators and in myriad other manufactured goods.

Steel is produced in a large variety of grades and shapes and numerous ways exist to classify it. Regarding chemical composition EN 10020 (“Definition and classification of grades of steel”) distinguishes between the following three broad classes:

- Non alloyed steel: Steel grades containing as alloy elements C, Si and Mn do not reach certain limit values of alloying elements (Al, B, Bi, Co, Cr etc.) in the ladle analysis. This segment comprises the majority of all steels (e.g. in Spain 88% in 2003, UNESID, 2003; 68% in the UK in 2001, Dahlström et al., 2004).

- Stainless steel: Steels with at least 10.5% of chromium and max. 1.2% of carbon. They are characterised by a high resistance to corrosion and/or heat and considerably more expensive than conventional non alloy steels. This segment is growing, but still relatively small (in Spain, 7% in 2003; 15% in the UK in 2001).

- Other alloyed steels: Steel grades (not complying with the definition of stainless steels) in which at least one of the limit values of specific alloying elements in the ladle analysis is reached (5% of all steel in Spain in 2003; 17% in the UK in 2001).

Non alloyed steels and other alloyed steels can be subdivided further into quality and special steels. Special (non alloyed) steels with high value added (e.g. valve spring steel, roller bearing steel) require high purity and few undesirable tramp elements and are not easily produced via the scrap recycling route (see below).

Regarding end product forms a distinction is typically made between the following:

- Solid crude steel and semi-finished material: This includes blooms and billets (as semi-finished material for square and rectangular high forms) used for the production of structural steel and seamless tubes as well as slabs (as semi-finished material of rectangular flat forms) for the production of flat products.

- Flat products: They are defined according to EN 10079 as products of approximately rectangular cross-section whose width is much greater than their thickness. Typical flat products include sheets, strips and plates (hot-rolled or cold-rolled, coated or non-coated) and electrical or packaging sheets and strips.

- Long products: They have, according to EN 10079, a constant cross-section over their length and are manufactured by rolling, and/or forging and drawing. Typical long products include wire rod (hot or cold drawing/rolling); hot-shaped bars; bright steel; ribbed and profiled concrete reinforcing and prestressing steel; hot-rolled and cold-formed sections; tubes, hollow sections and turned tubular parts; rings, wheel tyres and disks.

- Other product forms: Other product forms, which do not rank among the rolled steel products, include open-die forgings, closed-die forgings and castings. Casting and forging is more expensive than rolling and is used only to a limited extent for complex forms or steel products with special characteristics for specific applications.

In general, the distinction by chemical composition and product form is not easily matched. After all, product form and quality is, at least for non alloy steels, determined to a large extent by the rolling and heat treatment process.

5.2.2 Production process

Currently, there are two main process routes that dominate global steel manufacturing, although variations and combinations of the two exist:

- The integrated blast furnace (or primary) route:

In an integrated steelwork the blast furnace is the main operational unit where the primary reduction of iron oxides takes place leading to liquid iron. As inputs mainly iron ores (prepared in sinter and/or pellet plants) are reduced mainly by coke (produced in coke ovens) and sometimes by coal and/or oil. The share of ferrous scrap or scrap substitutes for cooling the hot metal reaches up to 25%. Liquid iron from the blast furnace (pig iron) is transported to a basic oxygen furnace (BOF) where the high amount of carbon in the feed is oxidised by the injection of pure oxygen, thereby resulting in steel. Following downstream ladle metallurgy and treatment the molten steel is cast and subsequently processed in rolling mills and product finishing lines to prepare them for the market. Currently, about 63% of world steel is produced in integrated steelworks and 61% (2004) in Europe.

- The electric arc furnace (or secondary) route:

The second important steel production method is based on the electric arc furnace (EAF). Iron-containing material, i.e. mainly recycled scrap and to some extent pig iron, sponge iron or direct reduced iron[13], are directly fed into the furnace for melting using primarily electric energy, natural gas and oxygen. The furnace itself consists of a cylindrical refractory lined vessel with water cooled wall panels and water cooled roof with a diameter to height ratio of about 4 to 6. Three electrodes in the AC EAF and one electrode in the DC EAF provide the electric arc for melting the scrap.[14] The molten scrap is tapped by tilting the vessel via a spout or by eccentric

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[13] Historically, the EAF was dedicated to high alloy special steels, by using pig-iron and DRI. As a result of technical progress most EAF today use mostly scrap to produce a variety of steel grades.

[14] Some DC furnaces can also be equipped with three electrodes.

bottom tapping. Apart from the EAF so-called mini-mills typically include secondary metallurgy in ladle furnaces and (sometimes) other metallurgical installations, a continuous caster and rolling/finishing plants. Compared to the integrated steelworks which rely on numerous interconnected production units and have to manage a large amount of monetary flows as well as physical resource or emission flows, electric steelmaking uses smaller production units and can react more flexibly to market trends. Almost 34% of world steel production is manufactured in mini-mills.

Both processes for the production of steel must be regarded as complementary and interdependent. Electric steelmaking on the basis of the EAF route depends on processing of scrap which is in times of increasing demand for steel products only available via the primary route on the basis of iron ore.

As to the product categories mentioned above, integrated steelworks produce mainly flat products and electric mini-mills produce mainly long products. More recently, some electric steelmakers (particularly in the U.S.) have managed to enter into the flat steel market, however (e.g. by using directly reduced iron, DRI). Mini-mills often focus on one type of product, and therefore require only a few casting, rolling and finishing processes, resulting in a linear production chain (Daniels, 2002, p. 46). Broadly speaking, electric steelmakers either produce simple relatively low-cost carbon steels like rebar, beams and sections (using the EAF as a melting aggregate) or more expensive high alloy special and quality steels (requiring advanced processes in secondary metallurgy).[15] Integrated mills produce higher volumes of steel and offer a much broader spectrum of different steel qualities. In total, however, EAF-based mini-mills can produce over 80% of all steel products and it is expected that mini-mills will continuously enter into new markets (Atkinson and Kolarik, 2001, p. 23).

Mini-mill plant layout will differ depending on a number of parameters and framework conditions (Heinen, 1997, pp. 267). The kind of steel product to be produced is certainly one of the most important parameters. In principle, three basic mini-mill configurations may be used as melting aggregates depending on the desired production programme: For normal carbon steels without particular requirements the EAF is accompanied by a ladle furnace. For low to medium-alloyed quality and special steels a vacuum degassing (VD) installations or a vacuum oxygen decarburisation (VOD) installation is used in addition. Steel plants producing large amounts of high-alloyed steel use the EAF, a subsequent converter (for decarburising and desiliconising) and a VOD installation (or other more complex ladle treatments).

Looking at the entire production process (i.e. not only the melting stage), the costs of a tonne of steel product increases by approximately 15% when liquid steel is transformed into intermediate products (blooms or billets). The transformation of liquid steel in final products increases costs by about 40% for “average” products (wire rod, rebar) and by up to 75% for products like structural sections (Daniels, 2002, p. 61 based on Eurofer data; higher numbers in Gielen and van Dril, 1997, p. 81). Differentiated by chemical composition it can roughly be said that low alloy steel is more expensive in terms of production value per tonne by a factor of 2.8 than carbon steel, and that high alloy steel is again more expensive by a factor of 2 than low alloy steel (Dahlström et al., 2004, p. 114).

[15] According to Eurofer information (which are neither complete nor up-to-date but presented in Quass et al., 2005) 62% of EAF plants produce carbon steel (especially in Italy and Spain) and 38% produce high(er) alloy steel (especially in Germany).

5.3 Overview of the electric steelmaking sector from an environmental perspective

Despite extensive emissions reductions across all media since the 1970s, resulting from technological change and better management, the iron and steel sector remains an energy-intensive sector with high total emissions loads and large volumes of solid by-products to manage. To maintain the downward trajectory in emissions to date requires ever greater attention to detail to combat the diminishing returns on pollution abatement investment (unit of emission reduction/capital investment), increased awareness of environmental management issues across the board, and innovative approaches to bypassing or controlling the most polluting processes. Within the steel process, it is the iron-making phases that are the most problematic in terms of environmental protection. The sinter and coke-making plants and the blast furnaces are major sources of atmospheric emissions, and they also give rise to specific wastewater and solid waste problems. Although the EAF route leads to considerably less emissions per tonne of liquid steel, there is an ongoing demand for virgin steel from integrated plants, therefore attention to these processes in terms of technologies and management is highlighted within iron and steel management circles. A comparison of integrated and EAF plants in term of atmospheric emissions reveals the environmental concerns linked to the sinter plant and the clear advantages of the EAF if compared directly rather than as related processes which would be more correct (see table 6).

Table 6: **Integrated and EAF plants: principal emissions (%) – contributions by processes (excl. coke plant)**

Integrated					
Emission	Total g/t	Sinter plant	Blast furnace	BOF and CC	Rolling
Dust	640	69.5	13.3	7.0	10.1
CO	27280	92.7	1.3	5.9	-
SO2	1830	66.9	7.9	-	25.1
NOx	1050	60.0	8.5	0.9	30.5
Landfill	51 kg/t	-	9.8	81.4	8.8
EAF					
Emission	Total g/t			EAF and CC	Rolling
Dust	165			60.6	39.4
CO	2500			100.0	-
SO2	60			83.4	16.6
NOx	500			50.0	50.0
Landfill	205.5 kg/t			97.3	2.7

Note: The comparison of the environmental profile between the two steelmaking routes is only possible to a limited extent since both processes must be regarded as complementary.

Source: EC (1996)

The main emissions from the EAF process are particulate matter. PM emissions from the arc furnace melting (primary emissions) represent about 95% of total process emissions from EAF. Other emissions sources are secondary metallurgy, handling, charging, steel tapping, continuous casting etc (secondary emissions). As primary and secondary off-gases are usually treated together, secondary off-gases are also considered as stack emissions (even though secondary emissions should be regarded as fugitive emissions).

The division of emissions into primary and secondary ("fugitive") categories is an important one since it is difficult to measure secondary emissions which evade the principal collection technologies. It is estimated that plants underestimate these latter emissions and that, compared with plants which capture these emissions, the underestimation can be as much as two orders of magnitude (EC, 1996).[16] Since the technologies to combat primary emissions are highly effective when well managed, and are widely applied, it is these secondary emissions which require increased attention. Much of the management of these fugitive contaminants involves effective maintenance and the channelling of emissions into capture systems within enclosed production areas. Continued investment in gases and particulate control, collection and recycling will be required for some time in order for firms to meet continuing reductions in emission limits, to deal with contaminants previously weakly regulated (such as dioxins and furans) and to meet pressures originating from new economic instruments such as carbon and energy taxes.

Water pollution control in the industry is well advanced around the world. As chemical and biological waste water treatment technologies improve, water contamination will continue to diminish. Apart from specific incidents (in response to production problems) and specific locational problems, technological efforts and new circulation and treatment systems have largely resolved previous problems, but the range of potential pollutants and indicators such as BOD, COD and temperature mean that the water monitoring and control remains a critical activity for environmental management teams. The outcome is that few firms have problems meeting environmental compliance for water discharges. Beyond improved treatment, firms have also sought to recycle water more effectively in closed or semi-closed circuits within the whole plant, cascading from one piece of equipment to the next, or independent systems for each major operation in the production process.

In the area of solid waste, rising landfill costs have provoked innovative responses from firms. Most firms now aim to reuse, sell or recycle over 90% of their products and by-products. Responses have varied since there are national policy variations for the use of by-products, particularly for blast furnace slag and steel-making slag. In many countries they can be used in cement production, construction and agricultural use; however, there are restrictions in other countries that lead to additional disposal costs.

Other areas of concern include demolition of redundant plant and subsequent land remediation. Increasingly remediation costs are being considered by firms which are coming under regulatory pressure for past environmental degradation and clean-up costs. Noise pollution is a further consideration for urban-based firms since noise complaints are the most common form of plant criticism.

A more detailed description and analysis of the role of some environmental abatement technologies in the electric steelmaking sector will be provided in chapter 7.

[16] However, the ongoing BREF revision will address this issue and more recent data will be provided in this respect.

5.4 Economic overview of the electric steelmaking sector

5.4.1 General economic overview

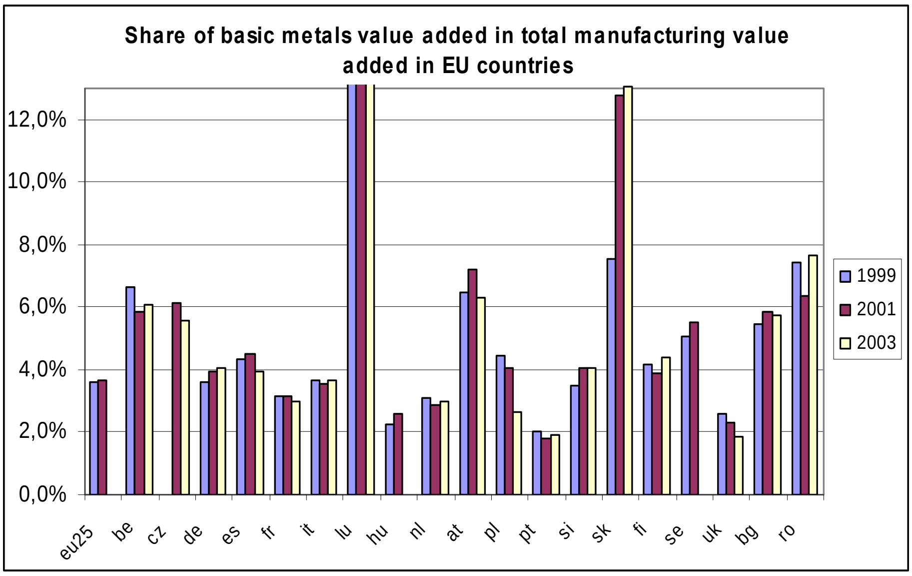
Economic significance of the steel industry

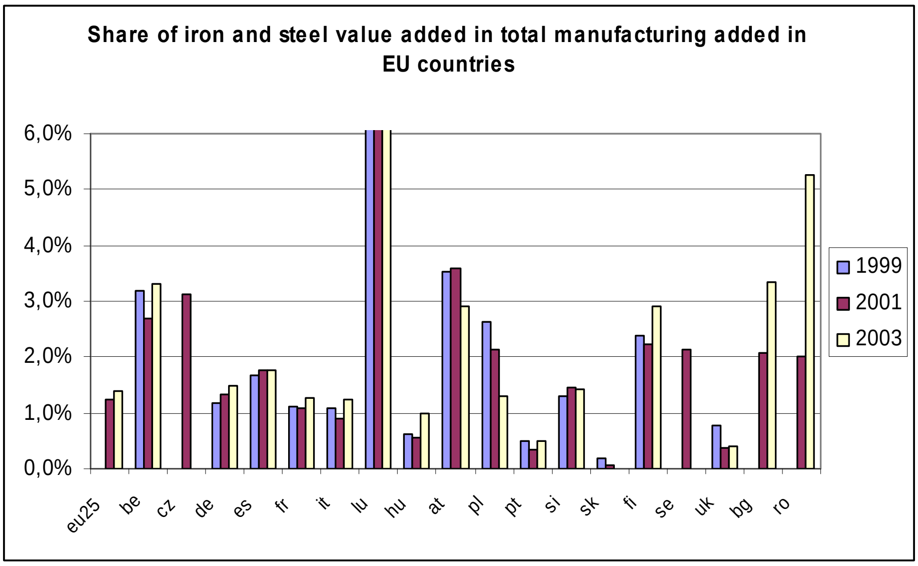
The steel industry has for a long time been considered a strategic sector for the development of modern economies. Closely linked to the industrialisation that started in the 19th century the industry has established strong linkages to other sectors of the economy and provided employment to a significant number of people. While the steel industry is by no means insignificant today and many inter-sectoral linkages still exist, it has lost its dominant or pivotal position in the national industry mix and in relation to the rising importance of the service sector and industry sectors such as electronics or chemicals. For about 40 years, and despite strong fluctuations, employment and the share in industrial value added has slowly decreased in most Western European countries (and only more recently in Eastern European countries). At the same time labour productivity has increased continuously.

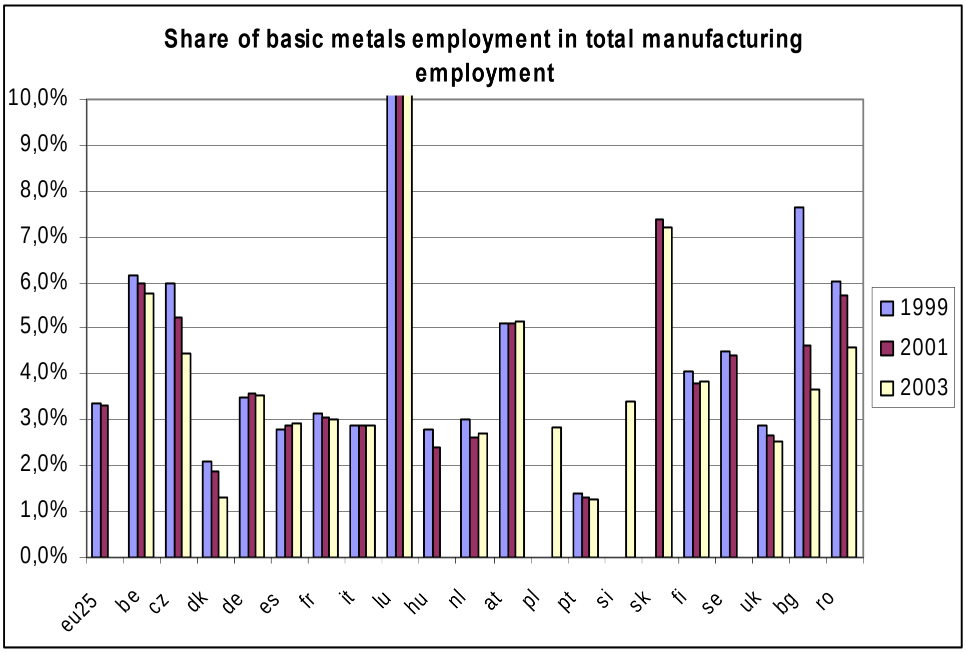
However, most countries have followed different trajectories resulting in diverging positions within total manufacturing of the basic metals industry in the wider sense and the iron and steel industry in particular. The recent development in most of the EU Member States is depicted in graphs 12a)-d).[17] On average, the EU-25 iron and steel industry as such represents 1.4% of industrial value added and 1.2% of its employment. With forward and backward linkages this share increases, however. Some of the smaller EU countries are more specialised in the iron and steel sector, most notably Luxembourg (15.9% of value added, 18.6% of employment), but also Belgium, Austria, the Czech Republic and Slovenia. Among the bigger countries Finland and Sweden should be mentioned (with Sweden having a considerably higher share than Finland in electric steelmaking), but both countries could be considered less “industrialised” than Germany, Spain, France or Italy. These four countries as well as (more recently) Poland and (to a lesser extent) the UK are close to EU-25 averages.

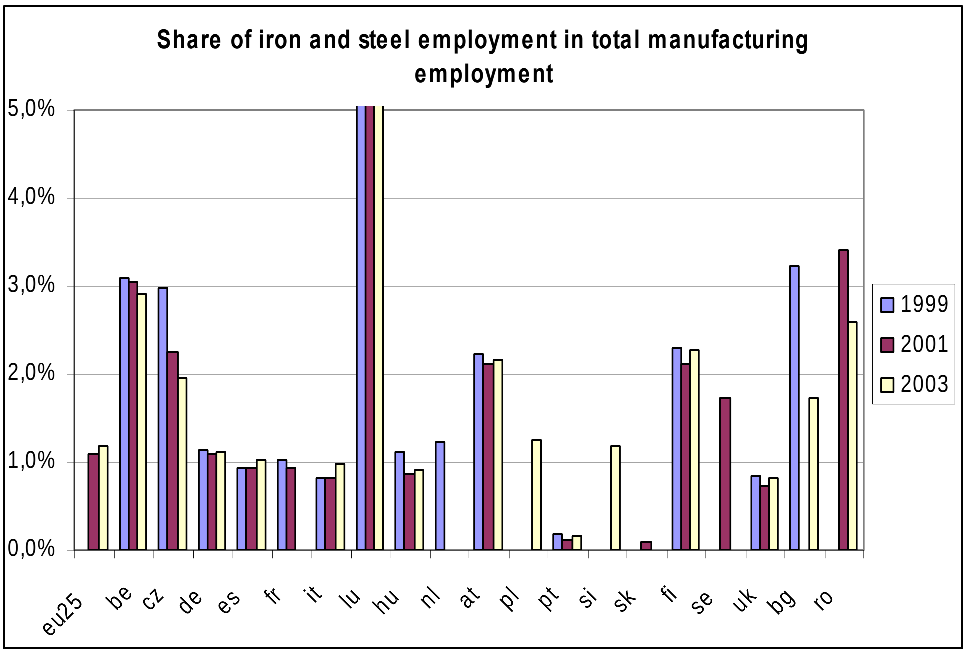
[17] Some countries, like Estonia, Denmark or Ireland, have been left out, as the industry is virtually non-existent here.

Graphs 12a) - 12d)









Source: Eurostat, Structural business statistics (http://epp.eurostat.ec.europa.eu)

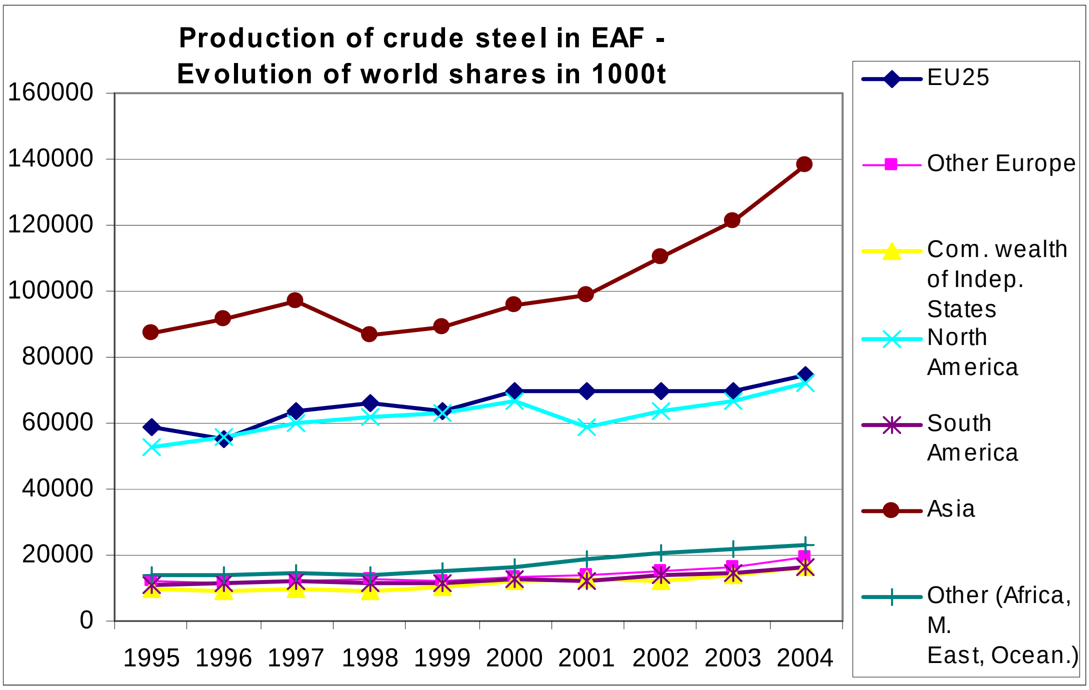
5.4.2 Production

In 2005, over 1400 EAF operate all over the world with about 15% in the European Union. Out of almost 1060 mill. tonnes of crude steel produced worldwide in 2004, 16% (18%) was produced in the EU-15 (EU-25). Divided by production process, 41% (38.5%) was manufactured via the EAF in the EU and 59% (61.2%) via the integrated blast furnace.[18] The EAF route has increased its share in total production considerably over the last ten years (1995: 34.9% in EU-15, 32.4% in EU-25). The rising importance of the EAF can even be traced back to the 1970ties when the open-hearth furnace slowly began to be phased out.

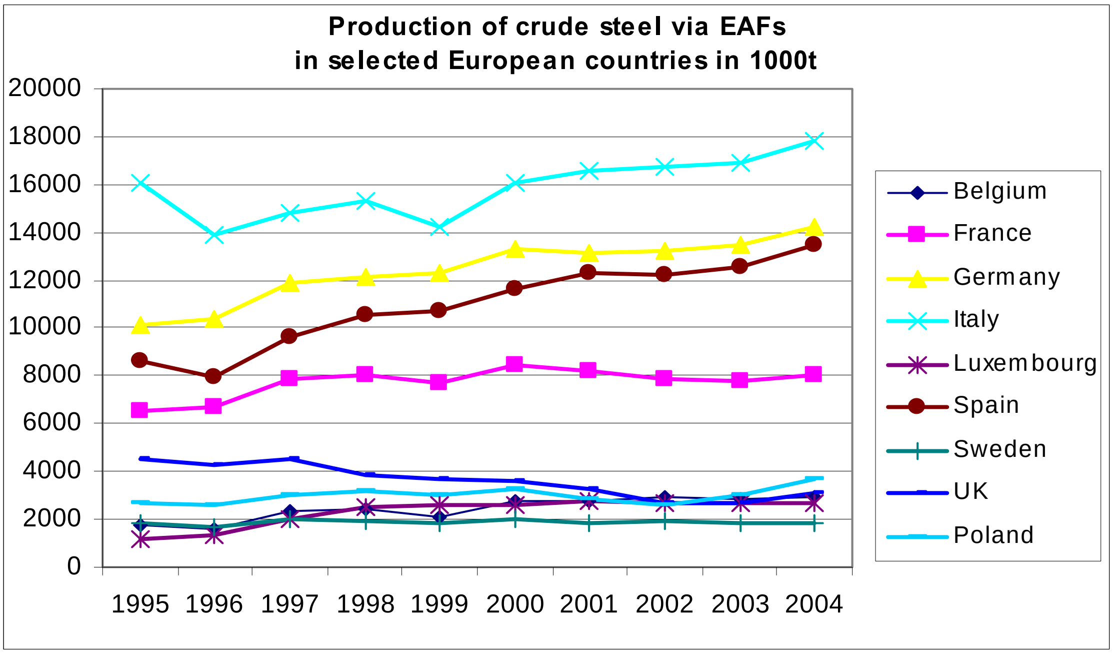
The following two graphs 13a) and 13b) show the evolution of electric steelmaking within the last ten years, both worldwide and within the EU (IISI, 2005). In absolute terms EAF steel production has increased almost everywhere (except the UK). Yet, in relative terms the share of EU-25 and the U.S. has decreased from 24% (21.5%) to 20.7% (20%), respectively, whereas the share of Asia has increased from 35.5% to 38.4%. This shift is almost entirely due to the industrialisation of China, South Korea and India (whereas in Japan production has actually slightly decreased over the last ten years). Within Europe four countries (Italy, Germany, Spain and France) account for more than three quarters (77.5%) of electric steelmaking. Among these four Italy has slightly lost and Spain has slightly improved its relative production share, whereas the position of Germany and France is more or less stable. Luxembourg, Belgium, Greece and Finland have also gained a stronger position by more or less doubling their respective production volumes (albeit from a substantially lower initial output in 1995). The new Member States have had relatively little effect on electric steel production, apart from Poland with 3.7 mill. tonnes in 2004.

[18] Only in Latvia and open hearth furnace is still in operation in the EU, contributing 0.3% of total production in EU-25.

Graph 13a):



Graph 13b):



Source: International Iron and Steel Institute

Looking at typical long products produced in the four main EU steel producing countries and Poland allows to highlight some differences in production patterns among the countries:

- Wire rod is the most important long product in volume terms. It has the most dominant position in Germany (47% of all its EAF based crude steel) ahead of Poland (27%) and the three other countries (each between 21-24%).

- The picture is reversed for concrete reinforcing bars, mostly a lower value product used for construction purposes. In Spain almost 31% of EAF based crude steel falls under this category (Italy 27%, Poland 26%, Germany 14%, France 11%).

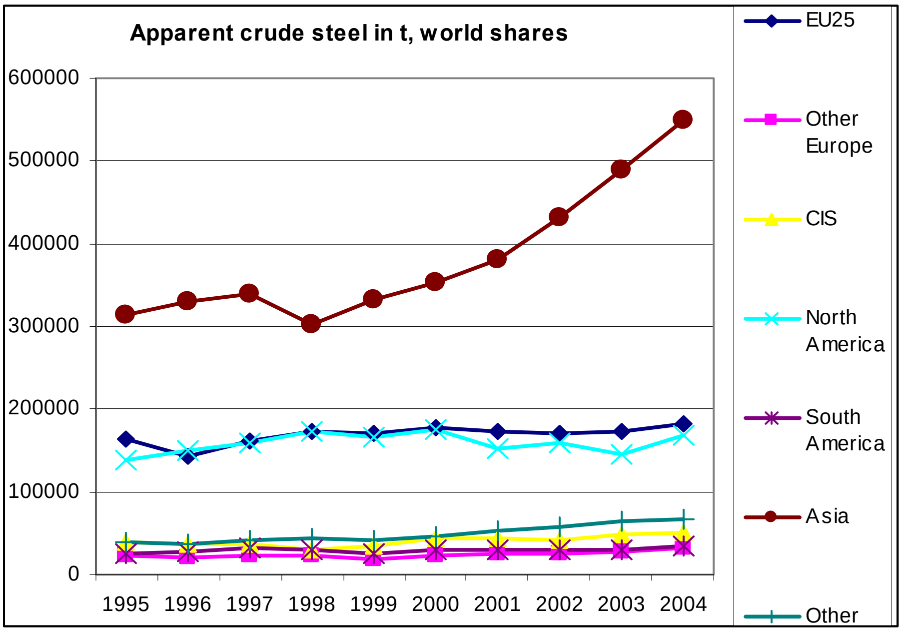
- A tonne of pipes and tubes (welded or seamless) is approximately 2-3 times more expensive than wire rod or reinforcing bars. Spain is the least prominent in this higher-value segment (9.6% of all its EAF based crude steel) compared to Poland (16.6%), France (17.5%), Italy (18.7%) and Germany (24.6%).

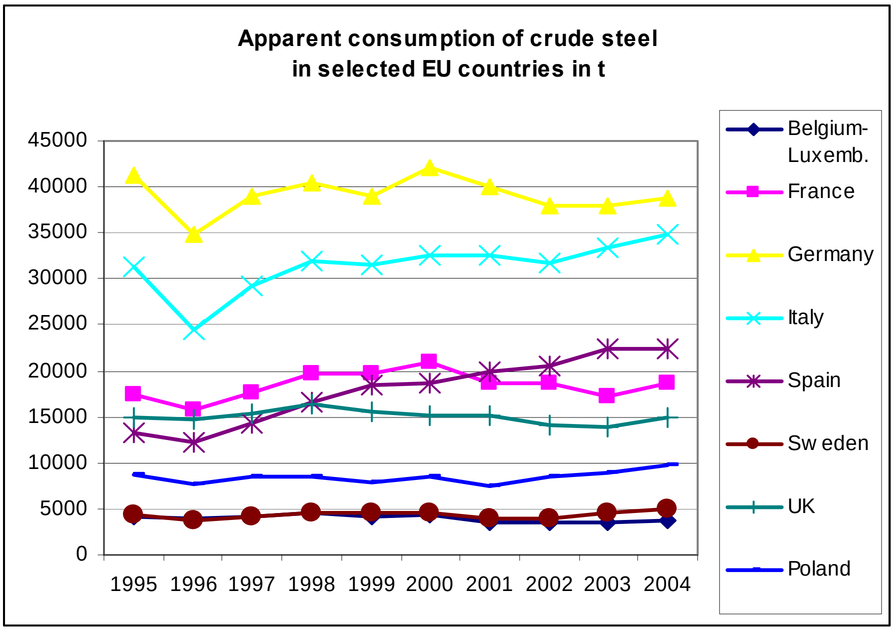
5.4.3 Consumption

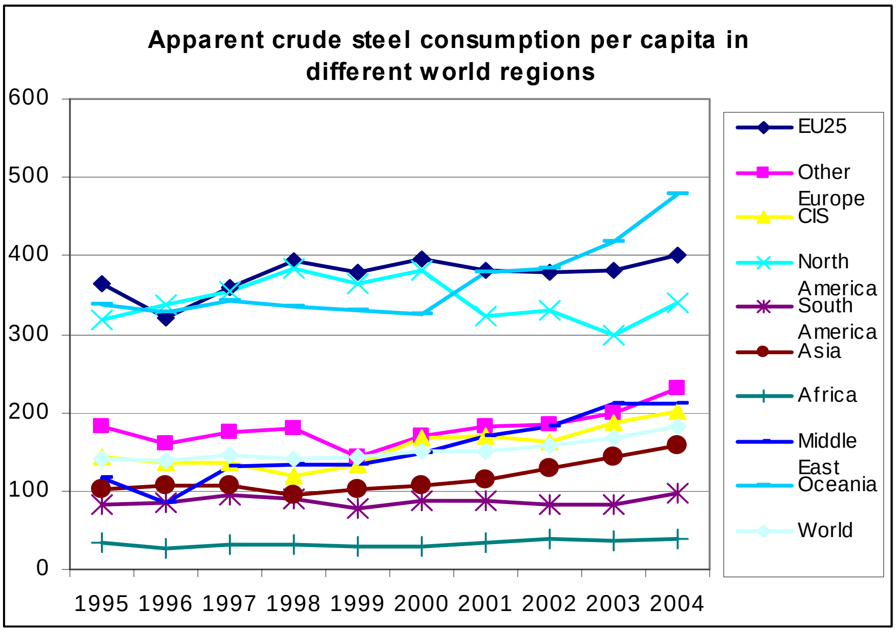
The steel consumption of a country is determined by the production activities of those sectors that use or process steel and their specific steel input volumes. Before looking at these linkages in some more detail (see chapter 5.5), we will look at steel consumption here in a more general and a more aggregated way (see graphs 14a) -14d). In 2004, Asia (in particular China) accounted for almost half (48%) of world steel consumption. Asia has increased its share only within the last six years or so. Absolute steel consumption in the EU-25 and North America, by contrast, has not changed much and as a consequence their share in world consumption has declined lately to 16% and 15%, respectively. Within Europe steel consumption is highest in the most industrialised country, Germany, but has also risen quite strongly in Italy lately. Interestingly, steel consumption has also increased substantially in Spain over the last ten years (by about 75%), whereas in the other countries shown no significant changes can be observed.

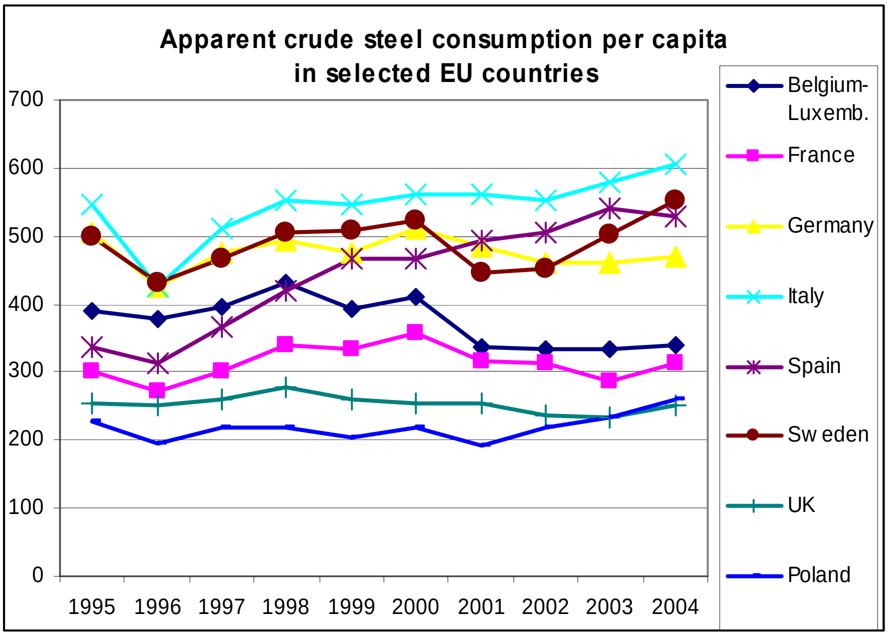
Within Europe a somewhat similar picture results when looking at steel consumption in per capita terms. Yet, the ranking changes to some extent with Italy taking the lead and Sweden being second. Differentiated by world region Asia “looses” its leading position. Among the richer countries, Australia (Oceania), North America and EU-25 still have a per capita steel consumption which is about twice or even three times as high. As a result, it is interesting to know more about what drives steel consumption (see chapter 5.5).

Graph 14a) – 14d):









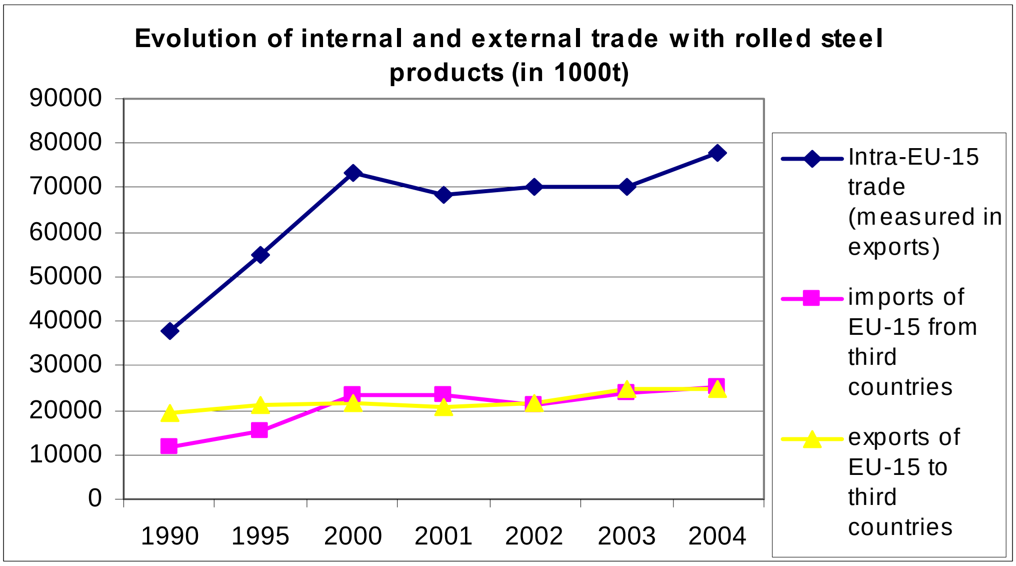
Source: International Iron and Steel Institute

5.4.4 Trade

Production and consumption data already suggest that a substantial volume of steel trade takes place, some of it over great distances. The world trade volume has reached about 363.5 million tonnes of semi-finished or finished steel products. In relation to crude steel production this amounts to 34.3%. Thus, compared to some competing materials (like aluminium) trade is less dominant, but still quite important (with a slightly increasing tendency over the last decades).

There is about three times as much trade with rolled steel products among EU-15 countries than with third countries resulting in relatively high mutual penetration rates (Graph 15). EU-internal trade has been boosted by the gradual creation of the internal market programme. Vis-à-vis other world regions Europe has tended to be a net exporter of steel. This has been facilitated by the proximity to North America, the relatively less developed status of the steel industries in the Middle East and Africa and, more recently, the strong steel demand from China. Lately, the external trade ratios are more or less balanced, however. EU countries which have typically a positive trade balance include Belgium/Luxembourg (with almost twice as much exports than imports), Germany, Austria, France, Sweden, Poland and the Czech Republic, whereas Italy, Spain and (only more recently) the UK import more than they export (see also table 7). Export-oriented countries like Germany reach an export-quota (percentage of production exported) for the steel industry of 50% with this share having risen continuously (1982: 36%, 1991: 40%).

Graph 15:



Source: International Iron and Steel Institute

Table 7 illustrates the diverse patterns of external EU-15 trade with rolled steel products. First of all, the numbers demonstrate that the percentage distribution of third countries receiving EU exports is somewhat more spread-out than the distribution of countries importing into EU-15. Secondly, external trade is somewhat country-specific. Whereas Germany mainly exchanges steel products with new EU Member States (69% of third country imports and 25% of third country exports), Italy and the UK import non-negligible amounts of steel from the Commonwealth of Independent States (CIS), for example (39 and 30% of third country imports).

Table 7: **External steel trade of EU-15 in 2004 according to main world regions**

	Belgium-Luxembourg	Germany	France	Italy	Spain	UK	EU-15
Imports in 1000t							
Africa	205	5	66	589	413	156	1647
(East) Asia	572	60	31	1219	369	246	2801
Oceania	4		2	31		17	64
CIS	300	301	115	3240	441	645	6384
Middle and Far East	110		20	353	81	7	598
North America	39	34	4	62	13	38	202
Latin America	1		47	2	28		83
South America	165	20	59	402	463	86	1518
Eastern Europe w/o CIS	88	149	4	685	257	81	1601
New EU-Members	274	2512	248	457	162	504	5292
non-EU West. Europe	154	550	88	1221	826	342	4806
Third countries	1913	3635	684	8260	3054	2123	25005
EU-15	11245	12859	13209	9118	7705	5081	74438
Total	13158	16494	13893	17378	10758	7204	99443
Exports in 1000t							
Africa	182	344	283	378	321	146	1875
(East) Asia	671	1313	185	378	165	586	3941
Oceania	32	27	29	3	4	25	174
CIS	48	132	8	14	1	23	323
Middle and Far East	365	701	298	189	279	615	2597
North America	721	1393	510	546	334	475	4796
Latin America	165	316	103	208	136	21	988
South America	72	125	77	19	77	38	456
Eastern Europe w/o CIS	18	57	9	81	9	10	360
New EU-Members	356	1895	285	466	14	100	4431
non-EU West. Europe	710	1199	610	653	251	158	4685
Third countries	3375	7502	2396	2935	1591	2196	24672
EU-15	18079	14617	13979	6190	3521	4384	77791
Total	21454	22119	16376	9125	5112	6580	102464
Exports - Imports in 1000t							
Africa	-23	339	217	-211	-92	-10	228
(East) Asia	99	1253	154	-841	-204	340	1140
Oceania	28	27	27	-28	4	8	110
CIS	-252	-169	-107	-3226	-440	-622	-6061
Middle and Far East	255	701	278	-164	198	608	1999
North America	682	1359	506	484	321	437	4594
Latin America	164	316	56	206	108	21	905
South America	-93	105	18	-383	-386	-48	-1062
Eastern Europe w/o CIS	-70	-92	5	-604	-248	-71	-1241
New EU-Members	82	-617	37	9	-148	-404	-861
non-EU West. Europe	556	649	522	-568	-575	-184	-121
Third countries	1462	3867	1712	-5325	-1463	73	-333
EU-15	6834	1758	770	-2928	-4184	-697	3353
Total	8296	5625	2483	-8253	-5646	-624	3021

Source: International Iron and Steel Institute

Looking at product categories or single products illustrates (trade) specialisation patterns among the most important steel producing countries. Given the importance of electric steel-making, Italy imports more of the typical flat products (hot wide strip, various sheets) than it exports, but has a positive trade balance in some of the long products (merchant bars, reinforcement steel, sections). Germany has a strong exporting position in most flat products and, among the long products, wire rod and (to a lesser degree) reinforcement steel and wide-flanged beams. The same is true for most of the flat products produced in integrated steelworks. Only in a few products (like bars) the trade balance is negative. Spain, by contrast, has a negative trade balance in almost all of the rolled steel products. Poland is quite specialised having a strong exporting position in some products (semis, sections/structural, wire rod, reinforcement steel) and relying on imports in others (most of the special steels and most of the flat products). The picture is more balanced in France. One striking feature is the strong exporting position in all the special steels (more than twice as much exports than imports in this category).

5.5 Supply and demand, market structure and competition

Supply

Based on what has already been said about steel products and steel production routes a brief overview on the supply side of electric steel production is in order. This includes basically an analysis of factor input relations in terms of volume and quality, i.e. of investments, raw material inputs, capital inputs, labour input and other requirements, including environmental ones.

Electric arc furnace plants vary greatly in size, but are easier to set up and require substantially lower investment costs than blast furnace/basic oxygen plants. Single EAFs have a heat capacity (heat size) of between 30 to 160t. As two or three of them are sometimes used in combination at one production site, the capacity may reach up to 400t. Reinaud (2005) considers a plant with a capacity of 120t to be an average plant. According to EUROFER a new installation should have a capacity of 150t today. The annual capacity depends on the characteristics of the production process (the furnace, continuous casting process and the rolling mill), the percentage of use of each process, but most of all the electric power (in MW) available in the melting process (cf. electricity supply contract). A 120t plant would be able to produce about 1 million tonnes of crude steel per year, operating at 85% nominal capacity.[19] The cost of asset would amount to about € 160 per tonne of produced steel.[20] The investment costs for the EAF itself represent only between 5-15% of total investment costs for a mini-mill (Heinen, 1997, p. 270). While the furnace is modernised from time to time (on average every nine years), its lifetime is typically about 20 years (European Commission, 2001 based on 1993 Eurostat data; Daniels, 2002). Roughly speaking, 20% of EAF plants in the EU have been built before 1970, a third in the 1970ties, 15% in the 1980ties and another third after 1990 (Quass et al., 2005). Worrell and Biermans (2005) provide a detailed picture of stock turnover and retrofitting for US electric steelproduction via the EAF and analyse its impact on energy efficiency. They show that it is difficult to assign a typical lifetime to an EAF. Indeed, age is not necessarily the determining factor in taking industrial equipment out of production and depreciation rates fluctuate quite heavily. Despite these difficulties in assessing stock turnover Worrell and Biermans (2005) suggest that on average 3.6% of the stock is taken out of production annually. At the same time stock turnover contributes to an improvement in energy efficiency of 0.7% per year

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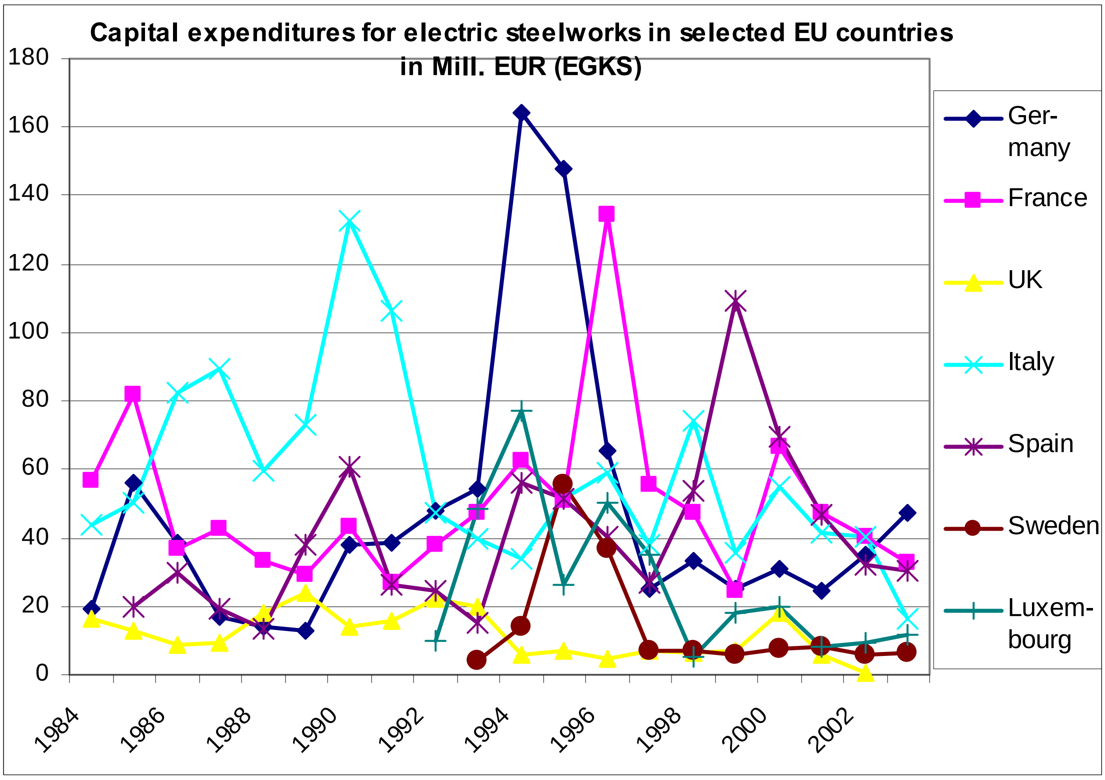
19 More precisely, the distribution of EAF plants by nominal capacity is bimodal (Quass et al., 2005 based on DG ENTR data): There is a relatively large number of rather small plants with a capacity below 200 kt, and a quasi Gaussian distribution, peaking around a capacity of roughly 500-600 kt per year. Thus, the numbers of Reinaud (2005) are at the upper bound.

20 Given differences in size and plant layout Daniels (2002) and Jahnke (2001) present significantly lower values (about half of Reinaud's). According to Ouvrado (2005) installation cost for a new steel shop and a continuous casting facility amount to € 150 per t of steel in the semi-finished market.

(via four analytically distinct factors, the retirement rate, the growth rate of new stock, the difference in specific electricity consumption between depreciated and average stock and the difference in specific electricity consumption between new and average stock). Yet, stock turnover only explains about 60% of the total observed efficiency improvement, suggesting that the rest must be due to retrofit of existing capacity, improved operation practice, change of product mix or the production of more sophisticated steel.

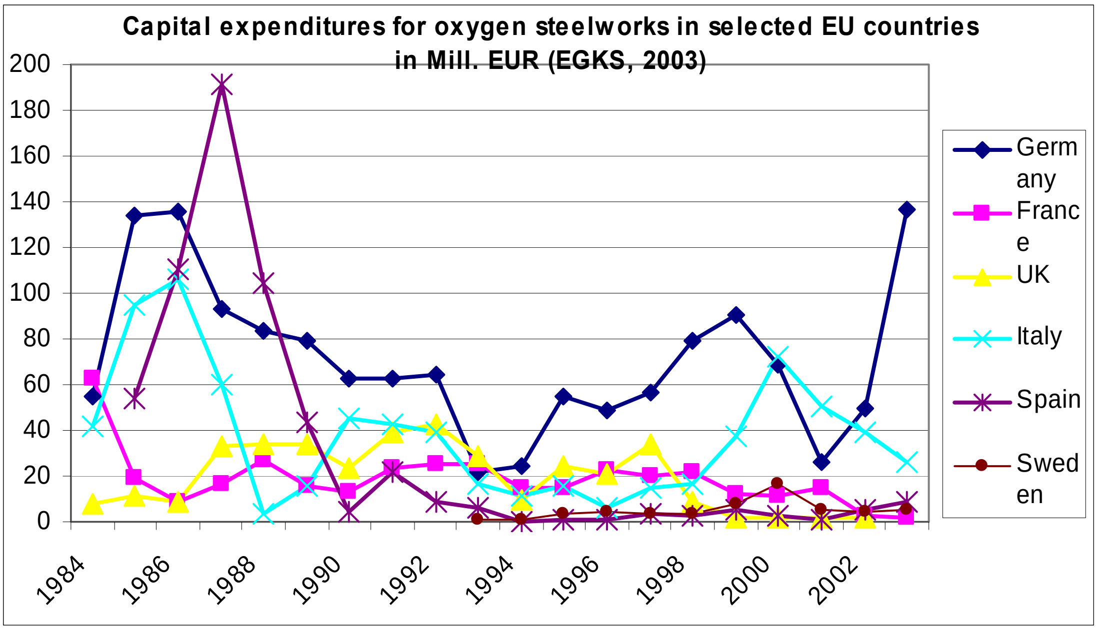
Graph 16a):



Source: European Community for Coal and Steel

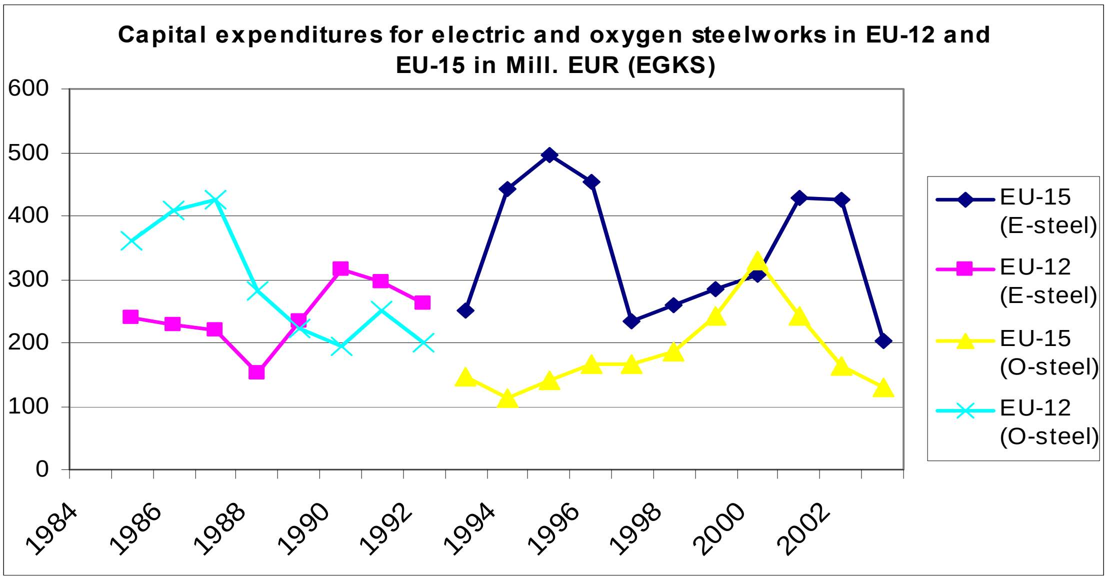
Graphs 16a), 16b) and 16c) provide an aggregated picture of capital expenditures in electric and oxygen steelworks. Obviously, investments fluctuate strongly over time. Yet, certain peaks can be recognised (for electric steel in 1990, 1995/6 and around 2000 and in somewhat longer intervals for oxygen steel). The most notable peak (1994/95) in Germany can be explained by high capital expenditure into two new plants replacing a BF/BOF route and an open heart furnace. Looking at investments over a 20-year time period illustrates changes in average investments between countries. In Spain, investments in electric steelworks have risen from a 20-year average of 40 Mill. € per year to a five-year average of almost 58 Mill. € lately. For Italy, by contrast, a downward trend can be discerned (from 59 to 38 Mill. €). When comparing investments between oxygen and electric steel there is somewhat of a downward trend for the former and an upward trend for the later corresponding to the rising importance of the secondary production route.

Graph 16b):



Capital expenditures for oxygen steelworks in selected EU countries in Mill. EUR (EGKS, 2003)
200
180
160
140
120
100
80
60
40
20
0
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
Germany
France
UK
Italy
Spain
Sweden

Graph 16c):

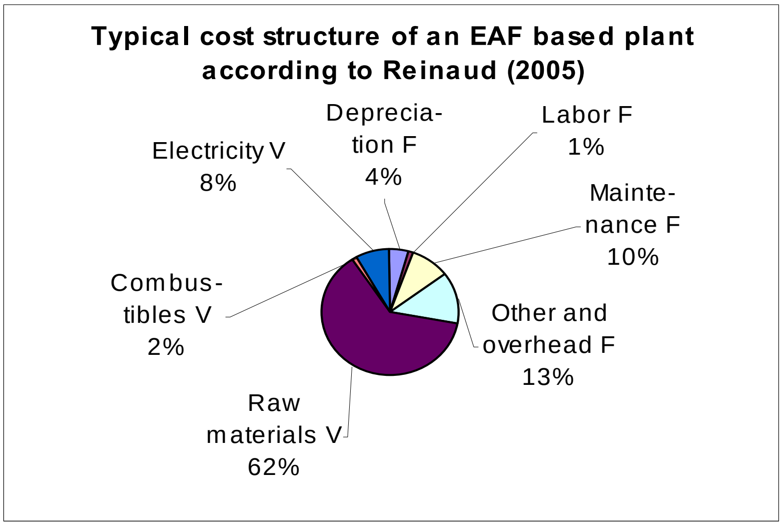


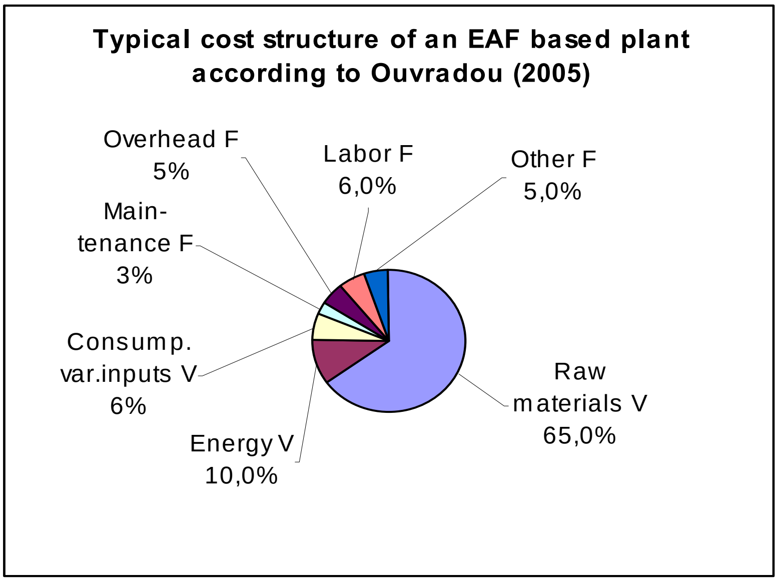
Note: Compared to the EU-15 countries EU-12 excludes Austria, Sweden and Finland (joined in 1995 only). Source: European Community for Coal and Steel

Graphs 17a) and 17b) show calculations found in the literature on the cost structure of producing electric steel in a "typical" EAF plant. The differences apparent in these graphs demonstrate in part real differences between production programmes (products transformed), but are also due to different methods in cost allocation[21].

