FWC Sector Competitiveness Studies - Competitiveness of the Glass Sector

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Abbreviations and conventions

ANFFECC	Asociación Nacional de Fabricantes de Fritas, Esmaltes y Colores Cerámicos (National Spanish Association of Ceramic Frits, Glazes and Ceramic Pigments)
APFE	Association des Producteurs de Fibre de Verre Européens (Association of European Reinforcement Glass Fibre Producers)
BG	British Glass
CE	Cambridge Econometrics, Cambridge, UK
CPIV	Comité Permanent des Industries du Verre Européennes (Standing Committee of the European Glass Industries)
IDEA	IDEA Consult, Brussels, Belgium
DTI	Danish Technological Institute, Aarhus, Denmark
ECORYS	ECORYS Holding BV, Rotterdam, Netherlands
EDG	European Domestic Glass
ESGA	European Special Glass Association
EC	European Commission
ETS	Emissions Trading Scheme
EU	The European Union as it was in the year of reference, e.g. EU in 2003 would be the EU15; EU in 2005 would be the EU25
EU10	The ten Member States that acceded to the EU on 1st May 2004
EU12	The 12 Member States that have acceded to the EU since 1st May 2004
EU15	The bloc of 15 Member States that made up the EU prior to 1st May 2004
EU25	The bloc made up of the EU10 and the EU15
EU27	The bloc made up of the EU25 plus Bulgaria and Romania
EURIMA	European Insulation Manufacturers Association
FEVE	Fédération Européenne du Verre d'Emballage (European Container Glass Federation)
ICF	International Crystal Federation
IFO	CESifo, Munich, Germany
IPPC	Integrated pollution prevention and control
IPR	Intellectual property rights
SME	Small and medium-sized enterprises (typically defined as a firms with less than 250 employees)
SWOT	Marketing/ strategic analysis technique highlighting Strengths, Weaknesses, Opportunities and Threats

bn	billion
GfE	Glass for Europe
GWh	gigawatt hours
m	million

mt	million tonnes
kWh	kilowatt hours
MWh	megawatt hours
pa	per annum
pb	per barrel
pp	percentage point

Executive Summary

The Mid-term Review of Industrial Policy in 2007 concluded that the integrated approach adopted in 2005 has been successful and should be continued. In order to do so, an up-to-date understanding of sectors is required and in recognition of this DG Enterprise and Industry set up a Framework Agreement for analysing the competitiveness of industry sectors. This report presents the work undertaken to study the competitiveness of the EU glass industry. The information presented in this report is based on data and literature collected from desk-based research and a questionnaire, the findings of which are presented in boxes in chapters two and three.

In 2007 the EU glass industry produced around 37 million tonnes (mt) of various types of glass. Growth in output in the EU has been quite flat since 2000, with much of the increase coming from the expansion of the EU. In volume terms, container glass accounted for 58% of production in 2007, with flat glass on 27%. Tableware accounted for 4% while insulating and reinforcement fibres accounted for 6% and 2% respectively. In terms of location, much is still located in the EU15 (the bloc of 15 Member States that made up the EU prior to 1st May 2004) and, in particular, Germany, France, Italy, Spain and the UK, which together accounted for 68% in 2007. The EU12 (the 12 Member States that have acceded to the EU since 1st May 2004) was responsible for 15%, while the rest of the EU15 accounted for 17%. Germany is the biggest producer overall, while production in the EU12 is concentrated in Poland and the Czech Republic.

Employment in the EU glass industry has generally been on a downward trend since 2000. The level of employment did increase in 2004 and 2007 with the accession of new Member States, but otherwise the level has been falling, driven largely by a combination of productivity requirements, increased automation, industry consolidation and low-cost competition. In 2007 the EU glass industry employed 234,000 people. Across the Member States, Germany is the single biggest employer, with just under 50,000 employees in 2007. France is the next biggest employer, with 9% of the workforce. The EU12 accounted for almost 40% of employment in 2007, indicative of the differences that exist between the EU12 and EU15 in capital and labour intensities. Most of the jobs in the EU12 lie within Poland and the Czech Republic, which together account for around 71% of employment in the EU12.

Typically, extra-EU trade has formed only a small part of the industry, with volumes equating to just 5-10% of production or consumption. Within this, is worth bearing in mind that glass exported as part of a finished good (as opposed to as an intermediate/ unfinished good) can be more important to some sub-sectors, eg. container glass. Nevertheless, import growth has accelerated in recent years, especially in flat and container glass for example, and remains strong. (In 2007 Chinese float glass imports increased by 162%, to just under 550,000 tonnes, which means Chinese float glass

imports have increased tenfold since 2004.) Export growth has not accelerated to the same degree and remains modest by comparison. As a result, import penetration has increased overall, and quite substantially in some sub-sectors, while the proportion of output export is largely unchanged. Consequently, trade, and in particular the terms of trade for EU exporters, have become important issues for the glass industry.

The EU glass industry faces a challenging period over 2007-09 as economic activity slows in the wake of the credit crunch and demand slows. GDP growth in the EU is expected to slow from 2.8% in 2007 to 1.9% in 2008 and 1.7% in 2009. The construction sector looks to be especially vulnerable as household confidence and spending weakens, and investment demand is curbed. The construction sector is important for several glass sub-sectors, and as such the outlook for the glass sector is not good.

The flat glass sub-sector looks to be the most exposed, as the housing sector enters a downturn and weaker household spending forces automotive producers to curb production plans further, while demand for domestic glass can also be expected to suffer form a weaker housing market and weaker household spending. Both fibres sub-sectors are also likely to suffer from a slowdown in construction activity, as lower building activity hits demand for insulation and structural material. While initiatives to support the housing market and the construction market would help the glass sector, it is difficult to implement them without distorting the market and so the prospect of any substantial initiative seems unlikely.

These challenging conditions will be exacerbated by the expansion of capacity in countries neighbouring the EU. Over 2004-09, an estimated 7.3 mt of production capacity will be added across several countries, including Russia, Ukraine, Belarus, Qatar, UAE and Egypt. Most of this increase will come in flat glass and container glass. With such expansion trade seems likely to continue to grow and this reinforces the need for policy makers to ensure that EU glass producers are operating on the same terms.

Against this backdrop of weaker demand in the EU and increasing competition from imports from neighbouring countries in the medium term, EU producers are likely to find it harder to rely on conventional products and revenue streams. With policy makers embracing the climate change challenge more fully, the glass industry has an opportunity to introduce more new products and educate policy makers on the benefits that glass products can deliver. To help foster the markets for these products and both help tackle climate change and support the glass sector, it is important for policy makers to consider the environmental and energy benefits that can be delivered by glass when setting policy and taxes on energy/carbon.

The EU glass industry is faced with a number of competitiveness challenges, many of which have been driven by globalisation, increased environmental regulation and rising energy costs. The gradual increase in the number of comparative low-cost glass products being imported from emerging economies is a sign that the EU glass sector's competitive advantage is diminishing, especially in the low-value product markets. Despite this, the report shows that the EU is still a major global player in several areas of the glass sector.

A second interrelated competitiveness factor is the increased environmental regulation that the EU glass industry is faced with, and there is concern about the full impact of Phase III of the EU ETS on the industry (a projection[1] for the UK container and glass sub-sector shows a three to four-fold increase in direct CO_2 purchase costs over 2013-20). The relatively high energy intensity of glass production makes the challenge of reducing carbon dioxide emissions especially demanding. The review shows that the technologies used in glass production to minimise energy use are already mature and that short-term future increases in efficiency are likely to be limited. One way the industry is reacting is by using increasing amounts of recycled glass in production and the review identifies the key benefits that this brings for glass producers, and society in general. However, even with increased recycling rates there are limits to the use of recycled glass because of purity standards and other demands imposed by the market. The availability of cullet can be an issue where, for example, it is diverted to the production of aggregates or because waste is not separated and makes recycling impossible. At the same time, weight-based targets for recycling and waste management tend to disadvantage glass (compared to substitute materials). Many of the barriers seem to be within the control of policy makers and authorities rather than the industry. If policy makers could be more aggressive in setting targets and standards, and authorities make more effort to recycle glass properly (or police the recycling), much more could be achieved with, for example, much less glass leaving the system.

The cost structures of energy-intensive glass producers are also disadvantaged by increasing input prices. A major factor here is the lack of competition in the markets for all raw materials, not just soda ash and crystalline silica (sand). This is compounded by a lack of competition in the energy market, which affects the glass sector directly, as an energy consumer, and indirectly, through its effect on the price of raw materials. The prices of some raw materials have increased as a result of the electricity sector passing through the environmental compliance costs. Together these trends are hindering the cost-effectiveness of EU glass producers.

Questionnaire results indicate the financial performance of the glass sector has come under increasing pressure since 2000, with net profit margins falling. Costs in the EU are reported to be significantly higher in the EU than in competitor regions, with labour costs, energy costs and environmental/ pollution compliance the main drivers. The general mood on future developments appeared to be more pessimistic than optimistic on balance, with compliance costs, for example, expected to increase and disadvantage EU producers further, while labour costs are expected to remain an issue. With regard to raw materials, the proportion imported by glass firms has risen since 2000. Although there is a fair degree of variation across sub-sectors, a figure of 30% is not unreasonable. Most questionnaire respondents expected this proportion to increase over the next five to ten years. Consequently, the sector has become more dependent on imports to meet its needs.