[21] Of course, it is always difficult to come up with a typical cost structure since factors like productivity, amount of orders, level of investment, etc. differ from plant to plant.

Graph 17a) and b)





A distinction is made between fixed and variable costs. Obviously, electric steel production is quite “variable-intensive”. Another (and similar) broad breakdown found in the literature is between raw material costs and processing/conversion costs (Heinen, 1997, p. 752ff.). The latter is particularly illustrative to show differences in producing steel via the primary or the secondary route: Whereas in primary steel production raw material costs amount to 88% and processing costs to 12%, electric steel production faces relatively higher processing costs (about 38% relative to 62% raw material cost). According to EUROFER the risen raw material prices increased the amount of raw material cost for EAF to 70 to 75%. Energy costs are estimated to amount to 10%.

The largest single component of the total cost is still the feedstock or raw material. In an EAF, mostly solid material in the form of scrap is melted to produce crude steel. The evolution of scrap prices influences considerably the economic situation of EAF plants. More recently, they have risen strongly given the increasing steel demand from Asian countries. The relationship between the prices for pig iron and scrap indirectly "regulate" the breakdown of steelmaking via the primary and secondary production route. Yet, all EAF plants more or less face the same trend of input prices since scrap is traded on international markets. Nevertheless, variation may result from differences in transport costs (in particular the proximity to coastal locations), the rate of substitution of scrap by other input factors (like directly reduced iron DRI or pig iron) and different contractual arrangements with customers (Ewers, 1997, p. 756).[22] Also, as "home" scrap and "prompt industrial" scrap is not traded internationally (other than post-consumer scrap), but directly recovered from steel mills and foundries, cost differentials may result from different scrap sourcing, recycling and management strategies. Finally, it needs to be taken into account that different steel qualities require different levels of scrap quality and purity, potentially leading to quite different charging costs.

A substantial amount of the total cost in electric steel production is spent on melting electricity. In the literature a value of around € 15-20/t of crude steel is given, but there is considerable variation depending on the structure, evolution and regulation of the electricity market. The absence of a real level playing field in the European energy markets and the disparities in national regulatory and fiscal regimes are currently a major concern for electric steelmakers affecting their competitiveness (Ameling, 2006 and chapter 5.6). A major cause of the current power price increases is the pass through of CO2 certificates as generators are using their dominant position in the power market to take advantage of the EU-Emission Trading Scheme. Consequently this represents an inter-sectoral distortion of competition.

More generally, the main competitors of EU basic metals producers are more and more based in countries that are able to offer lower electricity prices and long-term availability. In addition, there are differences in electricity consumption from one plant to the other. These result from differences in technical standards, energy management and the desired steel product quality, but depend also on the size of the EAF. Due to economies of scale larger EAF consume relatively smaller amounts of (final) energy.

Other energy costs include mostly costs for gas. The input of coal for slag foaming and the oxygen injections for process improvement can also be subsumed under energy costs. Again, there are differences from one production plant to the other (e.g. depending on the design of the furnace), but cost differentials matter less given the small share of these inputs in total costs. Yet, there is a trend to increase the amount of chemical energy in order to reduce electrical energy consumption and conversion costs, and to realise productivity gains (Raggio, 2005, p. 46; Jones, 1999, p. 90).

There are other input factors consumed or used up during the production process. According to Abbildgaard et al. (1997, p. 102) electric steel production requires 2.1 kg of electrodes per tonne of crude steel (CS) produced or 3.68 €/t and 3.5 kg of refractory per tonne of CS or 2.59 €/t. Electrode consumption has improved since 1997 with a reference installation consuming at present 1.1 to 1.3 kg electrodes per tonne of steel produced[23].

[22] The latter are used to equalise price fluctuations. Yet, they may contradict the rules of the European internal market.

[23] The refractory ratio (kg/ t) is not the most pertinent because the practice of refractory can be different from one site to the other. It is the cost in Euro per tonne which has to be taken into account.

Further input factors may include flux materials, oxygen, cooling water and fresh water. In addition part of the electric energy is subsumed under this category (but only 3.68 €/t compared to almost 20 €/t in the category above). The importance of these input costs depends on energy and resource efficiency and the technical standards of the respective plants, i.e. on technological progress.[24]

The production process results in a number of by-products. It is interesting to know whether these by-products add to the costs or help to avoid costs for the plant. Abbildgaard et al. (1997, p. 102) mention pelletized furnace dust (1.43 €/t) and used furnace refractory (0.06 €/t) as a cost category and district heating (-0.96 €/t) and furnace slag (-0.12 €/t) as avoided costs. Given certain regulatory requirements regarding recycling and waste management, the sale of EAF dust (pellets) and EAF slag is a means to reduce waste management costs by improving the recovery rate. Overall, by-products are only of minor importance within the breakdown of total cost. Nevertheless this issue deserves attention as there are may be inter-firm differences as well inter-country differences (due in part to different regulatory requirements). Contrary to the above graphs Drissen et al. (2005) mention, for example, that recycling of EAF dust has brought serious ecological and economic advantages to their plant (fewer external processing costs, reduction of alloy elements (for stainless steel).

Among the studies mentioned in graphs 17a) and 17b) there is some disagreement on what to include in fixed costs and on how to define the individual cost categories. Abildgaard et al. (1997) consider transport costs as variable costs, for example, whereas Ewers (1997) subsumes them under "other fixed costs".[25] Ewers (1997, p. 754) emphasizes that labour cost matter. However, some of these costs are hard to attribute to the categories making up the total costs per tonne of CS produced. As a result, costs for maintenance, the operation of additional on-site facilities and overhead contain a considerable amount of labour costs. Finally the costs of capital are also hard to pin down. Factors that influence these costs are in particular the malleability of capital equipment, interest rates, taxation, depreciation rules and debt/equity levels.

More broadly, fixed costs increase with part-time or reduced production. They are higher in those sectors with a high capital intensity resulting from technical economies of scale (investment costs per t of capacity decrease with growing unit size of the installations). While economies of scale are of great importance for the primary production route, they are less so for the EAF route (Wienert, 1997, p. 65). On the process level, costs may also result from operational bottlenecks along the various stages of production. A recent American survey, for example, indicates that among 32 electric steel plants casting is more often considered a bottleneck (64%) than the EAF itself (25%) or ladle metallurgy (7%) and cranes (7%) (Liebman, 2004).

Most of the information about cost structures in EAF steelmaking found in the literature does not explicitly account for the cost of environmental regulation. This does not mean that they are absent, but that it is inherently difficult to properly account for them. The issue is well covered in a US study by Joshi, Krishnan and Lave (2001) who report on environmental expenditures per ton of steel produced between 1975 and 1989.[26] The paper distinguishes between "visible" costs of regulatory compliance (i.e. costs that firms' accounting system classify as "environmental" and are regularly reported in the Pollution Abatement and Expenditure (PACE) survey)

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[24] Comparisons from one plant to the other are also difficult, because total energy consumption (including fist transformation of molten steel) depends on the product mix. For example, energy consumption for wire drawing depends largely on the final thickness of the wire (Gielen and van Dril, 1997).

[25] Regarding transport costs, it matters also where the system boundaries for cost allocation are drawn. According to EC (1999) transport costs make up between 5-15% of the selling price of a steel product. Yet, the fewer downstream markets are considered the lower are typically the transport costs.

[26] For more aggregated data for several EU countries see section 5.6.

and "hidden" environmental costs embedded in other accounts, measuring and comparing them to each other for a unique sample of 29 mini-mills and 26 integrated steel plants. Taking environmental expenditures as a proxy for the costs of compliance indicates that visible environmental costs are relatively modest, at about 4% of total reported costs per ton of steel produced and 3% per ton of steel capacity (with some fluctuations between the years). Within this category operating costs are usually higher than capital costs (again with quite strong fluctuations). Yet, by applying an econometric translog cost function approach the authors demonstrate that this covers only a minor portion of overall costs associated with regulatory compliance. For firms in the mini-mill sector, an increase of $1 in the visible environmental operating expenditures is associated with an increase in total costs of $ 10.68 at the margin (!), of which $ 9.68 is "hidden". Thus, hidden costs of environmental regulation far exceed the reported or visible costs of pollution abatement. While average costs are likely to be lower (since it is relatively inexpensive to reduce emissions initially) and the estimation of "hidden" costs is methodologically demanding[27], Joshi, Krishnan and Lave (2001) suggest that these costs may show up in various forms. For example, they may include costs from the alteration of input and raw material compositions, costs due to process changes (possibly associated with lower economies of scale), indirect labour costs to monitor and report emissions, costs to maintain pollution control equipment, increasing general and administrative costs e.g. for legal staff (permit application etc.). As a result, it matters how costs are allocated to different cost pools and how environmental regulation affects each of them.[28]

The fact that <u>EAFs</u> are relatively "variable-intensive" <u>compared to the integrated route</u> creates several <u>advantages</u>. Firstly, specific investment costs are lower and EAF often reach a higher return on asset or capital employed than integrated mills. Secondly, there is a higher degree of flexibility in controlling production rates and, consequently, a higher responsiveness to demand fluctuations. This may be interesting for companies wishing to add incremental capacity at relatively low cost. In addition, EAF based plants can be designed to make specific product qualities for particular end-user markets. As they are usually small units they also can be located near these end-user markets. Thirdly, since EAF dispose of continuous melting energy they also rely less than integrated steelworks on primary energy carriers and raw materials from international markets (Janke et al., 2001, p. 73). Finally, environmental reasons may be a decisive factor when considering investments in steel making facilities (Jones, 1999, p. 94): As some integrated plants use relatively old coke ovens and blast furnaces, the cost of modernising these facilities, coupled with bringing them up to current environmental compliance standards, may be too high to keep facilities operational. Obviously, this depends on whether environmental regulations incorporate any new source bias, discouraging the introduction of new plants and the continuation of existing plants.

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27 The study suffers from the following main limitations: The estimation of hidden costs is based on a statistical association between the variation in total costs and variations in the reported environmental costs, which does not establish causality (e.g. problem of bundling certain types of expenses with each other). Also, the model is based on contemporaneous variation in total and regulatory costs, and does not incorporate learning effects that may reduce hidden costs later. Thirdly, environmental expenditures are only an imperfect proxy of a complex set of emission limits and standards. Finally, environmental costs may also lead to hidden benefits, such as improved quality, increased consumer appeal, or lower contingent liabilities, which are not captured in the model. More generally also, the data cannot just be extrapolated from the specific situation facing EAF producers in the US some 25 years ago to today´s mini-mill producers in Europe.

28 Interestingly, the authors have conducted additional in-depth interviews with steel firm managers to gain a better insight in the nature of hidden costs and to explore the validity of their econometric estimations. These interviews revealed serious deficits in the traditional cost accounting systems used, and consequently, a considerable scope for improvement in internal environmental management. This issue will be picked up again in chapter 7 of this study.

As indicated above, the prices of steel products from EAF vary greatly depending on the differing quality of steel products. They may also vary due to regional specialisation patterns in different product segments (with these patterns being possibly induced by differences in costs). EAF plants typically respond more strongly and more flexibly to price signals and face fewer constraints in capacity planning than integrated steelworks (see below). Overall, there is a declining trend in the price index for typical steel products (Dahlström et al., 2004).

Demand

Graphs 14a-d have demonstrated that the level of steel consumption, whether measured relative to population or GDP, varies widely among countries. Various factors influence steel consumption per head and explanations will depend on the level of aggregation used. Globally, countries with higher GDP per capita seem to have higher steel consumption per capita, but there is wide variation among countries with comparable levels of GDP per capita. Analysing per capita steel consumption and level of GDP more closely indicates that some correlation exist for poorer countries in an early stage of their development (Moreau, 2005, p. 46). Yet, this is no longer the case for richer countries and remarkable differences exist (e.g. between Japan with 530 kg/capita or Italy with 490 kg/capita on one hand and the UK with 225 kg/capita and France with 285 kg/capita on the other hand). To account for these differences a closer look at the structure and evolution of steel consuming sectors and their products is necessary (Moreau, 2005)[29]:

Still a quite broad indication is given by the importance of the manufacturing sector in national economies. In many countries it has decreased over time and given way to the service sector. In some countries (like Germany) this is less strongly the case. Following this reasoning and given different patterns of specialisations the variation in per capita steel consumption is already reduced when taking into account indirect steel trade (quantity of steel contained in exports and imports of goods using the material steel).

More specifically, the output mix, production structure and steel intensity within the steel consuming sectors differ in several respects and these sectors are more or less dominant from one country to the other. The construction and public works sector, as the most important steel consuming sector, is marked by local specificities of either geographical, technical or cultural nature. In Southern Europe (Italy, Spain), for example, steel is far more widely used in construction than in Northern or Central Europe. In automobile production steel consumption per capita is much higher in the US, Germany or Spain than in Italy and France. Again, this is i.a. explained by different specialisation patterns, historical factors and cultural specificities (e.g. preference for heavy vehicles in the US). In the other steel consuming sectors differences are more difficult to detect. Yet, Italy is highly specialised in the first and second transformation of certain steel applications, for example (intermediate goods, mechanical industry, household appliances).

These sectoral differences have in turn repercussion on the level of use of individual steel products. Automobile construction relies strongly on flat products, for example. Long products play an important role in investments in construction and infrastructure.

In economic terms, there are likely to be differences in the price elasticity of demand from one sector and one application to the next and depending on the time horizon.

These long-term patterns do not reflect that steel demand is quite volatile in the short-term. Steel demand follows quite closely the evolution of the business cycle which in turn is largely driven by the sectors producing investment goods and using steel as an intermediate input.

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[29] For more detailed explanations from various perspectives see the extensive work of Moreau (2005).

Market structure and competition

In general, the minimum economic scale in steel production is high, and the investments in the sector are specific. At the same time, steel demand is quite volatile and hard to predict making capacity planning a difficult and risky undertaking. As a result, there are high market entry barriers. By contrast, those companies already in the market cannot easily adapt capacity when their predictions turn out to be too optimistic. From their point of view it makes sense to continue operation of old installations at a high level, even when prices cover only variable costs. More widely, this often creates a burden for the steel market (unless this is compensated by a quick increase in demand). As indicated above, however, EAF based steelmaking is not as much subject to these planning problems given its lower share in fixed costs and its relative flexibility in production. The greater degree of flexibility and the interdependencies between the level of scrap prices and overall steel demand, with scrap prices decreasing in times of low demand, explain that mini-mills face less variation in profits than large integrated steelworks. Yet, market exit is still constrained to some extent for electric steelmakers. Also, new players aiming to enter the electric steelmaking market need to be highly experienced and knowledgeable (both in technical and economic terms).

At present, Arcelor Mittal Steel is the EU and world's largest steel company, producing 110 million tonnes per year in Asia, Europe, Africa and America. Together with Thyssen Krupp Steel, Corus and Riva, they produce somewhat over 75% of EU steel. In comparison, ten years ago the top EU 5 companies produced only 23% of total EU output. As a result, the EU steel market today represents a more narrow oligopolistic market. EAF plants seem to operate on various market segments with some closely linked to the large integrated companies and others being independent and active in specific niche markets (with partly oligopolistic structures, if relevant markets are defined along relatively limited regional boundaries, segmented by transport costs and/or close co-operation with customers is maintained). The tendency to consider the steel industry as a "normal" industry sector that has to compete on markets without subsidies or other protectionist policy interventions and the increasing globalisation of the world economy has had a profound effect on the industry. Increasing competitive pressures are i.a. met by a further consolidation of the industry in Europe. So far the degree of consolidation varies considerably by product segment with top 10 carbon steel producers achieving lower market shares than stainless steel flat or long product producers (Moll, 2005). The move towards bigger entities should help to strengthen the position of the steel industry vis-à-vis important up-stream and down-stream producers. Another potential consequence of the concentration process could be the accelerated diffusion and application of new (BAT) technologies (technology spillovers). Put alternatively, increasing environmental requirements for the operation of steel plants might create further incentives for steel companies to re-group (e.g. to be able to finance sustainable technologies) (EU commission 2006, p. 25).

Vertical integration is also quite frequent in the steel industry: Many producers control an important part of the raw material production chain and most are integrated downstream into steel distribution and first transformation products such as sheets, profiles, tubes etc., and steel distribution (but typically not further). Again, this is less so for electric steelmaking and depends on the product segment.

5.6 Indicators of competitiveness[30]

As indicated in chapter 2.3 the concept of competitiveness is applied at different levels. While this study focuses primarily on the firm level, this section looks at competitiveness from the level of an industry sector and sub-sector. Framing the assessment of competitiveness along these lines may help gain a better understanding about the potential wider impacts of environmental regulation on a whole class of firms belonging to the same industry sector. After all, firms compete against each other and some of the competitive gains or losses a firm may make as a result of environmental regulation will also affect the position of firms belonging to the same industry (as well as firms belonging to other industries). This is even more important when regulatory requirements and strategies vary from one firm to the next and from one country or region to the other. Thus, there is a need to consider the different starting points and trajectories facing parts of the industry or the same industry in different countries.

To account for (at least some of) this complexity we propose to look at a selection of indicators of competitiveness at the industry level. The selection is quite strongly influenced by data availability and reliability: On one hand, there are only few usable quantitative data on most of the techno-environmental variables of interest for this study. On the other hand, data are sometimes not available at the required level of disaggregation. As a result, proxies or more aggregated data have to be used. The aggregation problem is particularly evident when data are not available for a well defined sub-segment "electric steelmaking from EAF installations", but only for broader statistical classes like "production of iron and steel" (NACE 27.1) or even "basic metals" (NACE 27).[31] By using not only one or two indicators, but a broader selection of them and by cross-checking the evidence we hope to be more comprehensive, however. In this sense, some of the indicators also have only an indirect relationship to competitiveness aspects. To enable comparisons among the main countries producing electric steel – Italy, Germany, Spain, France, the UK and Poland – we use common denominators to account for structural differences between these countries. In addition to cross-country comparisons, competitiveness is sometimes also defined in relation to the evolution of the indicators in other industries of the same country.

The following table 8 contains all the competitiveness indicators proposed for the sector analysis and described in greater detail below. We start with broader indicators and then move on to a selection of more specific ones.

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30 An overview of all references used in this chapter can be found in table 8 below.

31 Beyond problems of data availability and quality there are of course ample opportunities to refine the approach proposed here by using more elaborate econometric models. This was not possible given time and budget constraints.

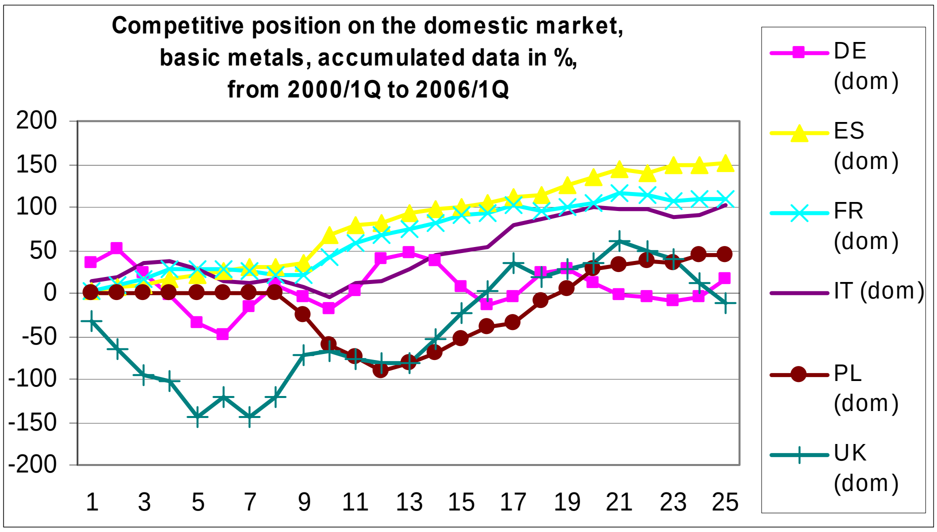
Table 8: **Overview of competitiveness indicators used**

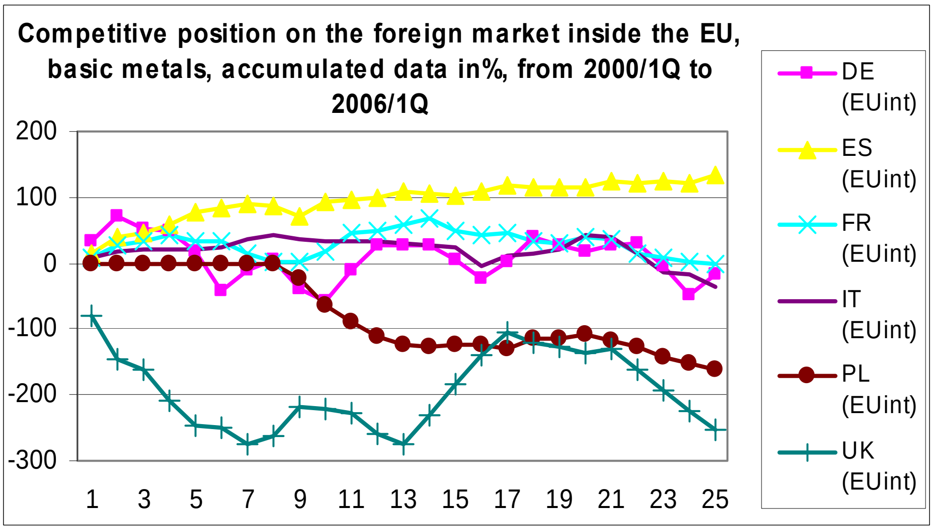
Indicator	**Source**
Expert appraisal on competitiveness	EC, Ifo Institute
Gross operating surplus over value added at factor costs (gross margin)	Eurostat
Gross value added per person employed (apparent labour productivity)	Eurostat
Gross value added per unit of personnel cost (wage adjusted labour productivity)	Eurostat
Crude steel production per number of persons employed	ECSC, VDEh
Evolution of average investments in electric steelworks	ECSC
EAF capital expenditures to yearly EAF steel production output	ECSC
Share of expenditures for EAFs in total expenditures	ECSC
Investment over value added at factor costs	Eurostat
Utilization rate of maximum production potential in electric steel	ECSC
Net investment over gross investment in tangible goods	Eurostat
Share of R&D in value added	Eurostat
Revealed Comparative Advantages (RCA) ratios	Eurostat, COMEXT
Shares of environmental protection investments in gross fixed capital formation	Eurostat
Current environmental expenditures in total purchase of goods and services	Eurostat Eurostat
Electricity prices for industrial consumers	Eurostat, WIIW
Price-quality gap indicator	

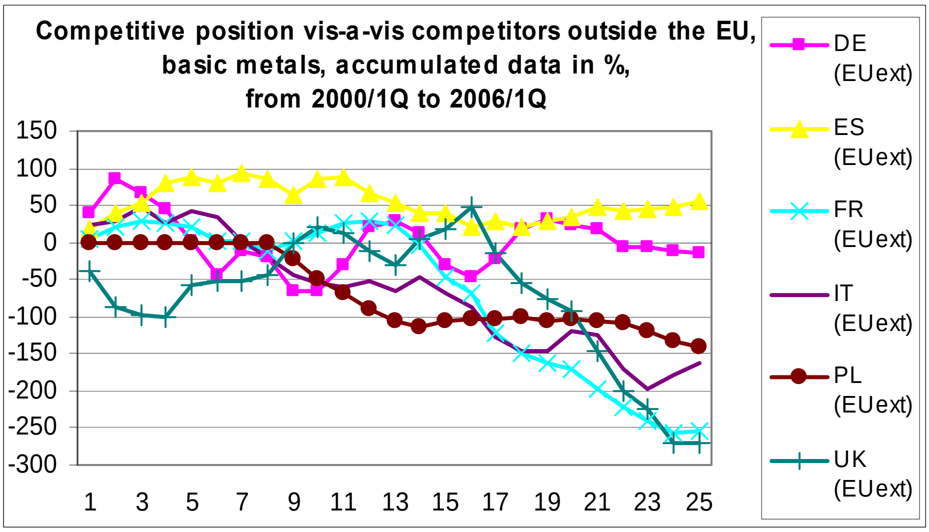
More general indicators

A straightforward way to look at competitiveness is to ask industry experts to appraise the competitive position of certain industries in certain countries. Supported by the European Commission the ifo Institute has conducted these expert surveys for a long time providing up-to-date information that is not easily available (i.e. inter alia only available with substantial time delays) from international statistics. Using this valuable (internal) resource, graphs 18a)-18g) have collated information about the evolution of the competitive position between 2000 and 2006 of both total manufacturing and the basic metals sector in the six countries of primary interest for our study. The term "competitive position" (not explained in any further detail in the ifo survey) is defined in relation to the domestic market, the foreign market inside the EU and in relation to non-EU competitors. While the absolute graphs contained in the graphs are of secondary importance, the data allow to come up with a broad ranking and show important general trends over time of the various "positions" presented:

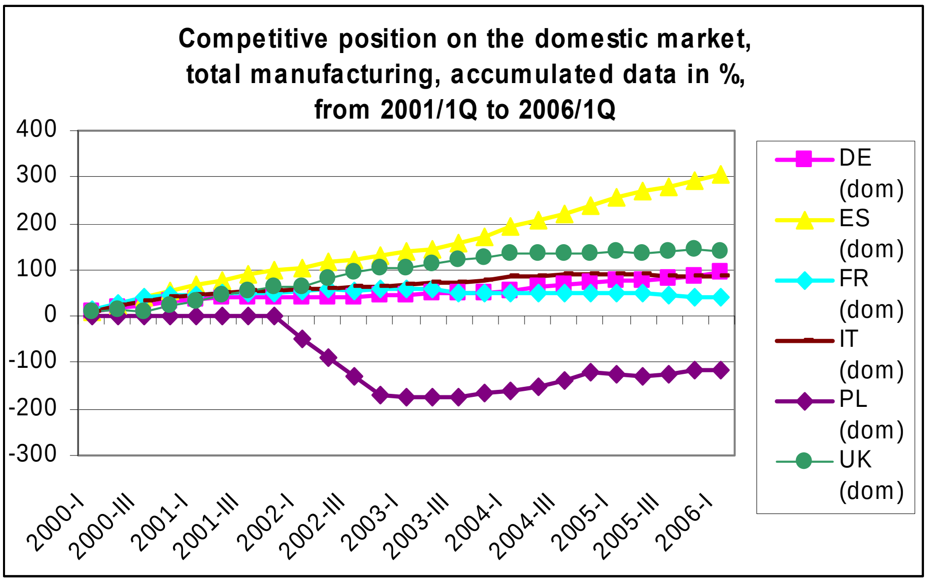
Graphs 18a) – 18g):

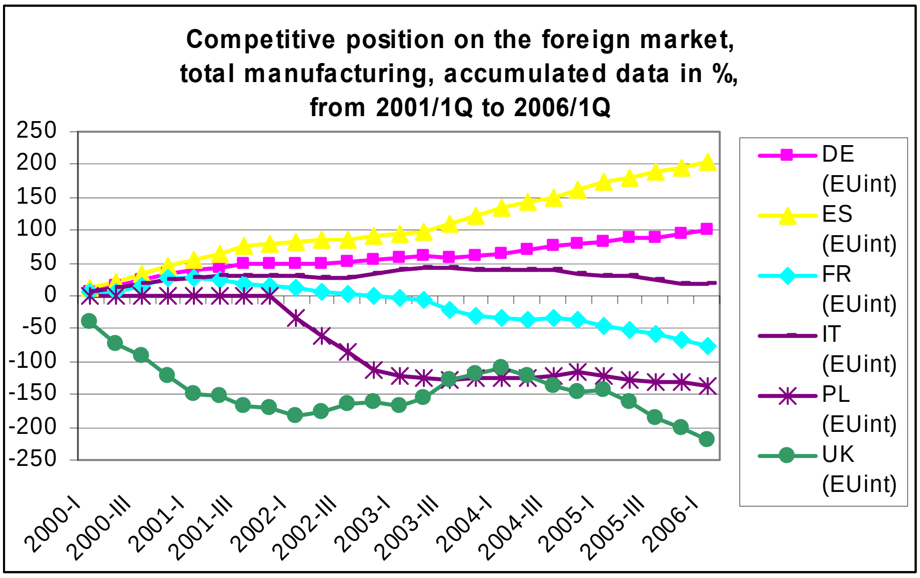


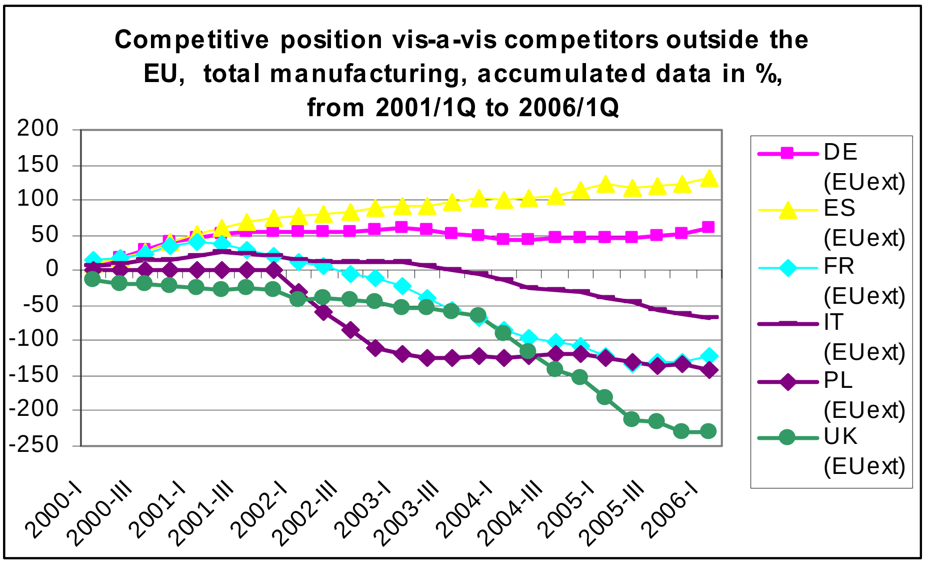




Ranking of countries and ranking relative to position of country's manufacturing total						
	DE	ES	FR	IT	PL	UK
2006 dom	5	1	2	3	4	6
2006 int	3	1	2	4	5	6
2006 ext	2	1	5	4	3	6
Diff. to total manufact.						
dom	-2 –	0 –	+3 +	+1	+2 +	-4 –
int	-1 –	0 –	+2 +	-1	0 –	0 –
ext	0 –	0 –	-1 –	-1 –	+2 – / +	0 –







Sources: EC, Ifo Institute

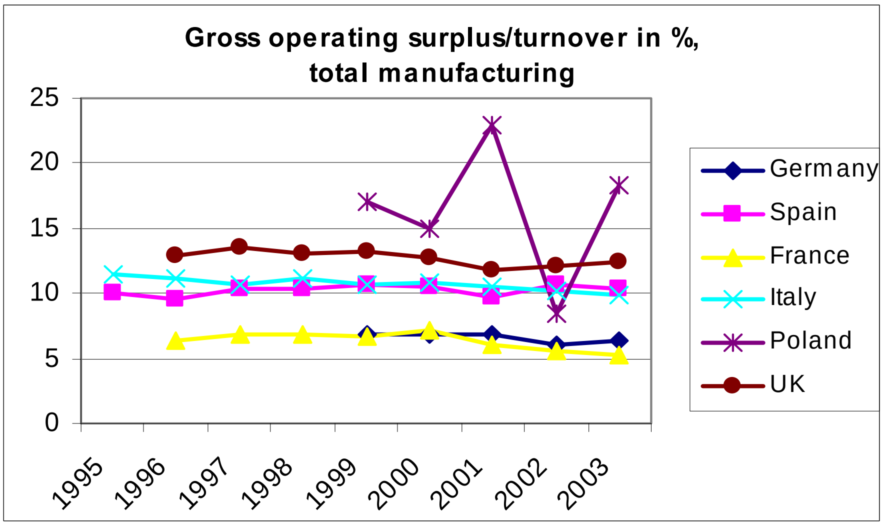
- First of all, the competitive position in basic metals is subject to considerably more fluctuations over time than manufacturing as a whole. This illustrates the sensitivity of the sector to the evolution of the business cycle.

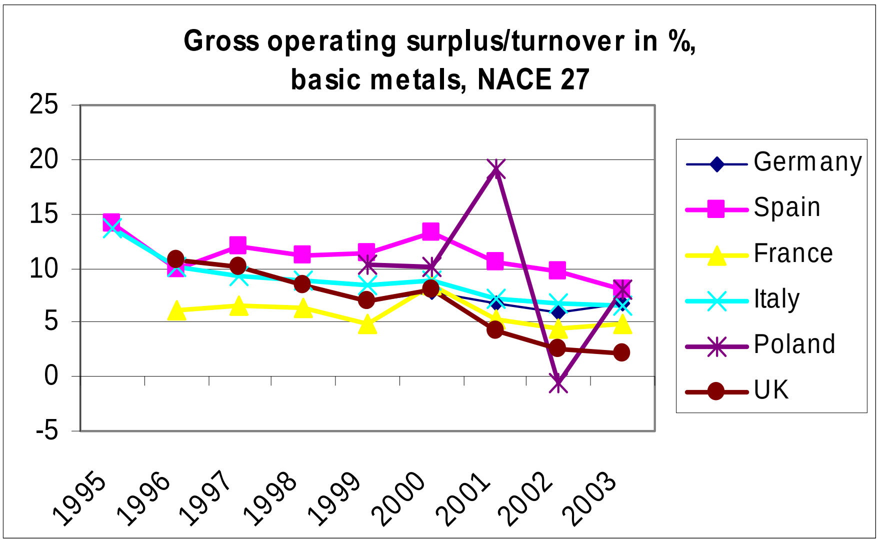
- For both “sectors” it is easier to defend or to strengthen the competitive position on the domestic market compared to international markets. For the majority of the six countries the competitive position vis-à-vis third countries outside of the EU has worsened over time.

- There are substantial differences between the countries in the basic metals sector. Spain scores first on all the markets considered, whereas the UK always shows up last. Germany and – at least with regard to third countries – Poland improve their relative position in international markets compared to France and Italy which loose some ground.

- Compared to total manufacturing the evolution of competitive positions in basic metals in each country is mostly less favourable. Yet, this is not always the case (e.g. in the domestic market in France, Poland or Italy). Possibly, it is more difficult to remain competitive in “old” branches like basic metals.

Graphs 19a) – 19c):





Source: Eurostat, Structural business statistics

The second broad indicator, presented in graphs 19a)-c) looks at a measure of profitability which is available at the sector and sub-sector level: the so-called gross margin. It is defined as gross operating surplus over value added at factor costs.[32] Gross operating surplus in turn is defined as the surplus generated by operating activities after the labour factor input (but not other inputs) has been recompensed.[33] It is the balance available to the "unit" which allows it to compensate the providers of own funds and debt, to pay taxes and eventually to finance all or a part of its investments. The graphs somewhat confirm that the evolution of competitiveness in basic metals is more variable and overall less favourable than in manufacturing as a whole. Also, Spain scores well again in basic metals and in iron and steel making whereas the UK has even endured negative margins lately (iron and steel). France, Italy and Germany evolve more or less in unison and relatively close to each other, but differences in gross margin of up to 3%

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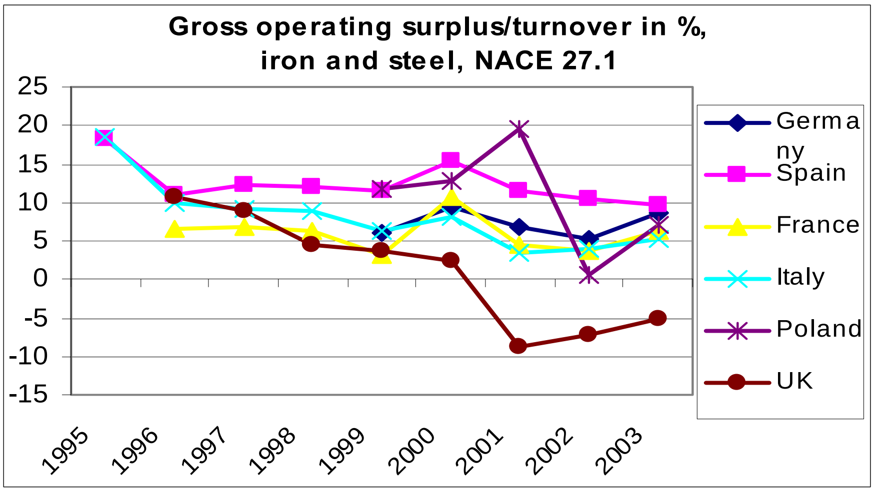
[32] When looking at single companies rather than a broader sector, total sales should be used in the denominator not the value added. Note that "value added" is already a category of profit so it is not analogous with the term "sales" at micro level.

[33] At micro level, the range of direct costs deducted is wider than in sectoral/macro level (including raw materials, fuel etc.).

may still occur. Since Poland has restructured major parts of its industry, there are considerable jumps in the data.



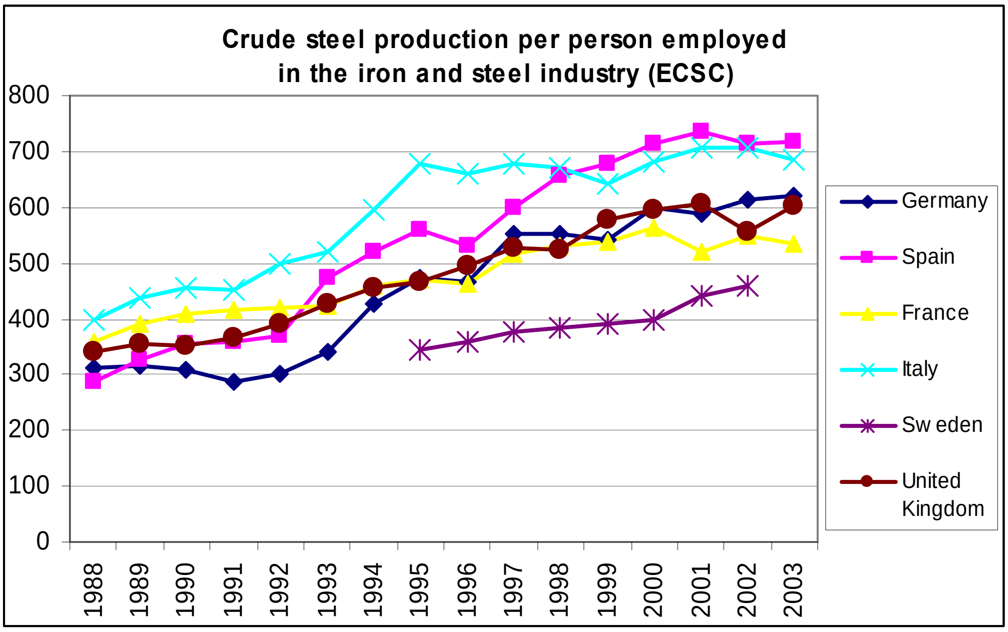
Source: Eurostat, Structural business statistics

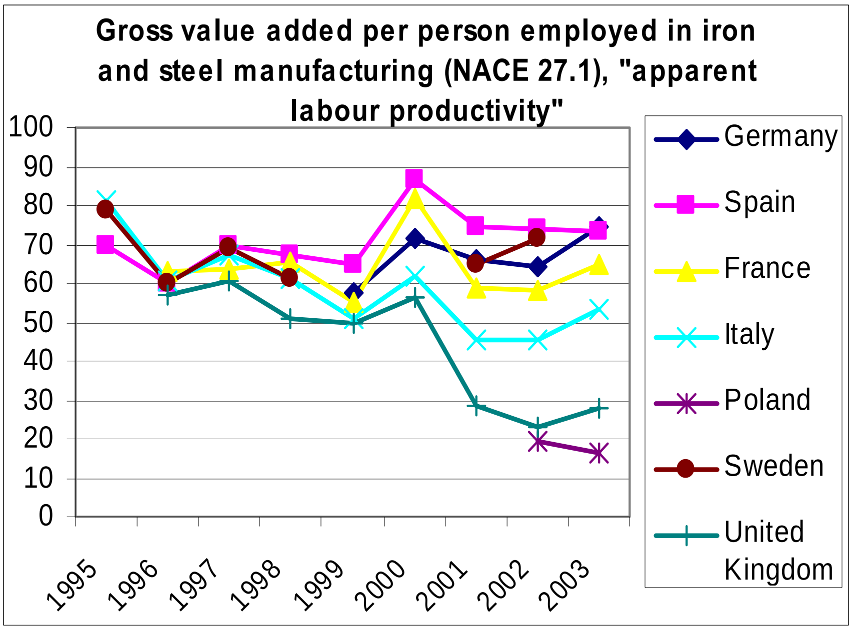
Comparing these data with industry sources reveals similar sources of magnitude (e.g. VdEh, 2005; Moll, 2005). Yet, they are more volatile and, as a result, margins can easily triple or quadruple from one year to the next.

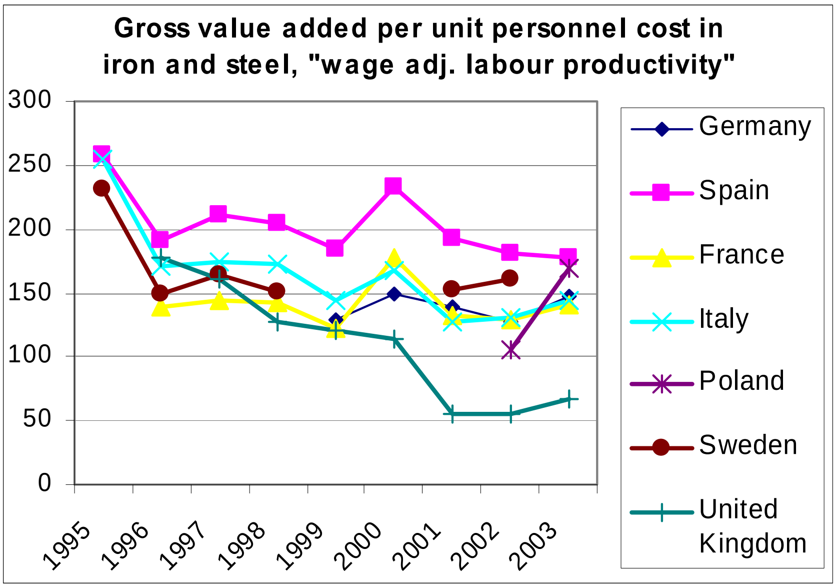
Measures of profitability may easily be affected by factors such as market power. Alternatively, some measure of productivity may be used as a proxy of competitiveness on the assumption that a sector with a high level or growth rate is likely to be in a favourable competitive position. Graphs 20a)-20f) present different measures of labour productivity and also contrasts iron and steel production with total manufacturing: gross value added in NACE 27.1 per person employed (also called apparent labour productivity) and gross value added in NACE 27.1 per unit of personnel cost (also called simple wage adjusted labour productivity) and crude steel production per number of persons employed. We suggest to consider relative differences over time (and the relative position vis-à-vis total manufacturing). After all, the data do not allow to draw any immediate conclusion about competitiveness for the particular sub-segment of electric steelmaking we are interested in: The graphs are likely to vary by the production process employed, the variety of products offered and the degree of vertical integration or processing depth (Wienert, 1997, p. 119). Productivity in EAF steel-making is usually a lot higher compared to integrated steel-making[34]. In addition, there may still be differences between countries in statistically measuring the labour input.

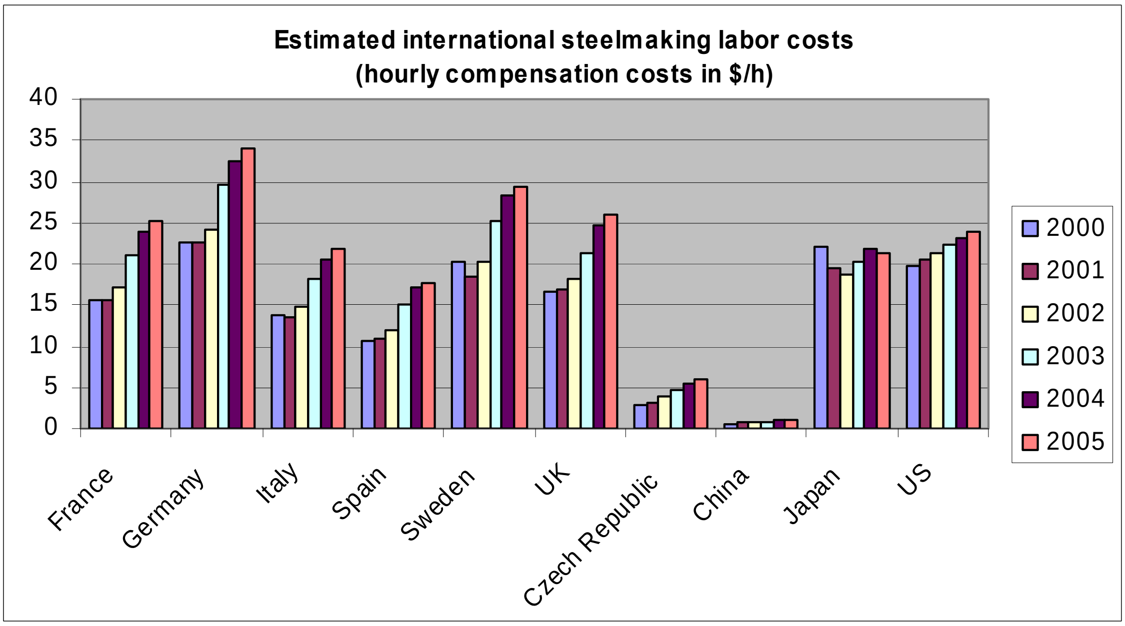
[34] According to industry sources, EAF plants have a productivity of up to more than 3000 tonnes/man-year.

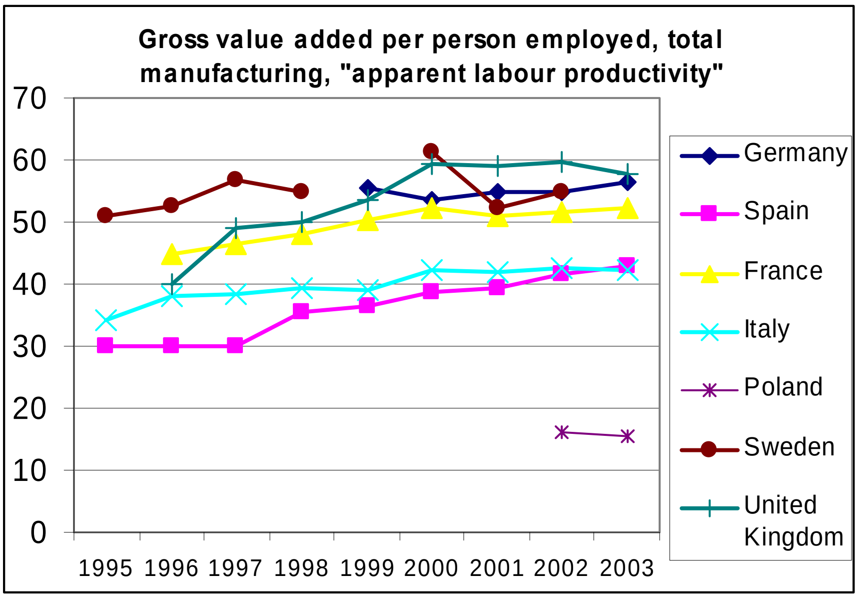
Graphs 20a)-20f)

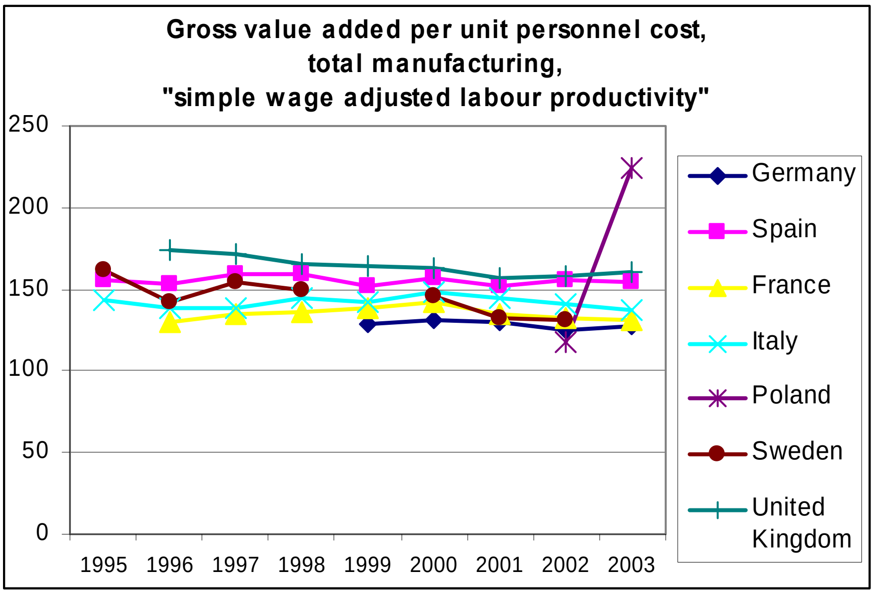





Gross value added per unit personnel cost in iron and steel, "wage adj. labour productivity"
300
250
200
150
100
50
0
1995
1996
1997
1998
1999
2000
2001
2002
2003
Germany
Spain
France
Italy
Poland
Sweden
United Kingdom


Estimated international steelmaking labor costs (hourly compensation costs in $/h)
40
35
30
25
20
15
10
5
0
France
Germany
Italy
Spain
Sweden
UK
Czech Republic
China
Japan
US
2000
2001
2002
2003
2004
2005





Sources: European Community for Coal and Steel, Eurostat, Metals Consulting International Ltd.

The first striking element in the graphs is the fact that the apparent productivity of the iron and steel sector is considerably higher in most countries than the productivity of manufacturing as a whole. The only exceptions are again the UK and Poland which underlines the special development of the iron and steel industry in these countries during the period considered. Yet, for most countries the higher productivity ratios are likely due to structural features (and particular technical characteristics) of the industry like its high capital intensity. The difference in the ratios between iron and steel productivity and total manufacturing productivity are associated with the major discrepancies in productivity levels among Member States. Apart from the UK again (where the rank of iron and steel is low), Spain is also an exception, however (higher rank in iron and steel). The high value for Spain can probably be explained by their high percentage of EAF steel-making.

Another remarkable feature are the significant discrepancies between the Member States regarding the level of productivity in the iron and steel industry (and to a lesser degree total manufacturing). While there are still fewer data available for Poland, labour productivity there is still two to three times lower than in the other countries studied. This structural productivity gap cancels out, however, when looking at wage adjusted labour productivity which takes into account the differences in average personnel costs and reflects the structure of employment by adjusting according to the share of employees in persons employed. From this perspective, Germany and France with their relatively high wages compared to Poland and (to some degree) Italy and Spain also score somewhat lower. The fact that labour costs are sometimes substantially different from one country to the other is also apparent in graph 20d) which includes additional information from countries outside the EU. Between Germany and China labour costs vary by a factor of 30 and between Germany and the Czech Republic still by a factor of 5 to 6.[35] Despite of this, the European steel industry is frequently reported to have a comparative advantage with respect to the skills and the commitment of its labour force.

A kind of physical measure of labour productivity is presented in graph 20a): crude steel production per person employed in the iron and steel industry. Using long time series from ECSC data illustrate the cross-country differences in the long term development of labour productivity. Italy and Spain – having both a high percentage of EAF steel-making – are now the most “productive” countries (with Spain catching up considerably over the period considered). The “leader” group is followed by Germany, the UK and France which all exhibit similar levels of productivity (yet with higher growth rates in Germany). Finally, smaller steel producing countries like Sweden only reach a productivity level that is about 30-40% lower than in Italy. Even below this level are still Poland (370-400 t/employee) and countries expected to join the EU in 2007 (Bulgaria, ca. 160 t/employee and Romania, ca. 90 t/employee) (Canila, 2004).

It needs to be taken into account that labour costs only make up for a relatively small portion of total costs in steelmaking. This is even more so in electric compared to integrated steelmaking. Thus, it is useful to assess comparatively and over time the cost and efficiency associated with the use of capital. A number of different indicators are proposed for the analysis (see graph 21a-f). The first is directly based on the graphs presented in section 5.5: the evolution of average investments in electric steelworks across countries (for those where data are available). While the typical yearly investment in the four major electric steelmaking countries (Italy, Germany, Spain and France) is around 45 Mill. €, the calculation of five-, ten-, 15- and 19-year averages show a somewhat decreasing tendency in Italy, an increasing tendency for Spain and mixed tendencies for Germany and France.[36]

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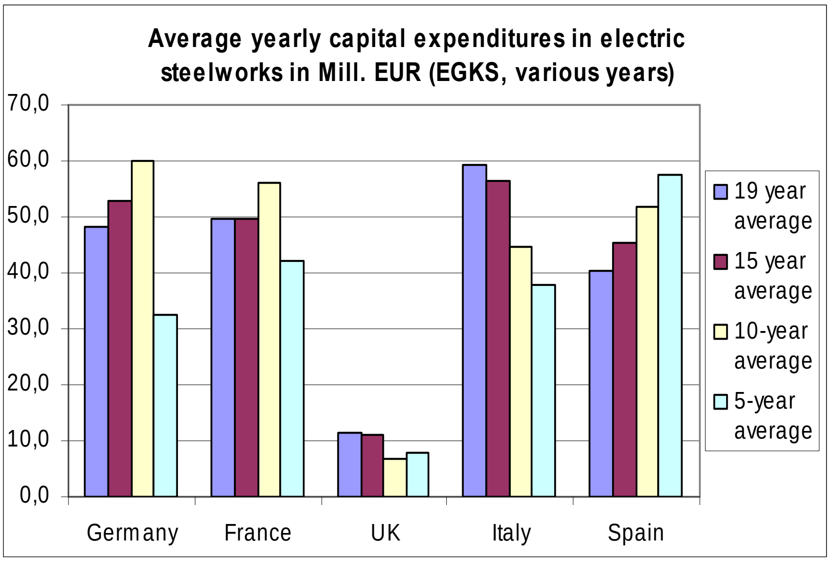
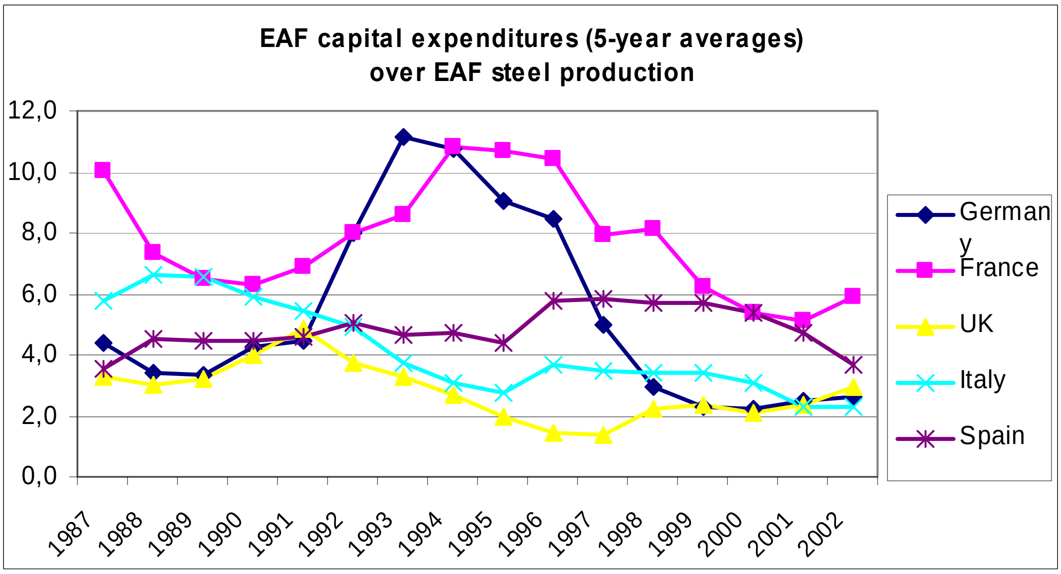
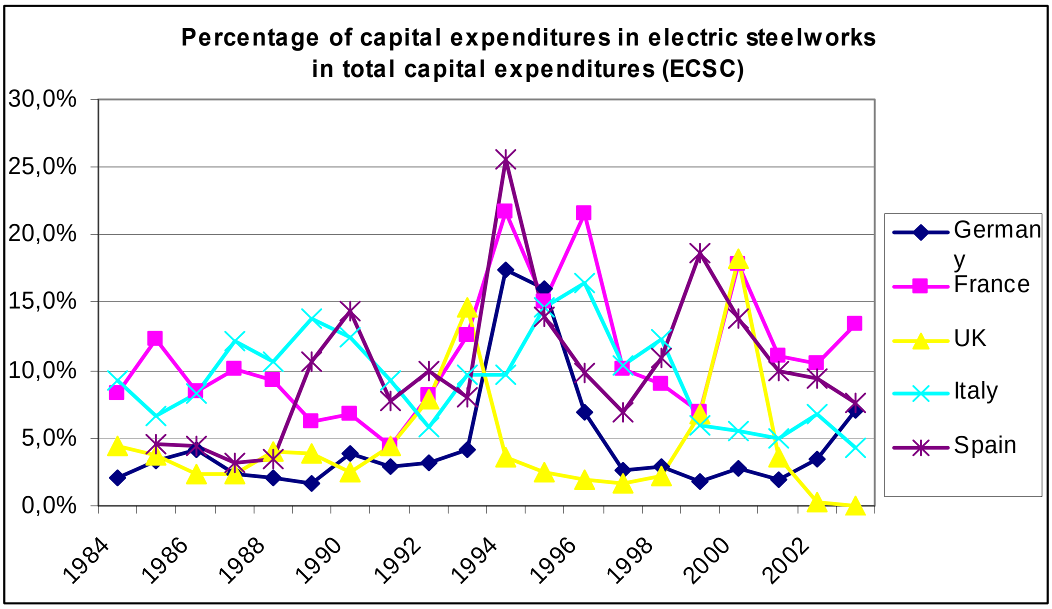
[35] Source: US Department of Labor, estimates by Metals Consulting International Ltd. Hourly compensation costs include hourly direct pay, employer social insurance expenditures and other labor taxes. Some labor costs (e.g. costs for recruitment, employee training, additional plant facilities like cafeterias etc.) are not included due to lack of data.

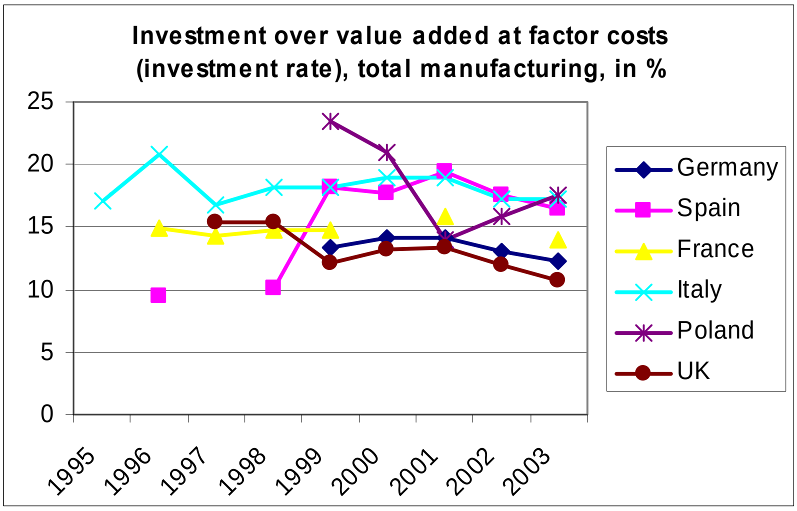
[36] The graphs should be interpreted carefully due to the volatility of investments in steelmaking.

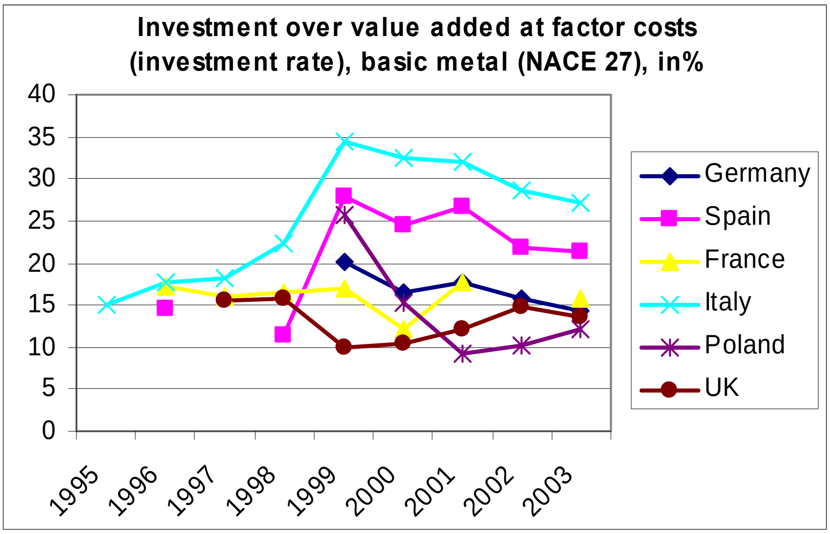
Graph 21a-f):

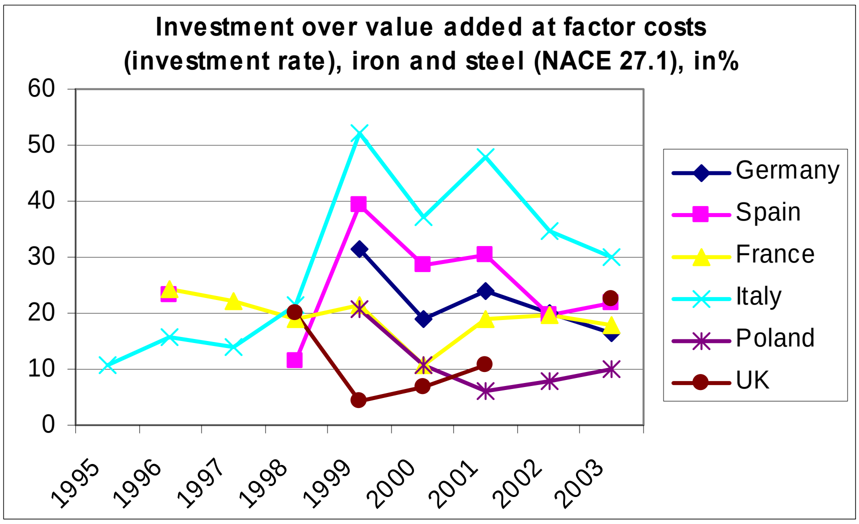

Average yearly capital expenditures in electric steelworks in Mill. EUR (EGKS, various years)
70,0
60,0
50,0
40,0
30,0
20,0
10,0
0,0
Germany
France
UK
Italy
Spain
19 year average
15 year average
10-year average
5-year average


EAF capital expenditures (5-year averages) over EAF steel production
12,0
10,0
8,0
6,0
4,0
2,0
0,0
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
Germany
France
UK
Italy
Spain


Percentage of capital expenditures in electric steelworks in total capital expenditures (ECSC)
30,0%
25,0%
20,0%
15,0%
10,0%
5,0%
0,0%
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
Germany
France
UK
Italy
Spain


Investment over value added at factor costs (investment rate), total manufacturing, in %
25
20
15
10
5
0
1995
1996
1997
1998
1999
2000
2001
2002
2003
Germany
Spain
France
Italy
Poland
UK





Sources: European Community for Coal and Steel, Eurostat

The second indicator relates a five-year moving average of EAF capital expenditures to yearly EAF steel production output taking into account the different position of the main EU countries in terms of electric steel production volume. This ratio could indicate the effort made by industry to modernise and deepen its capital base. The graph 21b shows that Germany (2nd in output) and France (4th in output) have strongly invested in the mid- to late 1990ties (with still a high ratio in France). In Germany three new EAF steel-making plants replaced three plants based on BF/BOF steel-making. In Spain (3rd in output) the ratio is more or less stable at an average value of about 4.5 €/t of steel. In Italy, by contrast, the ratio has quite continuously declined from over 6 €/t of steel to about 2 €/t of steel lately.

However, it needs to be taken into account that investments in electric steelworks only present a small fraction of total investments in iron and steel installations (on average between 5-10%).[37] Graph 10c shows the evolution of this percentage in the five main countries considered here. While in Germany total capital expenditures are clearly the highest among all countries, the share of expenditures in EAFs in total expenditures is low (with only a peak in the mid-1990ties and a slightly increasing tendency lately). In France, Italy and Spain this ratio is considerably higher. The complexity of the capital base and the difficulty of assessing its performance is also evident when relating iron and steel investments to other performance and profitability ratios. Graphs 21d)-f) present the commonly used ratio investment over value added at factor costs using the data from the Eurostat database instead of reports of the European coal and steel community (ECSC). Suprisingly, Italy clearly outscores the other countries with over 30% of value added in new equipment lately. A possible explanation could be that Italy and also Spain produce primarily iron and steel products with relatively low value added.[38] In Germany, by contrast, value added both in total manufacturing and in iron and steel is twice or even three times as high. So are investments, but more in absolute and less in relative terms. The data available for Poland indicate that the performance in terms of investment is still relatively low. Also, the ratio of investment over value added is lower in iron and steel than in manufacturing as a whole, which is mostly not the case in the other countries. For EU-25 the investment rate has declined for iron and steel between 1999 to 2003 from about 22% to 17% (EU Commission 2006, p. 43).

As a broad indicator for capital productivity the utilization rate of maximum production potential (MPP) in electric steel may be used.[39] According to ECSC MPP "is the maximum production which is possible to attain during the year under normal working conditions, with due regard to repairs, maintenance and normal holidays, employing the plant available at the beginning of the year but also taking into account both additional production from any new plant installed and any existing plant to be definitively closed down during the year" (ECSC, 2003). Graph 22 illustrates that the utilization rate has risen over the last ten years in most countries (except the UK). There is also quite a robust ranking between countries: Sweden has used its production potential most intensively ahead of Germany, Italy, Spain, France and the UK. In Eastern Europe utilization rates are mostly lower than in Western Europe, in Poland 70%, in Romania 67%, in Bulgaria 64% (2002; see Canila, 2004).

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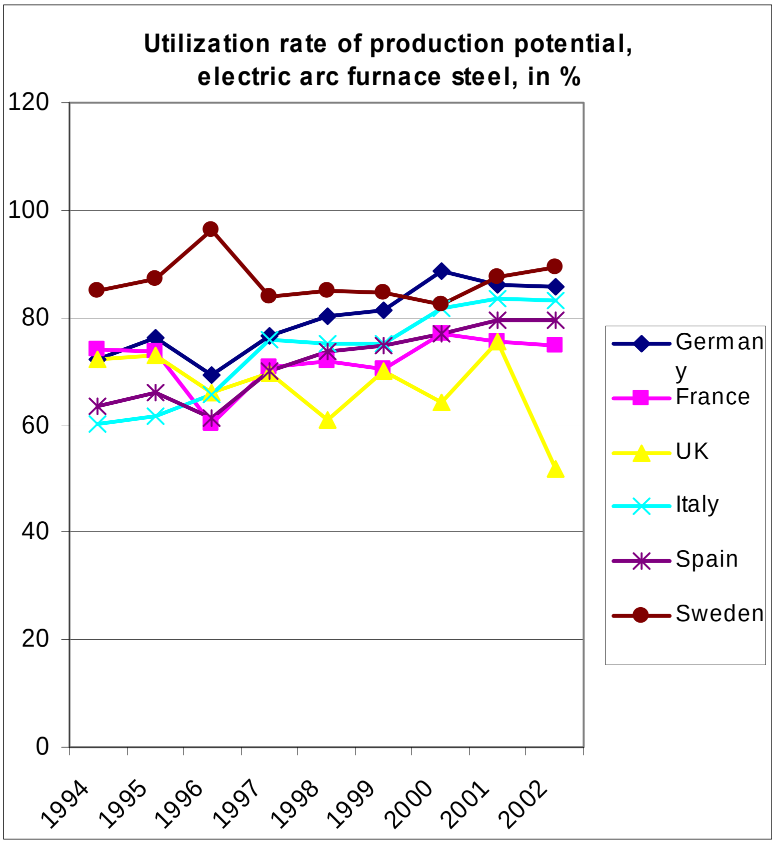
[37] The largest parts of the investments are allocated to rolling mills (in particular hot and cold wide strip mills).

[38] One may need a longer and possibly a revised time series to better sort out the evidence.

[39] However, the ratio may also indicate the pressure industry is facing to expand its capacity.

Graph 22:



Sources: European Community for Coal and Steel

There is one additional indicator which is sometimes used to assess the quality of the capital base: net investment over gross investment in tangible goods. Basically, this indicator gives the percentage of the capital base which is not yet depreciated. Thus, the closer the value is to 1 the more "modern" the capital stock would be, whereas lower values indicate a high percentage of older vintages in the capital base.[40] Yet, the indicator does not tell what drives a "wedge" between net and gross investment. Also, it is more difficult to explain at a more aggregated level. Graphs 23 a, b shows that the values in the iron and steel industries are quite close to 1 and similar to total manufacturing. The value is somewhat lower in Spain than in the other countries considered. For Eastern European countries investments certainly play a key role in industrial restructuring. It enables them to update their technological stock, to modernise their equipment and installations and to be competitive on the European market. While few information is available, Canila (2004) indicates, for example, that the return rate of the capital stock (investments over existing stock of equipment) is relatively low in Romania (average value of 5% in the period 1991-2000). Thus, there are still likely to be substantial gaps in technological developments compared to Western European companies.

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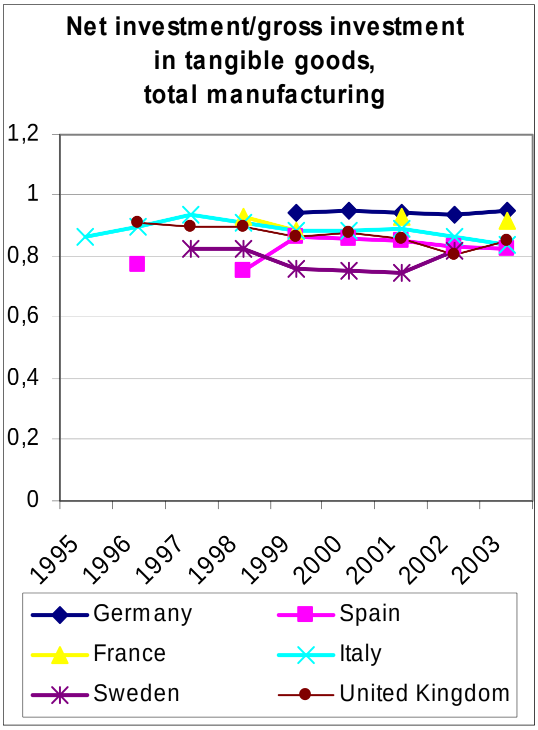
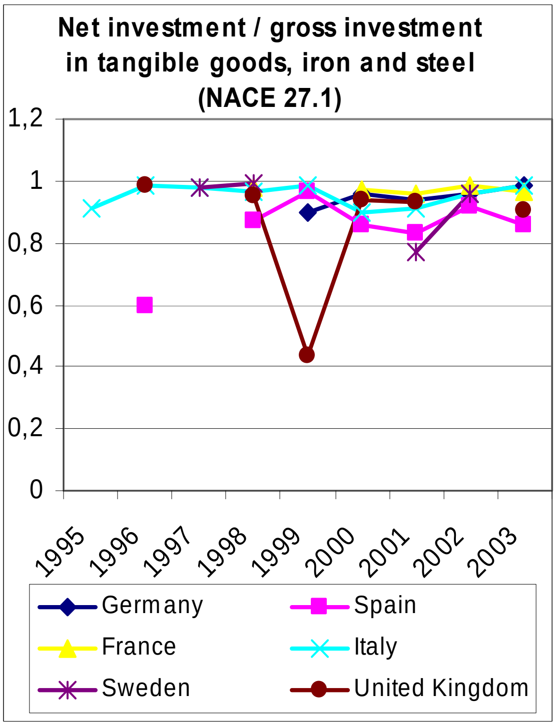
[40] An obvious confounding factor is that environmental regulation could "prematurely" depreciate older equipment and induce costs for parts of the new equipment that serve no other purpose but the new environmental purpose (see also below).

Graph 23a, b):





Sources: Eurostat

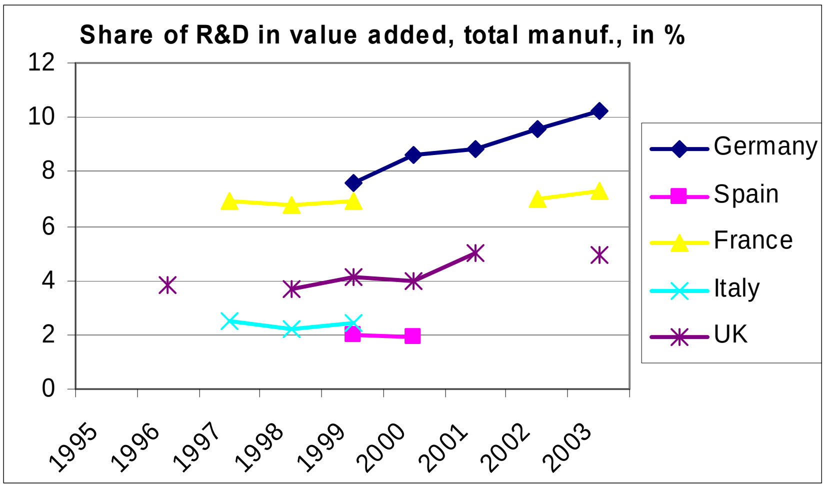
More generally, it is very difficult to track down quality improvements in the capital stock over time. Monetary measures do not account for pieces of equipment or lend themselves to vintage-level tracking, physical measures are often not categorised in a way to enable comparisons across plants or installations (Worrel and Biermans, 2005).

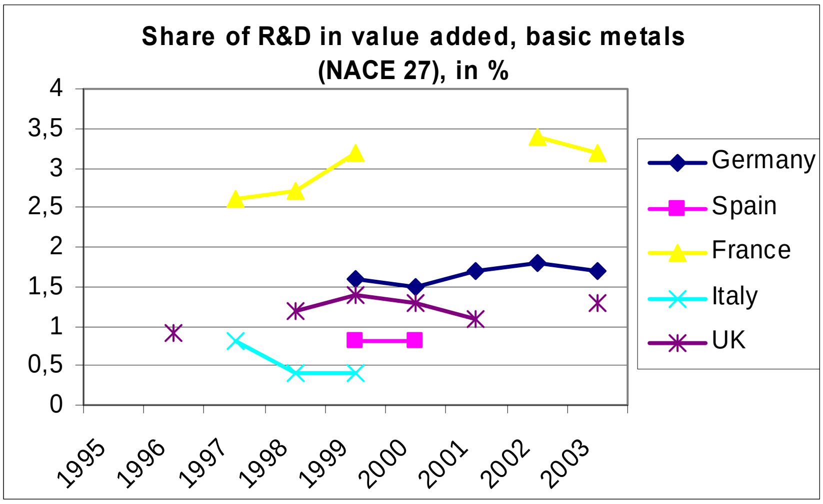
When looking into the future rather than the past, the share of R&D in value added may also be considered an indicator of competitiveness. After all, the capacity to innovate and restructure is often considered a critical component of competitive advantage for European manufacturing firms. In general, the EU steel industry is technology intensive and considered highly innovative relying on a skilled labour force. Only 30% of steel products (from over 2000 steel products) offered to the market today existed ten years ago (Commission of the European Union, 2005). Yet, compared to total manufacturing R&D spending (as rough input indicator for innovation) is considerably below average in basic metals and iron and steel (graph 24a)-c)). Surprisingly, the differences between countries in the sector are quite pronounced (e.g. between France and Italy).[41] [42]

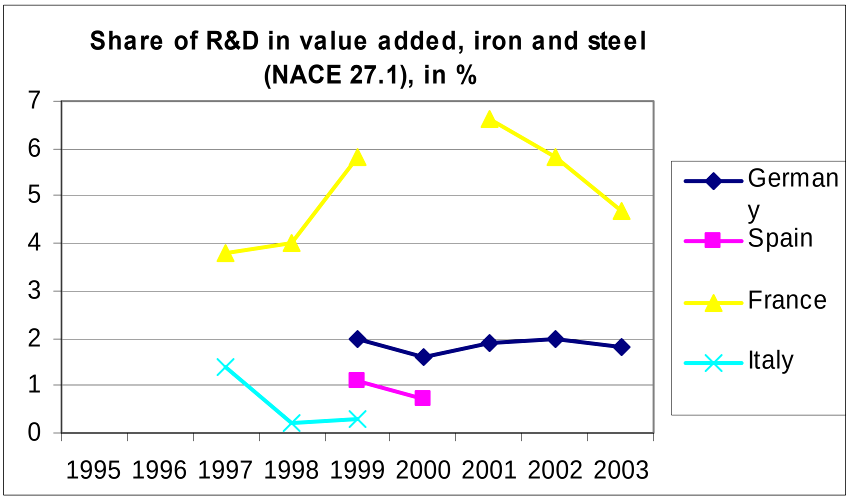
[41] The German steel institute reports on R&D expenditures per tonne of crude steel based on German data from the Stifterverband Wissenschaftsstatistik. The ratio has risen since 1997 up to almost 5€ per tonne of crude steel in 2003 achieving a level that has already been realised in the early 1990ties.

[42] Using the R&D spending of the steel industry as an indicator of competitiveness for EAF plants has unfortunately several disadvantages. Firstly, branch-internal expenditures are often focused on downstream processes and product innovations. Secondly, it may be better to look at R&D expenditures of supplying industries (like the non-electrical machinery sector) as their research efforts are sometimes targeted specifically at the steel industry. In the literature the steel industry is often labelled a "supplier dominated" industry (according to Pavitt's classification) (see Lutz et al., 2005).

Graphs 24a)-24c):







Sources: Eurostat

The indicators mentioned above say little about the performance of the steel industry in international trade. Yet, trade indicators are important, as they reveal the capacity of the industry to compete on international markets. The most frequently used is called “revealed comparative advantage” (RCA). It compares the relative shares of exports and imports of a particular industry i with the share of country’s total manufacturing exports and imports ($RCA_i = \ln (x_i / m_i) / (x_{tot} / m_{tot})*100$, with x for exports and m for imports). It is hypothesized that, by using this measure, not directly recognisable comparative advantages are revealed by looking at realised export and import flows in certain product segments. Positive values reveal a comparative advantage in the respective industry.[43] Like for many other competitiveness indicators we propose to look at relative changes and construct a ranking of RCA values for 2000 and 2005.[44] Table 9 considers four steel product groups and total electric steel production for the six major European steel producing countries. In general, the RCA values have improved between the two years and confirm the strong position of Italy and Spain in this industry. For Poland, however, the value has declined. In the higher value-added segment tubes and pipes (679) a strong position of Italy and Germany is evident, but all countries (except Poland) have positive RCA values here. In the other important product segment of electric steelmaking comprising typical long products like bars, rods and sections Spain and also the UK score best. Poland and Italy have also positive, yet declining RCA values (especially Poland). In the wire segment Italy and Spain have improved their position. In the rail segment Poland still scores first, but its RCA value has declined considerably.

The competitiveness of an industry as revealed in the trade performance data depends also upon a series of important factors that are more difficult to capture because of their very nature. These factors may be regrouped under the generic term of “quality competitiveness” and may include, among others, the quality of the products, its technical characteristics, the skills of the labour force, the competence of the management and the sustainability and safety of the industrial systems as regards their interaction with the environment and with the enterprises’ workers. While it is difficult to capture these factors in statistical data, quality competitiveness may be roughly captured by a quite simple indicator: the price level (unit value) of a country’s (or total EU’s) exports to the price level of its imports in the same product category. Under certain conditions (especially the “law of one price”) this price-quality gap indicator can be interpreted as difference in product quality. Hanzl (2005) indicates a below average price-quality ratio for the New Member States vis-à-vis the rest of the EU in the technology and capital intensive sectors like basic metals and iron and steel. From a dynamic perspective, however, the indicator has increased significantly for the New Member States, indicating a substantial catching-up in export prices and the quality of exports to the EU, respectively.

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43 A shortcoming of this indicator is that positive values may not only result from comparative advantages through product specialisation, but also from protectionist behaviour of governments in favour of certain sectors.

44 Direct comparisons between product groups based on absolute graphs are less reliable, since they are influenced i.a. by the intra-industrial division of labour (substitute trade), structural adjustments etc..

Table 9: **The evolution of revealed comparative advantage for six EU Member States between 2000 and 2005**

	2000 part of totalsteel Ex	2000 part of totalsteel Im	2005 part of totalsteel Ex	2005 part of totalsteel Im	RCA value 2000	RCA value 2005	ranking dom. 2000	ranking dom. 2005	ranking int. 2000	ranking int. 2005
DE										
676	44,1%	40,9%	41,1%	53,5%	-3	-4	3	3	6	6
677	2,0%	1,1%	2,3%	3,1%	44	-5	1	4	5	6
678	5,7%	29,0%	5,5%	8,8%	-174	-25	5	5	5	4
679	48,2%	29,0%	51,1%	34,7%	40	61	2	1	3	2
Totsteel	100,0%	100,0%	100,0%	100,0%	-11	22	4	2	5	4
ES										
676	60,0%	41,2%	62,4%	54,8%	83	94	1	2	2	1
677	1,4%	1,1%	2,9%	1,1%	66	179	2	1	3	2
678	6,6%	28,9%	5,1%	7,4%	-101	45	5	5	1	2
679	32,0%	28,9%	29,6%	36,7%	55	59	3	4	2	3
Totsteel	100,0%	100,0%	100,0%	100,0%	45	81	4	3	2	2
FR										
676	44,9%	39,3%	41,2%	49,5%	2	4	3	3	5	5
677	1,6%	0,7%	4,4%	1,3%	73	148	1	1	2	3
678	8,3%	30,0%	6,7%	10,8%	-140	-26	5	5	3	5
679	45,2%	30,0%	47,7%	38,5%	30	44	2	2	4	4
Totsteel	100,0%	100,0%	100,0%	100,0%	-11	22	4	4	6	5
GB										
676	48,6%	29,3%	50,1%	43,9%	45	53	2	1	4	2
677	2,4%	1,3%	1,9%	2,5%	57	9	1	5	4	5
678	8,3%	34,7%	4,7%	6,1%	-149	14	5	4	4	3
679	40,6%	34,7%	43,4%	47,4%	10	31	3	3	5	5
Totsteel	100,0%	100,0%	100,0%	100,0%	-6	40	4	2	4	3
IT										
676	39,6%	40,7%	37,0%	57,4%	49	38	3	5	3	4
677	0,6%	1,0%	0,7%	1,0%	-3	48	4	4	6	4
678	6,1%	29,1%	5,1%	6,8%	-104	52	5	3	2	1
679	53,7%	29,1%	57,2%	34,7%	113	132	1	1	1	1
Totsteel	100,0%	100,0%	100,0%	100,0%	52	82	2	2	1	1
PL										
676	68,9%	29,8%	62,9%	45,4%	120	41	2	2	1	3
677	8,4%	0,2%	4,4%	0,6%	406	214	1	1	1	1
678	2,7%	35,0%	3,7%	10,5%	-222	-97	5	5	6	6
679	20,1%	35,0%	29,0%	43,5%	-20	-32	4	4	6	6
Totsteel	100,0%	100,0%	100,0%	100,0%	36	9	3	3	3	6

Note: The classification by the United Nations is used (676 = iron and steel bars, rods, angles, shapes and sections, incl. sheet piling; 677 = rails or railway track construction material of iron or steel; 678 = wire or iron or steel; 679 = tubes, pipes and hollow profiles, tube or pipe fitting of iron or steel).
Source: Eurostat, COMEXT

Some environment-related indicators

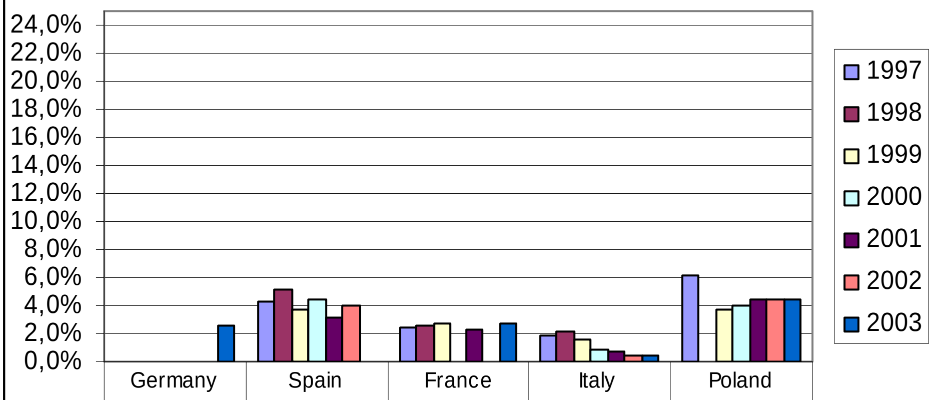
So far we have not or only implicitly covered the impact of environmental variables and environmental regulations and policy on the competitiveness of the European steel industry. Yet, environmental policies can create direct and indirect costs and other kind of restrictions and burdens for the affected businesses by changing the availability, performance and price of inputs and/or outputs and by placing restrictions on the production process. At the same time, some firms may perceive proactive environmental behaviour as an opportunity to realise competitive advantages.[45]

Empirically, it is quite difficult to specify environmental variables and measure the strictness, the design and the implementation of environmental regulation at the sectoral level (i.e. across many different firms from the same industry) (see Jeppesen et al., 2002). One indicator that is often used in the literature as a proxy for environmental stringency is private pollution abatement and control expenditures and investments. The advantage of this indicator is that quantitative data are available to give an indication about the scale of the direct impact resulting primarily (but not exclusively) from environmental policies. They also allow in principle for easy comparisons between countries and sectors. Yet, the data have to be treated with caution, since some environmental spending, like integrated, process-oriented investments, is difficult to identify and since the process of harmonising data collection and interpretation within the EU progresses only slowly. In addition, obvious shortcomings of this proxy are the loose relationship to policy instruments and regulations and the lack of information about the age of the installations which “benefit” from environmental expenditures and investments. Finally, abatement costs may be endogenous to the process of industrial reorganisation or even relocation (Wagner and Timmins, 2004). Given these caveats we propose here to look at some ratios instead of the absolute numbers and compare results across countries and between total manufacturing and basic metals (the most disaggregated level with available data). Graphs 25a), b) present the shares of environmental protection investments in gross fixed capital formation (total gross investments in tangible goods). The numbers indicate that the basic metals sector “has to” face considerably higher investments in environmental installations and equipment. In all the countries this ratios is higher by a factor of 2 to 3 (in France for the one value available even 3.3) compared to total manufacturing. Across countries the high investments in Poland – resulting from the recent restructuring process – and the relatively low graphs for Italy are most noteworthy.

[45] In addition, there are likely to be further direct and indirect ramifications along the value chain of the directly affected businesses and throughout the economy with some positive and some negative impacts on private business.

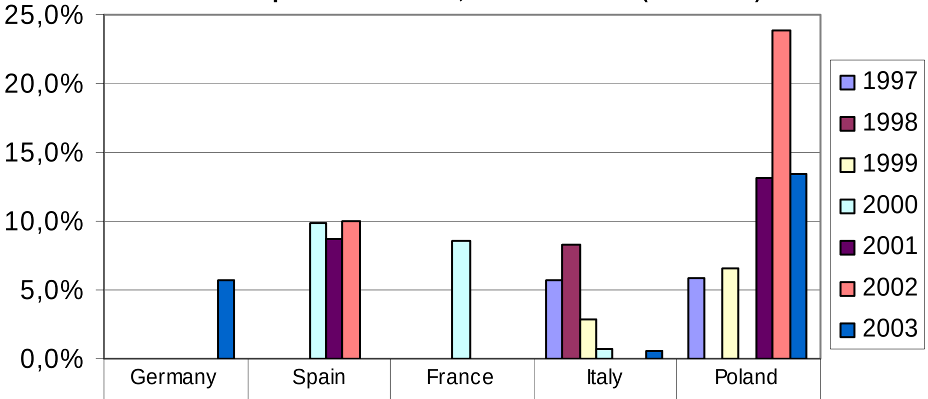
Graphs 25a, b)

Share of environmental protection investments in gross fixed capital formation, total manufacturing



	Germany	Spain	France	Italy	Poland
1997		4,2%	2,5%	1,8%	6,2%
1998		5,1%	2,6%	2,2%	
1999		3,7%	2,7%	1,6%	3,7%
2000		4,4%		0,9%	4,0%
2001		3,2%	2,3%	0,7%	4,5%
2002		4,1%		0,4%	4,4%
2003	2,6%		2,7%	0,4%	4,5%

Share of environmental protection investments in gross fixed capital formation, basic metals (NACE 27)

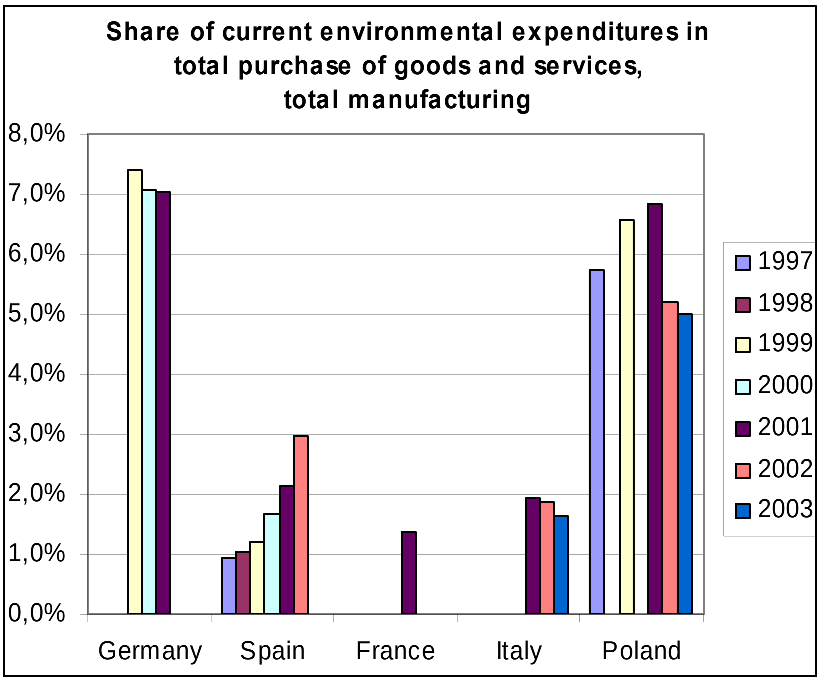


	Germany	Spain	France	Italy	Poland
1997				5,6%	5,9%
1998				8,3%	
1999				2,8%	6,6%
2000		9,8%	8,5%	0,7%	
2001		8,7%			13,1%
2002		10,0%			23,8%
2003	5,8%			0,5%	13,5%

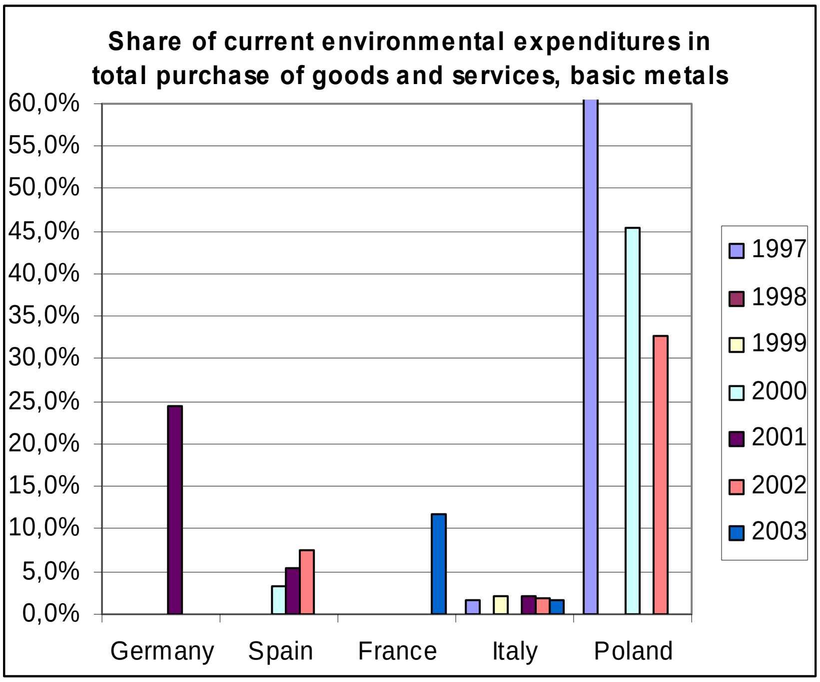
Source: Eurostat

Instead of looking at capital expenditures one may also use current expenditures for environmental protection comprising the expenditure for operating and maintaining an activity, technology, process or equipment designed to prevent, reduce, treat or eliminate pollutants and pollution or any other degradation of the environment resulting from the operating activity of the enterprise (Eurostat, 2005, p. 151). As they represent a part of the total purchases of goods and services (for resale or consumption in the production process, but excluding capital goods) the ratio current environmental expenditures in the total purchase of goods and services may be used as another environmental-economic indicator here.[46] As mentioned above the results, presented in graph 26a), b), should be interpreted very cautiously. Again, the high expenditures in Poland stand out (with the first graph in 1997 in the Polish basic metal sector actually exceeding 100% due to restructuring aids). A striking feature is that the German spending data exceed those of the other three West European countries by orders of magnitude. The spending level of Italy in basic metal seems quite low. Clearly, it would be interesting to find out more about the underlying causes of these differences (including the impacts of the European Emission Trading Directive, for example).

Graphs 26 a, b)



[46] We also tried to use current environmental expenditures over value added at factor costs as an alternative indicator. As the graphs are much more volatile there, we preferred not to use it, however.



Source: Eurostat

Unfortunately, official statistical data about environmental costs and investments are only available at a quite aggregated level. As a result, we cannot know how good of an approximation basic metals (NACE 27) is for the sub-sector electric steelmaking. Alternatively, main cost components of EAF steelmaking could be compared across countries as long as costs differ from one place to another.[47] Apart from the labour costs mentioned above, energy and electricity costs are of particular interest, both from an economic and from an environmental perspective. Given the distortions in the internal energy market in the EU, often disputed in the public debate, we propose to use the variations in electricity prices for industrial consumers as an appropriate indicator of competitiveness at the sector level.

Graphs 27 show the evolution of price levels for small and medium-level energy consumers in industry (applicable for small and large EAFs, respectively). Cross-country differences can clearly be substantial amounting to one order of magnitude sometimes. Electricity prices are almost twice as high in Italy than in Sweden or Poland, for example. For some countries a substantial part of the price increase is also due to energy/eco-taxes and the promotion of renewable energies (cross-subsidised by industry), for instance in Germany (Ameling, 2006).

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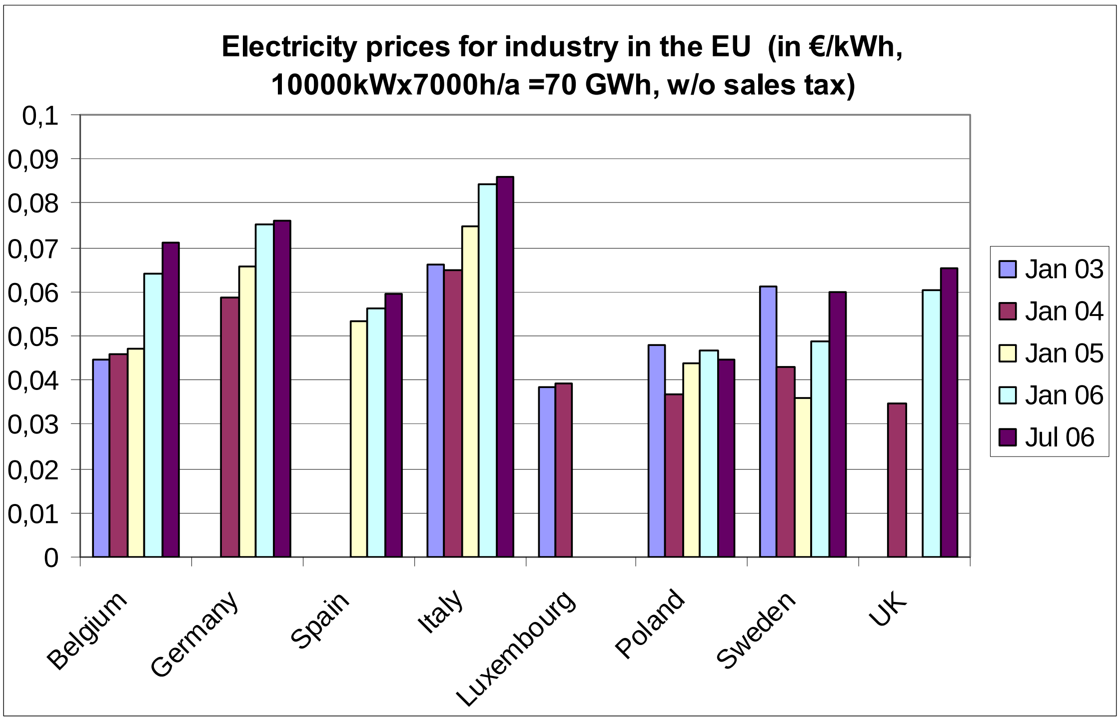
[47] As mentioned in section 5.5, operators face basically the same conditions on international markets regarding the main cost component (raw materials, in particular scrap).

Graph 27



Source: Eurostat

5.7 Main findings of electric steelmaking sector review

Within the EU the electric arc furnace route of steelmaking accounts for 38.5% of the total EU steel production. The most important producers are Italy, Spain, France, Germany and Poland. It as the role of this chapter to delineate this sub sector, to describe production and consumption trends as well as demand and supply characteristics and to eventually come up with a number of competitive indicators for the above countries.

An analysis of supply side factors of the electric steelmaking industry reveals competitive advantages and disadvantages between European countries and non-EU competitors. Due to data gaps and difficulties in disentangling cause and effect these competitive indicators cannot easily be linked with environmental variables and environmental regulations. While a more focused micro perspective is indispensable, the following central intermediate results on a sector level can be summarised:

- According to industry experts there are signs that the economic position of the main countries producing basic metals has worsened vis-à-vis non-EU competitors during the last five years. This is not the case or at least less significant for Spain and Germany, but more clearly recognisable for the UK and France.

- However, this trend is not clearly apparent when looking at profit margins in most countries. Also, the recent wave of mergers and acquisitions is very likely to have strengthened the role of the European metals industry.

- The cost of raw materials accounts for the highest share in total production costs. While the conditions within the EU are broadly comparable (especially scrap prices and availability), some non-EU competitors enjoy competitive advantages. Also electricity and other energy costs are significant for electric steelmaking and amount to about 10% of the total production costs. Due to different conditions on the European energy markets and due to differences in the fiscal regimes electricity prices vary considerably from one EU Member State to another. Electricity costs in Italy and Germany are significantly higher than in countries like the UK, Spain, Sweden and Poland.

- Concerning labour costs significant differences exist vis-à-vis non-EU competitors (variation between Germany and China by a factor of 30). Simultaneously, labour productivity is lower in countries with lower wages (e.g. in Poland and the new accession countries). Productivity measurements are strongly influenced by the share of electric steelmaking in total steel production.

- During the 1990ies the European steel industry as a whole was going through a restructuring leading to a shift from the BF route to the EAF route. The amount and the timing of investments in electric steelmaking plants still vary between Member States. Differences in age and modernity in the capital stock between MS partially explain their differing ability to compete on the market. A particularly high level of investment can be identified in France and Germany (especially in the mid 1990ies). Also in Spain absolute investment levels have risen during the last few years, while in Italy both in absolute and relative levels a decreasing trend in investments can be observed. In comparison with non-EU competitors many EU electric steelmakers are likely to have a more modern capital stock.

- When linking these general data with environmental variables, there are again significant differences between Italy on the one hand and Germany, Spain and France on the other hand. The share of current environmental expenditures in the total purchase of goods and services is significantly lower in Italy than e.g. in France and Germany. In Spain there is a rising trend. Concerning the share of environmental investments in gross fixed capital formation the falling trend in Italy and the growing values for Spain are conspicuous. Poland shows high values both for current environmental expenditures and investment expenditures which is a sign for the recent modernisation of the environmentally relevant capital stock. Due to data limitations it remains unclear to what extent these trends apply to electric steelmaking or other segments of the basic metals industry.

- The direct comparability between countries is aggravated by different patterns of specialisation in steel production. There are signs that e.g. Spain has specialised in products with relatively low value added. With regard to the new Member States the quality of products has gradually improved. The demand for steel products is in part also country-specific and depends on the different requirements of the steel demanding sectors. Depending on the specific application and time horizon the price elasticity of demand will be different.

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6 Review and analysis of the domestic glass sector in the EU

6.1 Introduction

6.1.1 Main focus of the study

This sector description is divided into two main sections. The first consists of technical background information with the aim of providing the reader a basic understanding of the domestic glass sector and the environmental constraints that it operates under. Much of the information presented in this section is taken from the BREF document for the glass industry.

The second section considers the economic driving factors for the domestic glass sector and uses literature review to assess the impacts of the IPPC Directive on competitiveness.

6.1.2 Arguments for choice of this sector

There were a number of reasons for selecting the domestic glass sector as the subject of the case study.

Firstly, the sector is heavily exposed to international trading and therefore presents a good subject for analysing the impacts of the IPPC directive on international competitiveness.

Secondly, it is well represented by small and medium size enterprises (SMEs), which form the majority of installations within the EU.

Additional reasons included the fact that the IPPC permitting process is relatively advanced within the glass sector and that an industry organisation, in the form of the Committee of European Glass Industries (CPIV), agreed to support the project.

6.2 Domestic Glass: The material, its production process and applications

6.2.1 The material

Glass may be defined as a hard, brittle, generally transparent or translucent, inorganic material. It is formed when minerals such as soda ash, sand, and lime are heated until they are liquefied, and then allowed to cool rapidly such that the mixture solidifies without giving the molecules sufficient time to form an orderly lattice structure.

Domestic glass products may be categorised based on their chemical composition. The main categories are described below.

Soda-lime glass

The vast majority of the industrially produced glass in Europe falls under the category of soda-lime glass. Typical soda–lime glass is composed of 71-75% silica (SiO_2 derived from sand), 12-16% sodium oxide (Na_2O derived from soda ash) and 10-15% calcium oxide (CaO from limestone).

Soda-lime glass is typically hard, smooth and non porous with good transparency making it an ideal material for use in the manufacture of tableware.

Lead crystal and crystal glass

Lead crystal is produced by replacing the calcium oxide used to make soda-lime glass with lead oxide (PbO) in a typical composition of 54-64% SiO_2, 25-30% PbO and 13-15% Na_2O. Crystal glass is produced when barium, zinc or potassium oxides are used instead of lead oxide.

The glass produced has a high density and brilliance and is easy to form. It is generally used to make high quality products such as fine drinking glasses, decanters, bowls and decorative items.

Borosilicate glass

Borosilicate glass typically consists of 70-80% silicate (SiO_2), 7-15% boric oxide (B_2O_3), 4-8% sodium oxide or potassium oxide (Na_2O or K_2O) and 2-7% aluminium oxide (Al_2O_2). It is characterised by having a high resistance to chemical erosion and temperature changes. Borosilicate glass is used to produce hardwearing domestic glass products such as cookware.

Opal glass

Opal (opaque) glass is similar in composition to crystal glass with the exception that it contains small quantities (3.5-5%) of either fluorine (fluorine opal) or phosphates and aluminium oxide compounds (phosphate opal). Opal glass is used to produce cups, plates, serving dishes, and ovenware.

Glass ceramic

Glass ceramic is a mixture of glass and ceramic materials such as lithium, silicon, or aluminium oxides. The combination yields a material that is resistant to extreme temperature shocks. Glass ceramic entered the domestic market through its use in glass-ceramic cook tops.

6.2.2 The production process

The processes used in the manufacture of domestic glass are as diverse as the products. They range from manual processes, such as in the case of hand made decorative lead crystal glass, to the highly mechanized, large scale manufacturing processes used to produce bulk consumer products for the tableware market.

Graph 28 below shows the main steps involved in the manufacturing process. Some of the steps shown are optional dependent upon the nature of the product and the scale of the operation.

Batch preparation

Batch preparation includes the handling, storage and mixing of the raw materials and the addition of cullet (recycled glass), where relevant, to form furnace feed material (known as the ‘batch’).

Most of the raw materials used in domestic glass manufacture are solid inorganic compounds (i.e. sand) whose texture ranges from very coarse to very fine. They are generally stored in storage bays or silos.

Gases (hydrogen, nitrogen, oxygen, sulphur dioxide, butane and natural gas) may also be used. These are generally stored in pipelines, dedicated bulk storage or cylinders.

Two principle mixing methods known as 'wet mixing' and 'batch agglomeration' are used. High silica content glass mixes are typically wet mixed by blending using a pan-type mixer. Glasses with high lead oxide are typically mixed by batch agglomeration, where batch particles are coated with each other using the smearing action of a mixer similar to a concrete mixer.

The mixed batch is delivered to a melting unit through a feeder.

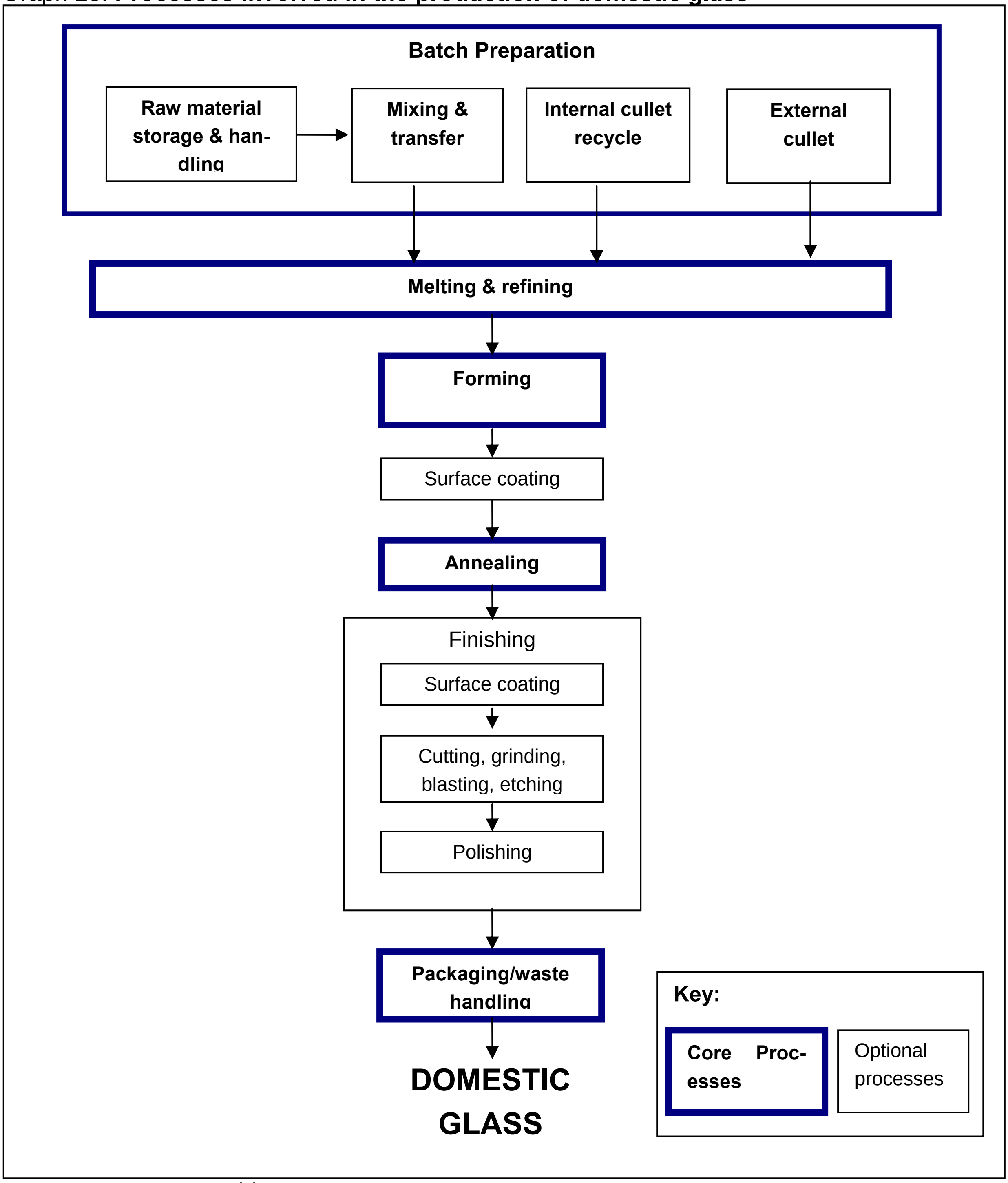
Melting

In large scale operations the batch materials are fed into a glass melting furnace which operates at temperatures up to 1,600°C. Typically the furnace operates continuously providing glass 24 hours day. Furnaces are usually designed to operate a 'campaign' lasting typically 10 years before they are rebuilt or demolished. In some cases, a large central furnace may be used to heat a dozen or so other pot furnaces.

Small scale operators and operators making high quality glass may melt glass in pot furnaces which typically hold less than 1 tonne of glass which is melted overnight ready for working the next morning.

The main energy sources used to fire the furnace are gas, fuel oil and electricity. The use of gas is increasing due to its high purity, ease of control and relatively low associated emissions. Today, oil is generally only used in smaller operations.

Graph 28: **Processes involved in the production of domestic glass**



Source: UK Sector Guidance Note IPPC SG2, 2003

The glass melting process can be divided into a number of phases:

- Heating – the glass is heated to a temperature between 1300°C and 1500°C.
- Primary melting – the chemical and physical processes involving the evaporation of moisture, dissolution of raw materials and ejection of gases trapped in the batch.
- Fining and homogenisation – homogenisation of the glass melt and elimination of gas bubbles
- Conditioning – cooling of the melt and re-absorption of remaining soluble gas bubbles.

In the case of soda-lime domestic glass, colouring agents may be added either in the furnace or in the feeder.

Glass melting furnaces are constructed from refractory materials capable of withstanding high temperatures, thermal shocks (from charging with cold batch) and the corrosive action of the melting batch and glass. A variety of furnace types are available, most of which are used by the domestic glass industry.

After the glass has melted, it is fed to the forming operation.

Forming

The techniques used to form the molten glass fall into two main categories: automatic processing or handmade/semi-automatic processing.

In the case of automatic forming, the molten glass from the furnace is fed to a forming machine via several feeder channels known as forehearths. The glass is then formed into the required shape using compressed air and iron moulds.

Four main techniques are used to form the glass: press and blow; blow and blow; pressing; and spinning. The term 'blow' refers to the use of compressed air to form items whereas 'pressing' involves the use of a mould and a plunger. 'Spinning' refers to the process of rotating the mould such that the glass is formed into the required shape by the resulting centrifugal force.

A single one or combination (i.e. press and blow) of these techniques can be used depending on the article being produced. The press and blow technique is used to form container items such as bottles and jars. Pressing is used to form items such as drinking glasses or dishes. Spinning is used to produce circular articles such as plates and shallow bowls.

In the case of handmade products, the items are usually gathered manually using a 'hollow pipe'. The glass is first formed into a small hollow body (the parison) by puffing through the pipe into the glass. The final forming of the glass into the required shape from the article is then done by turning the parison in a wooden or metal mould.

The formed articles are then usually fire-finished and polished in order to obtain the required surface quality. The firing process requires very high temperatures and therefore oxy-gas is often used as fuel due to its lower specific energy consumption, ease of use and reduced exhaust gas volumes.

Annealing

The forming process involves rapid temperature changes and introduces severe internal stresses into the glassware. The term annealing refers to the process of removing these stresses and involves reheating the glass followed by controlled cooling. In the case of automated processes, annealing is usually performed continuously by placing the glassware on a conveyor belt and feeding it through a long tunnel kiln known as a 'lehr'. The articles may be passed through a tempering furnace instead of an annealing lehr should high mechanical and thermal shock resistance be required.

Finishing

Following annealing, the articles may be put through a number of mechanical and chemical finishing operations.

Mechanical processes include cutting, drilling, grinding, and polishing while chemical treatments are used to alter the strength, appearance, and durability of the product.

Cutting involves carving decorative patterns into the glass using diamond impregnated wheels. This process can be carried out using machinery or by hand. Water, sometimes mixed with lubricants, is used both as a coolant and washing agent (to remove the fine glass particles produced) during the process. A variety of alternative techniques including frosting by sand blasting or acid etching and engraving can be used to engrave glass.