With regard to energy the price of energy in the EU has risen substantially since 2004 mirroring to a large extent the rise in the price of crude oil. A consequence of this is that energy costs are likely to account for a far larger share of operating costs than the roughly 20% estimated before oil prices surged. As a result, with regard to energy prices, the EU compares favourably against Japan, but less so against the US. EU industry would

[1] British Glass projection using CE assumptions, see pp. 65-68.

benefit form a better functioning, more competitive energy market to bring about more harmonised pricing and free firms from the decision of where to locate.
Looking across the EU, there is great variation in the price of electricity in the EU, created by differences in the cost of generation and the rate of taxation applied to end users. Gas prices and tax rates show less variation across the EU. These variations have implications for whether and where firms choose to set up operations and partly explains why glass firms have been leaving the UK and Italy and expanding in the newer Member States.

The main competitiveness problem that the EU glass industry faces is the relocation of production outside of the EU where environmental regulation is less stringent and Health and Safety laws are more relaxed. The specific economic problems this creates are reviewed. Relatively high levels of EU regulation has meant that EU glass producers are no longer competing on a level playing field in the global environment and this is handing a competitive advantage in certain markets to non-EU firms.

Whilst the negative effects of globalisation and increased environmental regulation are well documented, there is less literature regarding the potential economic benefits that it brings to the glass industry. Tighter environmental regulation has created a number of new opportunities for glass producers, especially in environmentally friendly items. Globalisation has encouraged specialisation in many markets within the EU and the EU is a world leader in producing *value added* glass products.

A systematic review through a framework profile of the glass sector was done, covering the regulatory conditions, the framework conditions and the so called exogenous conditions. The review was based on the literature survey as well as on additional sources. Particular attention was paid to the sub-sectors. For each of the various conditions surveyed, the assessment included the importance, the expected future trend, the geographical concentration, and significance for specific sub-sectors. Furthermore, another column was added to map the potential effects of each of the conditions on the competitiveness of the EU glass sector. This facilitates the subsequent step: matching the results with the ones of the competitiveness analysis. This indicates which of the potential effects that have been identified from a regulatory and framework perspective will bear further consequences in the field of competitiveness.

Based on an analysis of the framework grid we found that the following conditions have a substantial potential impact on the competitiveness of the glass sector as a whole:

- Cost of energy and security of supply
- Environmental regulations
- Regulations on working conditions
- Intellectual property right issues and counterfeiting
- Globalisation
- Competition from substitutes: alternative materials, and low-cost extra-EU imports

As far as regulations are concerned, environmental regulations dominate. The scheme for greenhouse gas emissions, the Integrated Pollution Prevention and Control, and REACH, as well as eco-design have substantial potential effects on the production costs.

Furthermore, a set of regulations affects the storage, handling and use of input materials which imply additional costs for production. However, it has to be mentioned that these regulations provide an incentive to invest in R&D for better energy efficiency, production methods and new products. The production process itself is perceived as quite mature. Yet in the area of outputs, the glass sector has a promising potential for energy efficient products, such as building materials or glass containers with a high recycled content. The returns on these investments are not always realised in the short run; energy efficient products represent an innovative and relatively young market, albeit a booming one. However, the adjustment and compliance costs of the environmental regulations and the aligned investments can be substantial and are felt in the short-run.

Other regulations that come to the forefront are intellectual property rights and regulations on working conditions. While glass is a labour intensive industry, the labour intensity of the glass sector varies across sub-sectors and regions. The flat and container glass sub-sectors are highly automated. Some parts of the domestic glass sub-sector are also highly automated but other parts are still very labour intensive. Stronger regulations on handling materials by workers provide a potential competitive disadvantage for the EU producers in comparison to companies located in countries with less stringent rules. Design protection may create a profitable market niche, yet the enforcement of the intellectual property rights remains challenging.

The costs of energy and globalisation are important framework conditions. Glass production is energy consuming. It has high sunk costs at the set-up stage. Production is to a large extent automated. Delocalisation towards low-wage countries is a threat since the relatively low wage costs provide a higher return on investment. As such a feedback loop is created. The new investments in the low-cost countries create excess capacity (in the short run at least) which in turn puts a downward pressure on prices, creating strong import competition for the EU based companies.

In terms of exogenous conditions, the competition from substitute materials is an issue of increasing importance. The container and domestic glass sub-sectors in particular face competition from plastic, carton, steel and aluminium. Regulations that apply to the glass industry do not necessarily apply to the industries where the substitutes are produced.

Not all regulations are equally important for all sub sectors, although some are relevant for the whole glass industry, e.g. environmental regulations and product regulations. Looking at the number of specific conditions that have a potential effect on the competitiveness of a sub sector, it appears that the conditions play a relatively larger role in the sub sector of domestic glass. Not only the amount of regulations matters, also the impact and weight in terms of competitive effect is relevant.

A strategic outlook for the EU glass industry in the medium to long term investigates these challenges further and explores possible strategic responses.

The European glass industry is still a major player in the world market for glass products and has good prospects for continuing to be so. However, the increase in the number of comparatively cheap glass products being imported from emerging economies is a sign

that in some sub-sectors, especially in flat glass and the low-value end of the domestic glass market, the EU's competitive advantage is put under pressure.

Looking at the European glass industry's strengths and opportunities, the most obvious opportunities seem to be most relevant to the parts of the industry producing high-value products, regardless of sub-sector. Firms producing glass products with high knowledge content have potentially a good chance to maintain and extend their position as a world leader in the market for high-value glass products. Currently, the European glass industry is a world leader in some areas of all glass-sub-sectors.

The European glass industry may build on its strengths as a world leader in the market for high-value glass products, giving higher priority to customers, branding, product development, cooperation, and R&D. The European glass industry may also respond to the growing demand for energy-saving products and processes, and engage more proactively in the climate change challenge and adapt a strategy to become a greener industry. Where it does, however, there will always be a challenge from non-EU producers who quickly learn how to manufacture the product and minimise the duration of EU firms' competitive advantage. The constant investment in production efficiency and maintaining a skilled, trained, and motivated workforce must be continued and encouraged.

In total, based on the SWOT analysis of the entire European glass sector and its sub-sectors, some of the key fields for strategic responses for EU policy makers and industry are indicated:

1. Seek product leadership
2. Engage in the climate change challenge
3. Increase efficiency and flexibility in production
4. Improve the skill base
5. Support a level playing field.

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1 Introduction

1.1 Background

In 2005 the EC set out for the first time an integrated approach to industrial policy with horizontal and vertical initiatives, to provide the right framework conditions for enterprise and innovation to succeed, and to drive the economy forward. The Mid-term Review of Industrial Policy in 2007 concluded that this approach has been successful and should be continued, with a focus on how best to respond to globalisation and climate change. And in highlighting the importance of productivity as a driver of long-term growth, the European Competitiveness Report 2007 reinforced the importance of industrial policy in helping to deliver the framework conditions that allow firms and employees to raise their productivity.

In order to sustain the progress made under the integrated approach an up-to-date understanding of sectors and the conditions affecting their competitiveness is required, and this prompted DG Enterprise and Industry to set up a Framework Agreement analysing the competitiveness of sectors and industries. Under this Agreement, the first set of competitiveness studies was commissioned towards the end of 2007, with the **glass** sector being the focus of one of them.

This final report presents the work undertaken on the competitiveness of the EU glass sector.

1.2 Purpose

The purpose of the study is to provide the EC with a clear and up-to-date understanding of the competitiveness of the EU glass sector (as it is now and how it might develop), which will then allow the EC to knowledgably engage with the sector in the development of horizontal and vertical policy.

This includes:

- Identifying the key aspects of the sector (performance, structure, processes and inputs) that can be described by reliable data sources or other available documentation;
- Identifying the competitive position of the sector in relation to main competitors;
- Identifying which horizontal aspects (eg regulation, labour force skills, infrastructure, energy supply, etc) are key issues for the sector;
- Presenting the strategic outlook for the sector, identifying threats, opportunities and policy challenges/issues.

1.3 Remaining sections

The Terms of Reference identified five key requirements:

1. The collection and presentation of data
2. A synthetic literature review
3. Assessment of the industry's competitive position on EU and global markets
4. Analysis of regulatory and other framework conditions which have an impact on the competitiveness of the EU glass industry
5. A strategic outlook

In relation to these requirements the remaining sections of this final report are organised as follows:

The collection and presentation of data is not confined to a single section or chapter. Collected data are used in chart and table form to illustrate and support points throughout the report where deemed necessary. However, most of the collected data that are presented in this report are used in chapters two and three.

Similarly, the synthetic literature review is not confined or relevant to just one part of the report, rather it is used to support and inform all sections of the report.

Chapter Two looks at key aspects of the glass sector by presenting some stylised facts on the way the sector operates. This includes a review of performance, structure, processes and inputs.

Chapter Three analyses the competitive position by looking at a similar range of factors, but focusing more on how they contribute to varying performance levels within sub-sectors and for individual firms.

Chapter Four presents and analyses the horizontal aspects relating to the competitiveness of the glass sector, including regulatory and environmental issues alongside external factors such as trade links outside of the EU.

Chapter Five presents a strategic outlook for the EU glass industry in the medium to long term based on an in-depth assessment of underlying trends, future competitiveness drivers, and challenges for the sector and its sub-sectors.

Finally, along with any supporting annexes, Chapter Six provides conclusions on the competitiveness of the EU glass sector.

2 Key aspects of the sector

2.1 Introduction

This section details the characteristics of glass as a product, and reviews the main types of glass relevant to the study. Using the data collected and the literature review, this chapter then presents an overview of the glass sector as a whole, and its sub-sectors, with a special emphasis on the new Member States where the data and literature permit. Where possible we review each sub-sector in relation to production, capacity and employment. We also try to identify the distribution and location of these across firms and countries, and the role of SMEs in the glass sub-sector. The importance of trade is also presented, along with the key EU and non-EU players.

2.2 Performance

2.2.1 Importance of the industry and its different sub-sectors

Glass In Society

Glass has been in society in its most basic form since circa 4000BC and was used mainly to produce weapons and jewellery, and by 1500BC glass vessels were used in cooking and drinking (British Glass, 2003). Glass has been developed for thousands of years and production methods have evolved considerably since its induction. A key factor that sparked a large increase in the mass production of glass was the development of the Solvay Process in the 1860s, which significantly reduced the cost of sodium oxide, a major input into the glass production process. Two important developments in the 20th century were automation, with the introduction of full mechanisation of bottle manufacture around 1920, and the introduction of the float process in 1952 for flat glass. Other major advancements in glass production have resulted from:

- Continuous large-scale production;
- Longer furnace lifetimes (typically 12-15 years, but in some cases (flat glass) even longer);
- Improved thermal efficiency;
- New production techniques (such as 'Just-In Time');
- Significant product innovation.

Improvements in the production process have led to a typical furnace output of 300 tonnes per day of molten glass (British Glass, 2003), but in some sub-sectors, such as flat glass, this figure is even higher: 500 tonnes per day is typical but some recent projects have hit 1000 tonnes per day. In the EU25, approximately 35mt of final product glass in various forms were produced in 2006 according to CPIV (Comité Permanent des Industries du Verre) estimations. Whilst production levels have increased, manufacturers

have also strived to further improve efficiency in what is an energy-intensive process, fuelled by the need to operate furnaces at over 1600°C. Improvements in furnace efficiency have had a significant impact on the amount of energy required to melt a tonne of glass. According to British Glass (2003), the recycling of glass has been a major factor since it uses 25% less energy than making glass from virgin raw material. Whilst this performance may sound impressive, EU glass producers have been put under further pressure from Governments to improve their efficiency due to increased environmental concerns by society, and this is something that is covered later.

A feature of glass is its versatility and that its specification such as its strength, weight, colour and appearance can be changed to suit demand and this has led to a number of glass sub-sectors which are reviewed below.

The Terms of Reference asked for '…key information on the EU glass industry as a whole, and on its sub-sectors, that is, container glass, flat glass, domestic glass, fibre glass, and special glass…'. Table 2.1 provides the statistical definitions of sub-sectors within the glass sector which we have tried to cover in the study. More detail on these sub-sectors is provided below.

Table 2.1 Glass sub-sector definitions

Sub-Sector	NACE Code	HS Code	Definition
Flat glass	26.11		Manufacture of flat glass
	26.12		Shaping and processing of flat glass
		7003	Cast glass and rolled glass, in sheets or profiles
		7004	Drawn glass and blown glass, in sheets
		7005	Float glass and surface ground or polished glass
		7006	Glass of 7003 – 7005 worked
		7007	Safety glass, consisting of toughened or laminated glass
		7008	Multiple-walled insulating units of glass
		7009	Glass mirrors, whether or not framed
Container glass	26.13		Manufacture of hollow glass
		7010	Carboys, bottles, flasks, jars, pots, phials, ampoules and other containers of glass
Domestic glass	26.13		Manufacture of hollow glass
		7013	Glassware of a kind used for table, kitchen, toilet, office, indoor decoration or similar purposes
Fibre glass (insulation)/ mineral wool	26.14		Manufacture of glass fibres
		7019	Glass fibres and articles thereof
Fibre glass (reinforcement)	26.14		Manufacture of glass fibres
		7019	Glass fibres and articles thereof
Special glass	26.15		Manufacture and processing of other glass (technical)
		7011	Glass envelopes, open, and glass parts thereof
		7014	Signalling glassware and optical elements of glass
		7015	Clock or watch glasses and similar glasses, glasses for spectacles
		7017	Laboratory, hygienic or pharmaceutical glassware
		8540	Thermionic, cold cathode or photo-cathode valves and tubes

Sub-Sector	NACE Code	HS Code	Definition
		8544	Insulated and other insulated electric conductors
		8546	Electrical insulators of any material
Glass frits	26.15		Manufacture and processing of other glass (technical)
		3207.4	Glass frit and other glass

- *Container Glass*

Container glass can be manufactured to suit the size, style or brand image of the final product, as well as being physically strong, transparent and impervious. It is used predominantly in packaging bottles for drinks and jars for food, and to a lesser extent in the packaging of pharmaceutical and perfume/cosmetics products (IPPC, 2001). The former are generally considered to be commodity items while the latter tend to be higher value-added products. Container glass is the largest sector of the EU glass industry, representing about 60 % of the total glass production, and the majority of container glass production is sold to customer industries within the EU, which then sell their packaged products into markets in the EU and the rest of the world.

- *Flat Glass*

Flat glass accounts for roughly a third of total EU glass production and the most common production process is the float method, which gives a superior product. The demand for flat glass is directly influenced by consumer demand for vehicles and commercial construction and housing (especially glazing). Flat glass production is a mature, cyclical, and essentially commodity business. In recent years the sub-sector has enjoyed strong and volatile output growth. According to CPIV estimates, 9.7 mt of flat glass were produced in the EU in 2006.

- *Domestic Glass*

In common with most sectors of the glass industry the domestic glass sector is an established mature business that experiences modest long-term growth in demand. Examples of domestic glass include products such as ovenware (cookware and heat resistant tableware), drinking glasses and giftware. Giftware is an important sector of the domestic glass sub-sector, producing high quality products using the latest technologies available, ranging from jewellery to home décor products. The domestic glass sub-sector accounts for around 4% of total EU glass output (CPIV). In lead crystal the best estimates indicate that the EU is a major global player with 80-90% of all lead crystal glassware being produced in the European Union.

- *Insulation fibres (mineral (glass) wool)*

The sector covers the production of glass wool fibre used for insulation (the production of stone wool fibre is part of the ceramics industry). These insulating materials are essentially randomly interlaced masses of fibre with varying lengths and bound by a resin based binder. Insulation fibres are typically used in building insulation (especially loft and cavity wall). The performance of firms in this sub-sector depends on activity in the building industry and the effect of building regulations. Although mineral wool is a mature technology, the business itself is constantly innovating. It is growing rapidly and is becoming increasingly competitive. One of the key drivers in recent years has been retrofit legislation aimed at reducing energy consumption and GHG emissions in the

housing stock in a bid to tackle climate change. The glass mineral wool sector represents around 6% of the total output of the glass industry.

- *Reinforcement fibres (continuous filament glass fibre)*

The production of continuous filament glass fibre is one of the smallest sectors of the glass industry in terms of tonnage, but the products have a relatively high value to mass ratio. Reinforcement fibres are used in the strengthening of composite materials, including thermosetting resins and thermoplastics. A considerable amount of production is devoted to the construction and optic fibre industries. On a global basis, the US is the biggest producer with over 40 % of worldwide output, Europe and Asia each account for 20 to 25%. Since products have a relatively high value and are readily transported there is significant international trade.

- *Special Glass*

The special glass sub-sector covers a range of products such as lighting glass, cathode-ray tubes, and specialised scientific and medical items such as optical glass and pharmaceutical tubing glass. There is some overlap between the special glass sector and other sectors of the glass industry, in particular the domestic glass sector, for some borosilicate and glass ceramic products, which are used for hobs and cookware. However, these products account for only a small share of this sub-sector's output. The special glass sub-sector is very diverse, and this is reflected in production processes and capacities. Most smaller producers of the low volume specialist products such as optical glass and glass for the electronics industry fall below the 20 tonnes per day production level. Of the plants producing CRT glass, lighting glass, borosilicate glass, and glass ceramics, most will be above this threshold. There are some integrated installations that produce a wide range of low and higher volume products, and in these cases total production may be above this level. This sub-sector also includes the production of water or liquid glass (formally Sodium Silicate), a glassy soluble compound which has a wide variety of applications, for example as a sealant, cement or binding agent, and for passive fire protection.

- *Glass Frits*

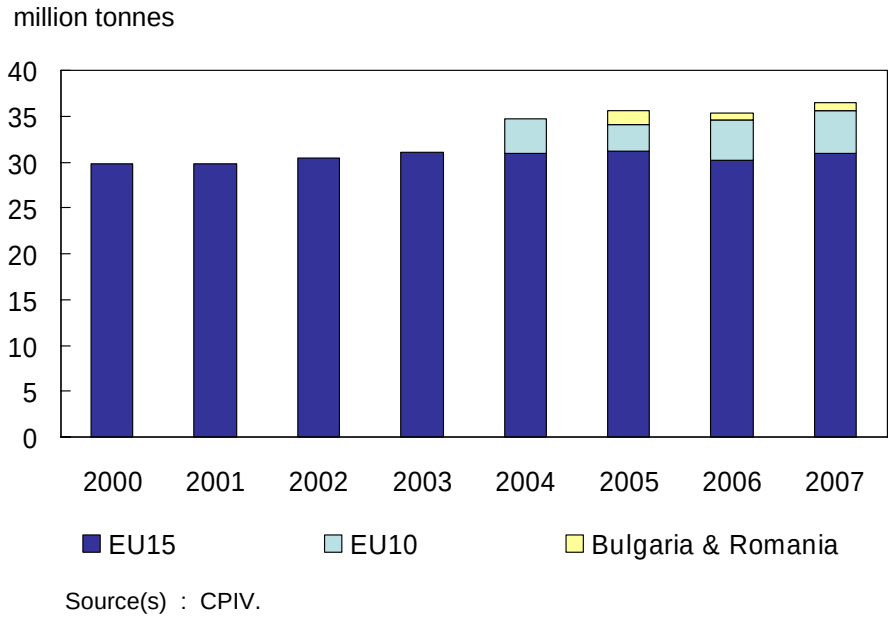
The sector covers the production of frits for glazes and enamels, which are used for decorating ceramic materials and metals. These glazes, when applied to the surface of ceramic bodies such as tiles and tableware, and then fired, provide an impervious, protective and decorative coating. It is a well established industry and has served the ceramics sector for many years. There is competition from other types of glazes (raw and plastic) but they suffer from leachability problems and the threat to enamel glazes is small. Production in the EU is estimated at 1-1¼ mt per year making frits one of the smaller sectors of the glass industry.