After cutting, the surface of the glass usually has a grey, rough appearance. It can be cleaned using a variety of agents including aqueous solvents, organic solvents (used alone or mixed with commercial cleansers), and hydrocarbon or halocarbon solvents (removal of non-polar organic compounds). Most typically, the articles are dipped in baths containing hydrofluoric and sulphuric acids followed by rinsing them in hot water to remove lead sulphate ('white skin') from the surface.

6.2.3 The applications

The main product types produced by the domestic glass sector may be categorised as tableware, ovenware and decorative items.

Tableware

For the purposes of this report, the term 'tableware' is used to describe household glass items used for serving food and beverages.

The category can itself be further broken down into serve ware, dinnerware and drink ware. Serve ware, as the name implies, is used for serving food. It is intended for holding relatively large portions of food and includes items such as bowls, platters, gravy pots and carafes. Dinnerware is used to serve individual portions of food during a meal and includes items such as plates and bowls. Drink ware includes items used to serve and consume beverages. This includes mugs, teacups, water glasses and wine glasses.

Most low price tableware is made from soda-lime glass. High quality tableware made from lead crystal and crystal glass is also available.

Ovenware

The term ‘ovenware’ is, for the purposes of this report, used to describe heat-resistant glass dishes that are used for the preparation and serving of oven-cooked food. Ovenware items include glass baking dishes, casserole dishes, and pie plates.

Ovenware is mainly produced from borosilicate glass.

Decorative Items

For the purposes of this report, the term “decorative items” is used to describe decorated/ornamental gifts, collectibles and souvenirs made of glass. Examples of decorative items are vases and etched glass wall decor.

Much of this category of product is made from lead crystal and crystal glass.

6.3 Environmental overview of the domestic glass sector

This section is designed to provide some background information on the environmental impacts associated with the domestic glass industry. It also describes the way in which the IPPC directive aims at minimising these impacts through the requirement that best available techniques (BAT) are used to control emissions.

6.3.1 Environmental impacts

6.3.1.1 Emissions to air

Raw materials storage and handling

Most of the raw materials used in the manufacture of domestic glass are powdered or granular solids. As mentioned above, these materials are usually stored in silos and storage bays where they are subject to air movement pressures that may result in significant releases of particulates to the atmosphere. Similarly the transportation of raw materials from storage areas to process areas as well as the mixing operation may result in particulate releases.

Melting

The most significant environmental impacts of the domestic glass industry are associated with the high energy consumption of melting activities and the resulting atmospheric emissions.

Table 10 below summarises the potential releases to air from the melting process.

Table 10: **Potential releases from the domestic glass melting process**

Emission	Source / Comments
Particulate matter	Condensation of volatile batch components. Carry over of fine material in the batch. Product of combustion of some fossil fuels.
Oxides of Nitrogen	Thermal NOx due to high melter temperatures. Decomposition of nitrogen compounds in the batch materials. Oxidation of nitrogen contained in fuels.
Oxides of Sulphur	Sulphur in fuel. Decomposition of sulphur compounds in the batch materials.
Chlorides/HCl	Present as an impurity in some raw materials, particularly man made sodium carbonate. NaCl used as a raw material in some special glasses.
Fluorides/HF	Present as a minor impurity in some raw materials. Added as a raw material in the production of enamel frit to provide certain properties in the finished product. Added as a raw material in the continuous filament glass fibre industry, and in some glass batches to improve melting, or to produce certain properties in the glass e.g. opalescence. Where fluorides are added to the batch, typically as fluorspar, uncontrolled releases can be very high.
Heavy Metals (e.g. V, Ni, Cr, Se, Pb, Co, Sb, As, Cd)	Present as minor impurities in some raw materials, post consumer cullet, and fuels. Used in fluxes and colouring agents in the frit industry (predominantly lead and cadmium). Used in some special glass formulations (e.g. lead crystal and some coloured glasses). Selenium is used as a colorant (bronze glass), or as a decolourising agent in some clear glasses.
Carbon Dioxide	Combustion product. Emitted after decomposition of carbonates in the batch materials (e.g. soda ash, limestone).
Carbon Monoxide	Product of incomplete combustion, particularly in hot blast cupolas.

Source: BREF on Glass Manufacturing Industry, 2001, with adaptations.

A number of factors including the internal design and age of the furnace, the type of glass being produced, the batch composition, the abatement techniques employed and the method of operation, are important in determining the environmental performance of the melting operation.

Finishing

Fire finishing does not give rise to significant emissions other than the combustion products outlined above. Acid polishing of lead crystal products can lead to the emission of acid fumes (HF and SiF_4) while grinding and cutting activities can result in particulate emissions.

6.3.1.2 Emissions to water

Generally, the domestic glass production process does not present a significant threat to the water environment. Most of the liquids used in the process (i.e. cooling and cleaning water, fuel oils etc.) can be either recycled or adequately contained and disposed if good practice and design is adhered to.

The main potential sources of water pollution are:

- Surface water drainage
- Spillage and leaks from storage tanks
- Contaminated drainage water
- Water used for process cooling and product cleaning
- Wet scrubber effluents

6.3.1.3 Emissions of solid wastes

The main by product of glass production is waste glass, the majority of which is recycled back to the furnace. Other wastes include those associated with raw materials storage and handling, deposits from waste gas flues and waste refractory material from decommissioned furnaces.

6.3.1.4 Energy consumption

Domestic glass manufacture is a highly energy intensive process. The melting operation alone, sometimes accounts for over 75% of the total energy requirements of an installation. The level of energy consumption, in instances where fossil fuels are used, is very closely linked to emissions. Therefore measures aimed at reducing energy consumption are also likely to have a positive spin off effect on emissions.

Table 11 below presents a summary of typical emissions from each of the main production processes.

Table 11: **Summary of typical emissions from domestic glass processes**

Source → **Release ↓**	**Raw materials handling, storage and mixing**	**Melting**	**Forming**	**Annealing**	**Cutting Decorating**	**Acid Polishing**	**Cullet handling/ Recycle**
NO_x		A		A			
SO_x		A		A			
Particulates	A	AL					
Chlorides		A					
Oxychlorides							
Fluorides		A				AW	
BREF Group 1 Metals - Arsenic, Cobalt, Nickel, Selenium and Chromium VI		A					
BREF Group 2 Metals - Antimony, Lead, Chromium III, Copper, Manganese and Vanadium		A				W	
Organotin							
VOCs					A		
Suspended solids					W	W	
Chemical Oxygen							
Demand (COD)							
Acidic pH						W	
Ammoniacal nitrogen		A					
Sulphate						W	
Odour							A
Noise	*		*				**
KEY	A - Release to Air, W - Release to Water, L - Release to Land, *** - High, ** - Medium, * - Low						
N.B. It should be noted that this is not necessarily an exhaustive list. Equally, not all installations will necessarily have all these releases.							

Source: UK Sector Guidance Note IPPC SG2, 2003.

6.3.2 The IPPC Directive and domestic glass

This section provides a summary of the emission reduction techniques (both BAT and non-BAT) available to the domestic glass industry.

6.3.2.1 BAT for controlling emissions from materials storage and handling

Fugitive dust emissions from the materials storage and handling operations can be reduced by using relatively simple techniques that constitute general good practice. Bulk powder materials should be stored sealed bags, enclosed containers or in silos with vents that discharge to appropriate dust abatement equipment such as fabric filters. Enclosures can be fitted around transport conveyors and furnace feeding areas. Additional measures for controlling emissions from the feed area include wetting the batch mixture and ensuring that the furnace has vents which discharge to a filter system.

Process areas where dust is likely to be generated can be provided with extraction which vents to suitable abatement equipment while buildings can be designed with the minimum of door and window openings.

Emissions from volatile raw materials can be minimised by ensuring that they are stored in appropriate vessels at low temperatures. Emissions from storage tanks can be controlled using a variety of techniques including tank insulation, temperature control, vapour return transfer systems and pressure/vacuum valves.

6.3.2.2 BAT for controlling emissions to air from melting activities

The vast majority of air emissions arise from the melting activities. Downstream activities contribute mainly to emissions of acid gases such as chlorides and fluorides. The actual level of emissions from an installation will depend on many factors including the raw materials selected, the melting technique chosen; the abatement techniques employed; and housekeeping practices.

A variety of abatement techniques are available for controlling emissions from the melting process. They may be divided into primary and secondary abatement techniques.

For the purposes of this report, the term ‘primary abatement techniques’ refers to techniques that aim to control emissions at source by preventing them from coming into being in the first place. They are based mainly on raw material changes (batch modification) and furnace/firing modifications.

The term ‘secondary abatement techniques’, is used to refer to techniques that aim to control emissions by capturing them after they have formed. They may be divided into techniques aimed at controlling particulate contaminants and those aimed at controlling gaseous contaminants.

Primary abatement techniques for controlling emissions from melting activities

Raw materials and fuel selection is one of the main primary techniques for controlling emissions from the melting process. The selection of raw materials and fuels that are unlikely to give rise to pollutants (i.e. low in nitrate, sulphur, chloride and fluoride) along with the increased use of cullet can significantly reduce emissions.

Another important factor influencing emission levels from the melting process is the choice of melting technique. A brief description of the main types of furnaces that are likely to be used in the manufacture of domestic glass is given below.

Regenerative furnaces (end fired or cross fired) utilise regenerative heat recovery systems. The combustion air is preheated to temperatures up to 1400 °C using heat from waste gases resulting in very high thermal efficiencies. Regenerative furnaces require a relatively high initial capital outlay, which means that they are generally only used in large scale operations.

Recuperative (unit melter) furnaces utilise heat exchangers (termed recuperators) for heat recovery, with continuous preheat of combustion air (to around 800 °C) by the waste gases. This type of furnace has a lower thermal efficiency than a regenerative furnace but is more flexible and requires lower initial capital outlay.

Oxy-fuel furnaces use combustion air that has a high percentage (>90%) of oxygen. This eliminates the majority of the nitrogen from the combustion atmosphere reduces the volume of the waste gases by about two thirds. Furnace energy savings are possible as it is not necessary to heat the atmospheric nitrogen to the temperature of the flames, and NO_x emissions are greatly reduced. A disadvantage is that Oxy-fuel furnaces do not utilise heat recovery systems to pre-heat the oxygen supply to the burners.

Electric furnaces - consist of a refractory lined box supported by a steel frame, with electrodes inserted either from the side, the top or more usually the bottom of the furnace. Energy for melting is provided by resistive heating as the current passes through the molten glass. The technique is commonly applied in small furnaces particularly for special glass. There is an upper size limit to the economic viability of electric furnaces, which depends on the cost of electricity compared with fossil fuels. The replacement of fossil fuels in the furnace eliminates the formation of combustion products resulting in low emissions.

Table 12 below summarises the main advantages and disadvantages associated with each furnace type.

Table 12: **Advantages/disadvantages associated with furnaces used in the domestic glass industry**

Furnace type	Principles of operation	Advantages	Disadvantages
Cross fired regenerative	Waste gases preheat "regeneration" chambers through which combustion air is passed and thus preheated	Combustion air preheated to 1400 ^{o}C High thermal efficiency Can control furnace temperatures closely Low emissions	High capital cost generally only viable for larger scale operations (>100 t/d) High temperatures favour high NO_x formation
End fired regenerative	Similar principle to the above.	High thermal efficiency Cheaper than cross fired regenerative Low emissions	High capital cost generally only viable for larger scale operations (>100 t/d) Less control of furnace temperature than cross fired regenerative and therefore used for lower capacity furnaces High temperatures favour high NO_x formation
Recuperative (unit melter)	Waste gases continually pass over heat exchanger across which combustion air is passed	Low emissions	Lower thermal efficiency than regenerative furnaces; generally small furnaces. Combustion air only preheated to 800 ^{o}C Small furnaces
Electric melter	Resistive heating by electrodes.	Relatively simple to operate High thermal efficiency due to lower heat losses of a smaller furnace. Very low direct emissions - eliminates combustion products (NO_X,SO_X, CO_2) Reduced size of abatement plant required. Low capital costs and furnace space requirements	Small furnaces due to high operating cost compared to fossil fuels. Can only be installed at a furnace rebuild Reduced campaign length Reduced flexibility Emissions associated with electricity generation
Pot furnaces, day tanks	Not continuous. Used to melt specific batches.	Primary emission control possible	Small (<20t/d) Difficult to optimize batch composition and combustion if pot furnaces are used.
Flex melter	Not continuous. Used to melt specific batches. Combination of electric and gas used for heating.	Primary emission control possible	Small and medium size Difficult to optimize batch composition and combustion if pot furnaces are used.
Oxy-fuel fired	High percentage of oxygen used instead of 21% combustion air	Reduces volume of waste gases by up to 85%. Sometimes substantial energy savings.	Waste gases require cooling

Source: Adapted from UK Sector Guidance Note IPPC SG2, 2003.

Almost all of the melting techniques available today are used in the domestic glass industry. In general, electrical melting is considered to be the melting technique with the lowest emissions. However, its high operational costs mean it is rarely economically feasible for other types of domestic glass production other than lead crystal and crystal glass production.

Thermal NO_x (i.e. NO_x derived from the combustion process) is one of the main emissions from the melting process and is also one of the main sources of overall NO_x emissions from domestic glass installations. A variety of modifications can be made to the combustion process to reduce NO_x emissions. Such measures include:

- Reducing the air fuel ratio - by preventing leakage of air into the furnace or by using natural gas, high pressure or steam as an alternative to air for oil atomisation.
- Reducing the combustion air temperature – lower flame temperatures result in lower NOx being formed.
- Staged combustion - reducing the proportion of either the air or the fuel injected at the burner reduces the maximum temperature and NO_x formation.
- Flue gas recirculation – where waste gas is re-injected into the flame to reduce the oxygen content and therefore the temperature and the NOx formation efficiency.
- Low NOx burners – the use of proprietary or glass company burner systems designed to minimise NO_x formation.

Table 13 below shows example measured emission data from some EU domestic glass installations in the period around 1997. Table 14 provides a key showing the type of furnace and abatement technology used at each of the installations measured.

Table 13: **Example installation emission data**

Furnace	**Melting Energy GJ/tonne**	**Dust mg/Nm^3 (kg/tonne)**	**NOx as NO_2 mg/Nm^3 (kg/tonne)**	**SOx as SO_2 mg/Nm^3 (kg/tonne)**	**HCl mg/Nm^3 (kg/tonne)**	**HF mg/Nm^3 (kg/tonne)**
DG 1	4.8	109 (0.23)	2314 (4.9)	186 (0.58)	-	-
DG 2	6.5	171 (0.7)	2087 (8.7)	3.1 (0.01)	-	-
DG 3	9.5	<1.0 (<0.003)	1400 (3.5)	-	-	-
DG 4	4.1	0.6 (<0.01)	-	-	-	-
DG 5	4.96	108 (0.25)	1243 (2.9)	126 (0.29)	-	-
DG 6	3.42	(0.02)	(1.0)	(0.02)	-	(0.001)
DG 7	3.8	1.7 (0.035)	11 (0.23)	0.36 (0.007)	0.42 (0.008)	0.05 (0.001)
DG 8	3.7	2.3 (0.02)	117 (1.07)	1.3 (0.011)	1.0 (0.009)	0.15 (0.0014)
DG 9	-	<1.0	-	-	-	-

Source: BREF on Glass Manufacturing Industry, 2001.

Table 14: **Example installation emission data key**

Furnace	Furnace Type	Fuel	Capacity (tonnes/day)	Abatement Techniques/Comments
DG 1	Regenerative end-fired.	Mainly gas, can use oil.	165	Primary NO_x control
DG 2	Regenerative end-fired.	Gas	65	Primary NO_x control
DG 3	Recuperative mixed melter	Gas and electricity	30	Bag filter.
DG 4	Electric melter	Electricity	28	Bag filter
DG 5	Regenerative end-fired. Extra white soda-lime glass.	Gas	165	Primary NO_x control, 1998 data
DG 6	100% Electrical Opal Glass	Electricity	65	Cold top electrical melting with bag filter and optimised batch formulation.
DG 7	100% Electrical Crystal Glass	Electricity	32	Lead free crystal glass. 35% cullet.
DG 8	100% Electrical, Soda-lime extra white	Electricity	48	Wet scrubber 405 cullet
DG 9	Recuperative	Gas	34	EP

Source: BREF on Glass Manufacturing Industry, 2001.

Table15 below illustrates how emission levels from conventional furnaces can vary depending on the type of product being made.

Table 15: **Typical air emissions by domestic glass product type**

Substance	Soda-lime Glass (mean figure)		Lead Crystal (mean figure)	
	mg/Nm3	kg/tonne of melt	mg/Nm3 [(1)]	kg/tonne of melt
Oxides of Nitrogen (as NO_2)	140 - 5500[(2)] (2300)	0.9 - 11 (4.8)	1000 - 2000 (1500)	0.9 - 5.0 (1)
Oxides of Sulphur (as SO_2)	50 - 1000 (250)	0.1 - 2.8 (0.7)		0.1 - 1 (0.2)
Particulate Matter	0.5 - 400 (200)	0.001 – 0.8 (0.4)	2 - 10 (5)	0.001 - 0.1 (0.02)
Fluorides (HF)	<5		0.1 - 1.0 (0.5)	0.0002 - 0.004 (0.0003)
Chlorides (HCl)	<10		0.5 - 5.0 (2.0)	0.001 - 0.003 (0.002)
Metals (including lead)	<5		0.05 - 0.5 (0.2)	0.0001 - 0.035 (0.01)

Notes: (1) These data relate to conventional furnaces (i.e. not electrical). (2) Some high results relate to the use of nitrates in the batch or to other specific conditions (e.g. very low pull rate).
Source: BREF on Glass Manufacturing Industry, 2001.

Secondary abatement techniques for controlling emissions from melting activities

The most well established secondary abatement techniques for particulates in the glass industry are bag (or fabric) filters, electrostatic precipitators and high temperature filter media. Bag filters are widely used due to their high efficiency in controlling fine particulate matter. The basic principle of bag filtration system is that the particulate-laden gas stream passes through a woven or felted fabric that filters out the particulate matter and allows the gas to pass through. The direction of gas flow can be either from the inside of the bag to the outside, or from the outside to the inside. Particles are initially retained on the fabric by direct interception, inertial impaction, diffusion, electrostatic attraction and gravitational settling. Gradually a dust mat forms on the fabric, resulting in more efficient collection of submicron particles by sieving. Bag filters have high dust collection efficiencies (95 - 99%) over a broad range of particle sizes. Particulate emissions levels below 10 mg/m^3 can be expected in most applications. They are extremely flexible in terms of design and can handle large volumes of gases with reasonable operating pressure drops and power requirements. A disadvantage is that periodic cleaning of the filter media is necessary to control the pressure drop that occurs over the filter as the dust mat thickens. Also the waste gas temperature has to be maintained within the operating range of the filter material.

Wet scrubbers remove particulate matter from gas streams by incorporating the particles into liquid droplets directly on contact. Different types of wet scrubbers are found including spray towers, wet cyclone scrubbers and venturi scrubbers. Wet scrubbers are applied to soda lime production as abatement technique but for most glass furnaces wet scrubbing is not likely to be a useful technique for particulate matter abatement (see BREF, p. 254).

Electrostatic precipitators are also used to control particulate emissions. An electrostatic precipitator consists of a series of high voltage discharge electrodes and corresponding collector electrodes. The particles are passed through the high voltage field generated by the discharge electrodes, which causes them to become negatively charged. The negatively charged particulates then move towards the positive electrode where they are collected and subsequently removed. The advantages of electrostatic precipitators include their wide applicability and high efficiency (95 - 99% or higher) for a wide range of particle sizes. Emission concentrations in the range 5 to 50 mg/m^3 can be achieved depending on the design used for the precipitator and such as waste gas characteristics. They can handle large volumes of gases without experiencing pressure drops allowing them to operate continuously with little maintenance. Disadvantages include the fact that they have a relatively high initial installation cost and generally require a great deal of space.

Secondary control techniques most commonly used to control gaseous emissions include dry and semi dry scrubbers. In the domestic glass industry, dry and semi dry scrubbers are used to control emissions of sulphur oxides, fluoride and chloride (SOx, HF and HCl) emissions. These techniques involve dispersing into the waste gas stream, a material (absorbent) that will react with the gaseous pollutant to form a solid. The resulting solid is then removed from the waste gas stream using an electrostatic precipitator or bag filter system. In dry scrubbers, the absorbent is a dry powder (usually $Ca(OH)_2$, $NaHCO_3$,or $Na_2(CO)_3$) while in the semi-dry process, the absorbent (usually Na_2CO_3, CaO or $Ca(OH)_2$) is introduced as a suspension or solution.

Table 16 below gives a summary of the emissions to air that may result from melting activities and describes the main abatement techniques available and shows those that are considered to be BAT.

It must be considered that some of the techniques shown in Table 16 are not directly applied in domestic glassmaking (e.g. SCR or SNCR). The glass BREF states that it is difficult to form firm conclusions on what constitutes BAT for NOx emissions in the domestic glass sector. Where electrical melting is not economically viable a number of other techniques could be used. The sector utilises a wide range of furnace types and selection of the most appropriate technique will depend on the features of the particular installation. It is envisaged that given the necessary time for development and implementation of techniques, the emission level for oxides of nitrogen (expressed as NO2) associated with BAT will be 500 - 700 mg/Nm3 which generally equates to 0.5 - 1.75 kg/tonne of glass melted. Currently, according to industry information, which is based on experience in other sectors the rigorous application of primary combustion measures could be expected to yield for the domestic glass sector reductions in NOx emissions of 20 -40%, i.e. in the region of 1000 -1500 mg/Nm3 which generally equates to 2.5 -3.75 kg/tonne of glass melted.

Table 16: **Summary of BATs for controlling air emissions from melting activities (conclusions going beyond the domestic glass sector)***

Release	Main Sources	Available Techniques		BAT
		Primary	**Secondary**	
Particulate matter	Batch material carryover Volatilisation and reaction of batch materials (80 – 95% of total dust emission) Metal impurities in fuel	Batch moisture Raw material modifications Temperature reduction at melt surface Burner positioning Conversion to gas firing	Electrostatic precipitators Bag filters Mechanical collectors High temperature filter media Wet scrubbers	Electrostatic precipitators Bag filters
Oxides of nitrogen (NO_x)	Thermal NO_x, raw materials, fuel	Combustion modifications – i.e. reduced air/fuel ratio, reduced combustion temperature, staged combustion, low NOx burners, use of gas as fuel Batch formulation - i.e. substitution of nitrate containing compounds Electric furnace Special furnace design – LoNO_x melters Use of the FENIX process – combustion optimisation and energy reduction Oxy-fuel melting – replacement of combustion air with oxygen Chemical reduction by fuel (CRF) – addition of fuel to waste gas stream to chemically reduce NO_x. Reburning – NO_x removal through use of fuel as a reducing agent	Selective catalytic reduction (SCR) – removal of NO_x through reaction with ammonia (NH_4) in a catalytic bed Selective non-catalytic reduction (SNCR) - NO_x removal through reaction with NH_4 at high temperatures	Electric furnace for lead crystal, crystal and opal glass. Emission levels of about 500-700 mg/Nm^3 where electrical melting is not economically viable (the latter mainly depends on the price differential between electricity and fossil fuels) Combustion modifications Reburning Oxy-fuel firing Chemical reduction by fuel SNCR or SCR
Oxides of Sulphur (SO_x)	Oxidation of sulphur in fuels Decomposition/oxidation of sulphur compounds in batch materials	Selection of low SOx containing fuels Batch formulation – use of non sulphate containing fining agents	Dry or semi-dry scrubbing	Dry or semi-dry scrubbing Use of fuel oil with <1% sulphur content
Fluorides (HF), Chlorides (HCl) and metals	Batch material	Selection of low sulphur content raw materials Increased use of cullet Electric boost Improved furnace design Reduced air/fuel ratio Oxy-fuel melting Low NOx burner systems Electric melting	Dry or semi-dry scrubbing	Raw material selection Dry or semi-dry scrubbing

* Note: Both SCR and SNCR are not directly applied in domestic glassmaking.
Source: BREF on Glass Manufacturing Industry, 2001

Table 17 below shows the BAT and associated emission levels considered appropriate for melting activities in domestic glassmaking.

Table 17: **Emission levels for melting activities in domestic glassmaking***

Release	**BAT**	**Associated Emission Levels (AELs)**
Particulate matter	Electrostatic precipitators Bag filters	5 - 30 mg/Nm^3
Oxides of nitrogen (NO_x)	Electric furnace for lead crystal, crystal and opal glass. Primary measures: Combustion modifications Reburning (for regenerative furnace) Oxy-fuel firing Chemical reduction by fuel SNCR or SCR	1000-1500 mg/Nm^3 (where electrical melting is not economically viable) 0.2 – 1.0 kg/tonne of glass melted (where electric furnace is used)
Oxides of Sulphur (SO_x)	Dry or semi-dry scrubbing Use of fuel oil with <1% sulphur content	Natural gas firing - 200 - 500 mg/Nm^3 Oil firing - 500 - 1300 mg/Nm^3
Fluorides (HF), Chlorides (HCl) and metals	Raw material selection Dry or semi-dry scrubbing	HCl < 30 mg/ Nm^3 HF < 5 mg/ Nm^3 Metals (Group 1 + 2) < 5 mg/ Nm^3 Metals (Group 1) < 1 mg/Nm^3

* It must be noted that some techniques like reburning, SCR or SNCR are not used in the glass industry.
Source: Adapted from BREF on Glass Manufacturing Industry, 2001.

Oxides of Carbon (CO_2, CO) are also emitted as products of complete and incomplete combustion of fossil fuels and other organic materials as well as from the decomposition of carbonate rich materials.

6.3.2.3 Emissions arising from non-melting activities

With the exception of the cutting and polishing operations, the emissions arising from post melting activities are in the majority of cases insignificant and require relatively little investment in the form of abatement technology.

In relation to cutting operations, water is usually used as a coolant and damping agent to prevent dusts. Extraction systems discharging into a bag filter may also be used to remove mists. Fume emissions from acid baths used to clean the products can be reduced using wet scrubbers.

BAT for cutting operations is considered to be cutting under liquid where practicable. Where dry cutting is required, then extraction to a bag filter should be provided.

Table 18 below gives the emission levels associated with BAT for non-melting activities.

Table 18: **The emission levels associated with BAT for non-melting activities**

Substance	**Emission level**
Chlorides (expressed as HCl)	30 mg/Nm^3
Fluorides (expressed as HF)	5 mg/ Nm^3
Particulates	20 mg/ Nm^3
Metals (gas + solid phase) (Group 1 + Group 2)	5 mg/ Nm^3
Metals (gas + solid phase) (Group 1)	1 mg/ Nm^3

Source: BREF on Glass Manufacturing Industry, 2001

BAT for controlling emissions to water

The potential for emissions to the water environment from domestic glass production process is relatively low. In general, standard pollution control technologies such as settlers, screens, oil separators and discharge to municipal wastewater schemes can be used to control these emissions.

BAT is assessed using a set of emission levels devised by the TWG. These are presented in the table 19 below.

Table 19: **BAT associated emission levels for water releases**

Release	**Emission limit**
Suspended solids	30 mg/l
Chemical oxygen demand (Note1)	100 - 130 mg/l
Ammonia (Kjeldahl)	10 mg/l
Sulphate	1000 mg/l
Fluoride	15 - 25 mg/l
Arsenic	0.3 mg/l
Antimony	0.3 mg/l
Barium	3.0 mg/l
Cadmium	0.05 mg/l
Chromium (Total)	0.5 mg/l
Copper	0.5 mg/l
Lead (Note 2)	0.5 mg/l
Nickel	0.5 mg/l
Tin (Note 3)	0.5 mg/l
Zinc	0.5 mg/l
Phenol	1.0 mg/l
Boric acid	2 - 4 mg/l
pH	6.5 - 9
Mineral oil	20 mg/

Source: BREF on Glass Manufacturing Industry, 2001

6.3.2.4 BAT for minimizing other wastes

Domestic glass industry produces relatively low levels of solid wastes. These consist mainly of waste raw materials and waste glass.

Waste raw materials can be minimised by ensuring that BAT, as described above, is applied in storage and handling operations. In addition, waste raw materials can be recycled back into the process. Similarly, other waste glass can be turned into cullet and recycled back into the process. Solid waste from wastewater streams is generally disposed of to landfill.

The adoption of a systematic approach to the prevention or minimisation of waste by primary means is considered to constitute BAT.

6.3.2.5 BAT for minimising energy consumption

The BREF does not specifically recommend a BAT for reducing energy consumption but makes reference to the following measures:

- Application of energy efficient melting techniques and furnace design (e.g. regenerators, recuperators, electric melting, oxy-fuel combustion, and electric boost).
- Application of combustion control techniques and selection of low emission fuels (e.g. l low NO_x burners, oil/gas firing).
- Increasing cullet usage – requires less energy to melt than virgin raw materials

6.3.3 Differences in implementation

The fact that the IPPC Directive contains elements of flexibility that allow Member States to determine the precise content of a permit has led to variety of different approaches to its implementation.

Table 20 presents current national emission limit values for dust and NO_x emissions for the whole glass sector in some of the Member States. The table shows that there are significant differences in the emission limits set by the countries surveyed.

With respect to particulates, the BREF suggests that the installation of a combination of electrostatic precipitators combined with wet scrubbers and an emission limit of 5 – 30 mg/Nm^3 constitutes BAT for emissions control.

The least stringent particulate emission limits are in Italy and Portugal which allow existing installations to emit up to 150 mg/Nm^3 of particulates. In the case of France, new installations are subject to the same limit on the condition that they have implemented NO_x reduction measures. Existing installations have to meet a stricter limit of 50 mg/Nm^3. The most stringent limits are in Sweden, where particulate emission limits of 10 and 5-8 mg/Nm^3 are imposed for new and modified installations respectively.

Table 20: **National emission limits for the production of glass exceeding 20 tonnes per day in certain Member States of the European Union**

Particulates, NOx	**Data based on**	**new/modified or existing plant**	**Particulates in mg/Nm^3**	**NO_x in mg/Nm^3**	**Source***
Austria	Na	Existing	50	1500 (a) 900 (b) 800 (c) 500 (d)	Federal Legal Gazette No. 498/1994; 1st and 2nd ELV report (no changes)
Belgium (Walloon Region)	P	new/modified	50 (e)	n.a.	Voluntary Agreement
Finland	P (d)	New/existing	50	2.5-4kg/tonne	HELCOM Recommendation (n.a. in 2nd ELV report)
France	Na	New existing	150 (if NOx is reduced) 50 (f)	890 (depends on furnace, glass type) 1500 (g) 1300 (h) 2000 (i) 1500 (j) 900 (k) 700 (l) 500 (m)	2nd ELV report Based on National regulation of 1993 (n)
Germany	Na	new/modified existing	20 50	500 800 (o, p, i, j) 1000 (s) 1200 (l, q, n) 1400 (k, q, n) 1800 (o, q, n) 2200 (p,q, n) 2200 (j, q, n) 3000 (i, q, n) 800 ®, n	2nd ELV report
Ireland	Na	new/modified	50	2700; 5400 (t)	BATNEEC Guidance Note, 1996
Italy	Na/P	Existing	150 (t) 80-100 (u)	1200-3500 depending on furnace and fuel type	1st and 2nd ELV report (no changes)
Portugal	Na	Existing regenerative kilns	150	1500-1800	Portaria n.º 286/93 from 12/03 and 1st ELV report
Sweden	P	New/modified Existing	10 and 5-8 50 (glass melting)	1000 2 (kg/t)	2nd ELV report
UK	Na (o)	new/modified existing	50 100	2000 2700	2nd ELV report

Notes: * Information is mainly based on available ELV reports for the period 2001-2002.
Na=National law; R=Regional law; P=Typical permit
a) for end fired and cross fired glass tanks with regenerative or ceramic recuperative preheating.- b) for cross fired glass tanks with other recuperative preheating.- c) for day tanks.- d) for other melting techniques.- (e) for a capacity greater or equal to 50 tonnes per day, otherwise no limit value.- (f) for special glasses and for a capacity greater or equal to 50 tonnes per day.- (g) for regenerative, end fired furnaces fired by gas.- (h) for regenerative, end fired furnaces fired by liquid fuel.- (i) for regenerative, cross fired furnaces fired by gas.- (j) for regenerative, cross fired furnaces fired by liquid fuel.- (k) for recuperative furnaces fired by gas.- (l) for recuperative furnaces fired by liquid fuel.- (m) for electric furnaces.- (n) for special glasses and glasses oxidized by nitrate compounds NOx emission limit values are doubled.- (o) regenerative horseshoe melting furnaces, gas fired.- (p) regenerative horseshoe melting furnaces, oil fired.- (q) minimisation obligation, coupled with a dynamic clause..- ® target value.- (s) If refining with nitrate is required for reasons of product quality. The nitrate input shall be documented; (t) emissions are defined as nitrogen dioxides. The higher ELV refers to situations where the raw materials contain significant quantities of nitrate. All ELVs (dust and NOx) are meant for new facilities. Existing facilities should make progress towards attainment of similar ELVs, but decisions are made on a case-by-case basis.

Germany, France and Sweden appear to have the most stringent NO_x emission limits for new installations, varying from 500 to 1000 mg/ Nm^3. The least stringent limits are in the UK, Portugal and Italy.

6.3.4 Main findings of technical overview of domestic glass sector

- The main air emissions from glass manufacturing are from the melting activities.
- Combinations of primary and secondary abatement techniques may be necessary to achieve BAT.
- Electrostatic precipitators and bag filters are considered BAT for controlling particulate emissions.
- BREF states that it is "difficult to form firm conclusions on what constitutes BAT for NOx emissions in the Domestic Glass Sector".
- The domestic glass industry uses a diverse range of furnace types.
- An electric furnace is considered BAT for controlling NO_x emissions from lead crystal, crystal and opal glass manufacturing.
- Other techniques considered likely to represent BAT for controlling NO_x emissions include combustion modifications and oxy-fuel firing.
- Currently, according to industry information, the rigorous application of primary combustion measures could be expected to yield for the domestic glass sector reductions in NOx emissions of 20 -40%, i.e. in the region of 1000 -1500 mg/Nm3 which generally equates to 2.5 - 3.75 kg/tonne of glass melted.
- Dry or semi-dry scrubbing and /or the use of fuel oil with less than 1% sulphur represents BAT for controlling SO_x emissions.
- Raw material selection along with dry or semi-dry scrubbing is considered BAT for controlling emissions of fluorides, chlorides and metals.
- Emissions arising from post melting activities are in most cases insignificant and require relatively little investment in the form of abatement technology.
- No BAT has been specifically recommended for reducing energy consumption from domestic glass manufacturing.
- Implementation of the IPPC Directive in relation to emission limits values for particulates and NO_x for the glass industry differs significantly across the EU.

6.4 Economic overview of domestic glass sector

6.4.1 Foreword on terminology and data availability

Terminology in the glass industry is not unified. There are a variety of classifications of glass products types. The European Statistical Classification of Economic Activities (NACE) includes sector 26, which is called “Manufacture of other non-metallic mineral products”. This sector in turn contains a sub-sector “Manufacture of glass and glass products” which is further sub-divided into:

- Manufacture of flat glass (26.11)
- Shaping and processing of flat glass (26.12)
- Manufacture of hollow glass (26.13)
- Manufacture of glass fibres (26.14)
- Manufacture and processing of other glass, including technical glassware (26.15)

The domestic glass sector forms a small part of some of above-mentioned categories.

In the United States, glass manufacture is divided into five major sectors based on end products:

- Flat Glass: windows, automobile windshields, picture glass
- Container Glass: bottles, jars, and packaging
- Pressed/Blown Glass (specialty): table and ovenware, flat panel display glass, light bulbs, television tubes, scientific and medical glassware
- Glass Fibre: insulation (fibreglass), textile fibres for material reinforcement, and optical fibres
- Products From Purchased Glass: items assembled from intermediate glass products (e.g., aquariums, table tops, mirrors, lab apparatus, ornaments, art glass)

In the Glass BREF document, the glass industry is divided into 8 different sectors:

- Domestic glass - glass tableware, cookware and decorative items
- Container glass – used for glass packaging (i.e. bottles, jars, tableware)
- Flat glass – float and rolled glass is used in greenhouses and the building and automotive industries.
- Continuous filament glass fibre – used in the reinforcement of composite materials (thermosetting resins and thermoplastics)

- Special glass – used to produce laboratory equipment and optical glass
- Mineral wool – used mainly for thermal insulation
- Ceramic fibre – used in the manufacture of general industrial and thermal insulation products
- Frits – used in the manufacture of ceramic and enamel glazes and pigments for coating tiles, tableware, silos, baths, electronic components and signs etc.

Statistical data availability, especially on domestic glass is very scarce. The main data sources examined as part of this literature study include the Glass BREF, Eurostat, Euromonitor and the CPIV. In various sources, different terms for glass products types are used. Therefore, throughout the report, depending on the issue discussed and data available, proxies may be used to describe the situation and trends in the domestic glass industry.

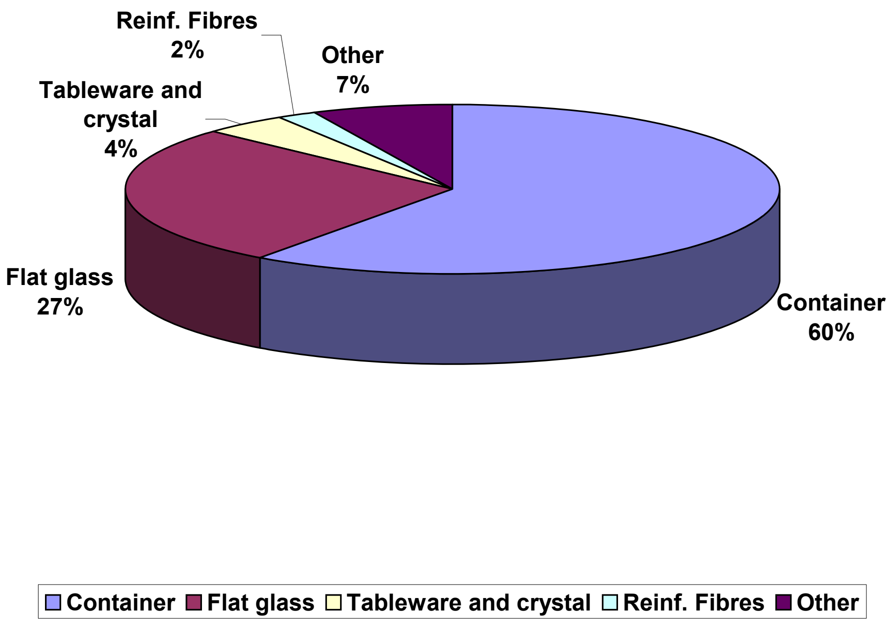
In some instances, domestic glass products are classified according to the material of origin (i.e. crystal and lead crystal, soda-lime, borosilicate and special glass). In other instances, domestic glass products are classified according to the types of items produced (i.e. cookware, tableware and decorative items\giftware). It should also be noted that in the CPIV statistics, tableware and crystal is in many cases used as a synonym for domestic glass.

6.4.2 Economic significance of the domestic glass industry

The European glass industry is very diverse and covers a variety of very different types of products and technologies. Graph 29 below shows the relative importance of each sector to the glass industry in terms of the percentage of total glass production. The graph is based on 2005 data from CPIV. The graph also reflects the situation in the EU15 in 1997 as described in the BREF. In both 1997 and 2005, domestic glass (i.e. tableware and crystal glass) formed 4% of the total glass production volume.

Graph 29:

Distribution of EU total glass production by sector in 2005 (% of weight)



Source: CPIV.

The size of the companies range from small to big multinationals, present in several countries.

According to the CPIV, installations are classified as:

- very small - producing less than 20 tonnes of glass products per day and not falling under the scope of the IPPC Directive
- small - producing 20 to 100 tonnes of glass products per day
- medium - producing 100 to 1000 tonnes of glass products per day
- large – producing more than 1000 tonnes glass products per day

Again, according to the CPIV, most installations are either small or medium sized. The CPIV distinguishes only one company as being large.

Industrial output from the domestic glass sub-sector forms less than 0,03% of total industrial output. It plays a marginal role in the EU economy and other industrial sectors are not dependent on it as most of products are supplied to sales directly.

In the crystal segment of the international domestic glass sector, the EU is a dominant player. 85% of all the crystal produced in the world is produced in the European Union. About 40% of all production is in the form of drinking glasses, the other 60% being giftware. Demand is very closely linked to developments in lifestyle and disposable income.

According to the BREF document, there were about 140 domestic glass manufacturing sites across the EU in 2001. Following the enlargement of the EU, this graph is now estimated to be closer to 200.

6.4.3 Production

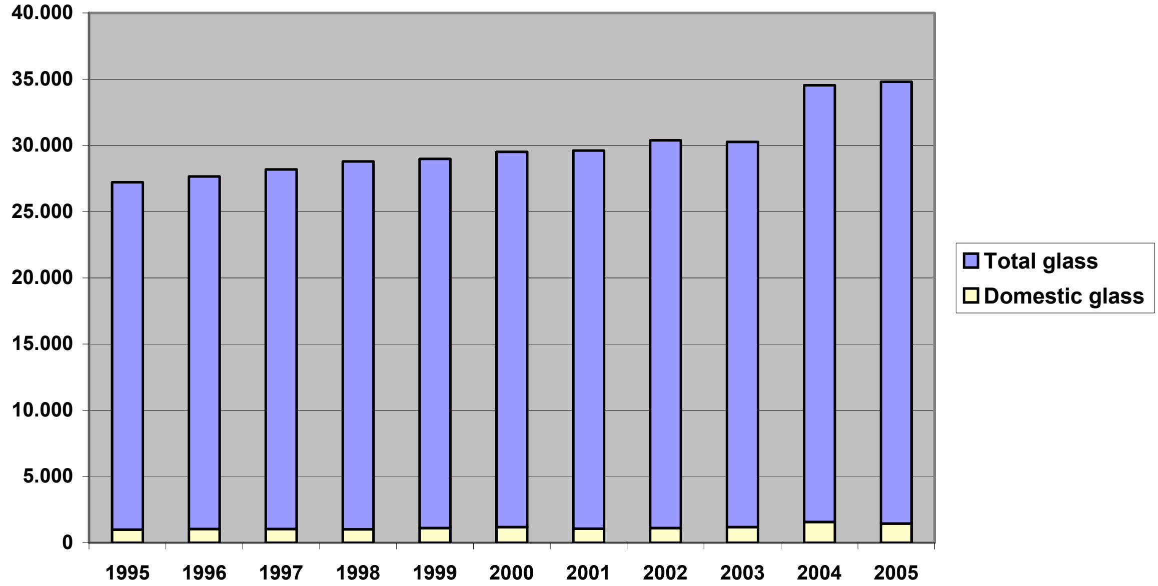
As indicated in the statistical overview of manufacture of glass, ceramics and cement in Europe by Walter Sura (2006), production of “other non-metallic mineral products” (a NACE classification that includes the glass sector), grew by a little over 8% in the EU25 between 1995 and 2005. This was approximately 12% less than the manufacturing average. This growth was the net result of increases in the two largest sub-sectors of this sector - ‘cement and concrete’ (NACE 26.5 and 26.6) and ‘glass and glass products’ (26.1). The growth of glass and glass products sub-sector was steepest, coming close to the manufacturing average of 18.9%.

In 2005, the total EU25 glass production reached a volume of 34.8 million tonnes, making the EU25 the largest glass producer in the world. Of this, approximately 1.5 million tonnes was domestic glass. The production value of total glass production in the EU25 amounted to approximately EUR 37 billion, around 32% of the total value of the world output of glass.

The majority of the EU members produce domestic glass. Graph 30 below shows development of the total EU output of domestic glass in thousands of tonnes over the period 1995 to 2004.

Graph 30:

The EU total and domestic glass sector's output in 10^3 tonnes (1995-2005)

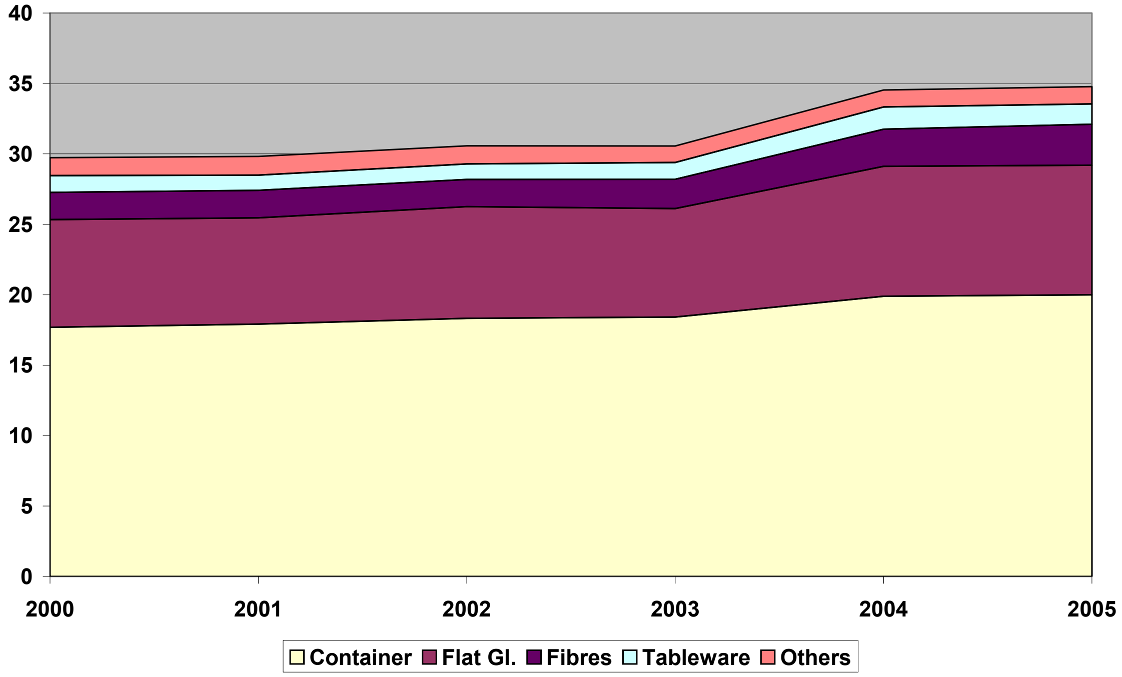


So urce: CPIV data; data for 2004 and 2005 represents EU25.

The following graph 31 shows shares in thousands of tonnes of the main glass sector product categories in EU15. From 2004 onwards the figures relate to EU25.

Graph 31:

Shares of the EU glass sector product categories in 10^3 tonnes 2000-2005



Source: CPIV

The domestic glass sector is well established in Europe. As Eurostat shows, the major players in the EU domestic glass market are countries such as France, Germany and Italy. Spain and the UK are medium sized producers. Among the 10 recently joined members of the EU, Poland, Hungary and the Czech Republic have the largest output. These old and new EU member countries have the highest levels of glass production in the EU.

The main threat to the sector comes from cheap imports from outside the EU (e.g. almost 80% of all imports stem from China and Turkey) and the increasing competition in export markets.

6.4.3.1 Production costs

Production costs, along with marketing, management and administrative costs are the major factors that determine whether glass products can be sold on the market at competitive prices. The main production costs – capital, operational and maintenance include:

- Investments in technology
- Operational and maintenance costs:
  - labour
  - raw and other materials
  - energy
  - transport
  - interest on capital investment etc.
  - other

The investment and operational costs can be very diverse depending on the glass type, the age of the plant and other factors.

Investments

The glass industry is highly capital intensive. Furnaces are one of the major investments, which once installed usually operate continuously for up to 10 years or more. For this reason, they are not easily modifiable or replaceable.

Unfortunately, data on investments in the EU glass industry in the Eurostat database is limited to only some countries and overall figures cannot be obtained. Moreover, manufacture of domestic glass is not included in the Eurostat database at all.

Expenditure on environmental protection reflects the financial effort made by companies to prevent, reduce or eliminate environmental pollution. Investment requirements for emission controls can be of the same magnitude as investments for melting facilities.

However, once again, statistics on the environmental expenditure relating directly to the domestic glass sub-sector were not available.

Labour

According to CPIV the cost of labour, both direct and indirect, is the most important production factor, forming an average of 30% of the total production cost for machine made glass, and over 50% for high quality hand-made glass items such as crystal.

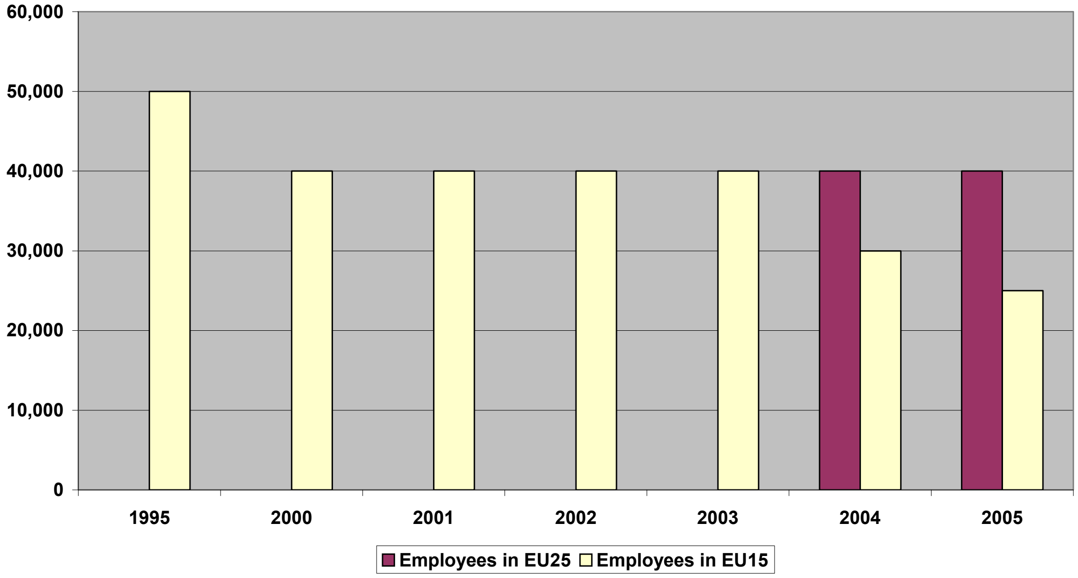
The glass sector employed an estimated 195,800 people in 2005 across EU25. CPIV data shows that the number of workers in the whole glass sector has been decreasing at a constant rate over last five years. Data for the EU5 shows a decline by 22% over the period 2000 to 2005. A similar situation is observed in the domestic glass sub-sector (see graph 32).

Currently, according to CPIV estimations, EU25 employs 30,000 - 40,000 persons in the domestic glass sector.

Graph 32:

Employment in the EU domestic glass industry, number of employees

Source: CPIV



In the crystal glass, soda-lime and borosilicate segments, the number of employees has been influenced mainly by increased automatization and increased outsourcing. Automated production does not require a highly skilled workforce. However, a segment with mainly manual production techniques requires labour with highly specific knowledge. Closure of companies and restructuring in the domestic glass industry, as explained by CPIV, were the main reasons for the reduction of employment numbers in 2004 and 2005. According to the detailed information on employment in the total glass industry per country, employment in Germany decreased from 63,938 in 2002 to 52,173 in 2005. Quite a sharp decrease in total glass employment numbers was in Spain: 15,000 in 2004 and 8,800 in 2005. These mentioned changes could influence the EU employment numbers in the domestic glass industry in the latest years.

Case Study

A Portuguese study from 2001, showed that 81% of the employees within the Portuguese crystal glass sector held an education lower than high school. 15% of the employees held a high school education while only 3% had a 'license degree/graduation'. Although 81% had an education lower than high school, 45% were considered to be highly skilled.[48]

Wages form a large share of the production cost for domestic glass producers. There are, however, differences between producers in the high value, hand made, and the lower value glass product segments. In the production of high value hand made glass, the cost of labour can reach 60% of the total production cost. The total cost of labour in the low value machine produced glass segment is considerably lower, amounting to approximately 30% of the total production cost[49].

Raw materials

[48] "Electronic commerce business impact project, Crystal sector Portugal 2001" by EBID and OECD .

[49] Interview with representative of installation within the glass industry

The share of the raw materials in the total cost of glass is typically around 20%.

Sand is a major input. Although it is readily available on the world market, its varying technical qualities mean that it is not always feasible for a glass producer to switch sources without altering the batch formulation, which is a delicate process. EU glass industry representatives indicated during the annual meeting with the European Commission in 2004, that attention should be paid to the increasing industry concentration in the production of sand in Europe and the consequential risk of the creation of a monopoly position in the EU.

Another important input and cost item in the operational process is soda ash. Approximately 60% of the cost of raw materials used in the production of soda lime based domestic glass can be attributed to soda ash. Today the European market is dominated by a few main players. For example, the Belgian soda producer Solvay supplied approximately 50% of soda (5.4 out of 10.8 million tonnes) in Europe in 2002. Although soda ash is readily available in Europe, it is also traded on the world market giving producers the option of sourcing it internationally from countries such as China.

Although the use of recycled materials in the glass industry has been growing rapidly over recent years, it is limited within the domestic glass sub-sector. Recycling of external cullet is generally not practised due to glass quality issues. However, internal cullet is universally used[50].

Energy

Another important factor affecting the EU glass industry is energy. The industry is highly energy intensive, with energy having a share ranging from 7% (crystal) to approximately 20% (flat glass) of the total production cost. The energy used in glass production is mainly derived from electricity, gas and fuel oil. Electricity is the main source for the melting process in crystal glass production whilst gas is the main source in production of soda lime, borosilicate and other domestic glass types. Fuel oil is usually only used in very small installations. Electricity is generally used in most other aspects of the production process.

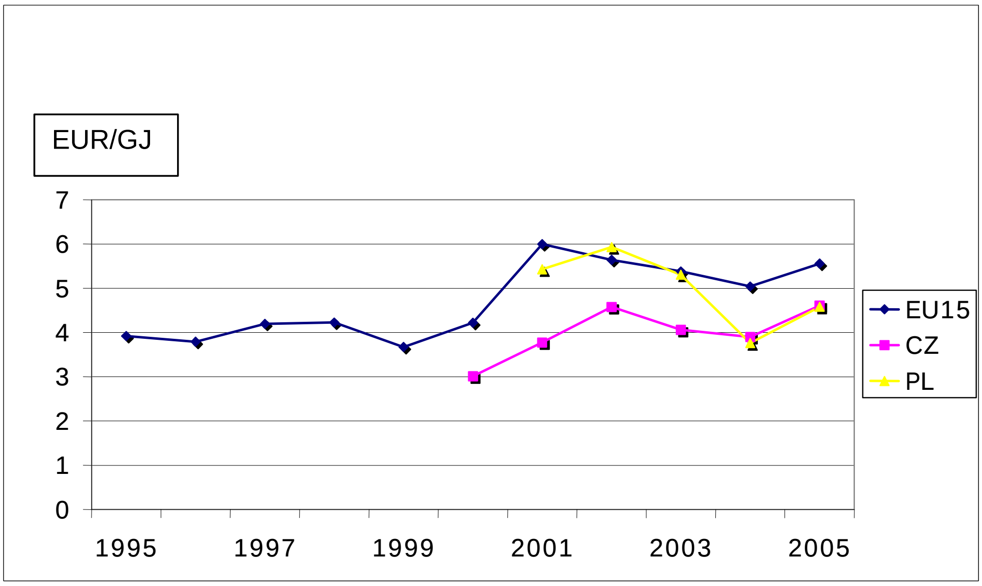
Glass industry representatives stated that the sector's energy consumption fell by 50% during the period from 1970 to 1990, with further reductions of 10% since then. Despite these efforts, the glass industry representatives note that, looking at the thermal balance, the glass industry reached a threshold below which it is difficult to go, and where further decreases entail significant marginal costs.

The increase in energy prices is a major driver for the development of production methods which are less energy consuming. While the trend in relatively high electricity prices in EU15 has remained stable over the last decade, energy prices in the 10 new Member States have increased significantly.

[50] BREF on glass manufacturing industry, 2001.

Gas prices have likewise increased since 1999 within all EU countries as illustrated in graph 33 below.

Graph 33: **Development of gas prices in Euro per Giga Joule in the EU15, Czech Republic and Poland (fixed prices, 2000 level)**



Source: Eurostat, different years.

The value of purchases of natural gas during the period 1997 to 2001 increased substantially. Unfortunately, equivalent data for the period 2000 to 2005 (during which gas prices increased substantially), is not available.

Transport

Transportation costs are another significant part of overall operational production costs, particularly when considering competition with non EU countries. Increases in tolls and taxes for transport in recent years have had a considerable impact in this area.

In summary, labour and energy form the largest part of domestic glass production operational costs. Raw materials, capital and transport costs are also very important cost items. It goes without saying that prices for these items impact prices of the final product and hence affect the competitiveness of a company.

It should be noted that there are, of course, variations in cost structure among individual firms. The variations are mainly due to different production methods and general conditions in individual member countries.

An example of this can be seen in the production of handmade products in Germany.

As indicated by the representative of one company, labour costs in the crystal industry can reach 60% of the total production cost, which is substantially larger than raw material costs (amounting to approximately15%) and energy costs (amounting to approximately 25%). Producers with higher automatization level of the production have lower labour costs.

6.4.4 Consumption

Domestic glass products range from everyday household items such as drinking glasses, cups, plates, serving dishes and ovenware to more high value products such as lead crystal decanters and goblets. The diversity of the end user customer base reflects the diversity of the sector itself.

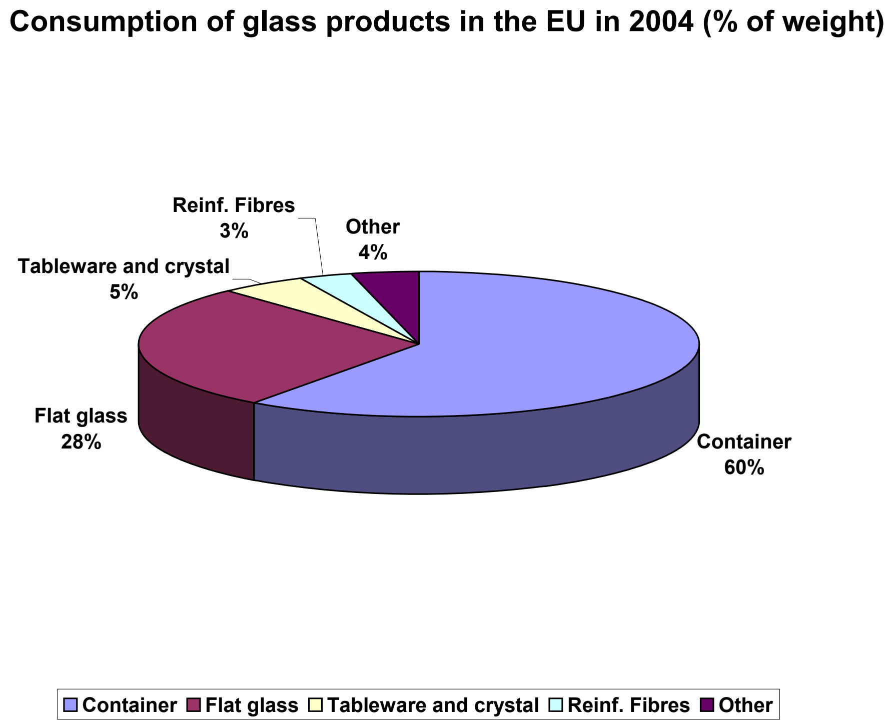
Domestic glass consumption is not significantly determined by production activities in other sectors. Consumption is largely dependent on the social demand for consumer goods.

Two types of final consumers can be distinguished: households and professional consumers. The latter covers hotels, restaurants, airlines etc.

6.4.4.1 Consumption volumes

CPIV numbers on consumption of glass products in the EU25 in 2004 are provided in graph 34. It can be seen that the structure is almost identical to the structure of the glass sector output (see graph 34).

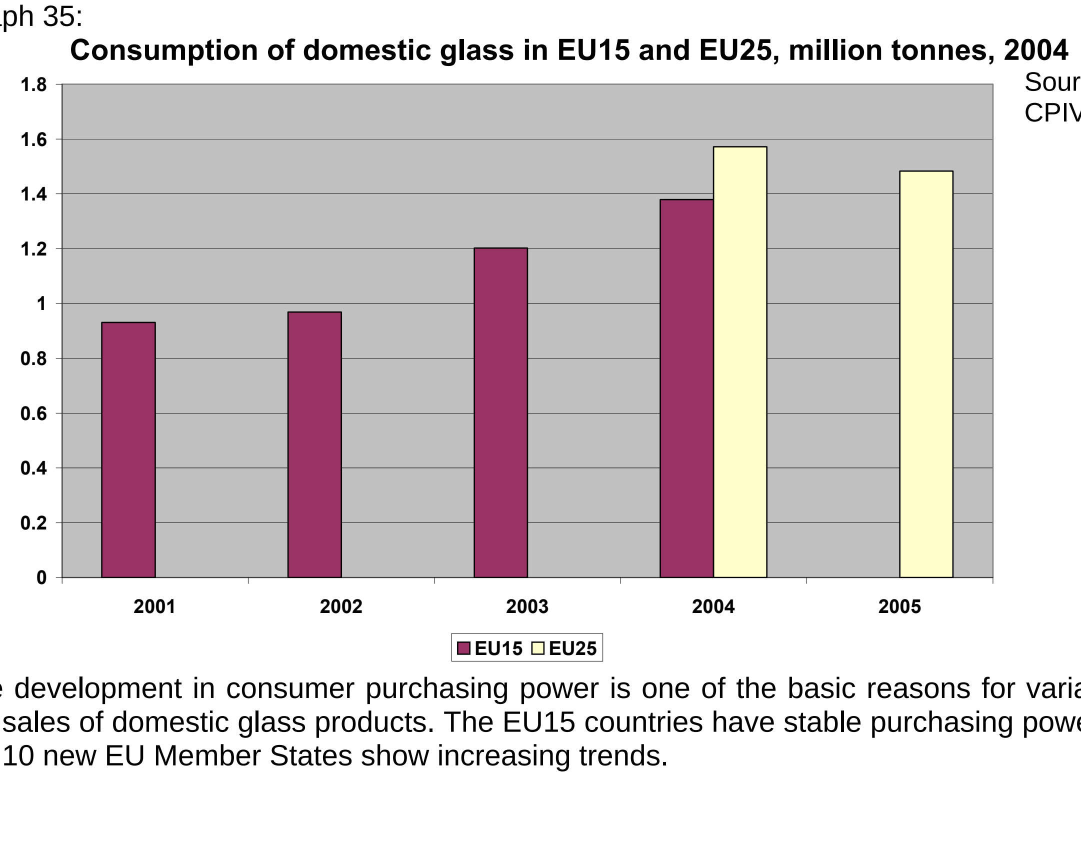
Graph 34:



Source: CPIV.

Domestic glass (tableware and crystal) consumption trends in the EU15 and EU25, based on CPIV data, is shown in graph 35.

Graph 35:



Source: CPIV

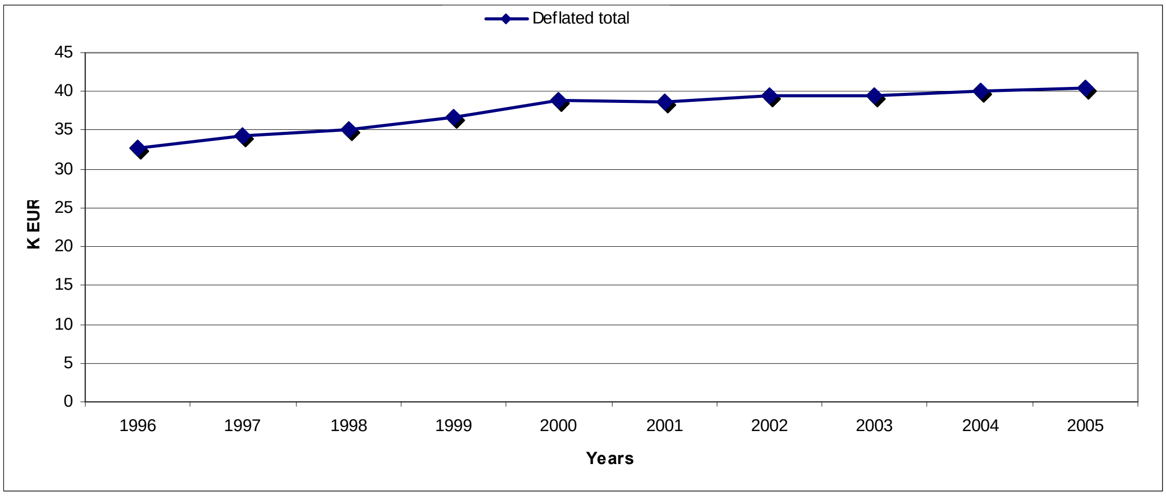
The development in consumer purchasing power is one of the basic reasons for variations in the sales of domestic glass products. The EU15 countries have stable purchasing power, while the 10 new EU Member States show increasing trends.

No data on EU consumer expenditure was available relating specifically to 'domestic glass' as defined previously (i.e. cookware, tableware and decorative items), However data relating to expenditure on 'glassware, tableware and household utensils' was found on the Euromonitor web-site. We are assuming that the trends observed in this data mirror the trends in the consumption of domestic glass as previously defined.

It can be seen from the graph below, that the rising trend observed in the EU consumption of domestic glass mirrors that for EU consumer expenditure on glassware, tableware and household utensils.

Since 1990 the total expenditures on domestic glass products have been rising steadily, as shown in graph 36.

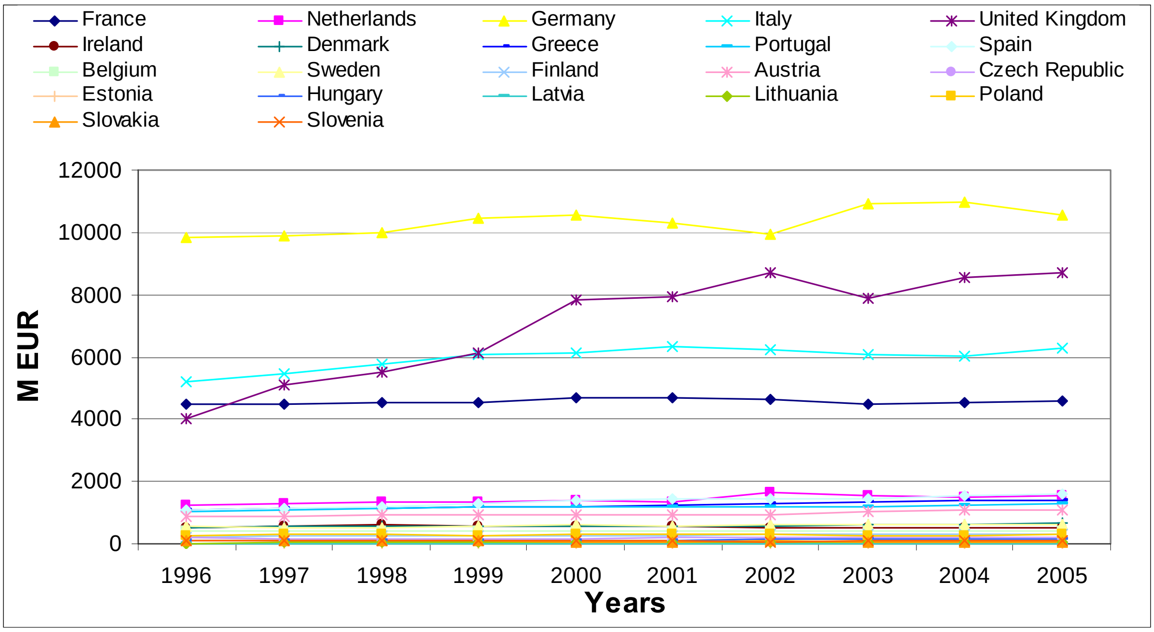
Graph 36: **EU25 expenditure on glassware, tableware and household utensils in million EUR (fixed prices, 2005 level)**



Source: Euromonitor.

Consumer expenditure on domestic glass products for various EU countries is shown in the graph below.

Graph 37: **Consumer expenditure on domestic glass in individual EU countries, M EUR, fixed prices of 2005**



Source: Euromonitor.

It can be seen from the data that the major markets in the EU are Germany, the United Kingdom, Italy and France. Germany, the United Kingdom and Italy are interesting because they diverge from the overall trend of stable market development. In these three countries, consumption has increased over the past 15 years. However, since 2004 domestic glass manufacturing capacities have almost disappeared from the UK (see e.g. closure of Edinburgh crystal).[51]

The professional consumer segment is considered to hold strong buying power. According to the Institut d'Informations et de Conjonctures Professionelles, 21.5% of the total sales value is derived from professional consumers[52]. This segment requires products with high durability and buys product in bulk. This consumer segment has strong bargaining power in the relationship with domestic glass producers, although the larger the size of the producer, the weaker the bargaining power of the segment.

The professional consumer segment is characterized as being a loyal segment. This means that when a relationship between a producer and consumer (e.g. a chain of restaurants) has been established, it usually lasts for a long time. This feature makes the market lucrative and enhances interest from the glass producers' side. Having products that are used at high end restaurants and hotels can also be used as co-branding for the professional buyer and the glass manufacturer, further underlining the exclusivity of the brands.

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[51] Evening News – Scotland, Hundreds facing job losses as Edinburgh Crystal cracks, 25/07/2006.

[52] Institut d'Informations et de Conjonctures Professionelles (2006), Le Marche des Art de la Table en France en 2004.

6.4.4.2 Sales

The domestic glass sub-sector's output is usually directed to wholesale or retail companies. Some domestic glass producers have set up their own shops selling their products directly to end customers. The main advantage of this approach is that the company has full control over the presentation and positioning of their product. At the same time they cut away the intermediary, giving the producer higher earning possibilities. The weakness of this approach is that it can be costly for a glass producer to set up a shop or range of shops. However, the setting up of retail shops does not generally lie within the core competency of most domestic glass producers. This approach accounts for a relatively small percentage of the overall sales.

Two examples from Europe (France and UK) showing the use of the different sales methods are given in the table 21 below.

Table 21:

Domestic glass sales channels in France and UK[53], % of sales value

Sales channel	France	UK
Specialist retail outlets	29.09	-
Department and variety stores	22.73	30.5
Hypermarket / supermarkets	26.36	25
Mixed and independent outlets	-	18
Hardware and cookware	-	16
Mail order	-	8.5
Other	21.82	2

Source: Euromonitor.

The table 21 shows that "specialist retail outlets" play the biggest role in France with 29% of the sales, closely followed by "department and variety stores" and "hypermarket/ supermarket" with 22% and 26% of sales respectively. The "other" group is very large with almost 22%, meaning that a relatively large portion of the sales is left unaccounted for in this analysis.

"Department and variety stores" and "hypermarkets and supermarkets" are the dominating sales channels in the UK amounting to 30.5% and 25% of the value sold respectively. The groups consisting of "mixed and independent outlets" and "hardware and cookware" represent 18 and 16% respectively, while "mail order" and "other" have the smallest percentage with 8.5 and 2% respectively.

The example shows that even though the use of supermarket type stores is widespread over most of Europe, there are differences in the shopping culture in different countries in the EU. For the producers of domestic glass, this means that they either face a fragmented European market if they wish to sell their product in specialist stores, or have to interact with big players like supermarket chains. Both channels have pros and cons in relation to the bargaining power of the domestic glass producer.

[53] Euromonitor

When using the specialist retailer channel, producers face the difficulty of working with a multitude of small shops or chains all over Europe. On the other hand, it provides an advantage in the negotiation process because of the relatively bigger size of the producer compared to the shop.

When a glass producer negotiates with a big supermarket chain, the latter has a stronger bargaining power because of the large scale of the purchases. This bargaining power is typically used to press the prices of the producer. The positive side of using this sales channel is that it is an easy way to reach a large number of end consumers.

6.4.4.3 "Lifestyle" driver of consumption and marketing

Domestic glass consumption is affected by the increasingly rapid shifts in consumer preferences and trends. Domestic glass is increasingly turning into a life-style product as opposed to a common consumer good.

Lifestyle products are strongly influenced by trends in society (e.g. fashions). The fact that domestic glass is a life style product increases the importance of marketing. The long history of the European crystal glass sector has proved to be a valuable asset in this regard as shown in the example given below.

Marketing costs constitute a major share of the total cost of sales. Such costs, especially in the crystal products segment, can reach levels equal to or even higher than the production costs. Hence any possible industry consolidations (i.e. mergers and acquisitions) are usually driven by the need to consolidate marketing channels rather than by traditional production side economies of scale factors[54]. A consolidation of the retail sector for luxury goods could have significant influence on the future development in the supply of such products.

The idea of using the concept of environmental friendliness as a marketing asset was investigated through interviews with representatives from the glass industry. All the representatives believed that consumers do not take environmental issues into consideration when purchasing domestic glass products. Still, the trend towards using environmental friendliness as a competitive factor is generally promoted by major players in the market like large store chains or department stores.[55]

6.4.5 Market structure and competition

Markets are becoming more international and total supply chain costs are coming under pressure. Consumers have bigger choices and their tastes tend to change more often and more quickly. The glass industry continues to react to market dynamics through product and process innovation by streamlining its production processes in order to decrease labour costs and energy consumption as well as to become more flexible and productive. The EU glass industry faces threats in the global market, particularly from countries where production costs are much lower and whose products are sold in EU markets. Of course, new markets create new opportunities and production units are also being set up outside the EU, close to these markets.

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[54] Interview with representatives of installation within the glass industry

[55] IKEA, Expert interview.

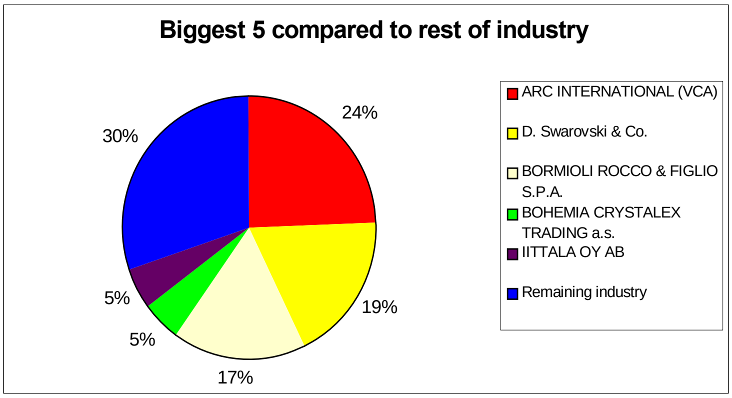
6.4.5.1 Number of enterprises

As mentioned above and described in the BREF document, there are approximately 150 to 200 companies operating within the EU25 domestic glass sub-sector. Approximately 40 to 50 out of these fall under the IPPC Directive (i.e. have a production of more than 20 tonnes of output per day).

The EU market share is dominated by a few ‘large’ companies as shown in graph 38 below. The graph shows that the majority of sales (60%) belonged to just three companies.

In terms of tonnage, however, some key players account only for a small percentage due to the type of their products (e.g. jewellery). It is important to note that the production of crystal glass has experienced a sharp decline since the last years of the 1990ies. Especially the production of drinking glasses made of lead crystal is declining steadily.

Graph 38: **Sales value of the biggest five companies compared to the rest of the domestic glass industry in the EU**



Source: Database Amadeus by Bureau van Dijk (2006).

Over the past few years there has been a consolidation (i.e. mergers and acquisitions) in the industry. This trend was triggered by an economic slow down that affected mainly small firms. These were either pushed out of the market or were bought by or merged with larger companies.

6.4.5.2 Trade

In general, volumes of total glass imports and exports in the EU are constantly increasing. Generally speaking, the weight of imports and exports of all glass products are balanced.

Table 22 presents the data related to the trade of all glass products and tableware (used as a proxy for domestic glass).

Table 22: **Trade data tableware and all glass for the EU in 2005**

Year 2005	**Million tonnes of tableware**	**Million tonnes of total glass sector**
Production	1.45	34.8
Apparent consumption	1.48	31.7
Exports Extra EU	0.38	3.18
Imports Extra EU	0.41	2.36
Key ratios		
Exports/Imports	0.93	1.35
Import penetration	28.67	6.07

Source: CPIV

In 2005 extra EU domestic glass imports exceeded extra EU exports. As EU producers are world leading in domestic glass production, these figures might seem surprising. It should be noted, however, that when EU producers outsource production and then sell it on the intra EU market, it appears as imports in statistics.

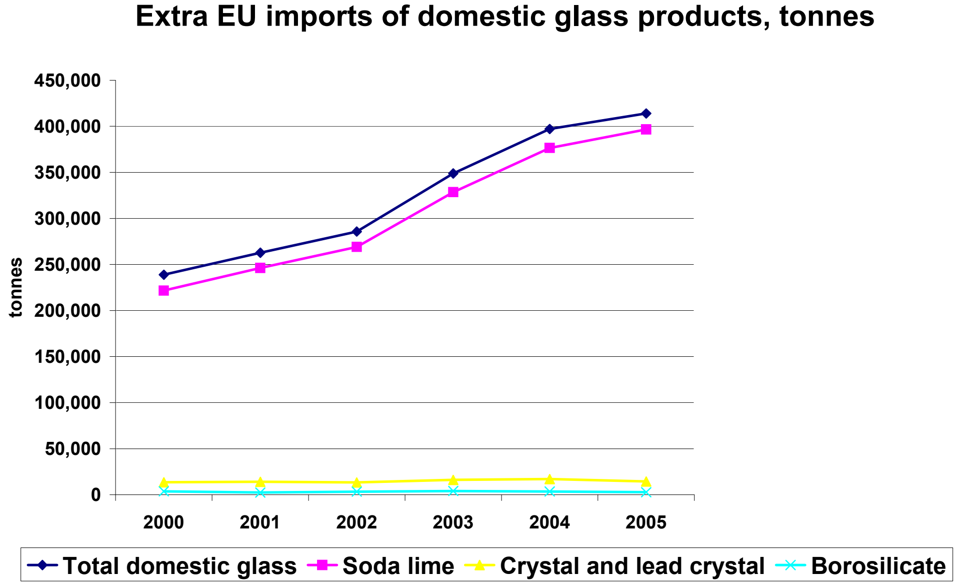
In 2005, tableware (i.e. domestic glass) formed approximately 12% of total exports and 17% of total imports of glass products.

According to CPIV data, intra EU trade exceeds the volume of extra EU trade. Intra EU sales are almost double the volume of extra EU export. Extra EU imports amount to 2/3 of intra EU sales.

Imports

Total imports of domestic glass are constantly increasing as shown in graphs 39 and 40. However, the crystal glass share of total imports of domestic glass is decreasing.

Graph 39:

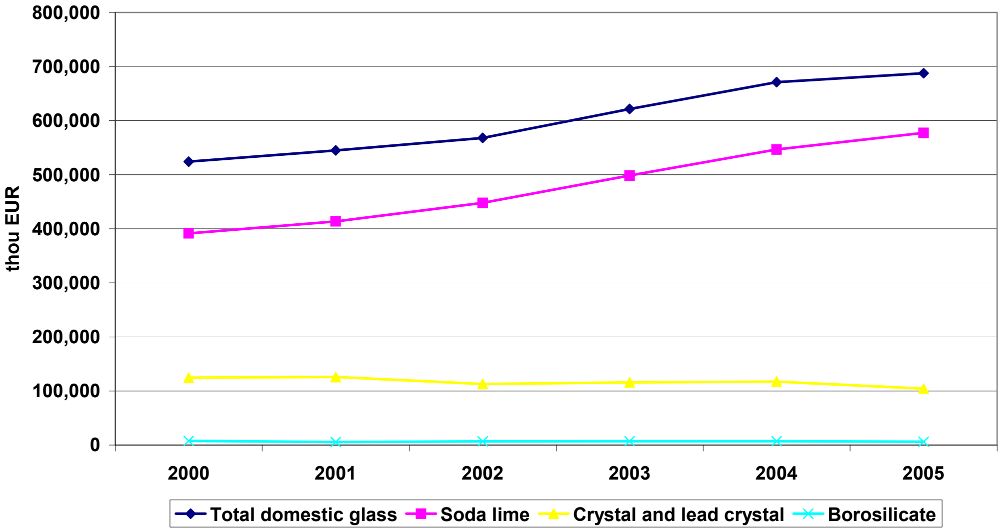


Source: CPIV

The development in the value of domestic glass imports to Europe over the period 2000 to 2005 is illustrated below.

Graph 40:

Import of domestic glass products in EU25, thou EUR, current prices



Source: CPIV

Imports are rising steadily mainly because of trade with Far East Asia. In 2005, extra-EU25 imports increased by 4.7% to 415,671 tonnes, with a very strong growth from Far East Asia (+ 24%), and China in particular (+ 41%). As it can be seen from the table 23, imports from Turkey and China are dominant, comprising 79% of total imports of glass tableware into the EU.

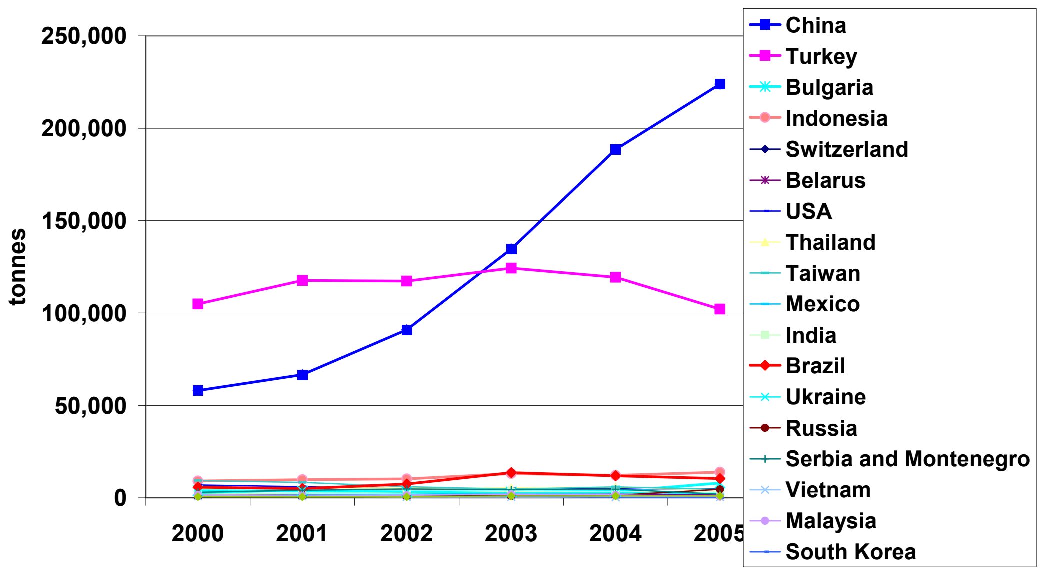
Table 23: **Extra EU25 imports of tableware and total glass products in 2005[56], tonnes**

	Tableware	Total glass
2004	397,270	2,163,119
2005	415,671	2,356,619
EU main competitors (2005)		
Far East Asia	252,609	1,003,800
Including China	227,422	694,064
Taiwan	4,486	40,689
South Korea	84	38,270
Rest of Europe	137,066	877,223
Including Turkey	102,030	276,095
Croatia	304	61,339
Russia	4,587	48,352
USA	4,742	194,841
Others	21,254	280,755
Total	415,671	2,356,619
Total in thou EUR		
2004	677,182	2,984,822
2005	697,334	3,211,152

Source: CPIV

Imports from separate countries in tonnage and value is shown below. Both in terms of tonnage and value, China and Turkey are the leading importers.

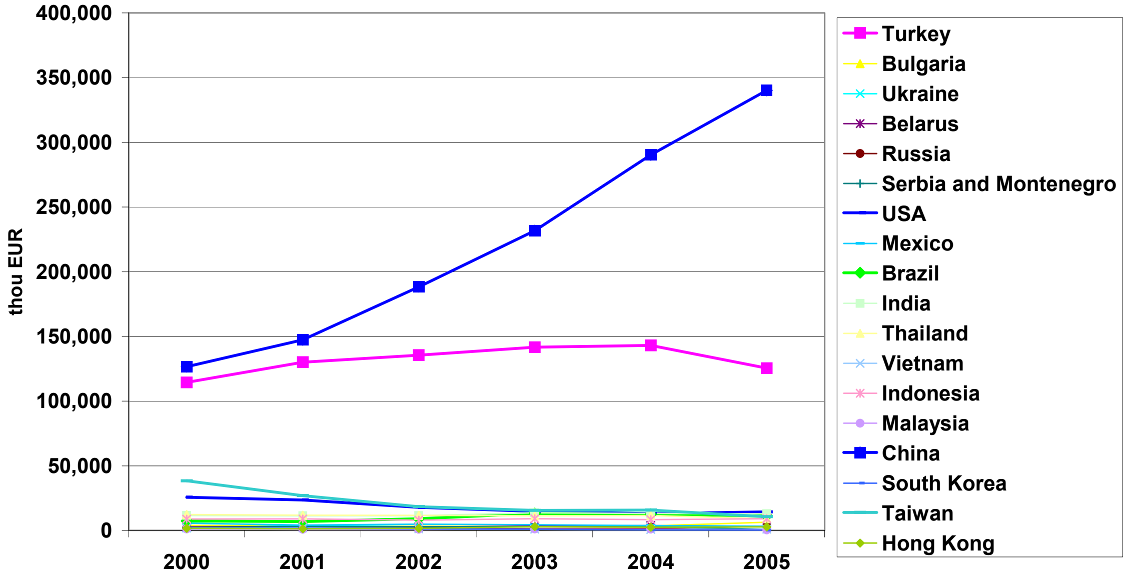
Graph 41: **Import of domestic glass products into EU25 by countries, tonnes**



Source: CPIV

[56] CPIV "Joint Meeting, European Comission CPIV Brussels 27 June 2006

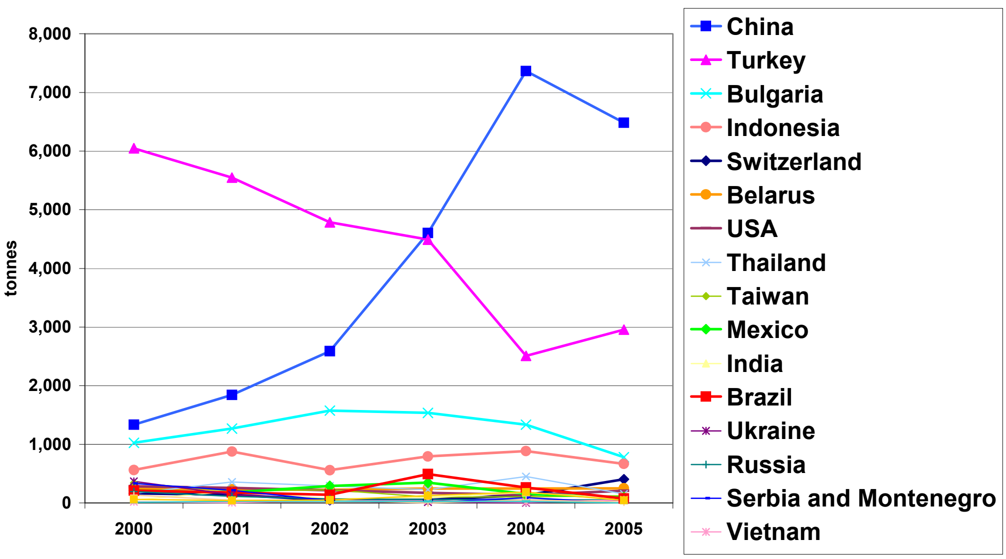
Graph 42: **Import of domestic glass products into EU25 by source country, 1000 EUR, current prices**



Source: CPIV

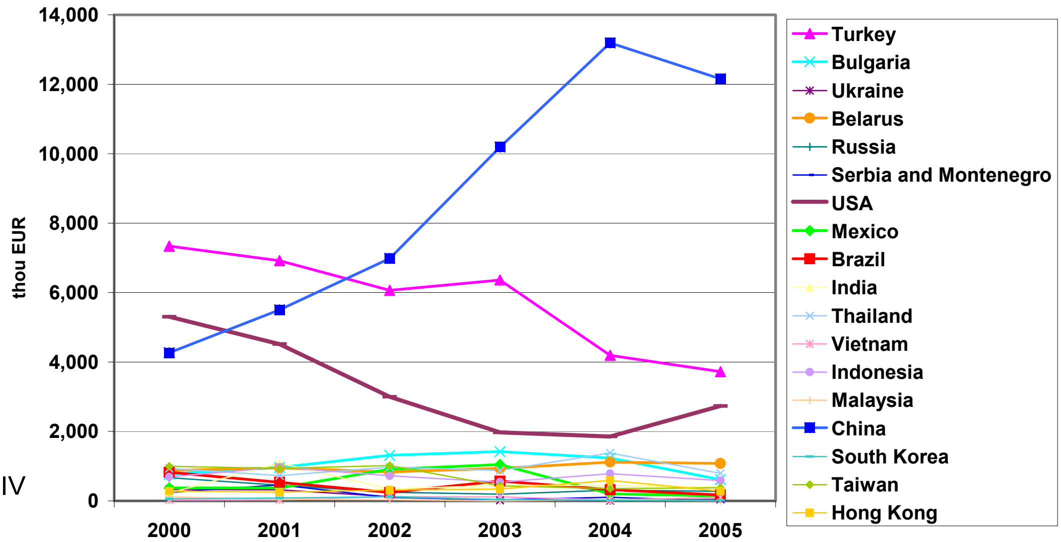
The major increases in domestic glass imports shown above are related to soda-lime products as can be seen in graphs 39 and 40. Imports of other categories of domestic glass products (i.e. crystal) were at a more or less stable position in terms of tonnage, except of crystal imports from China, as shown in graph 43 below.

Graph 43: **Import of crystal glass products into EU25 by source country (tonnes)**



Source: CPIV

Graph 44: **Import of crystal glass products into EU25 by countries, 1000 EUR**



Source: CPIV

Exports

In general, EU glass manufacturers export to the countries neighbouring the EU. For example, exports to Russia comprise almost 10% of total EU export of domestic glass. However, higher value added products, such as some crystal items and perfume containers, are sold further a field, mainly to countries such as the USA and United Arab Emirates.

The USA has traditionally been one of the most important extra EU export markets for EU domestic glass producers. EU crystal producers export some 50% of their output to the USA. Such exports amounted to 25% of total extra EU export in 2005.

In 2005, extra-EU25 exports of domestic glass fell by 3.2% (to 382,552 tonnes), including falling sales to the USA (- 10%) and the Far East Asia (- 18%).

Major numbers on glass tableware and total glass exports are provided below.

Table 24:

Extra EU25 exports of tableware and total glass products in 2005[57], tonnes

	Tableware	Total glass
2004	395,200	3,315,956
2005	382,552	3,184,151
EU main competitors (2005)		
Far East Asia	37,506	213,458
Including China	3,948	42,536
Taiwan	1,781	8,199
South Korea	2,751	43,309
Rest of Europe	105,663	1,713,971
Including Turkey	11,238	130,199
Croatia	5,07	80,985
Russia	37,47	427,019
USA	96,566	371,449
Others	142,817	885,273
Total	382,552	3,184,151
Total in thou EUR		
2004	1,424,096	5,487,714
2005	1,318,401	5,487,823

Source: CPIV

Changes in exports in different EU countries are provided in the following graph.

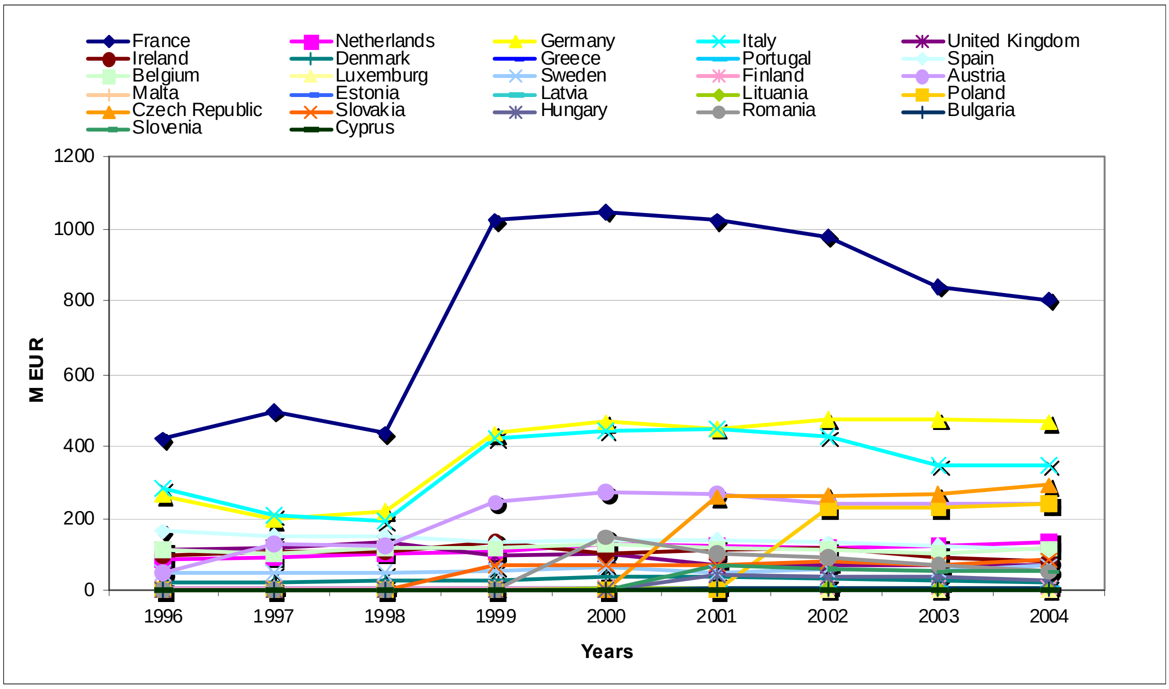
The graphs above illustrate the difficult trading conditions world-wide with a very strong European currency, fierce competition from Asia (Near and Far East), and a difficult US market.

EU domestic glass producers compete against each other in both domestic and export markets in all market segments. In the high price segment the fact that a product is European and is of high quality and expensive is a competitive advantage. The segment uses this to differentiate itself from similar segments in the rest of the world.

Lower price domestic glass products face heavy competition on many fronts. Inside Europe, the Eastern European producers (e.g. in Bulgaria) match the quality of domestic glassmakers in Western Europe, while having lower salary levels and cheaper production costs. Products in the middle price market segment are likewise produced in Asia where wages are even lower than in Eastern Europe. This adds pressure to the market segment.

[57] CPIV "Joint Meeting, European Comission CPIV Brussels 27 June 2006

Graph 45: **Export of all glass products in EU member countries, M EUR (fixed prices, 2005 level)**



Source: Eurostat

According to the International Crystal Federation (ICF), in some countries, the production of low value added soda lime glass products is no longer viable and only manufacturers of the higher value added crystal products remain. In the UK, for instance, a number of companies have closed in recent years and only a small amount of crystal production remains. It is considered that the success of the main large producers may overshadow a decline in the rest of domestic glass sector.

European producers are attempting to compete against these pressures by offering the consumers a "total tableware deal" (i.e. one stop shopping). Producers design large series of products, which interact and tell the same story. Brands are built to distinguish themselves from competitors who cannot offer equivalently wide product ranges or front line design.

Substituting products

Substituting products are items that have a similar purpose to domestic glass items, but are made of different materials. Examples are drinking glasses made from plastic and candleholders made from aluminium. The range of substituting products for decorative items can also be very wide. These products put pressure on the domestic glass sub-sector due to the influence of consumer trends on the market.

Entry barriers

Possibilities for outsourcing[58] have significantly changed the entry barriers to the domestic glass industry. Previously, large initial investments in furnaces and other production facilities had to be made in order to start up production. Such initial investments are not an absolute requirement today as production can be outsourced to places such as Asia[59]. However, a deep understanding of the product in combination with skills within design and marketing, as well as skills in the field of project and process management are still required.

Interestingly, there is a reverse movement with regards to outsourcing of production. It has become evident that outsourcing requires tight control and administration. Large overhead costs associated with outsourcing have made the overseas production more expensive than initially anticipated. This has led to some producers moving production back to the mother company site[60].

6.4.6 Main findings of glass sector economic overview

- The terminology in the whole glass industry is not unified, which makes analysis of domestic glass sector difficult.
- The domestic glass sector is one of the smaller sectors of the glass industry forming approximately 4% of the total output.
- In contrast to other glass sub-sectors, the domestic glass sub-sector does not have a significant impact on other industries.
- The EU is a dominant player within the crystal glass segment of the global domestic glass production. 85% of all the crystal produced in the world is produced in the European Union
- In 2005, the EU25 produced approximately EUR 1.5 billion of domestic glass.
- Approximately 150 to 200 companies operate in the domestic glass sub-sector in EU25. 40 to 50 out of these fall under the IPPC Directive.
- Data on investments in the <u>domestic</u> glass industry is not available
- The cost of labour is the most important production factor, with an average of 30% of the total production cost for glass, and even above 50% for high quality hand-made glass items
- The domestic glass sub-sector currently employs 30,000 to 40,000 employees.
- Raw materials form approximately 20% of the total cost of domestic glass production.
- Energy forms approximately 7% to 20% of the total cost of production depending on the type of glass produced.
- Raw materials, capital costs and transport costs are also very important cost items.
- Marketing costs, especially in the crystal products segment, can be as significant as production costs.
- Detailed statistics relating specifically to the household consumption of domestic glass in the EU are not available.

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58 Outsourcing refers to EU producers contracting companies abroad to perform licence production which is purchased back and sold as the EU producers “own“ production. Outsourcing does thus not imply an investment in production capacity abroad. This also implies that a designer of glass can contract a company to produce a range of products, hereby avoiding an initial investment to entry the market.

59 Interview with representative of installation within the glass industry

60 Interview with representative of installation within the glass industry

- Domestic glass consumption is impacted by the increasingly rapid shifts in consumer preferences and trends. This is in particular the case for crystal glass.
- Extra EU imports of tableware exceeded extra EU exports in 2005
- The import trade is steadily growing mainly because of trade with Far East Asia
- Imports from China are dominant and increase at a very high rate
- Increasing imports of domestic glass products are based on increasing imports of soda-lime category of glass. Imports of the the remaining products (i.e. crystal and borosilicate) have been stable in recent years.
- EU producers seem to lag behind Asian competitors in relation to the flexible production.
- The success of certain main domestic glass producers diversifying their products may be overshadowing a decline in the rest of domestic glass sector.

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PART III: Case studies for electric steel and domestic glass

The analysis of the data collected in the survey among electric steel and domestic glass producers follows two different research avenues. In domestic glassmaking the available survey data was classified according to whether the respondents themselves reported a competitiveness impact from IPPC implementation. This self-estimation was cross-checked with other data provided by the respondents in order to make sure that this self-estimation was plausible. Furthermore, the data was analysed by product group and not by country of origin of the respondents. Since in 14 of the 17 cases in domestic glass making there was only one observation per country, there would have been confidentiality problems involved in a country approach. However, this implies that – other than in the steel case -no particular focus on the institutional context could be provided. Still, the data quality in the domestic glass industry was sufficient to draw conclusions on the impact of IPPC implementation on competitiveness of different product categories in the sample.

To some extent, an analysis of survey data by country was possible in the electric steel case sudy. A stronger link with the institutional context of environmental regulation could therefore be provided. In addition, the case study is largely qualitative by nature and inspired by face-to-face interviews. Other than in the domestic glass study, a grouping according to economic categories like markets or products was less straightforward since there was too much diversity in the sample. Despite of this, confidentiality at the plant level was guaranteed, meaning that a country analysis will be provided in a way that no single installation can be recognised. Missing information is – wherever possible – filled in from the existing literature and face-to-face interviews with both managers and regulators.

7 Analysis of survey and interview data for electric steelmaking steel sample

7.1 Introduction

This case study examines potential competitiveness impacts arising from differences in implementation of the IPPC Directive for electric steel producers both within the EU and as far as possible in relation to non-EU competitors. In a survey and through site visits responses from a sample of 25 electric steel mills could be gained on the topic. Other than in the case study on domestic glass where due to data limitations no analysis by country could be undertaken, it was possible in the steelmaking survey to undertake broader data comparisons for Luxembourg, Germany and Spain for a sample of 19 electric steel producers. However, the entire sample including the sample sites from Belgium, France, Italy, Poland and the UK, will also be analysed in a predominantly qualitative way. Thus, for Luxembourg, Germany and Spain differences in implementation approaches as well as different competitive conditions can be analysed on a country basis. The country approach also allows for a closer link of the case study data to the analysis on the institutional level presented in chapter 4 of this report.

As in the Hitchens study the starting point for our analysis is that both positive and negative impacts arising from IPPC implementation on competitiveness are to be expected. The extent of these effects will largely depend on the competitiveness situation of the electric steelmaking industry as well as on the pace of implementation imposed on the firms by their respective permitting authorities and the overall institutional context. The corresponding research approach and the hypotheses tested in the electric steel case study are presented in the section 7.1.1 below. Section 7.1.2 contains an overview of the sample. The following chapter 7.2 provides an analysis which is refined step by step. First of all, a discussion of plant specific factors potentially influencing the relationship between competitiveness and IPPC implementation is undertaken. This is followed by a more refined analysis of individual cases and a closer look on the impact of IPPC vs. other regulatory and economic factors of influence. Chapter 7.3 analyses in more detail institutional and country specific factors in the implementation of IPPC and their link to competitiveness.

7.1.1 Research method and hypotheses

Other than in the case study on domestic glass presented in chapter 8 of this study which follows a matched plant approach including a quantitative analysis, in the electric steel case study a careful, mainly qualitative case-by-case research method is applied. This is due to the fact that both the quantity and the data quality of the returned sample questionnaires was not sufficient to carry out any statistical analysis.

This chapter tries to develop a more integrated perspective by merging insights from the institutional analysis of chapter 4 with this micro level assessment based on a sector specific survey and stakeholder interviews.[61] As explained in chapter 4 the institutional analysis is not sufficient by itself (since data are not always up-to-date, not based on case study evidence and not sector specific etc., see chapter 4). To explore the linkages between micro level and institutional analysis we repeat in box 3 the hypotheses pretested in chapter 2 trying to find out whether they can be confirmed or whether they need to be qualified in any way.

[61] This is an important step going beyond the Hitchens study which is tackled in a qualitative way merging survey data and results from interviews with regulators and managers.

Box 3: **Hypotheses on the institutional context influencing economically efficient implementation of the IPPCD**

(1) The more similar the pre-IPPC country regime is to the new IPPC regime the less potential influence on competitiveness from the new IPPC regime.

(2) A clear distribution of competencies without frictions and proper co-ordination among CA is less likely to impose a burden on companies subject to permitting and is also less likely to affect competitiveness negatively. Moreover, a high level of professionalism, integrity and training is less likely to lead to unequal treatment and competitive distortions.

(3) The impact of permitting on costs and effort of the operator (and eventually plant competitiveness) is the less important

a. the lower the level of stringency and the more transparent and coherent the relevant regulatory requirements

b. the less strict the enforcement regime and the less frequent the number of inspections

c. the faster the permitting process and the more co-operative the relationship to CA

d. the higher the consistency in the permitting and enforcement approach (i.e with regard to the above elements) from one site/region/country to the next (e.g. same level of ELV for “identical” process in “identical” plant in neighbouring region).

Source: Ifo Institute, 2006.

7.1.2 General overview of the sample

This section gives an overview of the full sample concerning sample size and geographical distribution of sample sites, size bands of sample sites, range of products, type of furnaces used in the sample and extent of IPPC permitting.

A total of 120 sites distributed across the EU were targeted in the survey in early May 2006 (see table 25). This population covers all electric steel producers falling under the IPPC Directive and was compiled from the Handbook of the European Steelworks 2005. Almost all questionnaires were sent out electronically to the environmental managers of the sites, only a few were sent by regular mail because no specific addressee could be identified.

The survey was also supported by EUROFER and to a varying extent by several national steel associations (e.g. Belgium, France, Germany, Poland, UK and eventually Spain). A few plants were contacted by the national associations themselves. Unfortunately Italy and Sweden did not want to participate in the study.[62]

Table 25: **Distribution of sites included in electric steelmaking survey**

Country	**Sites for electric steelmaking**
Belgium	5
France	19 (less than 19)
Germany	20 (17)*
Italy	27 (1)*
Luxembourg	3
Poland	9 (7)*
Portugal	1
Spain	21 (10)*
Sweden	8 (0)*
UK	7 (3)*
Total	120

* If the number of operators contacted by national steel associations differs from the number of operators originally identified and contacted, this is indicated in brackets. It remains unclear to which degree an intentional preselection of the participating sites has taken place. Any changes of the number of total available sites between 2005 and 2006 could not be taken into account.

Despite reminders by telephone the response rate to the survey was very low until end of June 2006. Therefore, a change in the data collection strategy took place. During further reminding phone calls the managers of the sites were asked whether it was possible to visit them and fill in the questionnaire in face-to-face interviews. This way of approaching the electric steelmaking sites was quite successful and altogether 10 interviews with information on 13 sites could be conducted. In parallel, 12 additional questionnaires were directly sent back without interview. Thus, the final sample consisted of 25 questionnaires which results in a response rate of 21% to the survey.

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[62] Eventually one Italian plant decided to participate in the study which is not a member of the Italian steel association.

The data received in the questionnaires was of varying quality. While most of the 10 face-to-face interviews guaranteed full coverage of all survey questions and additional qualitative information on particular IPPC implementation issues and companies´ environmental management, several of the questionnaires sent back via email or on the postal way were not well filled in. Although confidentiality was assured by the consultants, some plants refused to give any economic data. It was tried to fill these gaps with more general information quoted from the available literature.

As is shown in table 26 below the response to the survey was highest in Germany and Spain with 6 and 10 questionnaires respectively. Three of these German questionnaires were filled out in face-to-face interviews. In Spain all ten sites had sent back the questionnaire electronically. In addition two of the Spanish sites were visited. Also, two British sites were visited and the questionnaire was filled out in an interview. Moreover, data for three sites situated in Luxembourg was collected and there was also an interview where further information on these sites was given by the survey respondent. From Belgium, France, Italy and Poland only one site each replied. Both in Belgium and France the data was collected in a face-to-face interview.

Table 26: **Distribution of sample sites by country**

Country	**Sites for electric steelmaking**
Belgium	1 (interview)
France	1 (interview)
Luxembourg	3 (during 1 interview)
Germany	6 (of which 3 interviews)
Italy	1
Poland	1
Spain	10 (of which 2 interviews)
UK	2 (both interviews)
Total	25 (of which 10 interviews)

Size distribution of sample plants

Electric arc furnaces vary greatly in size. In the EU, according to Quass et al. (2005), there is a relatively large number of small plants with a capacity below 200.000 tonnes per year. Simultaneously, there are also many larger sites with a capacity of 500-600.000 tonnes per year. To some extent this is also reflected in the size distribution of the sample studied here (see table 27 below).

Table 27: **Size distribution of sample, nominal capacity measured in tonnes per year**

Location/Size	Small (< 200.000 tonnes of steel p.a.)	Medium (200.000 – < 500.000 tonnes of steel p.a.)	Large (500.000 + tonnes of steel p.a.)	Total Number of Plants
Total	6	3	16	25

Products sampled

In the survey questionnaire plants were asked to give a breakdown of their product range. A distinction was made by the amount of alloying elements (EN 10020 "Definition and Classification of Types of Steel") and end products. In table 28 below it is shown that altogether 22 sample plants produced non alloy steels, three plants produced stainless steel and in nine plants other alloy steels were produced. Concerning end products there was a strong dominance of long products. The detail by product and country is as follows:

There was a total of 15 exclusive producers of non alloy steels: All these sites produced low value added long products. The other sites had a mixed production program of non-alloy, other alloy and some with stainless steel. There were three sites which produced stainless steel amongst other products. Eight sites produced other alloy steels next to a variety of non-alloy steel qualities and one site produced alloy steels only.

Concerning end products it is shown that, as expected, in 24 sites long products were produced and only in 3 sites flat products. The majority of the plants producing long products did this in a low value added quality. The attempt to carry out a product classification according to differences in value added turned out to be difficult since no unequivocal way of classifying products as low or high value added products was possible (subjective ranking etc.). Only two sites produced flat products and in only one of them the share of this segment was larger than 30% of production.

Table 28: **Overview of production programme in the full sample**

Production Programme (as% of Production)	No. of producing plants	No. of plants for which segment represents more than 30% of production
Alloying elements and quality		
Non alloy steels	22	20
Quality steels	7	
Special steels	6	
Stainless steels	3	2
Other alloy steels	9	6
alloy quality steels	5	
alloy special steels	6	
End product		
Long products	24	23
Low VA	17	
High VA	5	
Flat products	2	1

Type of furnace

Considering the type of furnaces there is a clear homogeneity for the entire sample sites irrespective of country of origin being the single shell furnace the most widely used. There are also four EBT furnaces, two twin shells, one double shaft and one finger shaft.

Extent of IPPC permitting

In the entire sample of electric steel producers 17 sites already had an IPPC permit in place, six had applied for it and two planned to apply in the near future (see table 29 below).

In most countries having a pre-IPPC regime similar to the spirit of IPPCD the existing permits have not been entirely renewed, but only modified whenever substantial changes occurred (Germany, France, Luxembourg). Typically the last major modification requiring the review of the permits took place during the last ten years. In the UK a complete review of the permits of existing installations took place (with typically minor changes to the previous IPPC regime). In Spain and Italy more far reaching adaptations were necessary given the need for a complete restructuring of the previous national permitting regime. During our empirical survey we found that many applications especially in Italy and Poland are currently processed by authorities, but permits will not be granted until some time in 2007.

Table 29: **Extent of IPPC permitting in the electric steel sample**

State of IPPC permitting	IPPC permits in place	Application is processed by authorities	Will apply in the near future	Total
Belgium	1 (reviewed)			1
France	1 (reviewed)			1
Italy	1 (new)			1
Luxembourg	3 (all reviewed)	0	0	3
Germany	6 (all reviewed)	0	0	6
Poland		1		1
Spain	3 (of which 2 reviewed; in one case n.a.)	5	2	10
UK	2 (1 new; 1 reviewed)			
Total	17	6	2	25

It goes without saying that to be able to conduct an impact assessment it is not only the extent of IPPC permitting, but the amount of changes due to the implementation requirements of the IPPCD that is of interest (see the three stages discussed in chapter 2 and the further analysis in this chapter).

7.2 Analysis of plant specific factors potentially influencing the relationship between competitiveness and IPPC implementation

In this section technical and economic factors potentially influencing the relationship between competitiveness and IPPC implementation are analysed. First of all, input and output measures of competitive performance are presented and linked to the self-perceived overall impact of the respondents of IPPC implementation on profit.[63] Furthermore it is analysed whether there is a correlation between the type of competition (price competition, quality competition, etc.) and the self-perceived impact on competitiveness.

7.2.1 Input and output measures of competitive performance and their relationship with IPPC implementation – some broader comparisons

This section aims at giving an overview of technical and economic characteristics of the electric steelmaking sample which may have an influence on the relationship between competitiveness and IPPC implementation. Taking the respondents´ perceived possible impact of IPPC on competitiveness as a starting point input and output measures are tracked back helping us to explain this general self-estimation. Overall, five out of the 25 sites reported a decrease in profit due to IPPC, 11 reported no impact on profit and the remaining did not answer the question.

On the input side we propose to examine the impact of furnace age and modernisation as well as furnace size. Due to data limitations various other input factors could not be used for a more profound analysis (e.g. expenditures for research and development). On the output side we suggest to use export shares, plant growth as well as physical productivity as explanatory factors. There was not sufficient data to analyse the role of turnover and profitability on a site level. Moreover, the analysis of the type of competition found in the electric steel sample is also presented in this section. Whilst the type of competition is not an economic performance indicator itself, it is an important measure of the economic environment of sites and is clearly related to competitiveness issues.

While incomplete, this is a first step of analysis. A more fine grained analysis of individual cases will follow in section 7.2.2 and 7.2.3.

Input measures

Although there is a great variety of individual start-up years and plant/furnace age in the sample, the consideration of the updating dates shows a high degree of similarity for all sample sites irrespective of location (see table 30 below). Sample sites in Germany and Spain show a wider range of start up years, while furnaces in the sample sites in Luxembourg originate from the nineties. The Spanish sample plants show the widest range in start-up dates with furnaces from 1955 until 2004 in place, while the German sample shows a distribution of start-up years from 1974 to 1994. All furnaces in the sample sites in Germany, Luxembourg and Spain have been updated in the period 2001-2003. Also most sites in the other five Member States covered by the survey had furnaces in place which were on average updated 7 years ago.

Given that the average lifespan of a furnace is about 20 years, the sample mainly consists of updated and modern producers which is not only an aspect facilitating efficient and profitable production, but is also likely to be a favourable factor for environmental performance. This would be the case because modern machinery is likely to incorporate BAT either through retrofitting or complete rebuild. However, the rebuild date of a furnace could contain a variety of

[63] Other indicators describing the potential “overall” impact of IPPC implementation on competitiveness like BAT costs as percentage of product price were not available in sufficient quantity to be used for the analysis. As can be seen in chapter 8 this criterion of a self-reported competitiveness impact arising from IPPC implementation was the cornerstone for the entire analysis of the domestic glass survey data. In the sample of electric steelmaking it is one piece of the analysis given the constraints explained in the introduction of this chapter (see 7.1 above).

items from change of pieces of equipment to complete rebuild. This is a limitation of the age indicator presented here (see also section 7.2.2).