2.2.2 Distribution of production and employment within the EU

Production

Since 2000 the volume of total glass production in the EU has been broadly flat, with the EU15 producing 30-31 million tonnes (mt) each year between 2000 and 2007. However, there are variations in the performances of sub-sectors. The level of production increased to around 35 mt following the accession of 10 new Member States in 2004, but remained at around that level in the following years. In 2007, 37.5 mt were produced in the countries that now make up the EU27.

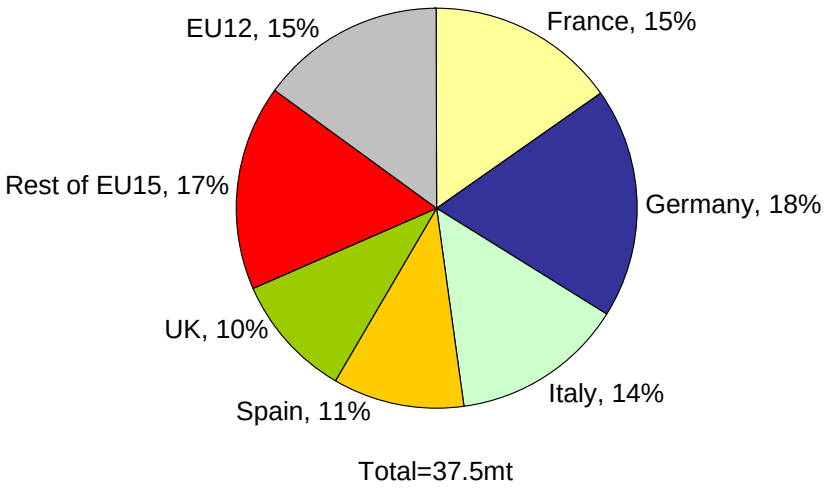
CHART 2.1: TOTAL EU GLASS PRODUCTION



Source(s) : CPIV.

With regard to the geographic distribution of production, in 2007 the five biggest producers of glass (France, Germany, Italy, Spain, and the UK) accounted for just under 70% of total EU production. The rest of the EU15 accounted for 17% with 15% coming from the EU12. Among the five largest producers, Germany produces the most. Production in the EU12 is concentrated in Poland and the Czech Republic. The Czech Republic is relatively specialized in flat glass compared to the rest of EU27, where container glass is the largest sub-sector in terms of output. In Romania meanwhile, the glass industry represents on 0.4% of national GDP, and 1.2% of EU glass production.

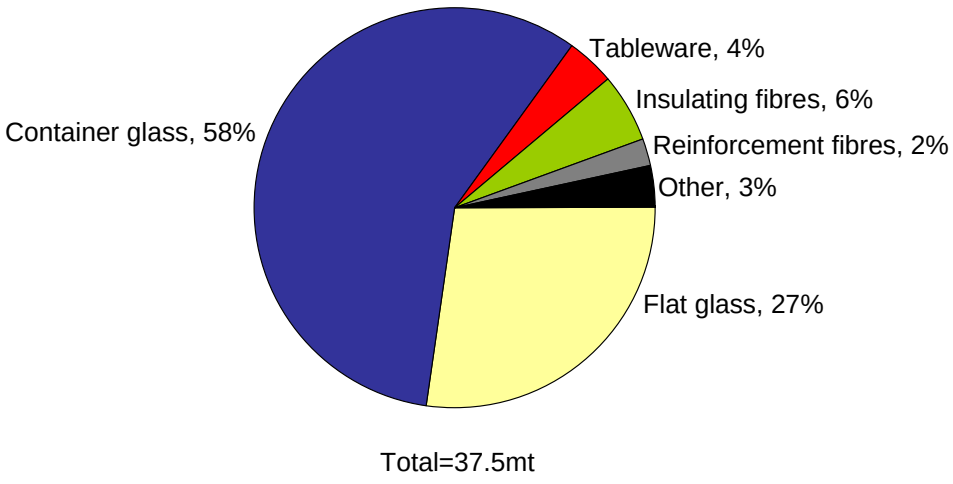
CHART 2.2: EU27 GLASS PRODUCTION BY REGION (2007)



Source(s) : CPIV.

Breaking down glass production by product, the chart below shows that container glass and flat glass are the main types of glass produced in the EU, with container glass making

CHART 2.3: EU27 GLASS OUTPUT BY SUB-SECTOR (2007)



Source(s) : CPIV.

up just under 60% of output in 2007; flat glass accounted for 27%. The remaining sub-sectors all account for 2-6% of EU glass production each.

The two tables below present a breakdown of recent production in the EU by sub-sector, although care should be taken in their interpretation, in particular the table with growth rates. As shown in chart 2.1, growth in production volumes in the EU has actually been virtually flat since 2000 and the impression of growth over 2000-07 is driven primarily by the expansion of the EU rather than organic growth.

GLASS PRODUCTION IN THE EU* BY SUB-SECTOR (million tonnes)

	EU15				EU25			EU27
Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Sub-sector								
Container	17.7	17.9	18.3	18.4	19.9	20.0	20.8	21.6
Flat	7.6	7.5	7.9	7.7	9.2	9.4	9.7	10.3
Domestic (tableware)	1.2	1.1	1.1	1.2	1.6	1.5	1.45	1.5
Reinforcement fibres	0.55	0.55	0.65*	0.65*	0.69	0.73	0.80	0.82
Insulating fibres	1.4	1.4	1.3	1.4	-	-	-	2.1
Other (incl. special glass)	1.3	1.3	1.3	1.2	1.2	1.2	1.1	1.2
Total	*29.7*	*29.8*	*30.6*	*30.6*	*32.6*	*32.8*	*33.8*	*37.5*

Note(s) : * Figures are EU15 for 2000-03; EU25 for 2004-06; and EU27 for 2007, except for Reinforcement Fibres which are EU25 from 2002 onwards; figures for Insulating Fibres not available for 2004-06.
Source(s) : CPIV.

In volume terms, the recent trends in sub-sector production are presented in the tables below. Note, that totals in the table might vary slightly with those in charts 2.1-2.3 due to differences in the collection of national and sectoral data. The general trends should still be captured, however. The total production volume in the EU increased by just under 20% between 2000 and 2007, from 29.7 mt to 37.5 mt, however this covers a period when the EU expanded to 25 Member States in 2004 and 27 in 2007. An analysis by EU bloc shows that growth in the EU15 was practically flat over 2000-03, with total output increasing by just 0.9 mt. Expansion of the EU to 25 members implied a large increase in production in 2004, but thereafter growth was variable: 0.6% in 2005 and then 2.9% in 2006. Overall the volume of output in the EU25 increased by only 1.2 mt over 2004-06. As a result, although the EU glass sector looks to have experienced robust growth over 2000-07 (implied annual average of 3.4%), in reality it hasn't. The apparent growth has been underpinned by significant increases in 2004 and 2007 due to the accession of ten new Member States.

GROWTH IN GLASS PRODUCTION IN THE EU* BY SUB-SECTOR

	EU15			EU25	
Year	2001	2002	2003	2005	2006
Sub-sector	(%)	(%)	(%)	(%)	(%)
Container	1.3	2.3	0.4	0.5	3.8
Flat	-1.1	5.0	-2.8	1.6	3.4
Domestic (tableware)	-9.3	3.7	7.0	-5.7	-2.0
Reinforcement fibres	-0.7	-	0.2	4.9	9.5
Insulating fibres	1.0	-7.9	12.5	-	-
Other (incl. special glass)	4.0	-3.3	-9.1	1.2	-11.7
Total	*0.3*	*2.6*	*-0.1*	*0.6*	*2.9*

Note(s) : *Figures are EU15 for 2000-03; EU25 for 2004-06; and EU27 for 2007, except for Reinforcement Fibres which are EU25 from 2002 onwards.
Source(s) : CPIV.

All sub-sectors have seen an overall increase in production volumes except for Other glass, which includes special glass. The biggest volume increases have come in container and flat glass where output has increased by 3.9 mt and 2.7 mt respectively between 2000 and 2007. The largest relative increases have been in reinforcement fibres and flat glass where output increased by 49% and 35% respectively between 2000 and 2007; production volumes in the container and domestic sub-sectors increased by 22% and 25% respectively. Flat and domestic glass saw the biggest percentage increase in production following the accession of ten new Member States in 2004.

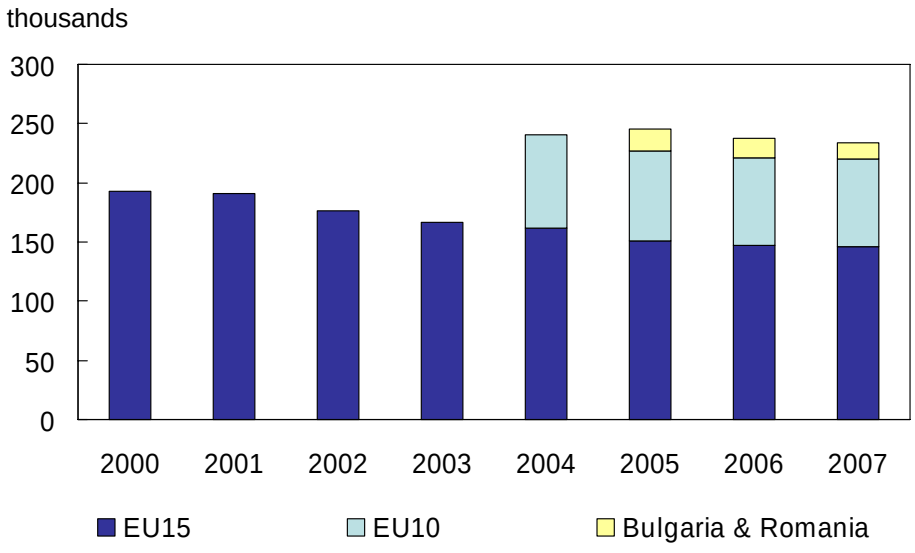
Although growth in output has averaged 3.4% pa over 2000-07, there is a great degree of variation in annual rates, due partly to the accession of new Member States. For example, after no growth in 2003, the total volume of output increased by just under 12% in 2004, when ten New Member States joined the EU. Annual growth has generally been in the range of 0-3%, with 2004 and 2007 (5%) the two years with much stronger growth. Flat and domestic glass in particular saw substantial increases in production volumes in 2004. The profile of output growth in these two sub-sectors has been the more volatile than in container glass. However, production of domestic glass in the EU25 fell in 2005 and 2006, reflecting the increasing pressure the sector is coming under from lower cost imports. The largest expansions over 2000-07 came in the fibres sub-sectors (with implied output growth of around 6% pa). However, the relative size of the container and flat glass sub-sectors (by volume of output) means the average for the glass industry as a whole was much closer to their averages for the 2000-07 period (2.9% pa and 4.3% pa respectively). The composition of total production has barely changed in the 2000-07 period with the most notable changes a small increase in the share of flat glass (27% to 29%) and a small decline in the share of other glass (just over 4½% to just under 3½%).

In general, the sub-sectors have tended to operate below full capacity. In flat glass, where 53 float tanks were operated in the EU in 2006, capacity utilisation tended to be around 80-90% in the 1990s, below the level required to ensure long-term profitability. Since the expansion of capacity brought about by the accession of new Member States post-2004, capacity utilisation has been around 90-95%. Nevertheless, capacity conditions are not expected to tighten in the near future. In the insulation fibre sub-sector (62 installations in the EU27 in 2005) there is excess capacity in some Member States despite the closure of several operations, while in the reinforcement sector average capacity utilisation in 2005 was around 95%. Capacity utilisation varies across the glass types in the special glass sector. In the cathode ray tube sub-sector the rapid adoption of flat screen panels led to excess-capacity and ultimately plant closures; in 2005 capacity utilisation was in excess of 80%. In the tubes and bulbs sub-sector capacity utilisation was only 55% in 2005. Together these two sub-sectors account for 75% of capacity in special glass where, overall, only 60% of capacity was used in 2005 (excluding water glass (also known as liquid glass or, more properly, Sodium Silicate)). In container glass, there are a large number of furnaces but over-capacity tends to be localised and short term. What proportion of capacity in a sub-sector is approaching rebuild in any one year will depend on the average lifetime of the furnaces being used.

Employment

The trend in the level of employment in the EU glass industry has been downward since 2000 driven largely by a combination of productivity requirements, automated production lines, industry consolidation and ultimately new low-cost competition. Increases since 2004 are due to the expansion of capacity brought about by the accession of new Member States.

CHART 2.4: EMPLOYMENT IN EU GLASS INDUSTRY

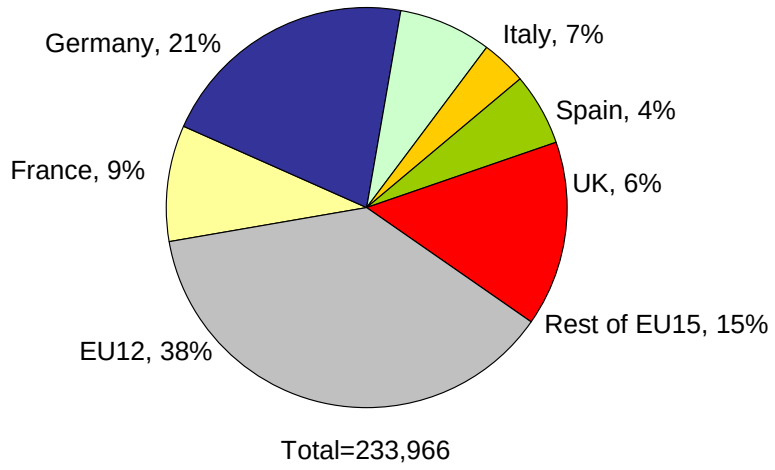


Source(s) : CPIV.

Between 2000 and 2007 the number of people employed in the EU15 glass industry fell from 193,000 to 146,000. Data and estimates from CPIV suggest employment in the ten new Member States that joined the EU in 2004 fell by just over 7% between 2004 and 2007 (from 79,120 to 73,485).

Looking at employment by region, Germany is the single biggest employer among the EU countries (just under 50,000 employees), accounting for almost a fifth of all employment in the EU in 2007. France was the next biggest employer, with 9% of the workforce. Spain, Italy and the UK all accounted for 4-7% of employment in the EU glass sector. Despite accounting for just 15% of production, the EU12 accounted for almost 40% of employment in 2007, indicative of the differences that exist between the EU12 and EU15 in capital and labour intensities. Most of the jobs in the sector in the EU12 lie within Poland and the Czech Republic, which together account for around 71% of employment in the EU12. However, although employment levels in Poland have not changed much since 2004, in the Czech Republic employment in the glass industry has fallen each year as a result of rationalisation brought on the by privatisation of the industry, which was completed in 2000. In Bulgaria, flat glass and container glass both account for around a third of employment, and tableware accounts for almost 16%.

CHART 2.5: EMPLOYMENT IN THE GLASS INDUSTRY BY EU27 REGION (2007)



Source(s) : CPIV.

It is difficult to estimate how employment breaks down across the sub-sectors. No precise statistics are available by sub-sector. And in frits, for example, the number of employees is difficult to establish because for many companies frits production is only a small part of the business. In some cases estimates are available but with a fair degree of variation. The following estimates come from ANFFECC, CPIV, EURIMA, GfE and EC (2008):

EMPLOYMENT BY SUB-SECTOR	
Sub-sector	**Number employed**
Container glass	40,000
Flat glass	16,000 (direct)* 100,000 (including processing)
Domestic glass (tableware)	≤ 20,000
Glass fibre (reinforcement)	8,200
Special glass	40,000
Other (frits – Spain only)	3,800
Source(s) : CPIV; EC (2008); ANFFECC, EURIMA, GfE.	

In domestic glass, employment has fallen substantially and this is attributed to changing market conditions. The influx of cheap domestic glass products with comparable quality from emerging economies such as China (where labour costs and other costs are lower) has forced the closure of many EU glass producers with associated loss of employment, especially in the UK. The relocation of production away from the EU to achieve lower costs, and to hurdle many of the barriers to entry surrounding the EU glass market identified later have also contributed to the decline in employment numbers in most sub-sectors. It should also be noted that the glass sector supports many jobs in other upstream and downstream sectors, eg, mining & quarrying, automotive industries, construction, and so the above figures are likely to underestimate its importance as a job provider within the economy.

2.2.3 Location and nature of key industry clusters

The previous sections have given an indication of where the aggregate sector is located within the EU. The data indicate that Germany is the primary centre of production. Across all the sub-sectors it always has one of the largest shares of total EU production. Within the EU15, the other main producers (France, Italy, the Netherlands, Spain, the UK) all have large shares in some sub-sectors, but small shares in others. But in most cases, France is the second centre of production after Germany. There are some sub-sectors where the EU12 appears to have no or very low capacity (frits, special glass) but there are others where it accounts for around 14-26% of production. In all sub-sectors where data are available, production is concentrated in Poland and the Czech Republic. There are small levels of production in most of the other central and southern mainland EU12 states. The glass industry in Romania is clustered in a number of provinces across the country. Major clusters have developed in locations that have deposits of raw materials: sand and alkaline, and in the forests that used to provide firewood for the furnaces.

The details for the sub-sectors are as follows:

Container glass

Because of its nature, container glass production tends to be located close to markets. As a result, there are production sites in most EU Member States. France, Germany and Italy are the largest producers in the EU, producing 3½-4 mt each and as a result together they accounted for over 50% of EU output in 2006. With just over 2 mt in 2006, Spain and the

UK are the next largest producers in the EU. The major producers in the EU12 are Poland, the Czech Republic and Romania. In Poland a third of production is coloured and two-thirds is clear. Production of clear glass in Poland has been increasing since 2000; production of coloured glass is rising after falling over 2000-03. In the Czech Republic container glass accounts for a smaller share of output compared to the EU27 average (just 28%). In Bulgaria, the manufacturing of container glass is shared between three major producers: Drujba Glassworks, Rubin and Interior glass, located in Sofia and Plovdiv, Pleven and Elena respectively. Outside the EU, and in the close neighbourhood of these countries, the Russian Federation and Ukraine are significant producers whose capacity is increasing. In Romania, the largest producers of container glass are located in Bucharest and Sighisoara.

Flat glass

Generally, flat glass is expensive to transport and so is generally supplied on a local or regional basis. However, increasing competition between companies has led to glass being transported over further distances with cost the limiting factor. Flat glass was produced at 58 tanks in 16 Member States in 2007. The main flat glass producers were located in Germany, Italy and France. Germany accounts for around 20% of production, with France, Italy and Belgium each responsible for 12.5% of output. The EU12 is home to ten tanks which produce around 14% of EU output. In the EU12 production is concentrated in Poland and, to a slightly lesser extent, the Czech Republic. The other production sites are in Hungary, Romania and Bulgaria.