Table 30: **Technical data for sample sites**

Technical Indicator	Luxembourg, 3 sites, all IPPC	Germany, 6 sites, all IPPC	Spain 10 sites of which 3 IPPC 5 applied 2 not yet applied	Other Member States, 6 sites of which 5 IPPC 1 applied	All sample sites, n=25
Average number of years after start-up	25 (Range of dates: 1993-1997)	11 (Range of dates: 1974-1994)	11 (Range of dates: 1955-2004)	22 (Range of dates: 1970-2006)	20
Average number of years after last update	5	3	3 (considering 7 plants)	7	5
Furnace size (average melting capacity in 1000 tonnes per year)	1167	632	593	662	712

Table 30 above shows that furnace size measured as the average nominal capacity in 1000 tonnes per year is higher in the sites in Luxembourg than in the German and Spanish sample plants as well as in the sites of the other Member States contributing to the survey.

Each of the three sites in Luxembourg had one furnace with a capacity around or higher than 1 Mill. tonnes per year installed. Both in the German and Spanish sample sites there was a much higher degree of variation in capacity which explains the lower average melting capacity there. E.g. only two sites in Germany and three in Spain had a nominal melting capacity higher than 1 Mill. tonnes. Still, also the smaller sites in Germany were able to comply with strict environmental regulation already prior to IPPC.

With respect to the six sites in other Member States covered by the sample only one site has a nominal melting capacity higher than 1 Mill. tonnes. The other five sites are either small or medium sized.

There was no particular relationship between furnace size and the reporting of a negative impact on profitability arising from IPPC implementation. Among the sample plants complaining about this, there were sites having both small and large furnaces.

Output measures

In the questionnaire sites were asked to give data on the destination of their sales. Overall, only a few sites in the entire sample are strong international exporters. Several sample sites in Luxembourg and Spain export to international markets, whilst German sample sites hardly export to international destinations. The reasons for this is to be found in the type of products, e.g. five sites in Spain produced steel shapes which are directly exported internationally. German sample sites only exported to European markets. However, downstream users of crude steel products which are closely related to the melt shop are sometimes also present on international markets. In the other five Member States covered by the survey two sample sites mainly produced for the national market, one for the European market and only one made a large part of its turnover with international exports (see details in table 31).

Three of the Spanish sample sites which exported their products to a large extent to international customers outside the EU reported a negative (not quantified) impact on their profit margin due to implementation of the IPPCD. This would be mainly because they compete on their export markets with competitors from third countries where environmental regulation is more lenient and causes lower environmental costs. Two sites located in other Member States of the sample also claimed a fall on profitability caused by IPPC. However, these sites did not export internationally and hardly on a European level.

Plant growth was measured as change in employment and as change in production volumes between 2000 and 2005. The overall growth rate of employment for the entire sample was 4.5%. On average, the sites in Spain have experienced the highest average growth rate of employment of 5.8% during the years 2000 until 2005. Still, there were four Spanish cases where the level of employment had decreased, with two very small decreases and two being more notable. Two of these Spanish sample sites experiencing a loss in employment simultaneously were strong international exporters and as reported above claimed a negative impact on competitiveness arising from IPPC implementation.

The sites in Luxembourg have on average lost 11.6% of employment, whilst the German sites maintained on average a stable employment with two sites having an increase in employment and two others a loss. However, despite the employment losses which could be a sign for negative business development, no impact on competitiveness arising from IPPC implementation could be traced for the sites in Luxembourg. In Germany one of the sites experiencing a decrease in employment, also reported a negative impact from IPPC implementation on its profit level. Data on employment growth was only available for four of the six remaining sites situated in five other Member States. In these sites there was either a stagnant development (one case) or strong employment increase (three cases) accounting for an average growth rate of employment of 18.5%.

Concerning growth of production volume the German sample plants show with 21.6% the highest growth rate followed by the Spanish sample sites with about 15%. Production declined in the sites in Luxembourg.

Productivity and productivity growth rates were measured in tonnes per hour (also called furnace productivity).

Average furnace productivity in 2005 was 58.8 tonnes per hour in the German sample, 130.7 in the three sites in Luxembourg and 114.0 in the Spanish sample. This variation of productivity levels mirrors in part the composition of the sample by size of furnace, energy price and availability and the use of various EAF technologies (e.g. oxy-fuel burners, oxygen lancing/carbon/lime injection/foamy slag practice). In Luxembourg there are only large sites with high productivity. In Spain all sites irrespective of size show a high level of productivity and one third of the German sample consists of small sites and relatively low productivity levels. Three of the remaining six sites showed relatively high productivity levels reaching the average level of the sites in Luxembourg and Spain. In one site with a special quality product productivity was low. No other data was provided. Average growth of furnace productivity was 6.7% for the German sites. Four sites had a positive growth rate and 2 sites had a negative growth rate. In the three sites in Luxembourg there was on average a loss of furnace productivity of 0.31%. Two of the sites in Luxembourg had a loss in productivity and in one site it slightly increased. The average growth rate of furnace productivity was 12.1% in Spain. This rate was composed of several strong increases in productivity as well as slight decreases (two cases) and no growth in another two cases. One case of a positive growth rate of furnace productivity was reported in the other six sample sites. Five sites did not provide any data on this issue. Overall, there was no particular link in the entire sample between the development of furnace productivity and any reported negative impact on competitiveness arising from IPPC.

Table 31: **Basic economic data of the electric steelmaking sample**

(numbers in brackets indicate the number of observations)

Economic indicator	Luxembourg, 3 sites, all IPPC	Germany, 6 sites, all IPPC	Spain 10 sites of which 3 IPPC 4 applied 3 not yet applied	Other Member States, 6 sites of which 5 IPPC 1 applied	Average entire sample
EU export quota, in % of turnover[1]	84.6 (3)	31.2 (4)	14.5 (10)	38.8 (4)	40.1 (21)
International export quota, in % of turnover[1]	15.3 (3)	< 5 (1)	12.7 (10)	30.0 (4)	14.5 (18)
Average employment growth, 2000-2005, in %	- 11.6 (3)	-0.25 (4)	5.8 (10)	18.5 (4)	4.5 (21)
Average growth of production, 2000-2005, in %	- 18.3 (3)	21.6 (6)	15.2 (10)	6.7 (3)	13.6 (22)
Average furnace productivity in 2005, tonnes/h	130.7 (3)	58.8 (6)	114.0 (9)	98.0 (4)	98.4 (22)
Growth rate of furnace productivity, 2000-2005, in %	- 0.31 (3)	6.7 (6)	12.1 (9)	Positive (only 1 observation)	8.4 (18)

[1] Note that downstream users of crude steel are present on international markets and often part of the same company as the melt shop.

Measures of the type of competition

Cost pressures do not necessarily affect competitiveness of electric steel plants, whenever costs can be passed on to customers in downstream markets or imposed on suppliers in upstream markets. While this depends eventually on the price elasticity of demand for various steel qualities we hypothesize that plants primarily competing on price are likely to be more vulnerable to an environmental cost increase than other plants being able to distinguish themselves by not directly price related factors (innovation rents, quality premiums, etc.)

In the survey questionnaire electric steel sites were asked to characterise the type of competition they faced in their markets and to rank the importance of the individual factors.

The three sites in Luxembourg all stated that price was the single most important parameter for their entire production programme. Given the importance of specific engineering know-how for their market segment the sites have a relatively strong bargaining position towards their suppliers and buyers, however.

The German sites were to a larger extent able to charge quality premiums for their products than the plants in Luxembourg. Five of the six sites ranked this to be true. Three sites indicated that they were operating in high quality segments of the industry. Only one German site exclusively competed on price and could not charge any quality premiums at all. Yet, during an interview at this site managers indicated that prompt delivery service and customer orientation was an advantage that cannot be easily copied by non-EU competitors. This additional factor was also mentioned by another German plant. Also the German sites reported to have a strong bargaining position towards their suppliers and buyers. This was also the case in the sites in Luxembourg, but not at all in the Spanish sites. German sites also gave on average a higher ranking to their flexibility and their ability to offer a large variety of products tailored to the needs of their customers. This was not as evident in the sample sites in Luxembourg and Spain.

In the Spanish sites it was in 8 cases clearly indicated that price was the most important parameter of their competitive environment and in two cases price was estimated to be an important indicator. Moreover, there was hardly any possibility for the Spanish sites to achieve quality premiums. Nor were there signs of a strong bargaining position vis-à-vis their suppliers and customers. In two of the cases where sample sites perceived a decrease in profits arising from IPPC implementation, there was exclusive price competition and no chance at all to achieve any quality premiums.

From the remaining six sample sites in the other five Member States covered by the survey two sites stressed that they compete on price with respect to their entire production programme. Still, one of these sites reported to be able to charge quality premiums to some extent. Only one site clearly stated that it was able to charge quality premiums for its products. Half of the sample sites in these Member States strongly denied this, but stressed that their main competitive strength was derived from their flexibility and their ability to produce a large variety of products tailored to the needs of their customers. One of the two sites reporting a decrease in profit due to IPPC implementation clearly competed on price only. However, the other site reporting a detrimental impact on competitiveness was able to charge quality premiums, had a relatively strong bargaining position towards its suppliers and buyers and seemed to be very flexible.

Although the picture is mixed on the role of price competition for the sample as a whole, the majority of those sample sites reporting a detrimental impact on their profit margins due to IPPC were clearly competing on price. This would in part explain why certain plants are more vulnerable to increases of environmental costs. Still, the question remains by how much IPPC increases environmental costs and overall costs.

Instead of distinguishing the above measures of the type of competition purely on a country by country basis it is also possible to distinguish by broad product categories. This reveals that producers of plain carbon steel usually have to face fierce price competition. This is more strongly the case in Poland and Spain than in Germany, Luxembourg and the UK because the latter carbon producers operate in a higher quality segment and hold a good reputation among customers (especially in Germany and Luxembourg).

Summary of findings

Overall, the up-to-date machinery found in the sample seems to be a factor which facilitates the economically efficient adoption of BAT and environmental performance. By contrast, there was no particular relationship between furnace size and the reporting of a negative impact on profitability arising from IPPC implementation.

Furthermore, there was no clear link between the available economic performance indicators found in the sample and any negative competitiveness impacts arising from IPPC implementation. The most obvious hint for a reported detrimental effect arising from IPPC regulation was found for some sample sites which are strong international exporters. These sites strongly compete with third countries where environmental costs are lower than in the EU (see also section 7.2.3 on the relative position of environmental costs pressure among other pressures) and therefore suffer from a cost disadvantage. In a few cases, sites which experienced a loss in plant growth, also reported losses in competitiveness due to IPPC. Among these sites were again two Spanish sites which were major exporters of steel shapes. However, there were also cases in the sample where a decrease in employment level was not accompanied by a perceived loss in competitiveness due to IPPC. Probably due to measurement problems no clear evidence on the role of labour productivity could be gained.

The results presented so far clearly show the desirability of an internally consistent explanatory framework. Within such a framework one could construct a counterfactual situation representing a non-IPPC world, work out causalities between IPPC implementation and competitiveness and control for other exogenous factors. In absence of a fully consistent model capable of controlling for factors like plant size, location, product segment etc. it may be more useful to carefully work one’s way backward. Having observed a diversity of outcomes among a set of plants, one may ask, whether characteristics of the sites can be linked to IPPC implementation or other “events” that happened at an earlier time. Therefore in the next sections more case specific evidence will be presented.

7.2.2 Intermediate measures approximating the impact of IPPC implementation on competitiveness

In the literature, the degree of environmental stringency is commonly perceived as the single most important influential factor on the competitive position of regulated companies (see chapter 3). Some empirical results have already been presented in chapter 4. A sector and/or case specific approach, however, is necessary to substantiate this finding within the electric steel case study. Therefore, in this section, we present the available survey material on past, present and future emission limit values for selected pollutants. Furthermore, a global picture of

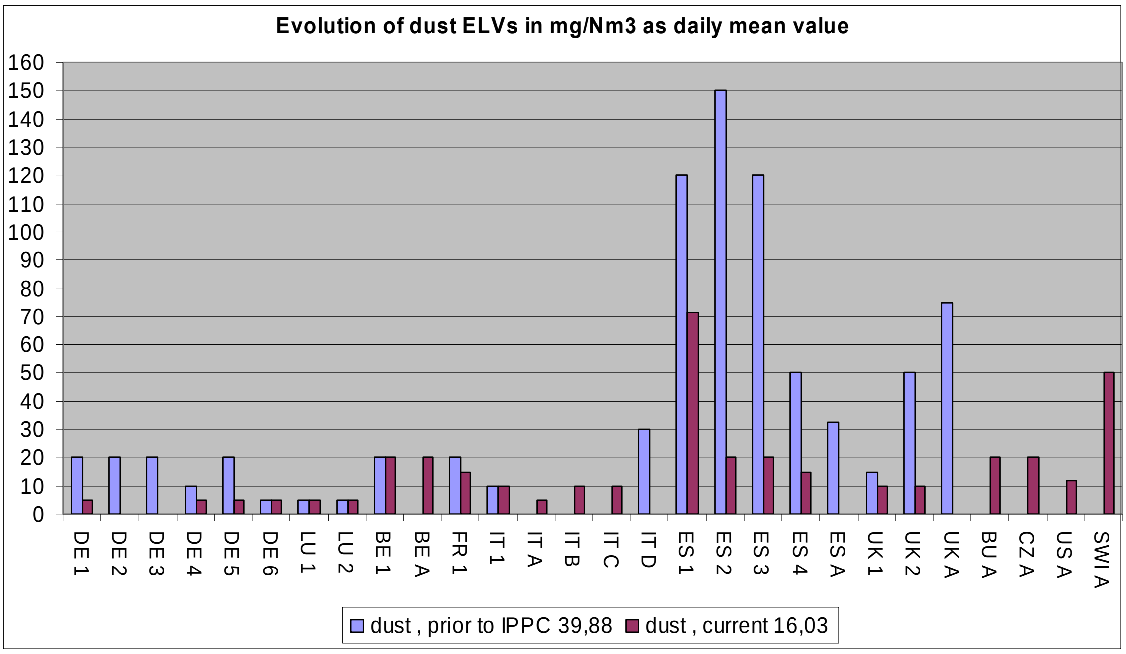
BAT specific compliance costs as obtained from survey responses is given. Also, a self-perceived estimation of the sample sites concerning the role of environmental pressure relative to other competitive pressure is presented.

Concerning the evolution of dust emission limit values it is conspicuous that the highest number of cases with a sharp increase in the stringency of regulation was found in the Spanish sample plants (see graph 46 below). By contrast, in some sample sites in Germany and Luxembourg there was no difference between past and present emission limit values for dust. The partial convergence in emission limit values between Spain and some Northern and Western European countries can be seen as a move towards a more level playing field (inequality view). But it needs to be stressed that the IPPCD is likely to be only one triggering factor in the process of convergence. Two main aspects need to be taken into account: Firstly, an increase in stringency can be directly influenced by the IPPCD or alternatively national regulations. It is more plausible to assume in Germany, for example, that the increase of environmental stringency is a consequence of national legislation than one of the IPPCD. By contrast, in Spain the higher level of stringency can be assumed to be directly related to the implementation of the IPPCD. Secondly, it is hard to prove whether changes in the ELVs are due to the IPPC permitting system or the need to comply with European and national ambient air quality standards. One of the sample plants mentioned that the localisation of the plant in a polluted area turned out to be the most severe economic constraint for production. This can be explained by the previously high level of pollution in the region and the need to comply with more stringent ELVs than in less polluted areas. To be able to increase production and the level of emissions beyond a certain limit the so-called compensating procedure undertaken in accordance with art. 226-229 of the Polish Environmental Protection Law (Journal of Laws No. 62 item 627) is applied. This implies that the increase of emission allowed for a given producer in the zone is equal to the reduction of emissions by other entities operating in the same zone.

Also in relation to PCDD/F emissions differences in the development of emission limit values are visible in our sample both within single countries and between them (see graph 47). The stringency in regulation of these pollutants is lower in sample sites in France, Italy, Spain and the UK than e.g. in Germany.

Graph 46:

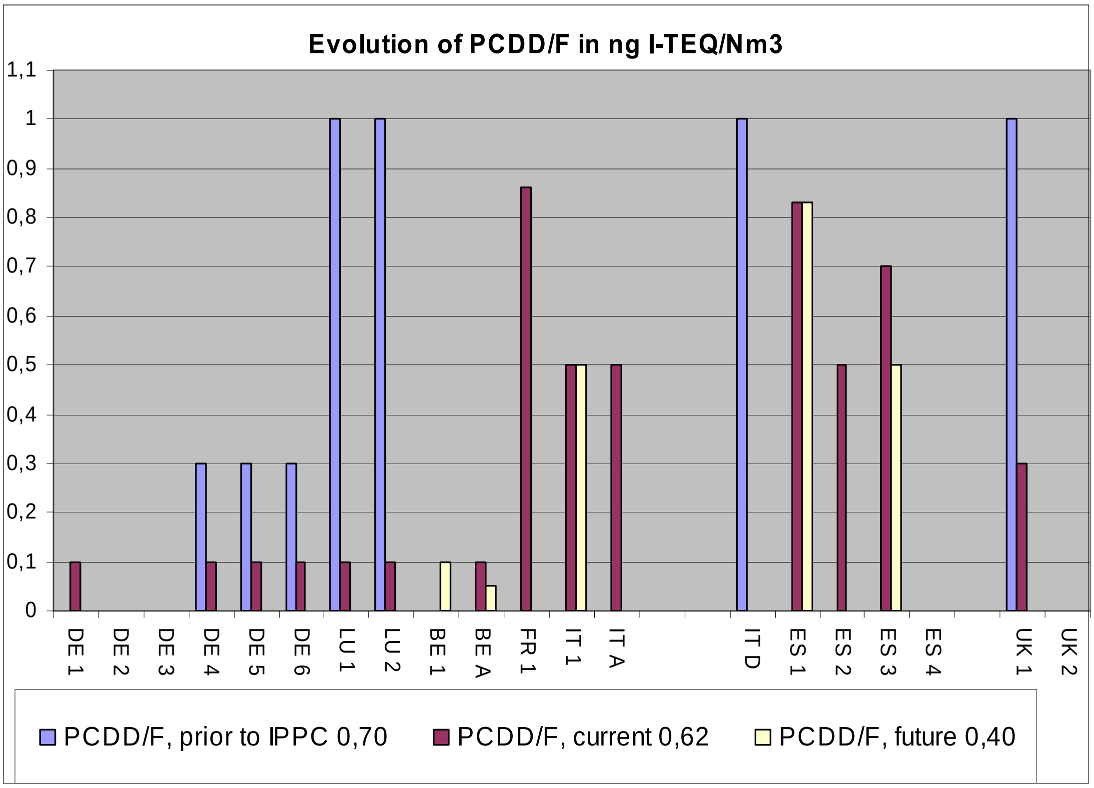
Evolution of dust emission limit values in the electric steelmaking sample incl. reference values from other sources and countries*, **



Notes:
*A figure as a subscript indicates that an observation is part of the survey sample, a letter as a subscript indicates that material from an interviewed authority or the literature (e.g. MS implementation reports) is shown.
** As indicated in the text above the tightening of ELVs in particular countries cannot always be attributed to the introduction of the IPPCD.
***The values 16.03 and 39.88 given in the graph represent averages.
Source: Ifo survey (2006), MS implementation reports, Kraus et.al (2006).

Graph 47:

Evolution of PCDD/F emissions in the electric steelmaking sample incl. reference values from other sources and countries*



Notes:
*A figure as a subscript indicates that an observation is part of the survey sample, a letter as a subscript indicates that material from an interviewed authority or the literature (e.g. MS implementation reports) is shown.
** As indicated in the text above the tightening of ELVs in particular countries cannot always be attributed to the introduction of the IPPCD.
***The values 0.4, 0.62 and 0.7 given in the graph represent averages.
Source: Ifo survey (2006), MS implementation reports.

The survey also asked for BAT specific compliance costs. However, only 13 of the total of 25 respondents gave information on this question. Presumably in countries with a pre-IPPC environmental regime which was already similar to the spirit of IPPC and where there is a history of environmental stringency, no or not much BAT specific compliance costs are encountered by sites. This would be one reason why in particular survey countries not a lot of answers are given. Most data were available for Spain. In other sample countries only selected figures were available. Any averaging across plants seems problematic given the high cost heterogeneity influenced by a wide range of economic and technical factors. It would therefore be erroneous to look at absolute figures or even take them as “the true” compliance costs of the IPPCD. In section 7.2.3 an attempt is made to explain some of the influential factors accounting for the large cost range between plants.

To illustrate what this range is like in a country only recently transposing the IPPCD we present the available survey data for Spain. In Spain all ten sites gave very precise data on this section. However, we have only absolute values of investment and cannot relate them to turnover since no data on turnover was provided. The range of absolute investment data was relatively high: from about 3 Mill. EUR at the lower end up to one case of 30 Mill. EUR spread out during the period of 2000 to 2005. Operating costs stayed for half of the sites below one Mill. EUR per year, in the other half several Mill. EUR of operating costs were encountered. In some cases operating costs also included staff cost. The relatively high absolute investment values for Spain should be interpreted in the light of the tightening of environmental stringency as presented in the graphs above. This – in comparison with other Member States – delayed increase of environmental standards triggers investment costs which have already been brought up in other Member States where the stringency of environmental regulation was tightened earlier.

In a round of follow-up phone calls with the participating Spanish sample sites in November 2006 it could be clarified that only in three cases the stated BAT specific compliance costs were exclusively undertaken because of IPPC implementation. E.g. there was one site which had to invest about 12 Mill. EUR. This site did not yet have an IPPC permit, but by means of voluntary agreements the BAT requirements were already defined for the plant. Another site which already had an IPPC permit in place, had invested about 14 Mill. EUR in BAT specific equipment. This site had to invest (among other things) in dust abatement techniques. In the third installation the defined BAT investment costs of about 3.35 Mill. EUR were exclusively related to dust abatement and were undertaken in order to comply with the IPPC. The remaining seven Spanish figures for BAT specific compliance costs shown above also contained data on other environmental investment due to other Spanish regulation and in one case also general investment due to plant restructuring.

In the survey managers were also asked to name the self perceived main competitive advantages and disadvantages of their production site vis-à-vis their EU and non-EU competitors with respect to the most important product segments they have. Based on a ranking this question was intended to help place the role of environmental cost into the broader context of competitiveness. In general, it turned out to be difficult to gain a full picture on this question. One of the reasons was that managers could not provide information at the site level, since the output is not sold on any markets and no direct competitors could be named. Answering the question for down-stream users, by contrast, would be inherently difficult given the multitude of applications of steel in end products.

The sector review has already demonstrated that environmental costs induced by regulation are only one among many factors influencing competitiveness of the electric steel industry. Especially looking at the cost structure of steel plants it is evident that costs and availability of raw materials, labour costs and electricity costs clearly dominate costs induced by environmental regulation. There is no reason to put this into question in this case study and it was confirmed during interviews that these other factors were prevalent in discussions about the future competitiveness of the electric steel industry (EU Commission, 2006).

Some managers assessed the role of environmental costs in relation to specific BAT or specific factors regarding the implementation of the IPPCD (see on this section 7.2.3 and 7.3). A more general picture could be gained for Spain.

Half of Spanish sites ranked environmental costs as a neutral factor in relation to their EU competitors. One site even ranked their current environmental costs as a small competitive advantage towards its EU competitors. Two sites thought that environmental costs were a small competitive disadvantage. But simultaneously, also lower labour costs and better/cheaper availability of raw material was also seen as a small disadvantage and lower prices of EU competitors were perceived as a strong competitive disadvantage. Overall this confirms again that – on average -environmental cost pressure should be regarded to be one of many factors influencing competitiveness.

While it is important to have the managers´ own assessment of the drivers of BAT related investment, it needs to be checked in a further step whether the heterogeneity of the reported data can also be attributed to various structural elements like furnace/plant age, plant size etc. or the history of individual companies (e.g. the evolution of their environmental policy, see 7.2.3).

7.2.3 Case specific and qualitative analysis of competitive performance and their relationship with IPPC implementation

Differences in economic impacts on a plant-by-plant basis

Section 7.2.1 presented plant/furnace age as an input measure of competitiveness performance, but it became obvious that further information is necessary to determine the relationship between compliance cost and plant age. To identify how the age of a given steel plant influences the level of abatement cost, it is necessary to consider two theoretically possible routes to reducing emissions:

- Investing in abatement equipment to retrofit the plant or
- Closing down the plant and replacing it by a new retrofitted plant.

The retrofitting costs are typically nil when the plant has just been built because the remaining lifetime of the plant during which the cost can be recovered is at a maximum. The replacement costs consist of two components. First, the cost entailed by plant closure, which decreases with plant age until it is nil when the plant is at the end of its lifetime (when the plant has to be closed down anyway, even in the absence of policy). Second, the cost of retrofitting the new plant is higher than the cost of retrofitting the existing plant because, typically, regulatory requirements for new plants are more stringent.

Some interesting insights about the role of furnace age could be gained during two site visits of relatively new plants. The investment into a new plant was in both cases undertaken mainly for non-environmental reasons. The environmental costs of this transition could not be separated from the entire investment, but it was mentioned that additional (clearly separable) environmental costs are typically minimal. In one case it was possible to tighten the ELVs further (compared to the old plant)[64], by about 1/3 regarding total dust and about 2/3 regarding dioxins and furans. At the same time, some new BATs could be installed which are not always used in other steel plants. For example, the total building evacuation scheme for dust removal, or the post combustion chamber in the EAF converting CO into CO2 (to use the exothermic energy). In the overall assessment of the impact of IPPC requirements on firm competitiveness, the environmental manager mentioned that the new state of the art plant gives a certain competitive advantage in facing increasing environmental pressures. New environmental techniques or emerging techniques are likely to become BAT valid for the sector as a whole at the next BREF revision. These new techniques might therefore be used as benchmarks when other plant operators will have to apply for a new permit or when their permit will have to be reconsidered.

[64] There is no basis for comparison in the other case.

The other case illustrates as well that there can potentially be large synergies between general investment and investment in environmental technologies whenever the investment is taken at the “right” moment in time or whenever managers adopt a forward looking attitude trying to strategically combine environmental and economic investment motives. Interestingly, the plant in case has proactively proposed a lower ELV for dust in the first permit than the value that was foreseen in national regulation. ELVs have been further tightened in a more recent modified permit (even though the earlier ELVs were already at the lower end of the performance associated with BAT in the BREF). It is interesting to note, however, that these tighter ELVs did not require substantial investment in any new BAT. As a result, large initial investments and a future oriented anticipation of tighter (national) standards could save costs overall, despite the high initial investment costs.

The plant in case was also able to align its own environmental management scheme with its permitting requirements, using the former to continuously improve environmental performance. The environmental management system is also seen as an instrument to reduce economic cost and to create future economic benefits. For example, while there are in general high competitive pressure to reduce costs, the environmental management system helps to uncover a number of small scale measures to reduce costs (e.g. saving of light energy). Other than in most of the plants surveyed and interviewed, environmental management was also perceived as a means to improve products (e.g. by using polymers instead of oil).

Both new plants emphasise that investment in new and environmentally sound equipment may also go along with certain competitive risks vis-à-vis other EU countries and non EU competitors. One of the managers saw the temporarily higher investment costs as a disadvantage whereas the other stressed the importance of differences in implementation and enforcement of EU environmental regulations (see chapter 7.3).

Overall, the relationship between plant age and abatement costs is clearly important, even though this cannot be backed up by a detailed calculation due to lack of data. This also became obvious during interviews with some older plants that have to face more stringent environmental requirements. Concerns about high costs were stressed quite a bit here. More broadly, there seems to be a correlation between plant age and the proactiveness of companies´ environmental management and policy.

Interviews at other plants revealed that synergies between environmental management systems and permitting are not always apparent. Some aspects that may be an integral part of environmental management systems, like the chance to enter new markets, cannot easily be matched with, or attributed to, investments in new BAT. Some investments in BAT are therefore purely driven by regulation and increase costs. One of the interviewed managers suggested that in his plant about half of the environmental investments entail no economic benefits, whereas the other half can bring about economic advantages but payback times of those investments may be quite long (five to ten years). While there is not always a link between investment in individual BAT and the general environmental management of a company, it is certainly helpful to coordinate permitting with the general environmental management and policy as far as possible. One interview, for example, revealed that since the introduction of ISO 14.000 investment planning is carried out in a way that better incorporates environmental protection issues and allows early feedback with the permitting process. This has also gone along with a slight change of mentality of those people responsible for general investment planning.

Within the survey a large majority of the environmental managers indicated that permitting coincided with their own efforts to improve environmental performance. Several environmental managers stated during interviews that these improvements have been triggered by demands from customers or other stakeholders. Whether or not environmental management is used strategically to enter into new markets or to respond to future customer demand is certainly a matter of different management styles and different competitive strategies form one plant to the other.

Apart from plant/furnace age also plant size could influence the level of costs. It would be reasonable to assume that larger plants can realise economies of scale in production and spend lower BAT costs per unit of output. Indeed it can be shown for the Spanish overall cost data which included both IPPC driven and other environmental investment that smaller plants had - according to the available data – to invest more per tonne of output than larger plants. This is particularly true for two small Spanish sites which reported a decrease of profits due to IPPC implementation. However, for these plants, no specific IPPC compliance costs were provided. Concerning the three Spanish sites reporting only IPPC related investment data no particular disadvantage for small or medium sized sites in comparison to large sites was recognised.

Another reason why it is problematic to compare quantitatively some BAT compliance costs across plants results form the fact that investment expenditures are not accounted for at the level of individual BAT but usually lumped together across several items. But even if a more disaggregated break down could be obtained, the level of investments also depends highly on plant layout and specific technical characteristics of the existing installations used at the plant. To achieve a similar environmental performance it may be much more expensive in some plants than in others to install similar environmental techniques just because it is more difficult to integrate a water recycling or a cooling system in some plants than in others, for example.

A more general problem is that plants do not define environmental costs in the same way or employ any standardised environmental accounting system. Most of the plants seem to account for the direct investment costs of environmental regulation (end-of-pipe investments) and may also have some estimates on resulting operating costs. A more elaborate accounting system (allowing to better track operating costs for example) is seen as desirable by several of the interviewed managers. At the same time, the current lack of precision and the methodological problems in defining environmental costs are still acceptable. Two plants reported about introducing more standardised accounting systems either at the plant or at the group level. Currently, however, only limited progress has been made. One of the managers expressed his hopes to regularly report environmental costs across all plants of his group and to introduce an internal benchmarking system for several of the plants across the world.

There have indeed been earlier attempts within the steel industry to harmonise environmental cost accounting. A working group has been established by the International Iron and Steel Institute (IISI) which agreed on a common methodology and then proceeded with internal comparisons and benchmarking. However, this exercise, which was continued within a large steelmaking group, was stopped later given both the sensitivity and confidential character of the data and the continuing methodological difficulties of the comparisons. It is an open question at the moment whether further attempts will be launched within the steel industry given some concerns about the high costs of environmental regulation.

An important question is whether steel companies are able to pass on the costs of environmental regulation to their customers or to charge their suppliers for them. This issue was already discussed in the previous section, where plant managers give various answers on the type of competition their company has to face. Interviews with some plant managers have revealed that it is difficult to pin down the economic consequences of increased costs of regulation on the level of the end-product market. After all, steel melting units are only a relatively small part of larger and sometimes vertically integrated companies, where steel production may contribute as little as 10 or 15% of internal turnover.[65] From an economic point of view, one could start from the end product and then trace back the value chains all the way to the steel melting stage. However, this is often unfeasible given the multitude of possible applications of steel. Also, the steel mill is not usually treated as a separate business or profit unit that could be abandoned or sold in case that it does not recover costs or realise profits. As a result, at the level of individual companies, analysis of possibilities to pass-through costs would need to be based on much more detailed and not usually collected information.

7.3 Analysis of institutional and country-specific factors in the implementation of IPPC and its link to competitiveness

This chapter builds on chapter 4 and analyses in more detail institutional and country-specific factors in the implementation of IPPC. Whereas the link to competitiveness was often quite weak in chapter 4, this section tries to come up with some case-specific evidence that puts the results of chapter 4 into perspective. Due to the case specific nature of the evidence cross-country comparisons are only possible to a limited extent. Two questions in the survey asked steel managers to compare the previous national regime to the current IPPC regime and to name potential obstacles as well as helpful factors they came across in the permitting process and which had an impact on their business activity. As a general rule, there were little changes noted in those countries where IPPC has not much changed the permitting regime of the country (like Germany or the UK). For those companies it was asked during the interview to more broadly compare permitting in the past and today, or to report on changes that are not directly related to the IPPC directive. For countries having to restructure their permitting regime, changes due to IPPC are more palpable.

7.3.1 Obstacles to IPPC implementation compared to previous regime

Across <u>all plants</u>, lack of information of IPPC at the production site as well as lack of know-how and skills concerning the implementation of IPPC at the production site posed no major problems. Also, there were no major complaints about lack of public support or lack of resources to implement IPPC requirements, the only notable exception being the Polish company responding to the survey.

[65] However, this does no mean that the larger the plant the easier it would be to pass on the costs. Further information on the exact price elasticity of demand is needed for a clearer answer to this issue.

In chapter 4.3 it was mentioned that the increased length of the permitting process from application to take-up of (changed) production can pose a potentially important burden for companies. In general, the results from the survey do not confirm this. Some interesting remarks were also obtained during interviews. In Germany no major complaints were raised about the length of permitting, but results are somewhat mixed anyway. Whereas two of the German managers interviewed describe the relationship with the authorities as cooperative and even emphasise some improvements resulting from better coordination within the C.A., a third environmental manager mentioned that the relationship with authorities has suffered lately and has impeded progress in the permitting process (but mostly independently from changes introduced by the IPPCD). On one hand, administrative structural reform in Germany was disruptive resulting in a change of responsibilities among authorities (see chapter 4.1). On the other hand, some concerns were also raised about the relatively low flexibility and responsiveness of authorities regarding a major renewal of the installations operated at the site. The French environmental manager interviewed emphasised that there is a need for a completely new permit (not a complementary permit) resulting from a capacity increase by 15% and that the permitting process itself can take up to two years form the submission of the first request to the final permit. While early start-up of production is likely to be granted, the manager complained that the level of detail in the application has increased substantially compared to the past. In the UK and in Belgium the length of permitting and co-ordination among CA was not perceived as an obstacle. The Belgian manager even mentioned that communication has improved and that procedures have accelerated (see also chapter 4.3). However, one of the two UK managers indicated that the competent authority lacks some technical expertise.

There were few signs that authorities do not take into account the time needed to introduce BAT. This confirms again that the introduction of BAT is usually not “forced” upon companies but aligned with the investment cycles and with the time necessary to experiment with new techniques. An exception to the generally positive assessment regarding the length of permitting, the relationship with authorities and the flexibility of authorities is apparent in the answers of the Polish site that responded to the survey and is still in the application process for an IPPC permit. The reasons for this negative assessment remain unclear. Interviews with the Polish steel association suggest that companies have relatively little technical support at their disposal. Representatives of the Environmental Ministry wondered why the steel companies hesitate in putting in their application forms. Two Spanish sites considered a lack of co-ordination/lack of guidance as well as a lack of understanding on the side of the authorities concerning the time needed to introduce BAT as an important obstacle to IPPC implementation. These two sites also claimed a fall in profits due to IPPC.

Compared to the permitting process itself, most of the survey respondents indicated that obstacles result more frequently from reporting obligations and differences in enforcement regimes (inspections, monitoring). Regarding reporting, two of the German sites as well as the Luxembourg sites did not note any major changes, while two other German sites considered the increased frequency and intensity of reporting as an obstacle. One of the environmental managers mentioned that it was somewhat burdensome to have parallel reporting schemes. The other German environmental manager estimated that the share of total working time spent for collecting information and writing reports has increased from 40% to 80% over the last ten years or so. Similar concerns were raised by the French and the Belgian environmental managers as well as one of the UK managers (several reporting obligations at the same time, and different formats for different reports)[66]. The majority of the Spanish sites regarded the need for more frequent monitoring/inspections as well as more frequent reporting duties as an obstacle of medium importance.

As to monitoring and inspections, the major concern of companies was not so much the increased administrative burden due to the increased frequency of inspections,[67] but differences within Europe or between Europe and non European countries. However, interestingly the comments made by environmental managers during interviews only partly confirm each other. For example, one of the German managers mentioned that, on average, French competitors benefit from a laxer enforcement of new environmental regulations (not only related to IPPC). According to the manager this was even acknowledged by a French colleague. A French environmental manager mainly complained about different regulatory requirements between France and Italy. While they may look similar on paper there is a "feeling", substantiated by casual discussions with colleagues in Italy, that the application of legal requirements is handed half-heartedly (especially in rural areas). At least, the required reporting to authorities is far less frequent and less reliable in Italy and also in Germany than in France. An example was cited where reporting in France is based on measurements once a day, whereas in the other countries measurements are done once a month. Another German manager, however, considered differences in environmental policies in Europe to be of minor importance. More important are differences in enforcement regimes between Europe and outside Europe. Two of the German managers indicated that, particularly in Russia, environmental cost and stringency of enforcement is considerably lower than in Europe. One of the managers could confirm this from a personal experience. As a potential example, the environmental manager indicated that ELVs could be set in a way which leaves companies some room to lessen the stringency of regulations.

[66] Note that the REGINE scheme introduced in Belgium (see chapter 4.3) is currently still in a pilot base and implemented on a voluntary basis with no legal obligation for companies to participate. In the future reporting is expected to be simplified also for a larger number of existing installations.

[67] Some managers (UK, Germany) also indicated during interviews that establishing trust with inspectors can pose difficulties.

7.3.2 Helpful factors to IPPC implementation compared to previous regime

Regarding helpful factors to IPPC implementation it needs to be stressed that in some countries IPPC did not induce much change at all. Therefore several of the helpful factors need to be seen in relation to specific or local conditions. For example, some of the German and the Luxembourg plants stressed that the relationship with authorities has become more cooperative. More strongly related to IPPC, the existence of the BREF was welcomed by companies, but with some managers especially in Germany putting less emphasis on this given the German approach to implementation of the IPPCD via general binding rules. Almost across all plants it was also welcome that one-stop-shop permitting or a higher level of co-ordination has taken place. During interviews it was also mentioned that this depends on personal relationships with competent authorities. In contrast to other countries phasing-in plans of authorities and the facilitation of permitting via voluntary agreements was highly welcome by the Spanish sites and the Italian site. This confirms the high importance of establishing trust between operators and authorities in these countries (see also chapter 4.3 on pre-application contacts).

7.3.3 Administrative costs

Managers were asked to give the administrative costs for preparing and carrying through the permit application for the first time. Administrative costs may entail annual permit fee and/or a one time application fee. In addition, there may be costs related to staff time as well as consultancy services. As shown in chapter 4.3 UK operators have to pay the highest administrative costs. Annual permit fees of the two UK steelmakers amount on average to 27,400 EUR and the one-time application fee to 47,300 EUR. In several countries annual permit fees are absent (Germany, Luxembourg, Belgium, Spain). They are lower in some other countries (France 10,000 EUR and Poland 3000 EUR). The one time application fee is absent in Luxembourg and reaches only a low level in Spain, on average 1500 EUR. It is surprisingly high in the one Polish site included and compared to the overview shown in chapter 4.3 (31, 550 EUR). Among the German sites there is a substantial variation in the one-time application fees given. Whereas one of the interviewed managers indicated that the cost of a typical modified permit is about 8,000 to 10,000 EUR, one of the plants which was newly permitted spent 50,000 EUR and a third plant gave a figure of 100,000 EUR (reviewed, but substantially changed permit). The Belgian environmental manager which was interviewed indicated that the main cost of the permit lies in the environmental impact study which can range between 100,000 to 200,000 EUR.

The average cost for in-house staff time amounts to 40,000 EUR, but there is a substantial variation between plants with some plants giving figures as low as 5,000 EUR and others as high as 100,000 EUR. This variation can in part be explained by the fact that some environmental managers only count staff costs for a small modified permit e.g. one of the environmental managers interviewed in Germany, whereas others calculate more generally the staff efforts that go into continuous interaction between the company and the authorities. E.g. one of the German managers interviewed indicated that about six months staff time can be attributed to permitting. Expenses for consultancy services are on average higher than internal in-house staff costs, on average 73,000 EUR. Again there is a large variation from one site to the other. The level of costs depends strongly on whether consultants provide more basic analysis and measurement or undertake more specialised services (e.g. for the set up of a new dust extraction installation).

Overall, the level of administrative costs is quite unimportant relative to turnover. It can be confirmed, however, that differences between plants and between countries are striking (see also chapter 4).

7.3.4 Differences in the use of a BREF when setting operating conditions

As mentioned in chapter 4.3, the IPPCD allows for a certain degree of flexibility concerning the interpretation of BAT in individual permitting decisions. There may in particular be differences in the way CA consider technical characteristics, geographical location and local circumstances of the installation at stake. Overall, survey results provide little information about the way this flexibility may have been used by permitting authorities. However, during two interviews some limited insights were gained on the issue.
In the first case, a guidance was available with an ELV between 0.1 and 0.5 ng/m3 for PCDD/F. (BAT-AELs in the BREFs are also between 0.1 and 0.5 ng/m3). In the permit of the plant in case an ELV of 0.3 was set. This value corresponded to the guarantee of the manufacturer supplying the abatement equipment. It was argued that lower values could potentially not be obtained for the scrap type used and would need further fine-tuning with the installed equipment. (Another example concerning the same ELV is presented by ENTEC (2006, Annex B 10, p. 12). Here the operator will undertake a study based on which an economically viable solution will be reassessed).
In the second case, one of the environmental managers interviewed emphasised the importance of a proportionate approach and the need for a certain flexibility of Member States in the setting of ELVs. The manager acknowledged the fact that the plant has a small competitive advantage in environmental costs vis-a-vis neighbouring EU competitors given some more lenient ELVs. This was justified mainly by the fact that the plant is located in a less densely populated area. At the same time, the manager indicated that this flexibility shouldn't be used by Member States to favour their industry on purpose vis-à-vis competitors abroad.

7.4 Conclusions on the impact of different approaches to IPPC implementation on competitiveness in the electric steelmaking case study

This case study has examined data of 25 electric steelworks located in the EU and interview material collected from various stakeholders. Various potential economic impacts following IPPC implementation were identified theoretically and addressed in the analysis as far as the available data allowed it. Conclusions can be drawn along the three lines of analysis used in the study. They should be read in conjunction with the sector review presented in chapter 5 (in particular the fact that environmental costs induced by regulation are only one among many factors influencing the competitiveness of the electric steel industry). Due to the small sample size the case study cannot be regarded as representative of the entire steelmaking industry.

(1) Conclusions from broader comparisons concerning the relationship of input and output measures and their potential influence on competitiveness impacts arising from IPPC implementation

In this first stage of analysis it was investigated whether plant specific input and output factors like age of machinery, size of plant, growth etc. have any systematic impact on plant competitiveness and the economically efficient adoption of IPPC legislation at the plant level. Any potential competitiveness impact was measured as self-perceived change of profits. This way of measuring competitiveness was done in the absence of other "hard" variables in the sample. It was also tried to establish a link between the type of competition a plant was exposed to and the change in profits due to IPPC. Whilst in the electric steel sample there were some hints for a possible influence of plant specific factors, for the majority of variables no direct link between competitiveness and IPPC implementation could be discovered.

The modern capital stock found in the sample seems to be a factor which facilitates the economically efficient adoption of BAT, whereas furnace size did not seem to be of relevance. Regarding market orientation the highest risk of a detrimental effect arising from IPPC regulation was present among some strong international exporters. This was most obvious for some sites located in Spain producing structural steel shapes. For some other companies competing on international markets it was more difficult to identify the impact of IPPC at the steel melting stage and to find out how costs are transmitted in the downstream value chain. Concerning the type of competition the majority of those sample sites reporting a detrimental impact on their profit margins due to IPPC, were exclusively competing on price.

For other output factors it proved to be impossible to identify any potential (causal) linkage to competitiveness impacts arising from IPPC (e.g. some plants with increasing and some plants with decreasing plant growth and a self-perceived negative impact on profitability).

(2) Conclusions on intermediate measures approximating the impact of IPPC implementation on competitiveness

The fact that there were only spurious correlations when using general input and output measures to assess the impact on competitiveness made it indispensable to appreciate competitiveness impacts on a higher level of detail. Therefore two intermediate measures approximating the impact of IPPC implementation on competitiveness were analysed. One was the level of environmental stringency approximated by the reported ELVs before and after the introduction of the IPPC regime. The other measure was the extent of BAT specific costs.

Variations in the stringency of regulation are perceived in the literature as a main source for causing competitive distortions which eventually may hamper plant competitiveness. The case study examined the strictness of environmental regulation for dust and PCDD/F emissions. The highest number of cases with a sharp increase in the stringency of dust regulation was found in the Spanish sample plants. This move suggests a dynamic adaptation to more stringent regulation and an attempt to a partially more level playing field. It should be stressed that several of the environmentally highly performing plants explicitly stated that their competitive position would improve (in the sense of a more level playing) if the stringency of regulation in previously more leniently regulated countries increases. The stringency in regulation of the PCDD/F emissions was found to be more lenient in sample sites in France, Italy, Spain and the UK than in Germany. The process of convergence does not seem to be as far advanced as in the case of dust.

Since a transition to an integrated permitting system is taking place in Spain, all ten sites were able to give very precise data on BAT specific compliance costs. For these plants a direct, but more transitory cost induced impact on their competitiveness could be expected. Still comparing results on a plant-by plant basis gives a mixed picture on the importance of IPPC compliance costs. For several of the plants it was not possible to disentangle the cost figures and attribute them to different drivers (IPPC, other national regulation, economic drivers). Therefore there is no point in giving an average figure of compliance costs.

Absolute values of the Spanish sample data for all environmental investment (not only IPPC) were related to plant size. It can be shown that smaller plants have - according to the available data – invested more per tonne of output than larger plants. This is particularly true for two small Spanish sites which reported a decrease of profits due to IPPC implementation. Concerning the three Spanish sites with IPPC related investment data no particular disadvantage for small or medium sized sites in comparison to large sites was recognised.

For sites located in countries with a pre-IPPC environmental regime which was already similar to the spirit of IPPC and where there was a history of environmental stringency, no or not much information on BAT specific compliance costs was or could be given. Not surprisingly, BAT specific compliance costs are either low or cannot clearly be attributed to changes induced by the IPPCD.

(3) *Conclusions from case specific material and interviews on the impact of IPPC implementation on competitiveness*

Interviews with plants revealed important further information on various factors which are important when analysing the impact of IPPC implementation on competitiveness. In the following the role of plant age, management style, quantification issues concerning environmental costs and also the ability of electric steelworks to pass on environmental costs are discussed. In addition, the analysis of institutional and country specific factors and its link to competitiveness which was already broadly discussed in chapter 4 was taken up again and linked to the competitiveness debate.

During interviews with both old and new plants it became clear that the relationship between plant age and abatement costs is very important, even though this cannot be backed up by a detailed calculation due to lack of data. It was reported that a new site enjoys a certain competitive advantage in facing increasing environmental pressures. This would be because new environmental techniques or emerging techniques are likely to become BAT valid for the sector as a whole at the next BREF revision. These new techniques might therefore be used as benchmarks when other plant operators will have to apply for a new permit or when their permit will have to be reconsidered.

Another new plant was able to align its own environmental management scheme (EMS) with its permitting requirements by using the EMS to continuously improve environmental performance. The environmental management system was also regarded as an instrument to reduce economic cost, create future economic benefits and to improve products.

However, even new plants emphasise that investment in new and environmentally sound techniques may also go along with certain competitive risks vis-à-vis other EU countries and non EU competitors where environmental regulation is more lenient (e.g. temporarily higher investment costs, differences in implementation and enforcement of EU environmental regulations).

Concerns about high environmental costs were especially stressed in older plants. The main reason for this was that synergies between own efforts to improve environmental performance (e.g. by means of environmental management systems) and permitting are not always apparent.

Interviews also revealed general problems with the quantification of BAT investment costs. On a general level it was stated that plants do not define environmental costs in the same way or employ any standardised environmental accounting system. Although there have been attempts within the steel industry to harmonise environmental cost accounting, only limited progress was made so far. Thus, even if data is available it is problematic to compare BAT compliance costs across plants. This results not only from differences in measurement approaches, but also from the fact that investment expenditures are not accounted for at the level of individual BAT but usually lumped together across several items (see conclusions on level (2) above). Furthermore, the level of investments also depends highly on plant layout and specific technical characteristics of the existing equipment of a plant. To achieve a similar environmental performance it may be much more expensive in some plants than in others to install similar environmental techniques just because it is more difficult to integrate e.g. a certain water recycling or a cooling system.

During face-to-face interviews with plant managers it was also discussed whether steel companies are able to pass on the costs of environmental regulation to their customers or to charge their suppliers for them. However, for a thorough analysis of the issue at stake much more detailed and not usually collected information would have been needed. Therefore we stick to the survey results on the type of competition presented above where it became clear that those plants exposed to international markets have greater difficulty in absorbing environmental costs.

In the survey electric steel sites were asked to compare the previous national regime to the current IPPC regime and to rank potential obstacles as well as helpful factors they came across in the permitting process and which had an impact on their business activity. As a general rule, there were little changes noted in those countries where IPPC has not much changed the permitting regime of the country (like Germany or the UK). In the Spanish sample, a few plants complained about more frequent monitoring etc. During interviews with sites situated in Belgium, Germany, France and the UK some aspects of the survey question could be deepened.

Concerning the length of the permitting process from application to take-up of (changed) production no major complaints were raised. Only in one case where a plant asked for a capacity increase the entire permitting process could take up to two years. It was stressed that a co-operative relationship with authorities facilitates coordination and progress in the permitting process.

There were few signs that, according to operators, authorities are not sufficiently flexible and do not take into account the time needed to introduce BAT. This confirms again that the introduction of BAT is usually not forced upon companies but aligned with the investment cycles and with the time necessary to experiment with new techniques.

Regarding a change in the frequency of reporting induced by IPPC, the answers received in interviews were mixed. Several sites complained about more reporting duties and the related workload as well as about several reporting duties at the same time.

As to inspections, the major concern of companies was not so much the increased administrative burden due to the increased frequency of inspections, but differences in enforcement in part within Europe and in particular between Europe and non European countries (e.g. Russia). Furthermore, an important issue which arose during interviews was the variability in the type of emission monitoring.

8. Analysis of survey and interview data for Domestic Glass Sample

8.1 Introduction

This case study addresses potential competitiveness impacts arising from differences in implementation of the IPPC Directive for domestic glass producers within the EU and also in relation to their non-EU competitors. In the first section the relevant hypotheses and the measurement of key variables are presented. Furthermore an overview of the sample data is given and it is described how representative the sample is in relation to the entire population of domestic glass producers (localisation of the sample). Also, the data is classified according to our analytical purposes. In the sections 8.2, 8.3 and 8.4 the analysis of the available data collected both in the survey and during interviews with domestic glass companies and their regulators is presented. The analysis is carried out for the three examined products, i.e. lead crystal, soda-lime and borosilicate, individually. Overall conclusions are presented in section 8.5.

8.1.1. Hypotheses

Since the study follows the Hitchens study insofar as it is tried to identify factors which are relevant for IPPC implementation on the plant level we use some of the hypotheses of the Hitchens study and adapt it to our level of available data. The intention of this first set of hypotheses is to identify factors at the plant level which are helpful, neutral or hindering to implementation of the IPPC regime, in particular with respect to stringent implementation of IPPC, i.e. adoption of many BATs and emission limit values coming close to the BAT associated emission limit values as suggested in the glass BREF. In addition, this current study focuses on specific implementation issues at the regulatory level imposed on installations which were not the included in the Hitchens study. Therefore, additional hypotheses concerning the interaction between regulatory authority and regulated plant on detailed implementation issues such as timing, administrative costs etc. are introduced. The main purpose of this second set of hypotheses is to get a deeper understanding of the implementation process at the interface between authorities and plants and to distil ways of implementation which contribute to a high level of environmental protection without or with the least possible detrimental impact on competitiveness of enterprises.

The starting point for our analysis is that both positive and negative impacts arising from IPPC implementation on competitiveness are to be expected. Thus, as pointed out in the Hitchens study, a priori one could expect that the adoption of Best Available Techniques (BAT) and stringent emission limit values could place firms at a competitive disadvantage and could be reflected in the loss of markets to imports from countries with less stringent environmental regulation. Simultaneously, high environmental standards could be a driver to push firms in the medium and longer term on to a higher growth path by forcing them to make product and process changes that yield higher competitiveness. The extent of these effects will largely depend on factors internal to the firm as well as on the pace of implementation imposed on the firms by their respective permitting authorities. Therefore, as explained above, we differentiate between two sets of hypotheses, those related to internal firm factors and those related to implementation specific elements arising from the specific regulatory framework to which companies are exposed (see boxes 4 and 5 below). The latter will also contain information on the stringency of pre-IPPC environmental legislation.

Box 4: Hypotheses for identifying IPPC factors at the level of plants/firms

(1) The stronger the competitive position of plants is in terms of input indicators like age of machinery and R&D efforts (the likely explanations for competitiveness), the easier it will be for a plant to integrate environmental regulation.

(2) Plants with a strong competitive standing in terms of output indicators (the consequences of strong competitiveness) like growth of turnover, growth of employment, high profitability and high investment ratios, high physical productivity, high export quotas and high capacity utilisation are more likely to adapt to environmental regulation and its cost consequences more easily.

(3) Plants and companies which are less exposed to price competition will be less vulnerable to the additional cost of environmental regulation because they are in a better position to pass on environmental costs to their customers.

(4) Plants where environmental pressure is just one or a less important pressure amongst other competitive pressures, are more likely to integrate the costs of environmental legislation into their business activities.

(5) The size of plants will have an impact on the relationship between regulation and competitiveness on the plant/firm level since the cost of compliance is likely to be a negative function of the size of plants/firms. I.e. smaller plants are more likely to suffer from a loss in competitiveness by stringent environmental regulation than large plants.

(6) There will be differences in the economic impact of implementation of individual BATs across plants. Those plants which are able to gain positive effects of BAT investment e.g. on process efficiency or product quality are likely to be less negatively affected by BAT in their core competitiveness aspects.

Source: Hitchens et al. (2001), with adaptations by Ifo Institute.

Box 5:

Hypotheses related to IPPC implementation specific factors arising from the regulatory framework of companies

(1) Plants with a history of stringent environmental regulation and a pre-IPPC permitting system which is similar to the IPPC regime will find it easier to adapt to the IPPC regime.

(2) Implementation of the IPPC Directive is undertaken in the survey sample through general binding rules and case-by-case approaches. It is hypothesised that plants which are subject to a strong increase in the stringency of the emission limit values in their IPPC permits compared to their previous permits are likely to suffer from a loss in competitiveness due to a possibly sharp increase in compliance costs irrespective of the type of implementation approach.

(3) Plants which encountered one or several helpful factors during the IPPC implementation process are less likely to suffer from a negative impact on competitiveness arising from IPPC.

(4) Plants which are confronted with a series of obstacles throughout the IPPC implementation process are likely to encounter competitiveness impacts which are stronger than in plants where there are less obstacles.

(5) IPPC can raise the administrative costs of permitting in some cases. Where this cost is significant as a % of turnover, it may have the potential for detrimental impacts on competitiveness.

Source: Ifo Institute, 2006.

8.1.2 Research method

The research method applied here is a matched plant analysis where the detailed micro-level data gained from the survey and interviews allows for a systematic comparison of supply-side features of the firm after controlling for size and product type and links them to indicators of environmental regulation (e.g. BAT investment costs). While the approach does not use a formal production function approach to study the question at hand, it yields important insights for both policy makers and company managers on how environmental regulation impacts on company competitiveness. The approach has been in the past used to trace linkages e.g. between product innovation and competitiveness and there are also several studies which explored the linkages between environmental regulation and competitiveness (see e.g. Hitchens et al., 1990 and 1993, Mason et al.1994; Hitchens et al. 1998, 2000, 2001).
Various competitiveness indicators to test the IPPC factors at plant level and the related hypotheses in Box 1 above are measured through key variables shown below. It was then examined to which extent the key competitiveness variables themselves impact on the take-up of environmental regulation or in turn are changed by implementation of the IPPC Directive. This approach takes up the central consideration of Hitchens et al. (2001) that the relationship between BAT (or here rather the approach to implementation of BAT) and competitiveness is likely to be two way: the fact that the firm is competitive may lead to the early adoption of environmental initiatives while at the same time environmental initiatives are expected to have consequences for the competitiveness of firms. Therefore we expect both positive and negative competitiveness effects of IPPC implementation at company/site level (see introduction to this study). Furthermore, the measurement of variables depicting implementation specific factors related to the hypotheses shown in Box 4 above is carried out in order to gain further insights into the process of IPPC implementation itself and its potential impacts on company competitiveness.