Domestic glass

The manufacture of domestic glass is widely distributed across the EU. Estimates suggest production is spread out across between 16 (CPIV) and 20 (EC (2008)) Member States. ICF indicates that there are 50-60 installations spread out across the EU. France, Germany, Italy and Austria account for 60% of EU production with the remainder coming from 16-18 other Member States (EC (2008)). Production in the EU12 is centred in Poland and the Czech Republic, which each produce 5-5½% of EU output. Slovakia accounts for 3% of EU output. Domestic glass manufacture in Bulgaria is covered by a number of companies, some of which specialise in hand-made mouth blown glassware. The rest of production in the EU12 is located in central and southern mainland Europe; there appears to be no production in Estonia, Latvia, Lithuania, Cyprus or Malta.

Fibre glass: insulation

The production of insulation fibres was spread out across 62 installations in 2005: 15 of these were in the EU12 with 47 in the EU15. The installations in the EU12 accounted for 26% of production while those in the EU15 accounted for 74%. Within the EU12 production took place in only six countries, and Poland accounted for half of all production in the bloc. The next biggest producer in the EU12, the Czech Republic, produced only a quarter as much. In the EU15, Germany and France had the lion's share of production, with 18.3% and 10.3% of total EU production respectively. Together with the UK and the Netherlands, they produced 45% of total EU output. Denmark and Finland each account for just under 6%.

Fibre glass: reinforcement

Figures for 2005 show that production of reinforcement fibres is spread out across 31 furnaces on 17 sites in ten Member States; 26 of the furnaces are located in the EU15. There are five furnaces in Germany and Belgium, four in France, and three in Finland and Italy. There are five furnaces in the EU12 in total, with one in Latvia and four in the Czech Republic. Northern Europe (Germany, Finland, Latvia, Netherlands, UK) accounts for 29% of total production, with the rest being produced in Southern and Central Europe (France, Belgium, Czech Republic, Italy, Spain), EC (2008).

Special glass

The location of production depends to some extent on the type of glassware being produced, but production is generally concentrated in Germany. There are also facilities in France and the Benelux countries. The UK used to be the second largest producer in this sub-sector but this is no longer the case now that there is no primary manufacture of tube or bulb glass in the UK. Most CRT factories in the EU were closed during 2005 and 2006 and the one remaining plant is in Piaseczno in Poland. It is owned and run by VIDEOCON of India. There are no fully operational flat panel plants in the EU, as they tend to be close to the main panel producers, who are located in Asia. The only flat panel plant currently in the EU is in Germany (belonging to Schott AG) but it is only in the trial phase for the moment. Tube and bulb production is distributed across the EU, but it is centred around Germany and the Netherlands. There are three plants in Germany that account for 40% of EU production while two in Netherlands-Belgium account for a third of EU production. Borosilicate glass production (excluding tubes and lighting) is concentrated in Germany, France and in the UK.

Frits

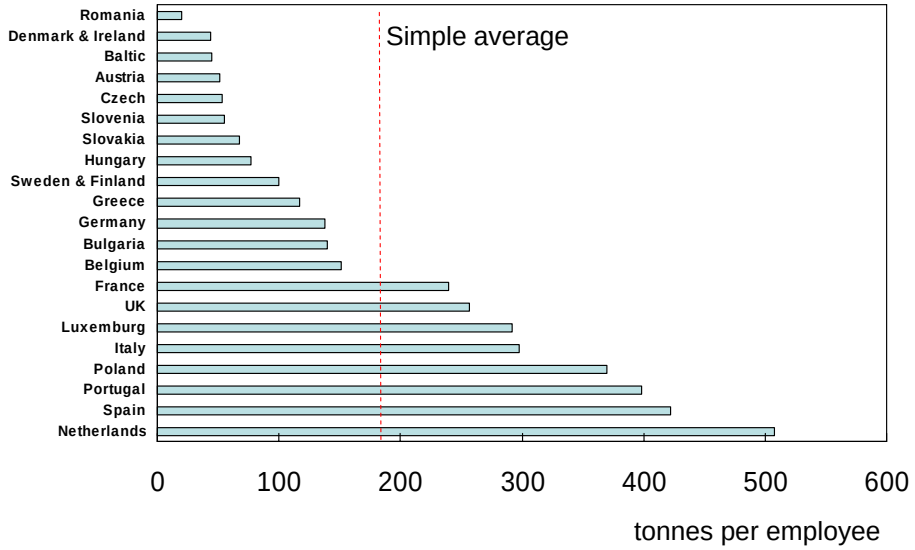
The production of glass frits is mainly concentrated in Spain and Italy. There are an estimated 50 installations in the EU, with 21 in Spain and 9 in Italy. Most of the others are located in the EU15, with five in Germany and four the UK. In the EU12 there are two in Poland and two in the Czech Republic. Spain is the largest producer in the EU (and the world) accounting for over 80% of total EU output of 1.25 mt pa.

2.2.4 Productivity

The chart below shows the relative productivity of Member States in 2006. The average across the Member States of the EU27 in 2007 was just over 180 tonnes per employee. The Netherlands had the highest productivity, at just over 500 tonnes per employee, and was one of eight Member States above the average. Broadly speaking the EU15 countries had higher levels of productivity, with seven of the eight above the average coming from the EU15 and most of the lowest positions occupied by newer Member States from the EU12. Although this is partly due to the large scale and scope of output they produce and the higher level of automation in general, it also reflects the differences in industry structure in countries. Some Member States are more focused on sub-sectors with higher levels of automation and lower labour intensity, while others rely more on sectors with higher labour inputs, such as Romanian domestic glass, where traditional, hand-blown methods are still used extensively. Nevertheless, there are exceptions. Poland is ranked fourth and Bulgaria tenth, just ahead of Germany, boosted by their increasing capacities

in flat and container glass. Bulgaria has also benefited from substantial investment by Turkey's Sisecam and Greece's Yioula and the positive impact of this on labour productivity is expected to continue as more new investments are planned in the sector.

CHART 2.6: EU GLASS PRODUCTIVITY (2006)



Source(s) : CPIV; CE calculations.

2.2.5 Profitability and price-cost margins

Excess capacity, trade and competition (often in high value-added segments) have all put pressure on profitability in recent years. A major cause of the squeeze on margins in recent years has been the substantial rises in costs, driven by strong increases in energy and raw materials (eg. soda ash) prices since 2004. Activity in the flat glass sub-sector is cyclical and so profits in the industry tend to fluctuate also; the sub-sector is one where capacity has been under-utilised and operated at an unprofitable level. In domestic glass, where some products are high value, a key threat is competition in the domestic markets from increased imports, and greater competition in the important export markets. This has led to severe pressure on prices and therefore restricted profitability. There is a wide range of factors that can affect the market for container glass. The main threat is from alternative packaging materials, especially plastics (principally PET – polyethylene terephthalate), metals (steel and aluminium) and laminated cartons. However, the container glass sub-sector is also coming under increasing pressure from imports from outside EU and faces a growing threat from the increase in production plants in countries close to or bordering the EU. In the fibre glass sub-sector, where products tend to have a relatively high value-added, increasing competition has placed pressure on prices, and curbed profit growth, despite strong growth in demand. Meanwhile, the outputs of the insulation fibres sub-sector are essentially commodity products with little scope for

differentiation. Competition takes place based mainly on price. This has resulted in cost reductions and downsizing within the sub-sector to protect profit margins. In the segments where products are less of a commodity and technical aspects are more important, price competition is weaker and margins are better. In the special glass sub-sector profitability can vary widely for each product segment, depending on how mature the market is and to what extent it is a commodity product.

Profits

Questionnaire results confirmed that net profit margins have been falling since 2000. The fall varies across some sub-sectors, but all respondents (seven in total) reported falling margins over 2000-07 and lower margins in 2007. In 2000, margins varied from 'slightly positive' to 10-15%; the simple average of those reported was 7.3%. In 2007, the margins varied from negative to 7-13%, and the simple average of those reported was -7.1%. The prospects going forward seemed gloomy also. None of the respondents expected margins to increase over the next five to ten years. All but one expect net profit margins to fall further, while one was unsure. The return on investment is very important for the sector. A continued fall in profit margins would undermine the glass industry as an attractive investment.

Tax

The percentage of profits paid in tax in 2007 was 30-40% in most cases, with a couple of exceptions outside this range. For four of the respondents, this had not changed since 2000; two others reported that the percentage of profits paid in tax had, on average, fallen since 2000. Only one respondent thought that the EU's competitive position with respect to taxes on profits had improved since 2000. Looking forward, there was no clear consensus on how taxes on profits in the EU might change over the next five to ten years, and so neither was there a clear consensus on how the EU's competitive position might change over the same period.

Costs

Survey results also provided some support for the argument that the glass sector is disadvantaged on a cost basis. All respondents reported that costs in the EU were higher than costs in main competitor regions. In most cases the difference was reported as more than 20%. In two cases the reported difference was 10-15% and one reported a difference in the range of 0-5%. Among the drivers cited for these differences the three main ones were labour costs, followed by energy costs and the costs of complying with environmental/ pollution measures. Two respondents indicated bureaucracy as an important driver of these differences, while land costs were an issue for only one respondent. Other drivers put forward by the respondents included tax rates (one respondent), exchange rates (two), and material costs (two).

With regard to labour costs, four respondents reported that the proportion of firms' operating costs paid as social security or pension contributions had risen since 2000, while five said the EU's competitive position had weakened since 2000 as a result. There was no clear consensus on how the proportion of firms' operating costs paid as social security or pension contributions might change over the next five to ten years and although views on how the EU's competitive position might change over the same period varied, four respondents did expect the position to deteriorate.

As a result, it is not entirely surprising that all the sub-sector respondents reported that the end price of EU-produced goods was higher than that for non-EU-produced goods. Five respondents put the difference at 10% or more, with two of them putting it at more than 20%. Another said that EU-produced goods were dearer by 5-10%, while one did not give a figure.

Outlook

Looking ahead, thoughts on the outlook were mixed and balanced. With regard to the differences in end prices, two respondents expected no major change in the next five to ten years, two expected the differences to fall (EU goods become less expensive compared to non-EU goods), while two expected the differences to increase.

Expectations with regard to the outlook on costs were also mixed, with some respondents expecting the cost differential to shrink over the next five to ten years, while others expected it to increase. There was recognition that the cost difference will be driven in part by the availability of inputs and raw materials, environmental compliance requirements and exchange rate fluctuations, while the actions of policy makers will also play a role. While this creates some uncertainty, the mood seemed to be, if anything, on the pessimistic side. Compliance costs (environmental or otherwise) are expected to increase and disadvantage EU producers further in some cases, while regulations aimed at other industries and trade are expected to raise production costs for some glass firms. Labour costs were expected to remain an issue for some sub-sectors, which do not expect any decrease in labour costs over the next five to ten years, while the effect of a strong euro was also highlighted as a concern. A more positive expectation among the responses was that the EU's competitive position against Asian producers should improve due to high inflation in Asia and rising transport costs.

2.2.6 Exports and trade

Overview

Whilst 80% of output is traded with other Member States (EC Technical Update, 2006), extra-EU import flows are increasingly having a significant impact upon the make up of the EU glass industry. The total volume of extra-EU exports increased by 5.4% between 2004 and 2007, from 3.32 mt to 3.5 mt; the volume of extra-EU imports increased by 66.4% over the same period, from 2.16 mt to 3.6 mt. Consequently, a healthy surplus of

1.15 mt in 2004 has been eroded and in 2007 the EU glass industry recorded its first trade deficit (by volume).

If we look at the value of trade, the story is similar but not quite so extreme. The total value of extra-EU exports increased by 13.4% between 2004 and 2007, from €5.49bn to €6.22bn; the value of extra-EU imports increased by 40%, from €2.98bn to €4.18bn. As a result, the EU glass industry still trades at a surplus in value terms, but it has seen this surplus fall from €2.5bn in 2004 to €2.0bn in 2007.

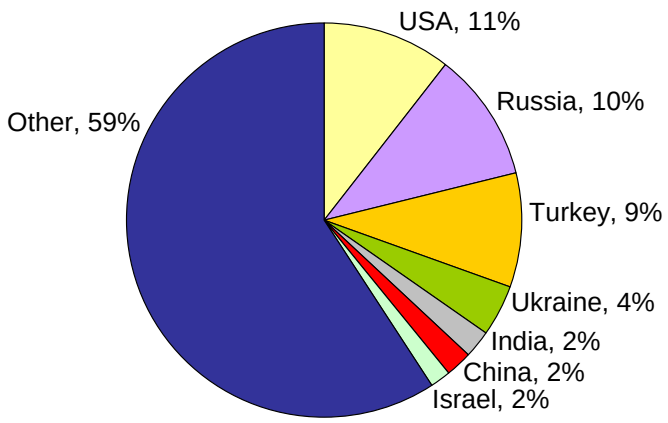
There are a couple of interesting results from these trends. CE calculations using CPIV data (CPIV (2008)) show that, firstly, since export values have increased by more than export volumes, the per tonne value of exports has risen. Despite falling in 2007 following two years of increases, the per tonne value of exports was still 7.5% up on the 2004 figure (2004: €1,655 per tonne; 2007: €1,780 per tonne). In a period when the euro has been appreciating this is encouraging. The euro appreciated by around 3% against a basket of currencies between 2004 and 2007 (based on annual averages). Thus, the industry as a whole (there are exceptions among the sub-sectors) has managed to secure an increase in the export price greater than the appreciation of the euro alone, and still managed to increase export volumes.

Secondly, despite far stronger increases in import volumes and values, import values increased by less than volumes. This means that the per tonne value of extra-EU imports fell by 16% between 2004 and 2007, from €1,380 per tonne to €1,160 per tonne. Consequently, for every tonne of glass traded in each direction, the EU glass industry earned €620 in 2007 (compared to €275 in 2004).

The fall in the per tonne value of imports suggests two things. Firstly, with the volume of imports increasing by more than the value, non-EU firms have increased flexibility to lower their price. This is consistent with lower production costs that come about from increasing economies of scale as a result of expansions in production. Secondly, firms producing these imports are using the appreciation of the euro to help lower the price of their goods in the EU and increase their share of the EU market.

The chart below shows the major destinations for EU exports in 2007.

CHART 2.7: DESTINATION OF EU27 GLASS EXPORTS (2007)

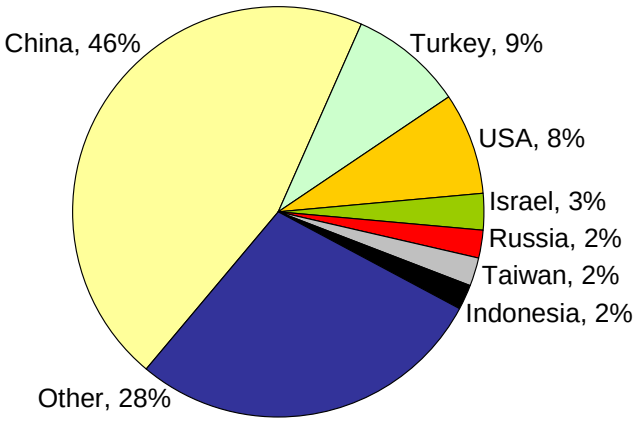


Total=3.5mt

Source(s) : CPIV.

The primary sources of imports are China and Turkey as the chart below illustrates.

CHART 2.8: ORIGIN OF EU27 GLASS IMPORTS (2007)



Total=3.6mt

Source(s) : CPIV.

The main export markets are the USA, Russia and Turkey which all account for 9-11% of exports. On the periphery of the EU, Ukraine accounted for 4% of exports; China and

India just 2% each. Just under a half of imports came from China in 2007 and 9% came from Turkey. The USA is the next major source of imports, accounting for 8%. There was very strong growth in the volume of imports from Ukraine and Belarus in 2007; the growth in imports from Russia and Croatia was weaker but also strong (17-19%).

The diagram below summarises the key global trade movements. Key import streams come from China and Turkey where much domestic glass originates, and the USA, which supplies mostly fibres and untransformed flat glass to the EU. In 2005, Turkey and China accounted for just over 40% of total imports (EC, 2006); in 2007 it was 55%. In 2007, the EU exported approximately 9% of its production, up from 8% in 2006. The main export streams were to the USA, Russia and Turkey, which accounted for 9-11% of EU exports each. All other EU exports were to countries that are geographically close the EU, including Switzerland and Ukraine. A key development in recent years has been the rapid increase in capacity in countries surrounding the EU (eg. Russia, Belarus, Ukraine, Turkey) and further a field (eg. UAE). This expansion, which is expected to continue in the medium term, poses a serious threat to EU glass exports and probably the EU domestic market in the longer term, especially as operating conditions in these countries tend to be less rigorous. In time, the increased capacity can be expected to result in reduced demand for EU exports in these countries and increased competition in EU markets from these countries' exports, which typically sell for less.

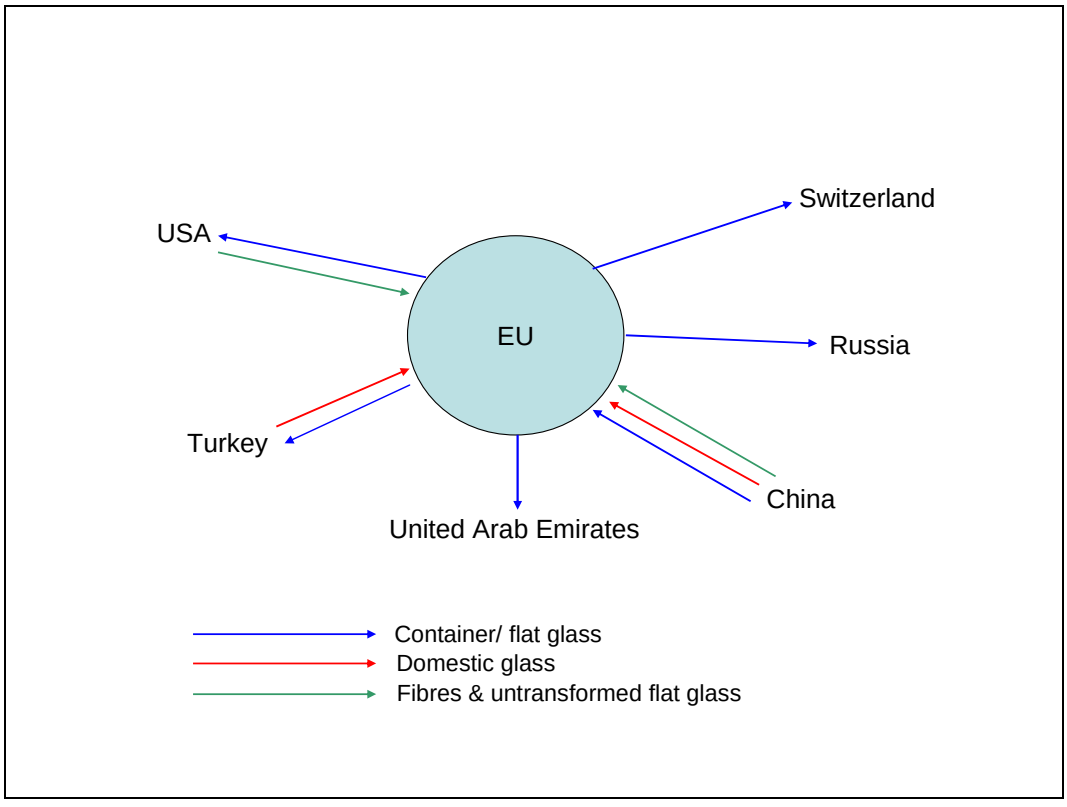
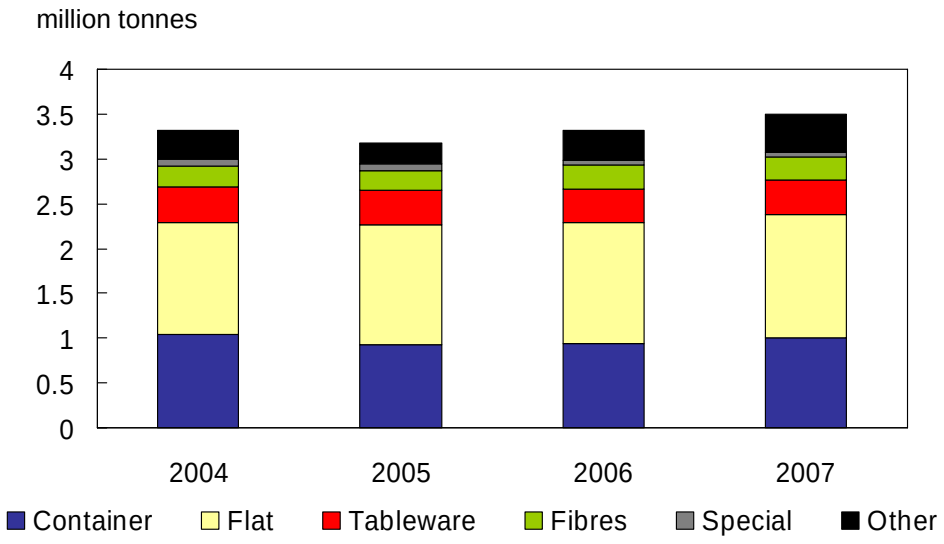