8.1.3 Measurement of key variables

The key variables which are important for the answering of the above stated hypotheses were measured in the survey questionnaire of domestic glass producers in the following way:

Measurement of IPPC factors at plant level:

- Size of firms was measured by employment and by total nominal melting capacity in tonnes of glass per day;
- Age of glass furnaces was measured in terms of the year of start up and also in terms of the date of the last rebuild of a furnace; since a rebuild of a furnace is equal to a complete modernisation the relevant age factor used in the study is the date of the last rebuild;
- R&D efforts were measured as a percentage of turnover both in 2000 and 2005; then a growth rate was calculated;
- Turnover, employment and production volumes were asked for the years 2000 and 2005 and respective growth rates were calculated;
- Profitability was measured as so-called EBIT ratio (earnings before interest and taxation relative to turnover) as average during the last three years;
- The level of investment was measured as ratio of investment over depreciation costs as an average of the last five years;
- Export quotas were calculated both for the EU and international level for the years 2000 and 2005; respective growth rates were calculated;
- The rate of capacity utilisation was measured as ratio of actual and nominal melting capacity for the years 2000 and 2005; respective changes were calculated;
- Managers were asked to give a ranking of both competitive advantages/disadvantages of their own plants and of all competitive pressures including environmental pressures in relation to EU and non-EU competitors on the domestic glass market;
- Specific additional compliance costs in order to obtain and operate according to an IPPC permit were asked directly in absolute value for investment and operating costs, also as % of total investment and in the annex of the questionnaire information on investment and running costs of all individual BATs implemented in the plants irrespective of their IPPC status was collected.

Measurement of variables related to IPPC implementation specific factors arising from the regulatory framework of companies

- The stringency of the pre-IPPC permitting system relative to the IPPC regime was measured by a comparison of pre-IPPC emission limit values for dust and NO_x emissions; there was also a question in relation to general changes necessary with regard to the new IPPC regime; moreover, it was measured which BATs were necessary to comply with the permits issued under the IPPC Directive;

- Timing or phasing-in issues were measured by means of ranking of helpful factors and obstacles with respect to IPPC implementation;
- Monitoring and reporting issues were also distilled by means of ranking of helpful factors and obstacles with respect to IPPC implementation;
- Administrative costs were measured as annual permit fee, one-time application fee, staff time in-house, consultancy and other costs.
- Account was also taken of the type of implementation approach used, e.g. general binding rules or case-by-case approaches.

8.1.4 Overview of sample and representativeness

Sample size

In co-operation with CPIV an original list of 57 domestic glass producers was established. Two additional installations were identified during the survey process so that a total of 59 questionnaires were distributed. All 59 installations received a survey questionnaire via email in early May 2005.

However, during the process of the survey, it turned out that several of the installations did not produce domestic glass or were too small so they were not subject to IPPC. Moreover, CPIV helped with additional addresses of several non-EU installations. Eventually, there was a targeted sample of 47 installations supposed to be covered by the IPPC Directive (or similar legislation, in case of those outside the EU) and which received the survey questionnaire. 6 of the 47 installations were located outside the EU. Altogether, there were responses of 17 installations, accounting for a response rate of 36%. From the 17 questionnaires 15 were returned electronically, one by regular mail and one questionnaire was filled in during a visit (see table 32).

Table 32:
Overview of sites included in survey for domestic glass production and number of responses

Survey item	EU	Non-EU	Total
Received names and addresses of CPIV	51	6	57
Additional names and addresses found during survey	1	1	2
Submitted questionnaires to total of	52	7	59
Experienced irrelevant (not glass, too small)	11	1	12
No. of relevant sites (i.e. targeted sample)	41	6	47
Received completed questionnaires (i.e. actual sample size)	15	2	17

Location of sample plants

Two of the 17 questionnaires came from Non-EU countries, the other 15 questionnaires came from 12 different Member States. This implies that in most cases only one observation per country is made. For reasons of confidentiality no further details about the location of plants can be given throughout the analysis.

Representativeness of company selection and size distribution of sample plants

Company selection

Although this survey deals with a small finite population and it would ideally be required to work with higher sample sizes, the actual sample size is considered sufficient to produce confident results. Among the respondents were eight crystal glass installations from eight different companies. This accounts for approximately half of all targeted crystal companies. With respect to soda-lime glass there were seven answers from five companies. In the targeted sample there was a total of eight different soda-lime companies. This means we have again caught about half of the targeted sample. Furthermore there were two brosilicate installations from one company which answered the survey. In the targeted sample there was one more company producing borosilicate glass. Thus, overall the survey could shed light on about 50% of companies operating in the three different market segments.

Size distribution

With respect to nominal melting capacity per day the sample largely consisted of small and medium sized producers. There was only one large producer (see table 33 for an overview of the size distribution). Within the crystal glass sample a dominance of small plants was found which corresponds to the total population of crystal glass producers. The soda-lime sample is characterised by medium sized producers. No small soda-lime producer participated in the survey. From the two borosilicate producers in the sample one was of small size and the other was medium sized.

Overall, also in terms of the size distribution, we assume the sample to be representative of the domestic glass industry in the EU.

Table 33:

Size distribution of sample plants with respect to nominal melting capacity per day (in brackets the size distribution of the total number of domestic glass producers is shown)

Nominal melting capacity in tonnes per day*	**Crystal glass**	**Soda-lime glass**	**Borosilicate glass**	**Total**
Small: 20 -100	6 (17)	0 (20)	1 (3)	6 (40)
Medium: > 100 - 500	2 (3)	6 (14)	1 (1)	10 (18)
Large: > 500	0 (0)	1 (1)	0 (0)	1 (1)
Total number of plants	8 (20)	7 (35)	2 (4)	17 (59)

* An indication of the classification of plant size as well as an estimation of the size distribution of all 59 producers was obtained from CPIV.

Products sampled

From the seventeen domestic glass producers constituting our sample eight mainly produce crystal glass, seven produce soda-lime glass and two are borosilicate producers. However, some installations also had various production lines installed. Within crystal glass there was one plant exclusively producing crystal glass and three plants only produced lead crystal. In addition there were four plants with a mixed production of crystal and lead crystal. Most of them produced more lead crystal products than crystal glass products. Five of the soda-lime producers focussed on soda-lime production only. Two of the soda-lime producers also produced other glass products, but the share of soda-lime production was in both cases the largest share of the total production and of turnover. For reasons of simplicity these two sites were treated as if they produced soda-lime glass only. The two borosilicate plants answering the survey exclusively produced borosilicate. Table 34 gives an overview of all products produced in the sample.

Table 34:
Number of products sampled in the domestic glass manufacturing sample

Product type measured as % of total production	No. of plants producing the product type in the sample
Crystal glass	
100% crystal	1
100% lead crystal	3
Mixed crystal and lead crystal with the larger part being crystal	1
Mixed crystal and lead crystal with the larger part being lead crystal	3
Total	8
Soda-lime glass	
100% soda-lime	5
Mixed with other glass types with the largest part being soda-lime	2
Total	7
Borosilicate	
100% borosilicate	2
Total	2

Extent of IPPC permitting in the sample

Altogether 10 of the 17 plants responding to the survey had already an IPPC permit in place (see table 35 below). This is about 58% of the sample and comes close to the level of permitting in the entire glass industry where - in the Member States with available data - about 60% of plants already have an IPPC permit. The highest number of IPPC permits was found in the crystal glass sample where one plant already in 2000 obtained its reviewed permit. The other permits were from the year 2003, twice from 2004, and one time each from 2005 and 2006. Three of the soda lime producers held an IPPC permit, one of them already since 1999. The other two were from 2005 and 2006 respectively. Within the borosilicate sample, one plant held a new permit from 2006, the other plant planned to apply in the near future.

From the other plants not yet having an IPPC permit, four had already applied and three others reported to apply in the near future.

Table 35: **Extent of IPPC permitting in the sample**

State of IPPC permitting	Crystal glass	Soda-lime glass	Borosilicate glass	Total
IPPC permits in place, of which	6	3	1	10
- new	1	2	1	4
- reviewed	5	1	0	6
Application being processed by the authorities	2	2	0	4
Will apply in the near future	0	2	1	3
Total number of plants	8	7	2	17

Similarity of pre-IPPC regulatory schemes to IPPC regime in the domestic glass sample

The sample can also be described according to its degree of similarity of pre-IPPC regulatory schemes to IPPC regime. Table 1.5 gives an overview of the diversity of the sample. First of all, the sample can be divided according to the question whether a plant already was regulated by an integrated permitting approach or not. Three quarters of the crystal glass producers in the sample had already been subject to an integrated approach, but only two of seven soda-lime producers were familiar with such a regulatory approach. Concerning borosilicate both plants were already acquainted with an integrated approach.

Furthermore, a very important indicator of the similarity between pre-IPPC and IPPC permitting schemes is the stringency of emission limit values (ELVs) prior to the IPPC permit. Then, as a measure of the pace of implementation, a comparison can be drawn between the previous emission limit values and the current or expected IPPC emission limit values which may be based on BAT associated emission levels.

Therefore in analysing the emission limit values in the sample – be it from IPPC or other permits - attention has been paid to looking at the ELVs applied and the corresponding BAT associated emission levels given in the glass BREF. Differences between the figures are noted, along with the factors behind this where known (e.g. the technical characteristics of installations, their geographic location and local environmental conditions). However, it is not the attention of the study to automatically assume that IPPC can only be correctly implemented when ELVs are either identical or very close to BAT associated emission levels. Since the BREF serves as a central, EU-wide reference point for permitting, it is important to examine how the definition of BAT as laid down in the BREF as well as the BAT associated emission levels have been taken into account across Member States. In particular with respect to competitiveness impacts differences between ELVs and BAT associated emission levels are of interest.

As is illustrated in table 36 below four of the crystal glass producers were stringently regulated before they applied for an IPPC permit in which these stringent emission limit values were just transferred. Throughout the domestic glass study we mainly refer to emissions of dust and NO_x because for these emissions the data quality was best. We are well aware that domestic glass production is also subject to further regulation of different emissions which we could not cover in this study.

Four other plants had been regulated in a more lenient way before they got an IPPC permit or applied for it. Two of these crystal glass producers, however, were in the later IPPC permit quite stringently regulated, i.e. there was a jump from lenient ELVs to the level of BAT associated emission levels both for dust and NOx emissions. One other maintained more lenient values for its IPPC permit, while the fourth plant did not have any emission limit values at all prior to its IPPC application. The plant was in the past evaluated by the regulators according to its actual emissions which were relatively high both for dust and NOx. The plant did not yet know anything about future emission limit values.

With respect to soda-lime three plants were already stringently regulated before they got or applied for an IPPC permit. Two plants each were subject to relatively lax regulation in comparison to the BAT associated emission levels suggested in the BREF. While two plants kept or expected to keep this lenient levels, two others expected emission limit values coming close to the BAT associated emission levels.

In borosilicate glassmaking one plant was subject to stringent emission limit values before its stringent IPPC permit, the other plant was less stringently regulated before its IPPC application and did not give any information about future regulatory levels.

Table 36:

Similarity of pre-IPPC regulatory schemes to IPPC regime in the domestic glass sample

Similarity of pre-IPPC regulatory scheme to IPPC regime measured by …	**Crystal glass**	**Soda-lime glass**	**Borosilicate glass**	**Total**
Integrated pre-IPPC approach	6	2	2	10
Non-integrated pre-IPPC approach	2	5	0	7
Of which:				
Stringent pre-IPPC ELVs*, already similar to ELVs of (future) IPPC permit and allows performance equal or close to BAT associated emission levels for domestic glass	4	3	1	8
Pre-IPPC ELVs more lenient than ELVs of (future) IPPC permit; ELVs in (future) IPPC permit itself more lenient than BAT associated emission levels for domestic glass	1	1	1	3
Pre-IPPC system did not use ELVs, but an evaluation according to actual emissions of which the level is more lenient than BAT associated emission levels for domestic glass	1	0	0	1
Pre-IPPC ELVs more lenient than ELVs of (future) IPPC permit; but ELVs in (future) IPPC permit itself equal or close to BAT associated emission levels for domestic glass	2	3	0	5
Total number of plants	8	7	2	17

* ELVs refer to dust and NO_x emissions as asked in the survey questionnaire.

8.1.5 Sample classification for analytical purposes

The analysis will be carried out according to the main product types found in the survey, i.e. crystal glass, soda-lime glass and borosilicate glass. The reason for choosing this approach is that these products serve different markets and should be carefully distinguished (see the background information on the domestic glass sector provided in this study). Therefore we differentiate between three sub-samples of lead crystal, soda-lime and borosilicate glass.

If a sample site produced several types of products, it was classified according to its main product both in terms of tonnage and value.

Within each sub-sample the plants were classified in so-called A and B plants. A plants stated that they did not encounter a competitiveness problem arising from IPPC implementation. The hardest measure for a competitiveness problem was a decrease in profit following IPPC implementation. The B plants reported negative impacts touching on their core competitiveness, be it through a decrease in profits or productivity.

In addition to this self-estimation of competitiveness impacts attributed to implementation of the IPPC Directive by the respondents there were additional consistency cross-checks in order to avoid distortions in the answers. Such distortions could arise, e.g. if a B plant being in worse financial situation tried to attribute all its problems to IPPC, but in fact the deterioration was caused by either a broader set of environmental legislations or market specific slowdown and the respondent was not aware of these. Therefore consistency checks involved the actual amount of BAT specific compliance costs incl. planned and already carried out BAT investment costs in the light of upcoming or current emission limit values in the future or current IPPC permits. In this way it could be confirmed that the self-estimation of installations was plausible.

A more precise classification of the A and B producers according to size, extent of IPPC permitting and similarity between pre-IPPC and IPPC regulatory scheme is shown in table 37 below.

The analysis is then guided by the two sets of hypotheses shown above in section 8.1. Thereby, two main research questions are answered:

1) Are there plant specific factors which make A plants less vulnerable to competitiveness problems arising from IPPC implementation?
2) Are there characteristics in the implementation process itself which facilitate implementation of the IPPC Directive for A plants more than it is the case for B plants?

In the following chapters the analysis for the three product groups is presented.

Table 37:

Overview of domestic glass sample according to competitiveness impact, size, extent of IPPC permitting and similarity between pre-IPPC and IPPC regulatory scheme

Descriptive Item	**Crystal glass**		**Soda-lime glass**		**Borosilicate glass**	
Competitiveness impact	No. of A	No. of B	No. of A	No. of B	No. of A	No. of B
	5	3	2	5	1	1
No. of A and B producers are of …						
Small size	4	2	0	0	0	1
Medium size	1	1	2	4	1	0
Large size	0	0	0	1	0	0
No. of A and B producers with …						
IPPC permit	5	1	1	2	0	1
Application	0	2	1	1	0	0
No application yet	0	0	0	2	1	0
Similarity of pre-IPPC regime to IPPC regime						
High*	4	0	0	1	1	1
Medium**	1	2	0	2	0	0
Low***	0	1	2	2	0	0

Notes:

* A high similarity of pre-IPPC to the IPPC regime is given, when both an integrated permitting system was in place prior to IPPC and when emission limit values in the previous permits were close to BAT associated emission levels.

** A medium similarity of pre-IPPC to the IPPC regime is given, when an integrated permitting system was in place prior to IPPC and when emission limit values in the previous permits were more lenient to BAT associated emission levels.

***A low similarity of pre-IPPC to the IPPC regime is given, when there was a fragmented permitting system in place prior to IPPC and when emission limit values in the previous permits were more lenient than BAT associated emission levels.

8.2 Results for crystal glass sample

This chapter presents the analysis of the reasons found in the survey and during interviews with headquarters and regulators why some of the crystal glass producers do not consider being hit by IPPC implementation in their competitiveness, whilst others are. The chapter starts with a classification of the crystal glass sample in A and B producers and gives a short overview of the results presented later on. The analysis itself largely follows the structure of the survey questionnaire. First of all, plant specific factors like technical and economic factors as well as cost of IPPC implementation are analysed with respect to their relation with IPPC implementation, then factors related to the implementation process itself are examined.

8.2.1 Composition of sample and brief overview of results

There were eight crystal glass producers in the sample. Five of them stated in the survey that they did not experience any competitiveness problem due to IPPC implementation and did not face any change in their profit margins. We call them A plants. All these companies had already an IPPC permit in place with the longest in place since the year 2000 and the newest being issued in 2006. All of these five companies were subject to emission limit values of which the stringency was equal or coming close to the BAT associated emission limit values suggested in the BREF. Four of the five A plants were of small size and one of medium size.

However, one of the A producers was unusual from the rest of the sample since it produced jewellery and experienced a very high growth rate of both employment and turnover. This plant was taken out of the analysis in order not to distort the results for the remaining sample sites producing mainly drinking glasses and other tableware goods where the market has been declining since the late 1990ies.

Three other crystal glass producers, called B plants, complained about decrease in profit and cost pressure related to IPPC implementation. Two of these plants had applied for a permit and did not yet have any information on the future level of environmental stringency, in the third plant the permit was already issued with strict emission limit values. Two of the three B plants were small and one was of medium size (see table 38).

Table 38:
Composition of the crystal glass sample according to competitiveness impacts

Descriptive sample item	A plants expecting no detrimental impact from IPPC implementation	B plants expecting a detrimental impact from IPPC implementation
Total number and plant size	5 of which 4 are small and 1is medium sized	3 of which 2 are small and 1 is medium sized
IPPC permit, with stringent emission limit values for dust and NO_x emissions	5 (but only 4 taken into account in the analysis)	1
Application for IPPC permit, no info on ELVs available yet	0	2

Overview of results for the crystal glass sample

Concerning plant specific factors it is shown that furnace size does not matter for a favourable implementation of IPPC. Furnace age was very low across the entire sample which could be a evaluated as a favourable factor for IPPC implementation. Furthermore, all types of furnaces were found among the five companies experiencing no economic problem. However, exports, expenditures for research and development activities, the rate of capacity utilisation, the level profit margins and productivity were higher than in the three companies with a less favourable estimation of IPPC implementation. In their general understanding of environmental policy A plants seem to be more proactive than B plants and also try to integrate environmental issues into their general business activities. Therefore, it is not surprising that A plants faced significantly less obstacles in the IPPC implementation process than B plants. Only three A plants moderately complained about more frequent monitoring and reporting, whereas all B plants faced more severe obstacles like substantial investment or lack of understanding of time needed on the side of the authorities. Also, the A plants are able to charge quality premiums to a greater extent than the B plants where price competition makes the plants more vulnerable to an increase of production costs e.g. through environmental protection expenditures. A plants seem to have a longer history of strict environmental regulation and have invested in BAT early onwards so that environmental cost is not an issue anymore for them at the time being. Less A than B plants thought that both in relation to EU and non-EU competitors environmental costs were a serious competitive disadvantage.

8.2.2 Analysis of plant specific factors influencing the relationship between competitiveness and IPPC implementation

In this section technical and economic factors influencing the relationship between competitiveness and IPPC implementation are analysed.

8.2.2.1 Technical data of crystal glass sample

As table 39 below shows average melting capacity in the A plants is smaller than in the B plants and even smaller than in the total sample of all seven crystal glass producers considered for the analysis. On the level of individual data, there were two A plants with very small furnaces (< 10 tonnes per day) and one B plant with small furnaces. Moreover, in both A and B plants there are plants with furnaces having a melting capacity of more than 20 tonnes per day up to 60 tonnes per day. Thus, it seems that differences in furnace size do not matter for economically favourable implementation of IPPC.

All but sites had several furnaces installed, usually between two and three. In terms of original furnace age there was not much of a difference across the sample. All furnaces were rebuilt after their start up and the number of years after the last rebuild was on average age 2.1 years for the A plants and in B plants it was 4 years. One of the B plants had a furnace which had not been rebuilt since 1998 which increases the average. All other B furnaces were between one and six years old. According to CPIV the lifespan of a furnace in crystal glass making is usually between three and five years with an average of three years. Thus the sample of the A producers is of average age, while in the sample of the B producers furnace age is a little bit below the average. Modern and up-to-date furnaces are considered to be a factor for economically favourable implementation of IPPC. This is especially the case because plants stated during interviews that environmental investment can usually only be built in when a furnace is completely stopped. Frequently, environmental investment is undertaken when a site increases its capacity.

Different types of furnace technologies were in place both across the sample and often within one plant. All of the A plants had either electric melting or oxy-fuel firing in place while in the B plants two of the three plants used electric melting. Electric melting and oxy-fuel firing are according to the BREF for the glass industry to be BAT for domestic glass making.

Table 39: **Crystal glass producers: comparison of technical data**

Technical data	Average A, n=4	Average B, n=3	Average all crystal, n=7
Average furnace size in tonnes per day (=nominal melting capacity)	19.8	30.6	23.8
Average furnace age, years after last rebuild	2.1	4.0	3.2

8.2.2.2 Basic economic data of crystal glass sample

In table 40 we show basic economic data of the crystal glass producers.

Although it is known that the market for crystal glass is in decline, it is conspicuous that A plants have on average been able to achieve a slightly positive growth of production volume and turnover during the years 2000-2005. These indicators were clearly negative in the B plants being a sign that absorption of any additional costs would proof more difficult for the B plants. However, both A and B plants suffer from significant employment losses. Furthermore, the so-called EBIT ratio (indicating earnings before interest and tax relative to turnover) was positive in the A plants whereas it was negative in the B plants. Also, the ratio of investment over depreciation during the last five years showed an advantage for the A plants towards the B plants. Obviously, the A sites had invested more than the B plants. This is a sign of overall better economic standing in the A plants. Data on productivity is fairly limited in the sample. Therefore we cannot show any figures. Where it is available, however, the level of physical productivity, i.e. tonnes per employee, is higher in the A plants than in the B plants.

Table 40: **Sample of crystal glass producers: comparison of economic data**

Economic data	**Average A, n=4**	**Average B, n=3**	**Average all crystal producers of the sample, n=7**
Employment growth, 2000-2005, in %	-22.2	- 17.9	- 6.9
Growth of production volume, 2000-2005, in %	2.0	- 11.3	- 3.0
Turnover growth, 2000-2005, in %	3.6	- 24.6	- 11.9
EBIT, average 2002-2005, in % of turnover	Positive	Negative	Slightly positive
Ratio investment over depreciation, average 2000-2005	> 1	< 1	> 1
EU export quota, in 2005	36.0	34.0	33.4
International export quota, in 2005	37.8	40.6	37.8
R&D expenditures as % of turnover in 2005	5.25	0.4	3.9
Growth rate of R&D expenditures, 200 -2005	28.3	63.3	42.5
Rate of capacity utilisation in 2005	85.8	69.0	78.6
Growth rate of capacity utilisation 2000 – 2005, in %	10.5	7.0	3.2

Both A and B plants achieved high export quotas not only on an EU level, but also internationally. This reflects the fact that goods made of crystal glass are to a great extent internationally traded. However, significant differences with regard to research and development expenditures and capacity utilisation are found in the sample. A plants have on average spent 5.2% of their turnover in 2005 on research and development activities, whereas B plants spent only 0.4%. Also, the rate of capacity utilisation in A plants was with 85.8% much higher than in the B plants where it was only 69%. The growth rate of capacity utilisation between the years 2000 and 2005 was with 10.5% higher in the A plants than in the B plants where it was 7%. The high growth rate of research and development expenditures in the B plants is coming particularly from one company which after closure of an installation has developed a new strategy towards R&D in the remaining sites. In the A plants the growth rate of R&D is lower, but it seems to be steadier over time.

8.2.2.3 Type of competition in the crystal glass sample

In the survey questionnaire plants were also asked to characterise the type of competition they faced in their markets. The following list of answers was provided to them:

- Price is the single most important competitive parameter for our entire production programme
- Price is the single most important competitive parameter, but only for certain product segments (specify which segments)
- We are able to charge certain quality premiums to our customers
- We have a relatively strong bargaining position vis-à-vis our suppliers and buyers
- We operate in high-quality segments of our industry and rely on continuing innovation and improvement/renewal of our capital base (human/technical)

- Our competitive strengths result primarily from being flexible and from offering a large variety of products tailored to the needs of our customers
- Other, which?

Plants were also asked to rank the importance of the individual factors from 1 = absolutely true to 5 not true at all).

Four of the A plants clearly indicated that it was of greatest importance for them to be high quality producers and able to charge certain quality premiums to their customers. Two of the A plants reported their flexibility and their ability to offer a large variety of goods tailored to the needs of their customers as most important competitive strength. Moreover, in one case a site reported its operation in high-quality segments and its reliance on continuing innovation and improvement of its capital base as a very strong sign of the type of competition faced by the plant. A strong bargaining position towards suppliers and buyers was twice reported to be of high importance in the sample.

In the B plants price competition clearly played a more important role than in the A plants as the following analysis of the survey results shows: Only one plant is able to charge quality premiums, two others indicate that price is the single most important competitive parameter, at least in certain product segments. One plant even attaches a high ranking of importance to price as the single most important competitive parameter for its entire production programme.

8.2.2.4 Competitive advantages and disadvantages of crystal glass producers in relation to EU and non-EU competitors

Plants were also asked to rank the importance of their own competitive advantages and disadvantages vis-à-vis their EU and Non-EU competitors. Although crystal glass is mainly produced in Europe, recently there are some Non-EU competitors. As non-EU competitors the A plants named companies in Turkey, USA, Thailand, and China. The B plants also mentioned companies in China and added Brazil. Environmental costs were seen more frequently as a small disadvantage in the A plants than in the B plants (for the detail on the frequency of nominations please see table 41 below).

Comparison with EU competitors

Two of the A plants indicated their higher quality and their capital equipment to be an important competitive advantage vis-à-vis their EU competitors. Another one indicated its better raw material availability and/or lower raw material cost to be a strong competitive advantage. A further plant one estimated its lower energy and electricity costs to be very important. Two of the A plants saw labour costs as a competitive disadvantage with one ranking it as a small disadvantage and the other as a strong one. This was particularly stressed when EU competitors were located in Eastern Europe. Also environmental costs were felt as disadvantage in comparison with EU-competitors by three of the A plants with one stating it as a strong disadvantage and two as a small disadvantage. Another plant thought that environmental costs were a neutral factor. One A plant which had ranked environmental costs as a strong disadvantage, simultaneously saw the lower prices and lower energy/electricity costs of EU-competitors as strong disadvantage. From the B plants one plant regarded its environmental costs as a small competitive advantage, another one as a strong disadvantage and one reported just “disadvantage”. Labour costs were felt as a strong competitive disadvantage by all B plants.

Comparison with Non-EU competitors

In comparison with Non-EU competitors also capital and quality were seen as competitive advantages by all four A plants for which data was available. In addition, better co-operation with suppliers and buyers was an important advantage. Labour costs and price were felt by all A plants irrespective of location in the EU to be a very strong disadvantage. Also, as in the EU comparison, environmental costs were estimated by three plants to be a negative aspect in the competition with Non-EU crystal glass producers. However, the disadvantage was estimated by all A plants to be as strong as labour costs and price. One A plant still regarded environmental costs as a neutral factor. All B plants recognised better capital equipment and higher product quality as their most important competitive advantage in comparison with their non-EU competitors. Also, in one case brand name and lower environmental cost were cited as competitive advantages. Also raw material supply was evaluated to be advantageous for the B plants. Energy costs were in one B case regarded as a clear disadvantage. Labour and environmental costs were regarded as equally strong negative factors as by most of the A plants.

Table 41:

Crystal glass sample: Most important competitive advantages and disadvantages vis-à-vis EU and non-EU competitors, frequency of nominations

Categories	**Competitive advantages and disadvantages vis-à-vis EU and Non-EU competitors**							
	A sites, n=4				**B sites, n=3**			
Input indicators	EU		Non-EU		EU		Non-EU	
	Comp. Adv.	Comp. Disadv.	Comp. Adv.	Comp. Disadv.	Comp. Adv.	Comp. Disadv.	Comp. Adv.	Comp. Disadv.
Lower labour costs				4		3		3
Lower energy and electricity costs	1	2		1				1
Better raw material availability or lower cost	1						2	
Better capital equip-ment	2		4				3	
Lower environ-mental costs		3		3	1	2	1	2
Other:								
Output indicators								
Higher quality	2		4		3		3	
Lower prices				4				
Better co-operation with suppli-ers/customers			4					
Other: - brand name							1	

8.2.2.5 Plant size and BAT specific compliance costs

An important task in the context of this study would be to establish a relationship between BAT compliance costs specifically needed in order to operate according to an IPPC permit and size of plants. However, in the small sample there is only anecdotal evidence which is shown in the following section.

When asked for the BAT specific additional compliance costs which were necessary in order to operate according to an IPPC permit, one of the small A plants answered that there were no BAT specific compliance costs. This implies that the plant had already invested in BAT before it obtained the IPPC permit, due to national regulation. Another, medium sized A plant reported investment costs of 200,000 Euros (this is equal to about 0.4% of turnover in 2005 or 7.7 EUR per tonne of product produced in 2005) and operating costs of 20,000 Euros per year. Three other A plants did not give any data on this issue. One did not know about it yet, and in the other two costs are likely to be very small because the plants were already in their pre-IPPC regulatory system stringently regulated. In the sample of the B plants two plants could not yet give an answer to the question of BAT specific compliance costs because their application was still pending. The third B plant which was of small size reported quite high costs: a total of about 2.4 M Euros of investment costs for waste water treatment, alteration of pipes and scrubbers spread out over two years which equal about 1% of the plant's turnover, high operating costs and 0.7 M Euros annual maintenance costs. More details on the cost of individual BATs and their wider economic impacts are presented in the following section.

8.2.2.6 Economic impacts of BAT implementation

In terms of general changes the majority of the four A plants (i.e. three out of four) indicated that there are no changes necessary due to IPPC implementation. This may also be due to the fact that the application of electric melting in crystal glass making has been common for a long time. Two others generally said that new environmental technologies were required. However, the amount of investment was very small and no impact on competitiveness was triggered. From the B plants, only one plant (i.e. a third of all B plants) did not expect any changes, another expected more monitoring activities and a need to reduce its water consumption. The third plant was aware of future investments in energy saving, particle filters and NO_x abatement.

Plants were in the annex of the survey questionnaire asked to give specific details on individual implementation of BATs. They were shown a list of possible BATs relevant for their plant and asked to state the year of investment, any economic impact like effect on process efficiency, other investment/production, product quality, products price and markets. The economic impacts should be judged in a qualitative way: positive, neutral or negative. Moreover, the questionnaire asked for the corresponding investment expenditure, annual operating and maintenance costs and for economic benefits or avoided costs associated with a certain technique. Further details were given in the annex of the questionnaire only by one A plant and one B plant.

As shown in the section above, only two plants encountered BAT specific investment costs in order to obtain an IPPC permit. One medium sized A plant had stated an investment equal to 0.4% of its turnover and one small B plant reported an investment of 1.1% of its turnover spread out between 2003 and 2005. A comparison of the available material shows that the A plant has invested in BAT concerning dust removal, waste water and waste and has undertaken part of these investments early onwards in order to comply with national regulation. This explains why the investment need for IPPC compliance is low. Moreover, the A plant has implemented its three BATs in a slightly more beneficial way for its business than the B plant did for the same type of BATs (details are shown below). The B plant has invested in best available techniques concerning NO_x reduction, dust removal, fluorides reduction and waste water and indeed could spread out this investment only during 2003 and 2005. This explains why the B plant is hit harder by IPPC compliance than the A plant. The details are as follows:

NOx reduction

The B plant had installed electric melting in 1995 as a measure of NOx reduction. This measure was reported to have only positive economic impacts (i.e. positive for process efficiency, synergies with other investment, product quality and price as well as markets).

Dust removal

The A plant had already in 1986 invested 400.000 Euros (equals 0.7% of turnover) in an electrostatic precipitator. Annual operating costs were reported to be 10.000 Euros. Impacts on process efficiency, other investment, product quality and markets were said to be neutral. However, there was a negative impact on price. The B plant has only in 2003 invested in a bag filter of which the impact on both price and markets were assumed to be negative. There were no other impacts on business. No investment figure for the bag filter was available.

Fluorides

The B plant had invested 450,000 Euros or 0.2% of turnover in scrubbers in order to reduce fluorides. There were negative impacts on both process efficiency and product price. Other impacts on the business were neutral. The A plant had not invested in abatement of fluorides.

Waste water treatment

Both plants have in 2006 invested in waste water treatment plants. The B plant spent 1.5 M Euros for the waste water treatment plant which equals about 0.7% of its turnover. The A plant invested only 0.7 M Euros which equals about 1.2% of its turnover. Both plants implemented the waste water treatment plant with mixed effects on their business: Both plants reported a positive impact on process efficiency, no impact on other investment and product quality and a negative impact on product price. The A plant stated that there was no impact on its markets served, whereas the B plant felt a negative impact on its markets. As a further waste water measure, the B plant had in 2005 invested in an alteration of its piping system in order to segregate process water from surface water run-off. The investment was about 600,000 Euros or about 0.28% of turnover. The plant reported the same economic impacts as from the implementation of its waste water treatment plant.

Waste

Only the A plant reported about three investments concerning waste. All activities which were waste segregation, recycling of cullet and recollection and disposal of sludge were undertaken in 1980. Impacts on business were reported to be neutral. Investment costs were low (< 100.000 Euros) and for two activities there were economic benefits amounting to either 50% of annual operating costs or even double the operating costs.

Energy efficiency

Plants were also asked whether IPPC implementation has an impact on their energy efficiency. Only one of the A plants reported an increase in energy efficiency of 2.5% due to IPPC implementation. The four other plants did not experience an increase in energy efficiency. In the B plants 2 installations could not yet answer the question, a third one denied an increase of energy efficiency because of more energy used for dust filters.

8.2.3 Changes due to IPPC implementation compared to previous regime: implementation specific factors

In this section characteristics of the implementation process itself which can influence the relationship between plant competitiveness and the implementation of the IPPC Directive are examined.

8.2.3.1 General understanding of the drivers of environmental activities at plant level

The survey also asked questions related to a general understanding of the drivers of the plants' internal environmental policy and management. Respondents were asked to rank the importance of the following reasons (from 1 = not important to 5 = very important):

- Necessity to meet regulatory requirements
- Cost reduction
- Chance to improve production process
- Respond to customer demands
- Improvement of products
- Chance to enter into new markets
- Environmental responsibility of management
- Other, which?

All four A plants ranked not only regulation, but also cost reduction with the highest possible ranking. One plant estimated regulation to be a driver of only medium importance and also gave cost reduction the highest importance. The chance to improve the production process or the responsiveness to customer demands and the improvement of products as well as the environmental responsibility of management were ranked by all four A plants either with the highest possible or the second highest possible importance. This shows that A plants recognize environmental policy not only as a necessity imposed on them from the authorities, but also as a chance to improve their general business by simultaneously addressing process efficiency, customer demands and improvements of product quality. On the contrary, B plants always estimated regulation as the most important driver for their environmental activities and ranked in two of the three cases all business related motives as not important. Only one plant gave the responsiveness to customer demands the second highest ranking of importance. Another B plant thought that the environmental responsibility of management was an important driver for environmental activities.

Potential obstacles to IPPC implementation compared to previous regime

Plants were also asked whether they experienced any obstacles in the IPPC permitting process compared to the previous national regime which had an impact on their business activities. The following list of potential obstacles was shown to them (from 1 = no obstacle at all to 5 = serious obstacle for our business):

- Lack of information on IPPC at the production site
- Lack of know-how and skills concerning IPPC at the production site
- Lack of resources / public support at the production site
- Increased length of the permitting process from application to take-up of (changed) production
- Lack of phasing-in plans by authorities, disruptive approach of authorities, breach of former agreements
- Authorities were/are not willing to sufficiently take into account the time needed for introducing Best Available Techniques
- Authorities did not sufficiently co-ordinate permit-related activities among themselves or were ill-informed about the permitting procedure (e.g. lack of guidance). This resulted in confusion, additional work etc.
- More frequent monitoring and/or inspections of authorities and related time and effort for us
- More frequent reporting and related time and effort for us
- Other, which?

Not surprisingly, two of the four A plants which reported no impact from IPPC implementation on their overall competitiveness, also reported to have encountered no particular obstacle in the IPPC permitting process in comparison to their previous national permitting regime. Three other crystal glass producers in the A sample attached a low or medium ranking of importance (2 or 3 out of a scale of 5) to more frequent monitoring and reporting compared to the previous national permitting rules. One A plant moderately complained about a lack of phasing in plans on the side of the authorities. Only one plant mentioned the increased length of the IPPC permitting process from application to take up of production as an obstacle of minor importance.

However, the three B plants which eventually noted that they would suffer from a competitive disadvantage due to IPPC implementation, reported also more obstacles in the permitting process. One plant even attached to all but one answers a ranking of 4 or 5 with more frequent monitoring and reporting, lack of resources, length of the permitting process and the lack of understanding of authorities of the time needed for those investments being the most important ones. However, no complaints about a lack of phasing-in plans were brought forward by this plant. One other plant reported the lack of both information and skills in relation to IPPC as an obstacle of notable importance. The third plant estimated the need for more frequent monitoring and reporting to be an obstacle of medium importance (see table 42 for an overview).

Table 42:

Overview of most frequently reported obstacles for implementation of the IPPC Directive in the crystal glass sample

Importance of obstacles	**A plants, n=4**	**B plants, n=3**
High	Nothing particular, three of the five plants did not encounter any particular obstacle	More frequent monitoring and reporting (in one case also a medium obstacle) Lack of resources Length of permitting process
Medium	More frequent monitoring and reporting; Lack of phasing-in plans	Lack of information on site; Lack of know-how and skills
Low	Length of permitting process	Lack of phasing-in plans

In table 43 below the average ranking values of all obstacles to IPPC implementation identified in the survey among crystal glass producers are shown for A and B producers as well as for all seven crystal glass producers analysed in the sample. All but one obstacles were on average experienced to be less severe in the A plants than in the B plants. Only the lack of phasing-in plans was not experienced as an obstacle by the B plants.

Table 43:

Average ranking of obstacles to IPPC implementation: sample of crystal glass producers

Obstacles to IPPC Implementation	**Average A plants, n=4**	**Average B plants, n=3**	**Average total crystal sample, n=7**
Lack of information on IPPC at the production site:	**1.4**	**2.7**	**1.9**
Lack of know-how and skills concerning IPPC at the production site	**1.1**	**2.3**	**1.7**
Lack of resources / public support at the production site	**1.3**	**3.0**	**1.8**
Increased length of the permitting process from application to take-up of (changed) production	**1.6**	**5.0**	**2.2**
Lack of phasing-in plans by authorities, disruptive approach of authorities, breach of former agreements	**1.4**	**1.0**	**1.3**
Authorities were/are not willing to sufficiently take into account the time needed for introducing Best Available Techniques	**1.0**	**4.0**	**1.6**
Authorities did not sufficiently co-ordinate permit-related activities among themselves or were ill-informed about the permitting procedure (e.g. lack of guidance). This resulted in confusion, additional work etc.	**1.1**	**5.0**	**1.8**
More frequent monitoring and/or inspections of authorities and related time and effort for us	**1.5**	**5.0**	**2.2**
More frequent reporting and related time and effort for us	**1.9**	**4.0**	**2.5**

Notes: Averages of a ranking from 1 = no obstacle at all to 5 = serious obstacle

Helpful factors to IPPC implementation compared to previous regime

Plants were also asked which factors were helpful in the IPPC permitting process compared to the previous national regime. Plants were invited to rank these factors from 1 = did not happen or apply to 5 = very helpful for our business).

- “One-stop shop permitting” (e.g. single authority responsible for entire permit)
- Permitting facilitated by voluntary/negotiated agreement between company and authority
- Existence of BREF or guidance on BAT to prepare permit application
- Phasing-in plans by authorities compared to more disruptive or time-insensitive approach previously
- Relationship with authorities has become more co-operative
- IPPC permitting coincided with our own efforts to improve environmental performance
- Knowledge/experience about preparation of application for permit(s) prior to IPPC
- Other, which?

The difference between the A and B producers is not as pronounced as concerning potential obstacles. The detail is as follows:

Three of the four A plants with no negative competitiveness impact arising from IPPC implementation attached a high importance to the coincidence of their own efforts for environmental improvement with the regulatory need for the IPPC permit. Also, the existence of the BREF notes was appreciated to be of medium to high importance in three A plants. Three plants also attached a medium importance to the improvement of the co-operation with the authorities during the IPPC permitting process. The use of a phased-in approach of authorities concerning IPPC implementation did not happen in most of the A plants. Where it occurred, the plants under concern estimated it to be low importance. One plant in the A sample reported no particular helpful factors. The same plant did not experience any particular obstacles either.

The three B plants amongst the crystal glass producers attached the highest value of importance of a helpful factor to the existence of the BREF (see table 44). The coincidence of their own efforts for environmental improvement with the regulatory need for the IPPC permit was reported to be a helpful factor of medium importance for the B plants. Where a phased-in approach was undertaken in the sample, plants did not find it particularly helpful. With respect to a phased-in approach one plant reported that authorities had not sufficiently taken into account technical and economic circumstances of BAT implementation.

Table 44:
Overview of most frequently reported helpful factors for implementation of the IPPC Directive in the crystal glass sample

Importance of helpful factors	**A plants, n=4**	**B plants, n=3**
High	Co-incidence of own efforts with IPPC permitting; BREF	BREF
Medium	Improvement of co-operation with authorities	Co-incidence of own efforts with IPPC permitting
Low	Phased-in approach did hardly happen	Phased-in approach was not helpful

In table 45 below the average ranking values of all factors which were found helpful for IPPC implementation are shown for A and B crystal glass producers as well as for all eight crystal glass producers in the sample. The most conspicuous difference between A and B sites in the crystal glass sample is that the B sites rank the importance of the BREF on average much higher than it is the case in the A sites.

Table 45:

Average ranking of helpful factors in the IPPC implementation process of the crystal glass producers

Helpful factors in IPPC implementation process	**Average A plants, n=4**	**Average B plants, n=3**	**Average total crystal sample, n=7**
"One-stop shop permitting" (e.g. single authority responsible for entire permit)	**2.3**	**2.0**	**2.2**
Permitting facilitated by voluntary/negotiated agreement between company and authority	**1.8**	**3.0**	**2.0**
Existence of BREF (Best Available Technique Reference Document) or guidance on BAT to prepare permit application	**2.4**	**5.0**	**2.8**
Phasing-in plans by authorities compared to more disruptive or time-insensitive approach previously	**1.9**	**2.0**	**2.0**
Relationship with authorities has become more co-operative	**2.3**	**3.0**	**2.6**
IPPC permitting coincided with our own efforts to improve environmental performance	**2.2**	**3.0**	**2.5**
Knowledge/experience about preparation of application for permit(s) prior to IPPC	**1.6**	**2.5**	**2.0**

Notes: Averages calculated from ranking values in the range of 1 = did not happen or apply to 5 = very helpful

8.2.3.2 Administrative costs

The survey also asked for the extent of administrative costs of IPPC implementation. There was a wide variation both in the single cost items which plants have to face and in the extent of costs. Since we cannot analyse the reasons for this variation, we report on the issue of administrative costs only in a brief way.

Three of the seven plants (with two being from the B part of the sample) had to pay an annual permit fee which varied between 4,500 to 18,000 Euros. The range of the higher costs are paid by the B sample plants. Six of the eight plants (with one being from the B sample) pay a one-time application fee reaching from1,000 to 10,000 Euros with no particular variation between A and B plants. All plants reported staff costs. These varied between 1,000 and 30,000 Euro. There was no particular variation between A and B plants. Also, six plants reported consultancy costs. These costs frequently came close to the staff time cost, but were never higher than the staff time costs. The lowest value was 1,200 Euros and the highest was 25,000 Euros. One plant reported monitoring costs of 10,000 Euros. Two plants which were still waiting for their IPPC permit estimated some additional costs of which the extent was unknown for the time being. In total costs, the variation was between 5,000 and 90,000 Euros. This latter highest value of administrative cost was reported in one plant where also an overall negative impact of IPPC implementation was reported. Staff and especially consultancy cost was highest in this plant, maybe reflecting the fact that if a plant does not have its own in-house skills the costs of buying in know-how for IPPC implementation can indeed become relatively high. Where data was available, total administrative costs measured as % of turnover were 0.05% of turnover and 0.04% for a medium sized plant.

8.2.3.3 Stringency of emission limit values (ELVs) in IPPC permit

All four A plants in the crystal glass sample reported quite strict dust emission limit values in their current IPPC permit: One limit was as low as 4 mg/Nm^3, the highest value was 30 mg/Nm^3 which corresponds to the BAT associated emission levels for dust emissions. Also for NOx emissions values of 1,000 down to 500 mg/Nm^3 were either in place or expected for the future in all four A sites. In all four sites IPPC was implemented by general binding rules.

Information on ELVs was more limited in the B sample. In one B plant dust emissions from the furnace were not regulated. Other dust sources were subject to a more lenient value of 150 mg/Nm^3. In a second B plants where the IPPC permit was still pending there were even no ELVs from the current permit available because the site was monitored according to its level of emissions. In the one B plant which already had an IPPC permit the dust ELV was with 10 mg/Nm^3 very strict. This plant commented that its environmental protection agency (EPA) had been very strict in adhering to the BAT associated emission levels concluded in the BREF document from the glass sector. Although the EPA had allowed for a time frame for the implementation of new limit values, technical or economic issues were not taken into account. The reason for this was that it was believed by the EPA that the technology to meet the BREF limits was already in place. The plant under concern, however, reported that it had not experienced this in relation to lead emissions to sewer. It requested that BREF associated emission levels should be technically and economically feasible.

There were three cases in two countries where IPPC was implemented using general binding rules (GBR) and five sites were regulated by an installation-specific approach. Three of the A sites were regulated through a GBR approach, but there were also two A sites regulated by an installation specific approach.

8.2.4 Results from headquarter visits

In the product segment of crystal glass three headquarter visits took place of which two are analysed. One headquarter visit each of an A and B plant are analysed.

The A company which already had an IPPC permit in place clearly confirmed the survey findings: IPPC implementation did not touch upon profitability or competitiveness in general. One company stated that already since the 1990ies emission limits were quite strict and these limits were transferred to the IPPC permit. Thus, at the time of IPPC implementation, there was no investment in BAT needed. During this headquarter visit it also became obvious that the strong R&D facilities of the company also helped to activate environmental research activities. This was much stronger than in the B company where the IPPC permit was still pending. In that company it was stressed that IPPC implementation was a formal obligation and no changes to existing techniques were necessary. However, the last environmental investment was from the 1980ies and it was feared that in the future the authorities could put more environmental pressure on the company. This would raise environmental costs and have a negative impact on competitiveness. This estimation confirmed the answer which was already given by the company in the survey questionnaire.

Furthermore, headquarter visits enlightened the fact that growth rates of the companies under concern were not affected by IPPC. Among the factors which would help growth were e.g. new products or the extent of local energy costs. One company even mentioned that it was seen as an advantage to have an IPPC permit with strict emission limit values. Productivity itself was neither related to IPPC implementation issues. Constraints to productivity growth were rather seen in problems related to a wide assortment, low production runs or lack of innovation. Overall, all visited headquarters did not recognise environmental regulation - be it the national regime prior to IPPC or IPPC itself – to be in direct connection to overall company competitiveness indicators like productivity, profitability, growth etc.

8.2.5 Results from visits to regulators

In the countries where headquarter visits took place, also meetings with the regulatory authorities were set up. In all countries it was stressed that a media based approach was now replaced by an integrated approach and the BREF was consulted for the identification of BATs. Two of the visited had transferred their existing emission limit values from the national regulation into the IPPC permitting process. The pre-IPPC legislation was stringent in one case and relatively lenient in the other. In a third country, the operator is requested by the authorities to compare all environmental aspects of the installation under concern with the BREF recommendations. Thus, any recommended emission levels in the BREF are used as a basis for consideration of emission limit value conditions. All regulators stated that local conditions can play a role in setting emission limit values, sometimes as early as in the planning process of an industrial site.

Moreover, remarkable differences in the frequency of plants inspections and monitoring became obvious. Economic and competitiveness considerations could not be answered by the interviewed regulators. It was said that they did not take the Economics and Cross Media BREF into account. Only one authority reported that it would take economic considerations into account if it negotiated emission limit values which are stricter than the general binding rules in place in the Member State concerned.

8.2.6 Overall conclusions on the crystal glass sample

In the A plants of the crystal glass sample which were mostly located in Member States with stringent national environmental regulation prior to IPPC implementation, no negative competitiveness impact is expected from IPPC implementation. This is mainly due to the fact that environmental investments were already undertaken in the 1990ies.

The specific situation of a declining market for crystal glass which was also the case in the segment of the A producers (but on average less severe than in the B plants) does therefore not play a decisive role for the relationship between IPPC implementation and competitiveness.

Two of the analysed A performers were regulated using general binding rules and in two A sites an installation-specific approach was used for implementation of the IPPC Directive. Only moderate complaints about higher monitoring and reporting efforts were recorded. There was no overall hint that early acquisition of an IPPC permit e.g. already in the year 2000 would trigger any benefits for a regulated company.

In other Member States with a more lenient history of regulation, any competitiveness impact depends on the speed and extent of harmonisation of pre-IPPC legislation with the conclusions made in the glass BREF in terms of notion of BAT and BAT associated emission values. In these cases it will be in particular difficult for the economically weaker plants to bring up the investment resources for a swift and stringent implementation of IPPC. Still, even in the case of the B producers interviews with executive managers at the headquarter level highlighted the fact that IPPC implementation is not a factor which influences long term company development.

A serious obstacle on the side of the authorities seems to be a certain lack of economic know-how when issuing permits as well as in part extreme variances in monitoring efforts and reporting duties across the EU.

No particular observations were made in terms of a negative impact on SMEs. There were many small plants among the A plants showing that a high level of environmental performance is possible without a detrimental impact on competitiveness.

Implementation of BAT sometimes triggered a negative price impact. However, in the A plants these price effects could be balanced through other positive impacts of a certain BAT e.g. on process efficiency or product price.

The problem of non-EU competition and a possible related loss of competitiveness due to higher environmental standards in the EU seems to be fairly limited in the crystal glass sample. This would be because all plants stated that their products are of higher quality than those of their non-EU competitors and that non-EU competition hits only those segments of the markets where there is price competition.

8.3 Results for the soda-lime glass sample

This chapter presents the results for the soda-lime glass producers and follows in its structure the presentation of the results for the crystal glass sample.

8.3.1 Composition of sample and brief overview of results

Composition and size of soda-lime sample

From the seven sites producing soda-lime glass three already had an IPPC permit in place. One of these permits was a new one, one was reviewed and no information was available for the third permit. Two other companies had applied for an IPPC permit, but had not yet obtained a reply from the authorities. Two plants were planning to apply in the near future. Two plants, one A and one B plant, were located in Non-EU countries and were subject to stringent environmental legislation.

Two plants reported in the survey that they did not experience any competitiveness problem due to IPPC implementation (see table 46). This was also in line with the consistency check undertaken in the same way as for the crystal glass producers in the sample. The sites with no competitiveness impact arising from IPPC implementation are again called A plants. These two A plants were of medium size. One of these plants was a newly established site which had just applied for an IPPC permit, the other one was a plant with a long history of production and with an IPPC permit from 2005. Both A plants were subject to stringent emission limit values for dust and NO_x emissions. Five other plants expect a negative impact from IPPC implementation of which the extent in two plants was explicitly reported to be only a small decrease in profit. Two of them already have an IPPC permit with stringent emission limit values for both dust and NO_x emissions. One plant had applied for an IPPC permit. In its current permit only dust is stringently regulated, but not NO_x emissions. Two further B plants have not yet applied and are currently subject to quite lenient regulation.

Table 46:
Composition of the soda-lime glass sample according to competitiveness impacts

Descriptive sample item	A plants expecting no detrimental impact from IPPC implementation	B plants expecting a detrimental impact from IPPC implementation
Total number and size of plants	2 medium sized plants	5 of which 4 medium sized and 1 large
IPPC permit, with stringent emission limit values for dust and NO_x emissions	1	2
Application for IPPC permi;, stringent pre-IPPC limit values	1	1 (only dust is stringently regulated)
Not yet applied for IPPC permit; lenient pre-IPPC regulation	0	2

Brief overview of survey results

It is found in the sample of soda-lime producers that furnace size does not matter for a favourable implementation of IPPC. Both a plant with a large furnace and a plant with several small furnaces was among the A performers. Furnace age was about five years across the entire sample with the lifespan of a furnace producing soda-lime glass to be up to eight years. Thus, sample furnaces can be considered to be in an good to average technical state which is likely to be a favourable factor for IPPC implementation. Furthermore, different types of furnaces were found among the two A plants.

A plants were doing better in all economic categories like growth of turnover and employment situation, profitability measured by EBIT and also in terms of investment ratios. Moreover, the level of international exports was higher in the A plants, also the growth rate of research and development activities was higher in the A plant. The rate of capacity utilisation was equal across the sample.

In terms of the type of competition the entire sample seemed to compete on a mixture of price and quality to a certain extent. However A plants stressed their ability to produce goods in large quantities tailored to the needs to its customers a lot more than B plants did. Overall, for both parts of the sample it became clear that environmental cost pressure is one of many cost pressures both in relation to the EU and non-EU competitors and therefore one of many competitive disadvantages. However, the survey answers suggest that environmental cost pressure is a more pronounced competitive disadvantage in relation to Non-EU competitors in particular for the B plants of the soda-lime sample.

From the limited amount of detail on the impacts of individual BAT implementation concerning NOx and dust the same result as in the crystal glass sample seems to hold true, i.e. A plants invest earlier and with more favourable economic impacts in BAT.

As in the crystal glass sample the A producers of the soda-lime sample seem to be more pro-active in their general understanding of environmental policy than the B plants. The entire sample encountered various obstacles in the permitting process, but A plants have given a higher priority to helpful factors than B plants.

8.3.2 Analysis of plant specific factors influencing the relationship between competitiveness and IPPC implementation

In the following we compare the plant specific survey data of the A plants with that of the B plants in the soda-lime sample.

8.3.2.1 Technical data of the soda-lime glass sample

Table 47 below shows average furnace melting capacity in the A plants was about 70 tonnes per day. The newly built plant, however, had a much larger furnace size than the other A plant where several smaller furnaces were operated. Average melting capacity per furnace was with 78.8 tonnes per day higher in the B plants compared to the A plants. With respect to furnace age measured as the number of years after the last rebuild there was with about 5 years not much difference between the A and B plants.

Different types of furnace technologies were in place in the soda-lime glass sample. The A plants used cross-fired regenerative and end port regenerative furnaces as well as recuperative unit melters. Also the majority of the B plants used these techniques for their furnaces with only two of the five B plants using electric and mixed electric in one of their furnaces. Also oxy-fuel firing was installed in only one B plant on one furnace.

Table 47: **Soda-lime glass producers: comparison of technical data**

Technical data	**Average A**	**Average B**	**Average All Soda-lime**
Average furnace size in tonnes per day	70.1	78.8	73.6
Furnace age, years after last rebuild	5	4.6	4.5

8.3.2.2 Basic economic data of soda-lime glass sample

In table 48 basic economic data for soda-lime glass producers is shown. Since one of the A plants is a new site, no growth rates can be reported for this plant. For reasons of confidentiality no quantitative data on growth rates of the remaining, already existing A plant can be shown.

Overall, in almost all sample plants there was a decrease in employment. However, the decrease was on average (and also on the individual plant level) much stronger in the B plants (> 20%) than in the existing A plant. Growth of turnover was clearly positive in the A plant, whereas it was on average negative in the B plants. Simultaneously, the growth rate of production was more negative in the A plant than in the B plants where it was – 5%.

Furthermore, the so-called EBIT ratio (indicating earnings before interest and tax relative to turnover) was very high in the existing A plant, in fact the highest in the sample, whereas it was only around 2% in the B plants. Also, the ratio of investment over depreciation during the last five years showed a remarkable advantage for the existing A plant in comparison to the B plants.

Table 48: **Soda-lime glass producers: comparison of economic data**

Economic data	Average A	Average B	Average all soda-lime
Employment growth, 2000-2005, in %	Decrease, but lower than in B plants	- 20.2	- 15.9
Growth of production volume, 2000-2005, in %	Strong decrease	- 5	- 7
Turnover growth, 2000-2005, in %	Positive	-2.9	- 2.1
EBIT, average 2002-2005, in % of turnover	Very high	2	4.2
Ratio investment over depreciation, average 2000-2005	> 1	< 1	< 1
Level of physical productivity	n.a.	58.9	n.a.
EU export quota, in 2005	High, but lower than in B plants	50.0	47.0
International export quota, in 2005	Higher than in B plants	25.5	30.2
R&D expenditures as % of turnover in 2005	Low	1.7	0.45
Growth rate of R&D expenditure, 2000-2005, in %	Very high	0.5	4.4
Rate of capacity utilisation in 2005	> 60 %	66.9	67.4
Growth rate of capacity utilisation 2000 – 2005, in %	Strongly negative	0	3.03

The level of physical productivity, i.e. tonnes per employee, can only be calculated for the B plants and is 58.9 tonnes per employee per year. For the A plants no average could be calculated because the figures for the newly built plant was distorted due to start-up conditions.

The percentage of turnover made on the national market varied between 20 to 30% for all plants in the sample. Concerning their EU export quota the A plants reach a high, but lower level than the B plants; with respect to international exports the A plants are doing better than the B plants. Main EU export destinations are Germany, France, UK, Spain and Italy. Worldwide the U.S., Australia, Japan and Brazil are the most frequently enumerated export countries.

With regard to the level of research and development spending the B plants have spent more than the A plants in 2005. However, the growth rate of R&D expenditures between 2000 and 2005 is higher in the A plant. The rate of capacity utilisation is stable across the sample with about 60 -70%. In the past the rate of capacity utilisation had remained the same in the B plants, but it had strongly fallen in the A plant.

8.2.3.3 Type of competition in the soda-lime sample

One of the A plants gave a high importance to price as the single most important competitive parameter in certain segments of its market. The plant was not able to charge quality premiums for its products, but it stressed the importance of continuous innovation and its ability to offer a large variety of products. Also the other A plant indicated that price was the most important competitive parameter in some of its market segments. However, the plant had a medium ability to charge quality premiums. This latter plant also attached a particularly high importance to the fact that it was able to serve high-quality segments of the industry, that it was relying on continuous innovation and that it was able to offer a large variety of products tailored to the needs of its customers.

One of the B plants clearly stated that price was the single most important competitive parameter for all its production and that it was not in a position to charge quality premiums. Another two of the B plants strongly suggested that price was the single most important competitive parameter, but only in certain segments of their markets. These two plants attached a medium importance to the possibility of charging quality premiums to their customers. The same two plants stressed that they had a strong bargaining position vis-à-vis their suppliers and buyers. The remaining two plants seemed to compete on a mixture of price and quality. Continuous innovation and the ability to offer a large variety of products was found significantly less important by all B producers in comparison to the two A plants.

8.2.3.4 Competitive advantages and disadvantages of soda-lime glass producers in relation to EU and Non-EU competitors

Most of the competitors of both A and B plants are located in Italy, France, Germany, the Czech Republic, Turkey, Romania and Bulgaria.

Comparison with EU competitors

In terms of competitive advantages vis-à-vis their EU competitors one A plant thought of both the quality of its products and its lower prices as a strong competitive advantage. The other A plant thought that its product quality was a small disadvantage for it in comparison with EU competitors. In both A plants the capital equipment was seen as strong competitive disadvantage towards EU-competitors. One A plant argued that its environmental costs were a strong disadvantage for it due to a sharp increase in the stringency of regulation. Still, it was able to absorb the costs. The other, newly built A plant regarded environmental costs as a neutral factor. Two of the B plants regarded their environmental costs to be a neutral factor of competition. Two other B plants argued that their environmental costs were a disadvantage in comparison to their EU competitors. For the fifth B plant no information concerning its estimation of competitive advantages and disadvantages was available. Three B plants also regarded their products to be of lower quality than those of their EU competitors.

Comparison with Non-EU competitors

In terms of Non-EU competitors A and B plants named Turkey, Brazil, the U.S. and Indonesia. Individual competitive advantages were seen in quality, but only to a limited extent in most cases both in the A and B plants. Only two B plants stated that higher quality was a small competitive advantage for them in comparison to its Non-EU competitors. Five sample plants thought that labour costs, energy and electricity as well as environmental costs are a strong competitive disadvantage for them, one of these plants was in the A sample. The other A plant considered environmental costs to be a neutral factor of competition in terms of Non-EU competition.

Overall, for both parts of the sample it became clear that environmental cost pressure was one of many cost pressures both in relation to the EU and non-EU competitors. However, environmental cost pressure was found to be a more pronounced disadvantage in relation to Non-EU competitors in particular for the B plants of the soda-lime sample (see table 49 below for a summary of nominations).

Table 49

Soda-lime glass sample: Most important competitive advantages and disadvantages vis-à-vis EU and non-EU competitors, frequency of nominations

Categories	**Competitive advantages and disadvantages vis-à-vis EU and non-EU competitors**							
	A sites				**B sites**			
Input indicators	EU		Non-EU		EU		Non-EU	
	Comp. Adv.	Comp. Disadv.	Comp. Adv.	Comp. Disadv.	Comp. Adv.	Comp. Disadv.	Comp. Adv.	Comp. Disadv.
Lower labour costs				1				4
Lower energy and electricity costs				1				4
Better raw material availability or lower cost								
Better capital equipment	2					3		
Lower environmental costs		1		1		2		4
Other:								
Output indicators								
Higher quality	1	1						
Lower prices	1							
Better co-operation with suppliers/customers								

8.3.2.5 Plant size and BAT specific compliance costs

As in the crystal glass sample only little data was available for the investigation of the relationship between plant size and BAT specific compliance costs. The detail is as follows:

BAT specific compliance costs varied substantially across the entire sample. They were estimated to be 20 M Euros in the newly built A plant and they accounted only for an investment in 54.000 Euros or 0.08% of turnover (and 2.6 Euros per tonne of product) for a low NO_x burner and about 12.000 Euros of operating costs of a dust filter in the other A plant. However, in two of the B plants investments of about 2 M Euros were necessary. This was equal to 3.6% of turnover in one case (about 121 Euros per tonne of product) and more than 9% (about 58 Euros per tonne of product) were expected in the other. Differences in costs reflect differences in production size. However, in the latter case it was clearly stated that the application for an IPPC permit which would require this investment for an electrostatic precipitator would only be undertaken when the plant´s furnaces would have to be rebuilt anyhow. One plant also calculated operating costs of dust removal to be about 60.000 Euros annually. A third B plant reported BAT specific investment of 600.000 Euros. In this case unfortunately no comparison with the plant´s turnover could be made; the investment amounts to about 115 Euros per tonne of product. More details on the costs of individual BATs are presented in section 3.2.6 below.

8.3.2.6 Economic impacts of BAT implementation

All soda-lime sample plants reported that new environmental technologies were required as a result of IPPC implementation. One of the A plants needed a low NO_x burner for some of its furnaces. In the B plants more investment was necessary, e.g investment in both NO_x and dust reduction in several plants.

Where BAT costs could be expressed as % of total annual investment these figures varied between 8 and 10%. Highest investment costs were found for dust removal and waste water treatment measures. Individual data from the questionnaire annex was available only in four cases. A short comparison of the main impacts in A and B plants according to BAT category is given in the following.

Overview of economic impacts for A and B plants in the soda-lime sample

With respect to NO_x reduction no negative impact on product price and markets served occurred in the A installation, but it was the case in one B installation. Also, whereas impacts in the B plants were often considered to be neutral, the A plant managed to get positive effects for process efficiency and product quality. Concerning dust, there were relatively high investments in bag filters throughout the sample with the A installation starting its investment much earlier than the B installations. One of the latter encountered a negative price impact, but largely the impacts were equally neutral across A and B installations. Concerning the reduction of SO_x emissions as well as of fluorides and chlorides not sufficient data is available in the soda-lime sample. Only B installations invested in waste water measures. Impacts from investment in waste water treatment mostly were either neutral or positive. Two negative impacts on price were reported. Impacts from waste activities undertaken in B installations were mixed. From the limited amount of data it is difficult to tell the differences between A and B installations. However, at least concerning NO_x and dust the same result as in the crystal glass sample seems to hold true, i.e. A plants invest earlier and with more favourable economic impacts in BAT. The detail is as follows:

NO_x reduction

One of the A installations was very active in terms of NO_x reduction where it had implemented four BAT measures in 2004. A low NO_x burner on one furnace as well as a reduction of the sulphate level in the batch had positive impacts on process efficiency and product quality and had no impact on product price and markets served. The measure of a less oxidised flame and the reduction of nitrate in the batch also were reported to have no impact on product price and markets, but a negative impact on process efficiency and product quality was measured. Investment and operating expenditure for these measures were relatively low and stayed below 30.000 and 20.000 Euros respectively. Three B installations had also invested in NO_x reduction activities. One had invested in combustion modifications in 2002 and reported negative impacts on product quality, product price and markets. Another installation had in 1992 installed a mixed melter and reported neutral impacts. The third B installations had invested in a low NO_x burner in 2006 and reported neutral impacts. The investment amounted to 78,000 Euros or 0.14% of its turnover in 2005.

Dust removal

One of the A plants had already in 1986 invested in scrubbers for dust removal. This was the earliest date in the entire soda-lime sample. The investment was said to be economically neutral. Three B installations had also invested in dust removal, but a lot later than the A installations. Where the investment dates were available, they were 1999 and 2001. In two installations data on economic impacts were available, all impacts were neutral except for price which was negative in one case. Absolute investment was 440.000 and 650.000 Euros or 0.8 and 0.9% of turnover.

SO_x reduction

Only one B installation had invested in 1999 in natural gas in order to reduce SO_x emissions. The measure was reported to have had negative economic effects.

Reduction of fluorides and chlorides

Again only one B installation had invested in this category. However, no data on potential impacts was available.

Waste water

Only B installations had invested in waste water measures. Two B installations had already a waste water treatment plant. One had installed it in 2006 with an investment of 200.000 Euros. However, it expected economic benefits of 150,000 Euros annually and reported positive effects on process efficiency, product quality and product price. The other B installations had already in 2001 invested 75,000 Euros and mostly reported neutral effects on its business. A negative price impact was reported due to the waste water treatment plant. The same installation reported identical impacts for an investment in alteration of piping made in 1992. Furthermore, one of the two installation had invested in alternative surface treatment methods and claimed positive impacts on process efficiency, product quality and product price. A third B installation had undertaken a small investment in cooling waste water and reported neutral impacts. One of the other two B installations had also invested in this activity and reported neutral impacts and even a positive impact on price.

Waste

Three B installations had invested in waste activities. One installation had in 2000 invested in the recycling of cullet and reported positive impacts on process efficiency, product quality and product price. However, a negative effect on process efficiency, product quality and product price was quoted from an investment in waste segregation undertaken in 2003. Impacts from recollection and disposal of sludge in another installation were reported to be neutral in one B installation. In the third installation which segregated its waste since 2004 a positive impact on product price was reported, other impacts were neutral. Effects from recollection and disposal of sludge were reported to have a negative impact on price, but otherwise being neutral.

Energy efficiency

Plants were also asked whether IPPC implementation has an impact on energy efficiency: One of the A plants did not expect an increase in energy efficiency and the newly built A plant did not yet know anything on this issue. From the B plants only one plant expected an increase of energy efficiency by 5%, two others denied this possibility and further two plants stressed that the use of dust filters will lead to a growth of energy consumption and that overall energy efficiency might be reduced.

Other

One installation had invested in noise reduction as much as 440,000 Euros or 0.9% of its turnover. The impact on business of this initiative were said to be neutral by large, but impact on price was negative.

8.3.3 Changes due to IPPC implementation compared to previous regime in the soda-lime sample: implementation specific sectors

8.3.3.1 General understanding of the drivers of environmental activities

Concerning the general understanding of the plants' internal environmental policy and management the A plants in the soda-lime sample had as their counterparts in lead crystal a more proactive approach to their environmental activities in place. They ranked all possible answers, those related to regulation as a driver of environmental activities and those related to other business activities with the highest or second highest possible importance. Most B plants also gave regulation and cost reduction the highest significance as motivation for their environmental measures. But particularly the improvement of product quality and the chance to enter new markets was only in one case evaluated to be a very important and integrated part of environmental policy.

8.3.3.2 Potential obstacles to IPPC implementation compared to previous regime

Plants were also asked whether they experienced any obstacles in the IPPC permitting process compared to the previous national regime which had an impact on their business activities. One A plant heavily complained about the lack of resources at the production site, all other factors listed as possible answers in the survey were seen as unimportant. The second A plant thought all factors except the need for more monitoring and reporting as serious obstacles in the IPPC permitting process. Also one of the B plants encountered a complete series of obstacles, while another one did not come across particular obstacles and three others all reported about lack of information, know-how and resources. One of these plants stressed as important that authorities were not willing to sufficiently take into account the time needed to introduce BAT. Considering the average ranking values of obstacles to IPPC implementation shown in Table 50 below it can be illustrated that A producers in the soda-lime sample experienced on average less obstacles to IPPC implementation than the B producers. Only with respect to an increased length of the permitting process from application to take-up of (changed) production the A sites gave an higher average ranking values as an obstacle than the B sites.

Table 50:
Average ranking of obstacles to IPPC implementation: sample of soda-lime glass producers

Obstacles to IPPC Implementation	**Average A sites**	**Average B sites**	**Average total soda-lime sample**
Lack of information on IPPC at the production site:	**3**	**3.6**	**3.4**
Lack of know-how and skills concerning IPPC at the production site	**3**	**3.8**	**3.5**
Lack of resources / public support at the production site	**4**	**3.8**	**3.9**
Increased length of the permitting process from application to take-up of (changed) production	**3.5**	**2.7**	**2.9**
Lack of phasing-in plans by authorities, disruptive approach of authorities, breach of former agreements	**2.5**	**2.6**	**2.6**
Authorities were/are not willing to sufficiently take into account the time needed for introducing Best Available Techniques	**2.5**	**3.2**	**3.0**
Authorities did not sufficiently co-ordinate permit-related activities among themselves or were ill-informed about the permitting procedure (e.g. lack of guidance). This resulted in confusion, additional work etc.	**2.5**	**3.0**	**2.9**
More frequent monitoring and/or inspections of authorities and related time and effort for us	**1.5**	**3.0**	**2.6**
More frequent reporting and related time and effort for us	**2.0**	**3.4**	**3.0**

Notes: Averages of a ranking from 1 = no obstacle at all to 5 = serious obstacle

8.3.3.3 Helpful factors to IPPC implementation compared to previous regime

Plants were also shown a list with potentially helpful factors in the IPPC permitting process. One A plant stressed the importance of one-stop-shop permitting and the existence of the BREF as well as the coincidence of IPPC with its own efforts to improve environmental performance as particularly helpful for IPPC permitting compared to the previous national permitting process. The other A plant was less active in its own efforts for environmental improvement, but stressed most of the listed helpful factors as important. Data was only available for four B plants and it was reported several times that IPPC coincided with their own efforts to improve environmental performance. In three B plants no particularly helpful factors were observed. Considering the average ranking values of helpful factors for IPPC implementation as shown in Table 51 below illustrates the fact that A sites found almost all listed helpful as more facilitating with respect to IPPC implementation than it was the case in the B sites. Only the fact that IPPC permitting coincided with the own efforts of sites to improve environmental performance was ranked to be of equally high importance for both A and B sites in the soda-lime glass sample.

Table 51:
Average ranking of helpful factors in the IPPC implementation process of the soda-lime glass producers

Helpful factors in IPPC implementation process	**Average A sites**	**Average B sites**	**Average total soda-lime sample**
"One-stop shop permitting" (e.g. single authority responsible for entire permit)	**5**	**2.5**	**3.4**
Permitting facilitated by voluntary/negotiated agreement between company and authority	**4.5**	**3**	**3**
Existence of BREF (Best Available Technique Reference Document) or guidance on BAT to prepare permit application	**5**	**3**	**3.7**
Phasing-in plans by authorities compared to more disruptive or time-insensitive approach previously	**4**	**2**	**2.7**
Relationship with authorities has become more co-operative	**4.5**	**1.8**	**2.7**
IPPC permitting coincided with our own efforts to improve environmental performance	**3.5**	**3.8**	**3.7**
Knowledge/experience about preparation of application for permit(s) prior to IPPC	**5**	**2**	**3**

Notes: Averages calculated from ranking values in the range of 1 = did not happen or apply to 5 = very helpful

8.3.3.4 Administrative costs of IPPC regime

The survey also asked for the extent of administrative costs of IPPC implementation. It was found that there is a wide variation. In one A plant no data was available and in the other costs were with about 3,000 Euros the lowest in the sample.

Also in one B plant no data was available. Three of the B plants had spent between 50,000 and 60,000 on staff time. In another plant staff time was only evaluated with 17,000 Euros. Consultancy costs in all four B plants where data was available varied between 7,000 and 47,000 Euros. In the entire sample only one plant had to pay a one-off permit fee. Total administrative costs varied between 0.01% for a large plant and 0.04 and 0.19% of turnover for medium sized plants.

8.3.3.5 Stringency of emission limit values in IPPC permitting

Emission limit values were very strict in the A plants, in one case even stricter than the BAT associated emission levels for dust emissions. But also the NO_x emissions in one of the B plants were more stringently regulated than the BAT associated emission levels suggest. In another one the current NO_x emission limit was already close to the BAT associated emission level for NO_x emissions. However, the current dust limit was very lenient. Three further B plants expected a jump in either only their dust regulation or both dust and NO_x regulation. Concerning dust all plants would face in the future emission limit values coming close to the BAT associated emission levels of 30 mg/Nm^3. Their current level of regulation varied between 30-50, 50 and 150 mg/Nm^3. With respect to NO_x emissions only one plant which currently had a permit with an emission limit value of 1800 mg/Nm3 expected an ELV of 500-700 mg/Nm^3 in its future IPPC permit.

In one of the seven soda-lime producers in the sample IPPC was implemented using general binding rules. This site was classified as a B producer. In all other sample sites installation-specific regulation was in place.

8.3.4 Results from headquarter visits in the soda-lime sample

There were two visits of headquarters in the soda-lime sample, one of an A and one of a B plant.

In the A company IPPC did not have a negative impact on productivity. On the contrary, after the introduction of a low NO_x burner melting efficiency increased by 50 %. As constraints to increasing productivity the lack of better melting facility and faster forming equipment were listed. Expectations of growth were negative due to low market demand. Some capacity in hand-made glass was already closed down. There are big fluctuations in the sales to supermarkets. One internal factor influencing growth was said to be machine capacity. A high capacity and speed on the production line reduces energy costs per unit as well as labour costs. Other limiting factors were said to be high wages and the quality of the glass. IPPC regulation did not play a role as a constraint to growth. Machine made goods were largely exported to supermarkets in Germany, the UK, France and Poland with a very strong price bargaining position towards the visited A company. Plans for production and delivery of products are agreed on year in advance between the company and the customer. For machine made products Turkey was mentioned as strongest Non-EU competitor. Turkish companies were regarded to have a competitive advantage due to more lenient environmental regulation.

The most important factor influencing sales of the company was seen in its flexibility in production and ability to produce glass in special colours, in large quantities and good quality. Environmental matters did not matter at all in this. Green products seemed not to play a role at all. Neither did location play a role (e.g. concerning better availability of raw material).

The company complained about the short time period to meet IPPC standards. The main objective of the investments in the last five years was to increase efficiency and quality. There was no investment necessary because of IPPC implementation. The company was in compliance without additional investment. R&D efforts are undertaken in-house and it was said that they also have an impact on environmental performance.

The company was aware of the fact that in the future sulphate and nitrate in the raw material will be regulated more stringently. This could have an impact on competitiveness. Also, IPPC could have an impact on energy consumption.

In the B company up to 80% of all products were said to be subject to heavy international competition. Only technical innovations or marketing developments enable the company to create a differentiation in the market and to keep enough profitability. Basic articles and copies of their success stories are sold 30 to 40% cheaper by Asian and Turkish competitors.

The company did not emphasize any particular constraints for increasing productivity, product quality or value added. However, it thought that there can be situations where environmental investment will be at the expense of other investment increasing productivity. As the A company the B company sold a large part of its products to supermarkets with very strong bargaining power. The important factors for influencing sales were quality, price, innovation and service. Environmental issues did not matter. IPPC was said to have no major impact on growth of the company. Growth influencing factors were rather seen in the control of the company´s distribution net, in a reduction of labour cost and delivery time. Most competition is coming from outside Europe where costs are lower. The strongest competitive pressure was felt by the company in its low end segment where volumes are high; also in glass drink ware there was strong competition. The company stated that the main elements it would compete on are (among other things) a mixture of quality, design, price, service and reactivity. As a major factor influencing competitiveness the strong evolution of customized products was mentioned. These products require new adapted processes. Furthermore, e.g. shorter production, digital decoration techniques and new colours play a role for competitiveness. The ability to innovate plays a core role. The company had a very strong R&D department and also had an R&D section with developments for manufacturing glass with lower environmental impact at reasonable cost. This includes innovative melting and manufacturing technologies with less emissions. BAT related problems like difficulties with electric melting for fining glasses were overcome mostly by in-house R&D.

8.3.5 Results from visits to regulators

Regulators of both the A and the B company were visited. Information in relation to the A company was very limited, more details are available for the B company.

In the A company the main difference between the old and the new system was that a single media regulation was replaced by integrated permitting. BAT shall be included in the permits as the highest possible standard. There were no complaints by industry since the law is now equal for all installations. The authority reported that local conditions can be taken into account through planning law in local zones. Monitoring of the regulated installation under concern is undertaken by the authorities themselves. Potential competitiveness impacts are not taken into account when the authority sets emission limit values. Administrative costs of the IPPC scheme are lower than under the old system. A fixed fee is directly paid by the regulated company to the authority.

In the B company sector integrated permitting had been in place long before the IPPC Directive and there were only minor changes necessary to fully implement the IPPC Directive. There are sector guidelines for the glass industry describing best available techniques and related emission limit levels which may be even stricter than the BAT associated emission limit levels described in the glass BREF. The sector guidelines are only partly based on the glass BREF since the BREF was recognised by the authority as a source for getting an overview of the glass sector and not so much as a reference document for determining emission limit levels. The main change compared to the previous permitting system is the explicit inclusion of the BAT approach. The use of cleaner technology has been taken into account in the past but it has not been adopted by legislation. Now BAT is considered when new installations are permitted. The installations have to prove that they use BAT. Emission limit values in the new permitting system mainly stayed the same for the glass industry; some minor changes were made to emission limit values and there was no reaction from industry when the IPPC permitting system was integrated in the existing permitting system. Also most procedures stayed the same. With respect to enforcement it was said that IPPC installations are inspected once every three years. The glass installations themselves have to monitor their emissions and annually report to the inspection authority. There was no information on economic and competitiveness impacts arising from IPPC implementation available. The administrative costs of the new IPPC scheme did not change. The authorities had made a comparative calculation of administrative costs prior to the implementation of the IPPC Directive. The Economics and Cross Media BREF was only used concerning cross media issues, but not in relation to economic impacts of BAT and BAT associated emission limit levels. Thus, overall, it seems that IPPC itself has not brought major changes to the regulated B installation. Any decrease in profits must be accrued to national regulation prior to IPPC.

8.3.6 Conclusions on the soda-lime sample

Certain operators in the soda-lime segment of domestic glass production reported to a various degree economic pressure arising from IPPC implementation. The available data for BAT investment requirements showed indeed for certain installations which were previously less stringently regulated a high absolute level of investment measured both as a percentage of turnover or of total annual investment. This investment need was independent of the type of IPPC implementation approach, be it via general binding rules or through a case-by-case approach. Simultaneously a high percentage of the soda-lime glass market is exposed to heavy international price competition. This import pressure is much more intense than in comparison to the crystal glass market or also the borosilicate market (see the sector review on chapter 6 for respective data). Therefore the competitive pressure on certain sites within this market segment may be intensified by additional costs caused by IPPC implementation. This will be the case particularly for the low end of the soda-lime glass market where there is fierce price competition. Any abrupt change in the stringency of environmental regulation due to IPPC implementation may have the potential to create additional competitiveness problems for certain installations of this market segment. However, as in the other two market segments examined in this study, environmental pressure was just one of many competitive pressures for the soda-lime glass producers in the sample. Therefore the extent of competitiveness impact stemming from IPPC implementation alone will be limited in comparison with e.g. impacts arising through differences in labour costs with respect to Non-EU competitors. Also at headquarter level it was confirmed that IPPC implementation itself is not a decisive aspect of company development.

8.4 Results for the sample of borosilicate glass

Only two medium sized sample plants produced borosilicate. Due to this limited amount of information the analysis in this segment remains qualitative.

8.4.1 Composition of the sample and brief overview of results

The first plant had an IPPC permit in place and expected a decrease in profit due to IPPC implementation. It had estimated additional BAT costs to be 20% of annual investment cost. The second plant intended to apply for a permit soon and did not expect any decrease in profit. It also estimated their additional BAT costs to be only 10% of annual investment cost. Corresponding to the terminology used in the segments of crystal and soda-lime glass we call the first plant B plant and the second A plant.

Overview of results

As in the crystal glass and the soda-lime sample the A plant was better able to absorb any additional cost of regulation because it had an overall better economic performance. Furthermore, in the implementation process itself the A plant encountered hardly any obstacles, whereas the B plant is.

In the following paragraphs the detailed results are presented.

8.4.2 Analysis of plant specific factors influencing the relationship between competitiveness and IPPC implementation

8.4.2.1 Technical and economic data

The A plant was with a melting capacity of 150 tonnes per day quite large and its furnace was just rebuilt. The B plant was with a melting capacity of 100 tonnes per day of medium size, but its furnace was also very recently rebuilt. Two thirds of the turnover of the B plant were made on the national market, whereas the export quota of the A plant was almost 80% with the largest export share going to members of the European Union. During the period of 2000 to 2005 employment in the B plant had decreased by 30% and turnover had remained constant. During the same period of time the development in the A plant was much more dynamic: Not only grew its turnover by 27%, but also employment increased by 5%. Whereas production in the B plant fell by 4%, it increased by 8% in the A plant. Still, labour productivity was lower in the A plant. However, both plants reported that their gross operating profit measured as a percentage of turnover (so-called EBIT ratio) was negative during the last three years. No comparison concerning the ration of investment over depreciation costs was possible. The rate of capacity utilisation was higher in the A plant, but growth rates of capacity utilisation were equal in both plants producing borosilicate glass.

8.4.2.2 Type of competition

The B plant clearly operated in a market where price was the most important aspect of competition for the entire production programme. Moreover, it sold the largest amount of its products to supermarket chains where there was no bargaining position possible for the plant. The A plant, however, stated that price was only important in certain segments of its production programme and that the plant was able to charge certain quality premiums for its products. Furthermore the A plant claimed to have a strong bargaining position towards vis-à-vis their buyers and suppliers.

8.4.2.3 Competitive advantages and disadvantages of borosilicate producers in relation to EU and Non-EU competitors

The A plant strongly complained about the disadvantage of higher labour costs in comparison to its EU competitors, but thought that environmental costs were neutral. A big advantage was seen in the plant´s better co-operation with customers and suppliers. In comparison to Non-EU competitors, also better co-operation, but in addition higher quality as well as better raw material availability were reported as important competitive advantages. As the strongest competitive disadvantage with respect to Non-EU competitors both lower labour costs and prices were named. Lower environmental costs of Non-EU competitors were only ranked as a moderate competitive disadvantage for the plant.

In the B plant the strongest competitive disadvantage towards EU competitors was not seen in higher labour costs, but in lower prices. Lower electricity and energy costs as well as environmental costs were also regarded as fairly important disadvantages. As in the A plant a strong competitive advantage was seen in the plant´s better co-operation with customers and suppliers. Vis-à-vis Non-EU competitors lower labour, electricity and energy costs as well as environmental costs were seen as strongest competitive disadvantages. Better co-operation and higher quality were the most important competitive advantages of the B plant with respect to its Non-EU competitors.

8.4.2.4 Plant size, BAT specific compliance costs and economic impacts of BAT implementation

The A plant had invested in modification of combustion, oxy-fuel firing, bag filters and cooling modifications, but did not give any cost details. Combustion modification was the only BAT implemented before the year 2000, all other BATs were quite recently implemented and all with positive or neutral economic effects. Other than the B plant the A plant did not encounter a negative impact on process efficiency and product quality from the operation of bag filters. It only stressed that there was an operating cost associated with bag filters.

The B plant invested 300,000 Euros or 1% of its turnover in BAT specific equipment and had operating costs of 21,000 Euros. The specific BATs were combustion modification, batch formulation, oxy-fuel firing and bag filters. Oxy-fuel firing was in place since 1991, the other BATs were implemented quite recently. Only bag filters were said to have a negative impact both on process efficiency and product quality. No specific difference in the timing of the BAT investment could be found between the A and B plant.

The energy efficiency increased in both plants. In the B plant it was said that this due to the implementation of BAT during the last furnace repair. This has produced energy savings on the furnace of 23% for gas, 23% for oxygen and 5% for electricity. However, these measures were introduced due to price pressures of the market and not as a response to IPPC.

8.4.3 Changes due to IPPC implementation compared to previous regime

8.4.3.1 General understanding of the drivers of environmental activities

The A plant clearly had a more business integrated understanding of its environmental activities than the B plant. Whereas the A plant ranked all possible answers in this category with the highest number (i.e regulation, improvement of production process and product quality etc.), the B plant only saw in regulatory pressure and environmental responsibility of the management the highest importance. All other, more business related answers were ranked to be of low importance.’

8.4.3.2 Potential obstacles

Both plants complained heavily about the lack of resources in place for IPPC implementation. Moreover, the A plant expected a lack of know-how in the plant and also was afraid of the length of the permitting procedure. No other particular obstacles were observed.

8.4.3.3 Helpful factors

The B plant thought that the one-stop-shop permitting procedure in its country and the co-operative relationship with the authorities were of greatest help in the entire permitting procedure. Also, voluntary/negotiated agreement between the authorities and a phasing approach were estimated to be quite helpful factors. The A plant did not expect any particular helpful factors.

8.4.3.4 Administrative costs

(Expected) administrative costs amounted to about 65.000 Euros (0.09 and 0.02% of turnover respectively) in both plants with the largest percentage spent on consultancy services. Only the B plant had to pay a one-time application fee.

8.4.3.5 Stringency of emission limit values

The B plant was in its new IPPC permit subject to quite stringent dust emission limit value of 30 mg/Nm^3. In the previous permit the limit had been 100 mg/Nm^3. The NO_x emission limit value was with 5400 mg/Nm^3 quite lenient and had remained the same in comparison to the old permit.

The A plant expected in its future IPPC permit a dust emission limit which would be by two thirds stricter per tonnes of product than the current limit. Also, the NO_x emission limit value was expected to become more stringent by one third per tonne of product produced.

While in the A site IPPC was implemented via general binding rules, in the B case an installation-specific approach was in place.

8.4.4 Results from headquarter visits

There was a visit to the B plant. It was stated that IPPC or other environmental regulation does have an impact on company profitability because of the need to implement control and/or abatement processes which do not add value to the product. The cost of these processes cannot be passed on to the customers. It was also stated that the funding of environmental control measures has taken away investment from productivity enhancement and/or new product introduction. The latter is together with price and cost the decisive factor for growth.

However, overall, it was stated that IPPC has no major impact on growth. Within the EU it was thought that early implementation of IPPC offers a short term advantage towards those Member States which are slower in the implementation process. Especially, the low end price sector is under pressure from outside EU competition. Then lower environmental costs are a competitive advantage for Non-EU competitors. The company has a strong R&D department which also helps to overcome environmental problems. There were no technical problems due to BAT introduction. Thus, it seems, even when IPPC slows down immediate profits to some extent, there is no long term impact.

8.4.5 Results from visits to regulators

There was also a visit to the regulator of the B plant. The main result was that national emission limit values were transferred to the new IPPC permit. These previous limits are valid until new limits are applied. Thus, there is some phasing-in element which is advantageous for business.

8.4.6 Conclusions on the borosilicate glass sample

Due to the limited number of observations the results on borosilicate glass are not as firm as in the other two samples covered by the survey. However, the main trend that competitive plants can withstand legislative pressure is likely to be confirmed also for borosilicate glass. Again, the history of stringent environmental regulation played a role for an implementation of the IPPC Directive without detrimental impacts on competitiveness. The A site was regulated by general binding rules and had had for a long time stringent emission limit values in place. Plants which experience an abrupt increase of the level of environmental stringency are likely to encounter more economic pressure. Still, the nature of the observed case of a decrease in profitability seemed to be short term, rather than long-term since at the headquarter level it was reported that IPPC does not have an impact on growth. Also, at the plant level no impact on price could be measured arising from IPPC implementation. With respect to non-EU competition especially the low end segment of the borosilicate market is hit. But even if environmental pressure is a strong competitive pressure, it is one of many pressures and according to the cost structure e.g. labour costs are of greater importance for international competitiveness than environmental costs.

8.5 Summary and overall conclusions

In the following first of all the results of the survey in the domestic glass sample are summarised according to the set of hypotheses developed in chapter 8.1 of this report (see section 8.5.1). First of all the results are summarised according to the plant specific factors influencing the relationship between competitiveness and IPPC implementation; then the implementation specific factors are presented. The findings are shown for the three product groups and their sub-classification in A and B performers. Second, a summary of the findings with headquarters and regulators is presented in section 8.5.2. Overall conclusions follow in section 8.5.3.

8.5.1 Comparative summary of survey findings according to original set of hypotheses

8.5.1.1 Plant specific factors influencing the relationship between competitiveness and IPPC implementation

Hypothesis 1: The stronger the competitive position of plants is in terms of input indicators like age of machinery and R&D efforts (the likely explanations for competitiveness), the easier it will be for a plant to integrate environmental regulation.

Answer: Across all product groups of the sample a very modern capital stock was found. This is likely to be a positive factor in implementing BAT in a competitive way. However, R&D efforts (measured as % of turnover in 2005) were always stronger in those plants and companies which did not consider themselves to be negatively affected by IPPC implementation. This confirms the hypothesis that plants and companies with strong R&D facilities can also more easily integrate environmental requirements arising from IPPC legislation than other plants and companies with a weaker R&D base.

Hypothesis 2: Plants with a strong competitive standing in terms of output indicators (the consequences of strong competitiveness) like growth of turnover, growth of employment, high profitability and high investment ratios, high physical productivity, high export quotas and high capacity utilisation are more likely to adapt to environmental regulation and its cost consequences more easily.

Answer: The hypothesis was confirmed for most variables, i.e. is indeed true for domestic glass making that the plants with a better competitive standing are in a better position to absorb additional costs from IPPC implementation. However, there was some variance in the single product groups as is shown in table 52 below. In crystal glass all but two output indicators of competitiveness were stronger in the A plants compared with the B plants. Only international export quota could not be identified as a stronger factor than in the B plants and both in A and B plants there were decreases in employment. Also in the sample of borosilicate producers the A plant was stronger than in the B plant in all output categories except profitability. No comparison could be made for the ratio of investment over depreciation costs due to a lack of data. Finally, with respect to the soda-lime sample, growth of production volume seemed to be lower for the A part of the sample, capacity utilisation was the same in A and B plants and no data on the level of physical productivity is available.

Table 52

Comparison of output indicators of competitive performance in the domestic glass sample

Output Indicator of Competitiveness	Crystal glass	Soda-lime glass	Borosilicate
	A plants in comparison to B plants		
Growth of turnover	>	>	>
Growth of production volume	>	<	>
Growth of employment	=	>	>
Profitability	>	>	<
Investment ratio	>	>	n.a.
Physical productivity	>	n.a.	<
International export quota	=	>	>
Capacity utilisation	>	=	>

Hypothesis 3: Plants and companies which are less exposed to price competition, will be less vulnerable to the additional costs of environmental regulation because they are in a better position to pass on environmental costs on price.

Answer: The answer varies according to the product type: Within the crystal glass and the borosilicate sample the A plants are clearly able to charge quality premiums to a greater extent than the B plants where price competition makes the plants more vulnerable to an increase of production costs caused by IPPC implementation. Across the entire soda-lime sample there was a mixture of price and quality competition making the product segment in general more vulnerable to any cost increase induced by environmental regulation. However, the ability to offer a large variety of products tailor-made to the needs of their customers was found significantly less important by all B producers in comparison to the two A plants in the soda-lime sample.

Hypothesis 4: Plants where environmental pressure is just one or a less important pressure amongst other competitive pressures, are more likely to integrate the costs of environmental legislation into their business activities.

Answer: Environmental pressure was measured to be one of many competitive pressures exerted on sample plants and almost all plants felt this as a disadvantage. But there was a certain variance between the product groups. In crystal glass less A than B plants regarded environmental costs as a severe disadvantage in comparison with EU competitors; however, almost the entire crystal glass sample felt environmental costs to be serious disadvantage when a comparison with non-EU competitors was made. In the soda-lime sample environmental cost pressure was found to be a more pronounced disadvantage in relation to Non-EU competitors in particular for the B plants of the soda-lime sample. The A plant in the borosilicate sample did not rank environmental costs to be a disadvantage in comparison to its EU-competitors and also with respect to its Non-EU competitors environmental costs were seen only as a moderate disadvantage. The B producer in the borosilicate sample, however, felt environmental costs as a strong disadvantage both in comparison to EU and non-EU competitors.

Hypothesis 5: The size of plants will have an impact on the relationship between regulation and competitiveness on the plant/firm level since the cost of compliance is likely to be a negative function of the size of plants/firms. I.e. smaller plants are more likely to suffer from a loss in competitiveness by stringent environmental regulation than large plants.

Answer: Where investment in BAT was required or expected as a demand of IPPC implementation, no clear relationship between compliance costs and plant size could be discovered. With the limited amount of data available we can only state that investment requirements for small plants do not appear do be greater than those for medium sized plants (see table 53). However, it is found that in those cases where the pre-IPPC system was relatively lenient in terms of emission levels, investment demand was found to be a relatively high percentage of both turnover and annual investment, in particular for some of the B plants on soda-lime and borosilicate glass production.

Table 53

Overview of available BAT specific compliance cost data in the domestic glass sample

BAT specific investment costs measured	Small plants – A and B category	Medium sized plants, A and B category
as % of turnover in …		
… crystal glass	0 (in two A plants),1 (B)	0 (A), 0.4 (A)
… soda-lime glass	n.a.	0.08 (A), 3.6 (B), 9.0 (B)
… borosilicate glass	-	1 (B)
as % of total annual investment in …		
… crystal glass	n.a.	n.a.
… soda-lime glass	n.a.	8 (B), 10 (B)
… borosilicate glass	-	10 (A) 20 (B)

Hypothesis 6: There will be differences in the economic impact of implementation of individual BATs across plants. Those plants which are able to gain positive effects of BAT investment e.g. on process efficiency or product quality are likely to be less negatively affected by BAT in their core competitiveness aspects.

Answer: Concerning BAT measures for the reduction of NOx and dust emissions in both the crystal and soda-lime glass sample it is found that A plants invest earlier and with more favourable economic impacts in BAT. In the borosilicate sample this result is confirmed only for dust abatement techniques and no specific differences in the timing of BAT investment were identified. No specific results concerning the timing of investment was found for borosilicate production.

8.5.1.2 Implementation specific factors

Hypothesis 1: Plants with a history of stringent environmental regulation and a pre-IPPC permitting system which is similar to the IPPC regime will find it easier to adapt to the IPPC regime.

Answer: This hypothesis is confirmed for the crystal and the borosilicate sample, where almost all A producers are located in countries where there is a history of stringent regulation and where the similarity between pre-IPPC and IPPC regime is high. Simultaneously there are cases in the crystal and also in the soda-lime sample where some A producers are located in countries where environmental regulation has been more lenient and the integrated approach to environmental regulation is new. There must be other helpful and hindering factors which may be more or equally important for a successful implementation of the IPPC Directive (see hypothesis 2 and 3 below).

Hypothesis 2: Implementation of the IPPC Directive is undertaken in the survey sample through general binding rules and case-by-case approaches. It is hypothesised that plants which are subject to a strong increase in the stringency of the emission limit values in their IPPC permits compared to their previous permits are likely to suffer from a loss in competitiveness due to a possibly sharp increase in compliance costs irrespective of the type of implementation approach.

Answer: Whilst it was found that there were five sample cases where IPPC was implemented via general binding rules, there were eleven sample sites in which a case-by-case approach was undertaken. Although the majority of sites regulated by general binding rules were classified among the A producers with stringent regulation and no impact on competitiveness, there were also sites where case-by- case regulation was relatively stringent and did neither trigger a harmful competitiveness impact. However, whenever there was a sharp tightening of emission limit values in the IPPC permits in comparison to the previous permit, it brought about the risk of a detrimental impact on competitiveness irrespective of the type of implementation approach.

Hypothesis 3: Plants which encountered one or several helpful factors during the IPPC implementation process are less likely to suffer from a negative impact on competitiveness arising from IPPC.

Answer: There are indeed some helpful factors which facilitate IPPC implementation. Amongst them can be found a co-operative relationship with authorities, the availability of glass BREF as reference manual, one-stop-shop permitting and very importantly the coincidence of IPPC implementation with own efforts to improve the environmental performance of a plant. These facilitating factors were especially helpful where the IPPC regime induced a major change in comparison to the pre-IPPC regime.

Hypothesis 4: Plants which are confronted with a series of obstacles throughout the IPPC implementation process are likely to encounter competitiveness impacts which are stronger than in plants where there are less obstacles.

Answer: The hypothesis is confirmed for the largest part of the sample: Both in the crystal glass and the soda-lime sample obstacles like lack of resources, information and know-how on IPPC, lack of phasing-in plans and increased monitoring and reporting duties were found more frequently and with a higher importance in the B plants than in the A plants. In the borosilicate sample no pronounced difference could be found.

Hypothesis 5: IPPC can raise the administrative costs of permitting in some cases. Where this cost is significant as a % of turnover, it may have the potential for detrimental impacts on competitiveness.

Answer: The range of administrative costs of IPPC implementation in the sample varied between 0.01 and 0.19% in the sample. Due to this small level of costs no direct impact on competitiveness can be expected from this.

8.5.2 Summary of findings of interviews with headquarters and regulators

8.5.2.1 Findings of interviews with headquarters

Altogether six visits to headquarters of domestic glass companies were undertaken. There were three visits of crystal glass producers, two of soda-lime glass companies and one of a borosilicate manufacturer. A common baseline for all three product groups in the visited companies was that Non-EU competition threatens only the low-end of the market. In this market segment lower environmental costs of non-EU competitors are a competitive advantage for them. Simultaneously, lower labour costs seem to be the most important competitive advantage for Non-EU competitors. Companies also stated that there was no impact from IPPC on long term growth. However, there was some variation in the answers according to product group which is presented below.

Crystal glass

Two crystal glass producers (both were A producers) clearly stated that IPPC implementation did not touch upon profitability or competitiveness. Also growth rates of the companies under concern were not affected by IPPC. Moreover, it was stressed that modernisation of furnaces and environmental upgrading was undertaken with a simultaneous capacity increase. Strong R&D activities facilitated the take-up of BAT. These two companies had been subject to stringent regulation since a long time. In a third (B) plant where the application for the IPPC permit was still pending, it was also stated that IPPC currently did not touch upon profitability. However, the last environmental investment in that company was from the 1980ies and it was feared that in the future the authorities could put more environmental pressure on the company. This would raise environmental costs and have a negative impact on competitiveness.

Soda-lime glass

In the A company IPPC did not have a negative impact on productivity. As constraints to increasing productivity the lack of better melting facility and faster forming equipment were listed. Expectations of growth were negative due to low market demand. IPPC regulation did not play a role as a constraint to growth. In the B company up to 80% of all products were said to be subject to heavy international competition. The company thought that there can be situations where environmental investment will be at the expense of other investment increasing productivity. The strongest competitive pressure was felt by the company in its low end segment where non-EU competitors are heavily competing. The ability to innovate plays a core role for staying profitable. Therefore the company had a very strong R&D department where also research on manufacturing glass with lower environmental impact at reasonable cost was undertaken.

Borosilicate glass

The headquarter of a borosilicate manufacturer (B category) stated that IPPC or other environmental regulation can have a short term impact on company profitability because of the need to implement control and/or abatement processes which do not add value to the product and take away investment from productivity enhancement and/or new product introduction. The latter is together with price and cost the decisive factor for growth. Still, overall, it was reported that IPPC implementation has no major impact on growth. Within the EU it was thought that early implementation of IPPC offers a short term advantage towards those Member States which are slower in the implementation process.

Thus, it seems, even when IPPC implementation slows down immediate profits to some extent, there is no long term impact on growth paths of companies.

8.5.2.2 Findings of interviews with regulators

In the countries where headquarter visits took place, also meetings with the regulatory authorities were set up. Everywhere it was stressed that a media based approach was now replaced by an integrated approach. In most cases the BREF was consulted for the identification of BATs. In one case there were sector guidelines for the glass industry describing best available techniques and related emission limit values. These sector guidelines were only partly based on the glass BREF since the BREF was recognised by the authority as a source for getting an overview of the glass sector and not so much as a reference document for determining emission limit values. Many visited regulators had transferred the existing emission limit values from the national regulation into the IPPC permitting process. Since these pre-IPPC values showed differences in environmental stringency in the countries visited, there are indeed differences in the stringency of IPPC implementation across EU Member States. All regulators stated that local conditions can play a role in setting emission limit values. Economic and competitiveness considerations could not be answered by the interviewed regulators. It was said that they did not take the Economics and Cross Media BREF into account when regulating a plant. Only one authority reported that it would take economic considerations into account if it negotiated emission limit values which are stricter than general binding rules.

8.5.3 Overall estimation of the impact of different approaches to IPPC implementation and their impacts on competitiveness in the case study

In this case study different approaches of IPPC implementation have been identified by means of a survey among 17 domestic glass producers of which 16 answers have been used for the analysis. One crystal glass company producing jewellery was not used for the analysis in order not to distort the results of the other crystal glass companies producing mainly tableware.

The two main market segments studied here are crystal glass and soda-lime glass. Overall, the market for crystal glass is in general decline due to changing trends in style and a reduction in consumption. The survey results found in the sample of crystal glass producers suggest that IPPC is not found to be a major factor affecting competitiveness of this market segment. The segment of soda-lime glass is very price sensitive and exposed to fierce international competition. Generally, the sample results suggest that any increases of production costs for EU producers acting in the low end of the market are difficult to absorb. Further differentiations of results are as follows:

With respect to the impact of different types of IPPC implementation there were five sample cases where IPPC was implemented via general binding rules. Simultaneously, there were eleven sample sites in which an installation-specific approach was undertaken. Although the majority of sites regulated by general binding rules were classified among the A producers with stringent regulation and no reported impact on competitiveness, there were also sites where case-by- case regulation was stringent and did neither trigger a harmful competitiveness impact. However, whenever there was a sharp tightening of emission limit values in the IPPC permits in comparison to the previous permit, it triggered the risk of a detrimental impact on competitiveness irrespective of the type of implementation approach.

It was also found that environmental pressure was one of many competitive pressures faced by the domestic glass industry. This process has started long before IPPC implementation. Other competitive pressures like e.g. lower labour costs in Non-EU competitor countries exert a higher degree of pressure on the EU domestic glass producers than costs following IPPC implementation.

Overall, no significant impact of IPPC implementation on competitiveness and long term growth or company development of high quality segments of the domestic glass industry in the EU could be traced. This was the case across all product groups and also across different types of implementation approaches. That means that a plant could be an A plant experiencing no detrimental impact on competitiveness from IPPC implementation even when its pre-IPPC legislation was more lenient than the requirements of the new IPPC permit.

However, there are also certain risks connected to IPPC implementation. First of all, the competitive impact for the domestic glass industry lies in the low end part of its markets where there is a high degree of price competition and companies are exposed to non-EU imports coming in large quantities especially from China and Turkey.[68] This is the case regardless of environmental legislation, but the competitive impact may be increased through additional costs arising from IPPC implementation. The segment of soda-lime glass manufacturing is especially exposed to imports from non-EU competitors. A large part of the survey respondents producing soda-lime glass complained about non-EU competitors and negative impacts on profitability arising from IPPC implementation. Second, the case study also revealed that when there were jumps in the stringency of regulation, BAT specific compliance costs can indeed be demanding and have the potential to intensify competitive impacts which are already inherent to the domestic glass industry for other reasons (e.g. decreasing demand).

At the same time headquarter interviews with companies of all three product groups showed that IPPC implementation did have no impact on growth and market development which are central long term indicators of competitiveness. Therefore, the negative competitiveness impacts on profitability reported by this particular industry seem to be of a short-term nature because growth and company development was not affected in the long term.

Whilst no particular impact on competitiveness could be discovered, there was also no evident gain from IPPC implementation for industry: Early IPPC implementation e.g. already in 2000 did not yield an obvious competitive advantage for forerunners. Only one of the companies with an IPPC permit reported the fact that it had a stringent permit as a competitive advantage. However, in the entire industry environmental concerns did not seem to matter very much in the supplier-producer-buyer relations.

[68] E.g. in 2005 the import quota for all domestic glass is reported by CPIV to be about 29 %. Thereof imports of Turkey and China account for 79 %.

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9. Comparative conclusions on the two case studies and concluding remarks on the chosen research design

In this chapter the results of the two case studies are compared and the validity as well as the limitations of the study are addressed.

9.1 Comparative conclusions on the two case studies

Although the two case studies on electric steelmaking and domestic glass production do not follow an identical research approach, a broader comparison of main variables having a potential impact on the relationship between different approaches to IPPC implementation and competitiveness can be drawn.

In both case studies there were some common plant specific factors examined which seemed to facilitate the economically efficient adoption of the IPPCD.

Definitely a young plant/furnace age had a positive impact both in electric steelmaking and domestic glass production. The role of plant growth measured in terms of employment was less evident: A clearly positive impact could only be found for the soda-lime plants of the domestic glass sample. Also with respect to productivity (i.e. physical productivity measured in tonnes per employees) only in the crystal glass sample there was clear evidence for a positive role in the implementation of the IPPCD. Those sites which export a lot are potentially put at a disadvantage in the electric steel sample since in certain product segments sample sites are exposed to strong price competition on international markets. For domestic glass a more differentiated view on the role of further plant specific factors like profitability, investment ratio, R&D capacity etc. was possible and there was evidence that plants showing a higher performance concerning these factors experienced less or no competitiveness impacts arising from IPPC implementation (see also table 54 below). Due to data limitations this latter set of variables could not be tested in the steel sample.

Concerning the analysis of a possible relationship between plant size and compliance costs arising from IPPC implementation there was in both case studies only limited data available. From this data, however, there was in both case studies no evidence that small plants would suffer more from costs related to IPPC implementation than large plants.

Table 54 Overview of the type of the likely influence of plant specific factors having an impact on the relationship between IPPC implementation and competitive performance in the electric steelmaking and the domestic glass sample

Plant specific factor	Electric steelmaking sample	Domestic glass sample
Plant/furnace age	Positive	Positive in all segments
Plant growth (i.e. employment growth)	No clear evidence	Positive for soda-lime; little data for borosilicate; no evidence for crystal glass
Physical productivity (tonnes per employee)	No clear evidence	Positive for crystal glass; not enough data in other glass segments
International export quota	Depending on type of competition	No influence in crystal glass; positive for soda-lime; little data for borosilicate
Plant size	No evidence	No evidence for crystal and soda-lime glass; little data for borosilicate

The two case studies also analysed the potential influence of the type of competition and the role of cost pressure arising from environmental regulation relative to other competitive pressures on the relationship between IPPC implementation and competitiveness.

In both case studies there was evidence that sample sites operate under varying types of competition with the dominant characteristics being price and quality competition and sometimes a mixture of both. Sample plants operating in a business environment with a high degree of price competition were more vulnerable to an increase of environmental costs induced by IPPC implementation than those sample sites where quality aspects dominated the type of competition.

In both case studies environmental cost pressure was identified to be one of many competitive pressures. In addition, from the sector descriptions presented in chapters 5 and 6 in this study it became obvious that e.g. costs of raw material account for a much larger share in total production costs than environmental costs. This was generally acknowledged during interviews.

In the case studies the individual economic impacts of BAT implementation for each sample site were analysed. Data were scarce, but some interesting findings can be reported.

An analysis of individual economic impacts of BAT implementation showed for the electric steel case that in many cases investment in any BAT represented an additional cost for the plants with relatively long pay-back periods (if any). Still, there were cases where BAT investment was reported to trigger positive impacts on e.g. process efficiency and labour productivity.

Concerning certain BAT measures for the reduction of NOx and dust emissions in both the crystal and soda-lime glass sample it is found that plants which have invested earlier and have done this with more favourable economic impacts experience no competitiveness impacts from IPPC implementation.

Concerning the wider implementation specific and institutional context of the survey countries in both case studies it seems that countries with a history of stringent environmental regulation and a pre-IPPC system which was already similar to the IPPC regime experience no problems in the transition to the IPPC regime.

Simultaneously there are cases at least in the crystal and also in the soda-lime sample where environmental regulation has been more lenient and the integrated approach to environmental regulation is new. Still, the sites did not encounter any competitiveness impact when implementing the new IPPC system. Survey data of the domestic glass survey and interview material obtained in electric steelmaking proved that there are helpful factors on the institutional level which facilitate IPPC implementation. Amongst them can in both case studies be found a co-operative relationship with authorities, the availability of the BREF as reference manual, one-stop-shop permitting and very importantly the coincidence of IPPC implementation with own efforts to improve the environmental performance of a plant.

However, sample sites also encountered obstacles in BAT implementation. Both in the crystal glass and the soda-lime sample obstacles like lack of resources, information and know-how on IPPC, lack of phasing-in plans and increased monitoring and reporting duties were found to be frequently quoted obstacles in those plants reporting a negative impact on competitiveness. In electric steelmaking interviews revealed few complaints concerning the length of the permitting process from application to take-up of production. It was also found out that the introduction of BAT is usually aligned with the investment cycles and with the time necessary to experiment with new techniques. Complaints were especially raised in the electric steel sample sites that there can be several reporting duties at the same time. It was also pointed to the different types of monitoring across EU and non-EU countries which may result in cost differences and differential competitiveness impacts between plants.

The above has shown that even different perspectives on the available data and different ways of analysing the research material reach the same conclusions, i.e. that there is only limited evidence of any competitiveness impacts arising from IPPC implementation. In the sample IPPC implementation has not triggered any long term impact on growth and company development. However, it does not mean that there are no limitations of the study which require further thought (see section 9.2 below).

9.2 Concluding remarks on the chosen research design

In the following a few general and also some more specific concluding remarks on the chosen research design are presented.

Firstly, generally speaking, the chosen research approach has been a case study operating on multiple levels (institutional analysis, sector reviews and analysis of survey/interview data). On the level of data analysis it is in the nature of case studies that they usually operate with small data pools. Therefore no statistical generalisations can be made. Still, case studies are based on analytical grounds, i.e. aim at making plausible that the insights gained can be valuable in other situations. For this purpose case studies need to guarantee validity which refers to correctness of a description, conclusion, interpretation or an explanation. A major advantage of case studies is that they often combine quantitative and qualitative data and thus can shed light on otherwise intangible factors (e.g. the role of strategic positioning of management towards environmental policy issues). Moreover, a deeper understanding of the motivations of stakeholders can be gained than in a merely quantitative study focused on aggregated results. Very importantly, case studies achieve their validity – among other things - by developing a balanced view on positive and negative factors influencing the research area.

Secondly, there are also some more specific remarks on the scope and the robustness of the chosen research design in this study.

In comparison to the Hitchens study where a purely interview-based approach was chosen we have introduced the additional method of a survey in the sensitive area of measuring competitiveness impacts arising from recent environmental regulation. The survey method was chosen in order to obtain data for a large sample of both electric steelmakers and domestic glass producers. However, for both a survey and interview approach a high degree of industry cooperation is necessary. It was certainly experienced throughout the project that face-to-face interviews helped to build trust with industry and facilitated the understanding of the issue at stake. Therefore they not only improved the quality of the data collected during the survey by filling gaps and/or adding details, but sometimes even replaced the survey. Interviews must be regarded as an indispensable part of the research method applied in this study. The issue of confidence building and the need for interviews which are detailed by nature and time consuming in an international research context also imply that the sample size cannot easily be extended.

Overall, our research does not claim any cross-sectional or longitudinal validity as would be the case for research work based on census data. In particular, in the light of about 50.000 IPPC installations a comparison between the case studies is only possible to a limited extent. The study shows a largely qualitative character and does not aim at extrapolations on the total sector or other industries.

The robustness of research results certainly also depends on the one hand on the type of definition used for competitiveness and on the other hand also on the definition of what is considered a competitive distortion. Here clearly a multi-level approach of competitiveness using various indicators (e.g. plant growth, profitability etc.) and rankings (e.g. of competitive advantages and disadvantages) was preferred to a maybe more accurate, but at the same time more limited measure of competitiveness like e.g. an exclusive focus on the change in labour productivity induced by IPPC implementation. The advantage of the chosen approach is that it depicts both quantitative and qualitative factors influencing competitiveness which usually are missed when a mere quantification approach is applied. Qualitative details can usually only be generated by in-depth interviews. The disadvantage of the case study approach is that less emphasis can be put on quantitative estimations.

Concerning competitive distortions, the study could show a partial convergence in emission limit values between Member States which can be seen as a movement towards a more level playing field (inequality view of competitive distortions). Still – related to the baseline problem - it needs to be stressed that implementation of the IPPCD is likely to be only one triggering factor in the process of convergence next to other national and/or EU regulations and standards.

In most cases where data was available the BAT specific compliance costs were relatively low in the two case studies (apart from several cases where a (expected) rapid increase in the stringency of environmental regulation require sample sites to large investments). However, no attempt was made to measure the so-called hidden costs of regulation arising e.g. from monitoring, reporting etc. which would raise the level of overall compliance costs. Likewise, the methodology used in this study did not focus on the environmental benefits of IPPC regulation. In the light of the main aim of the IPPCD which is to secure a high level of protection of the environment as whole, this is an important point to be addressed in other studies of the overall IPPC review process.