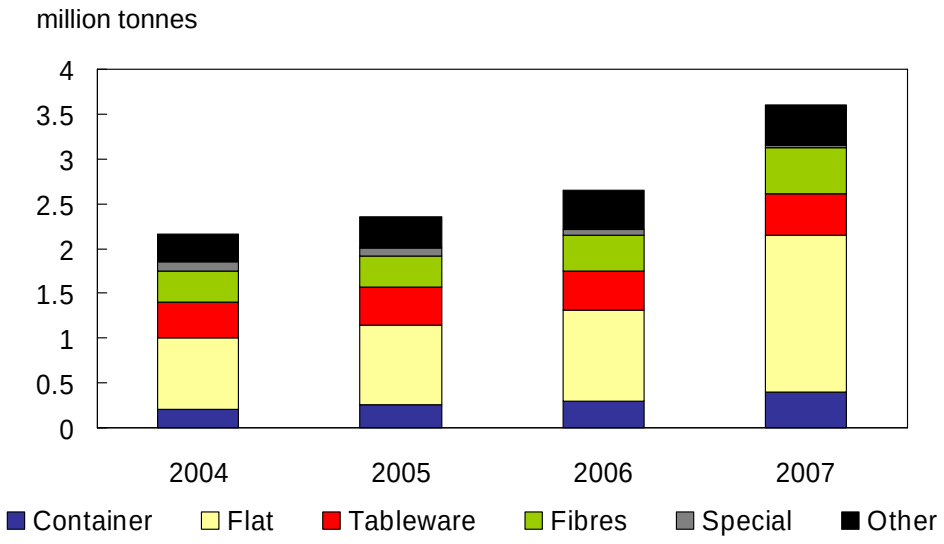
CHART 2.9: EU27 GLASS EXPORTS BY SUB-SECTOR



Source(s) : CPIV.

The chart above shows the trend in exports by sub-sector since 2004, and the performances have been mixed. Although the total volume of EU27 exports increased from 3.3mt to 3.5mt between 2004 and 2007, not all sub-sectors saw an overall increase. While exports of flat glass and glass fibres in 2007 were higher than in 2004, exports for the other sub-sectors were lower in 2007 than in 2004. In the intervening years, export volumes fell and rose in all sub-sectors. A concerning trend in terms of competitiveness is the steady growth in import volumes to the EU27 since 2004, as shown in the chart below, driven by imports from China and Turkey. The EU27 imported 3.6 mt of glass in 2007, generating a trade deficit (by volume) for the first time. Flat glass is the primary import product (by volume), followed by container glass, tableware (principally from China and Turkey) and glass fibres (mostly from the USA).

CHART 2.10: EU27 GLASS IMPORTS BY SUB-SECTOR



Source(s) : CPIV.

Container glass

In 2004 EU27 exports were around five times greater than imports. Stronger growth in imports means that by 2007 exports were around only two and a half times greater. Total extra-EU exports represent only 4.6% of total production of 21.6 mt. Although the volume of exports has fallen, the value per tonne has risen (from €707 in 2004 to €825 in 2007) while for imports it has fallen. This has supported a pick-up in the overall value of container glass exports and prevented a slump in the balance (by value) in the face of a near doubling in import volumes. It is worth remembering, however, that for the container glass sub-sector, net exports of glass containers as part of final, packaged goods is much more important than those of empty glass containers.

Areas on the fringes of the EU can be subject to quite severe competition from non-EU countries, often with significantly lower prices but acceptable quality. The sheer scale of investment currently taking place in the Middle East means countries like the UAE will become a serious challenger to the EU container glass sector in future.

Flat glass

Flat glass exports were 11% higher in 2007 than they were in 2004. Imports more than doubled however, and as a result a surplus of 445,000 tonnes in 2004 became a deficit of 358,000 tonnes in 2007. This was driven by substantial growth in basic and transformed glass imports. Consequently, despite a modest increase in the per tonne value of exports and a larger fall in the per tonne value of imports, the flat glass sector (as a whole) recorded a €143m deficit in 2007 (a surplus in basic glass was outweighed by the deficit in transformed glass). On average around 13% of EU27 production is exported to non-EU countries. A slightly lower figure was imported into the EU market up to 2006, predominantly from Eastern Europe, but in 2007 the import penetration jumped to around

17% of production. Imports from China were a major driver of this surge in imports. Chinese float glass imports increased by 162% in 2007, to just under 550,000 tonnes. (This mean Chinese float glass imports have increased tenfold since 2004.) In addition to the strong growth in Chinese imports, the sheer scale of investment currently taking place in the Middle East means flat glass production in the Middle East will become a serious challenger to the EU flat glass sector in future; the same can be said for countries on the edge of the EU: there are six tanks in Turkey and 14 across Belarus, Russia and Ukraine (compared to 58 in the EU27).

Domestic glass

There is substantial intra- and extra-EU trade. The main threat to this is increasing competition in the domestic markets from imports and greater competition in the important export markets. The majority of imports come from Turkey and China (83% of all domestic glass imports), and these greatly outweigh EU exports to these regions. Tableware exports have fallen each year since 2004 (to 387,000 tonnes in 2007), while the volume of imports has risen. The result was a deficit of around 84,000 tonnes in 2007 (and deficit in each year since 2004). At the same time the per tonne value of exports and imports have slipped back since 2004, more so in the case of imports. What is more, the per tonne value of exports (€3,517 in 2007) is more than twice that of imports (€1,615 in 2007). Thus, despite operating at a deficit by volume, by value the sector ran a surplus of €605m in 2007.

Fibre glass: insulation and reinforcement

For insulation fibres there is significant trade within the EU but extra-EU trade represents less than 5% of output. Extra-EU trade is greatest where Member States border non-EU countries, eg. exports are greatest from Sweden and Finland into Russia. Trade in reinforcement fibres is much more developed, with exports and imports in the region of 30-40% of EU production. Figures discussed here are for the sectors combined. Across both sub-sectors, export volumes have increased slightly since 2004, even after a small fall in 2007. However, there has been a stronger increase in import volumes. In 2007, the EU exported 253,000 tonnes and imported 508,000; creating a deficit of 255,000 tonnes. As for tableware, trade in fibres has been running at a deficit since 2004 (by volume). Nevertheless, the per tonne value of fibre exports has increased by 22% to €3,122, while the import value has fallen from €1,685 per tonne in 2004 to €1,583 per tonne in 2007. This has supported the value of exports and means that in value terms, the trade in fibres has fluctuated between a surplus and deficit; in 2007 a deficit of €13m was recorded.

Frits

There is fierce competition between the producers in the EU both within, and between Member States. Most of the frits produced in the EU are used internally but exports are an important market for EU producers and are generally significantly higher than imports from non EU countries. The performance of the frits sector closely follows the success of the ceramic sector as a whole, and if the latter declines, then the Frits Sector that serves it, will also suffer. Imports into the EU of products using frits is potentially a greater threat than imports of frits themselves

Special glass

In 2004, the EU27 ran a trade deficit as it imported around 30% more than it exported (by volume). Over 2004-07 the volume of exports and imports has fallen, but with a stronger fall in export volumes. The result is that by 2007, the EU exported 58,000 tonnes and operated a trade surplus of 26,000 tonnes. At the same the value per tonne increased for exports and imports, but with a much larger increase for imports. As a result exports were valued at €4,768 per tonne in 2007 but imports at €5,940 per tonne. Consequently, for every tonne of glass traded in each direction, the EU special glass industry lost money in 2007 making it unique among the sub-sectors. The only reason it turned in a surplus in 2007 (by value) is because it exported almost twice as much as it imported. The main export markets are China, the USA and Russia; the main sources of imports are China, India and the USA.

Degree of specialisation

Excluding other glass, the sectors with the highest export value (per tonne) are special glass (€4,768), tableware (€3,517) and fibres (€3,122) (transformed flat glass is next on €2,787). Tableware and fibres also offer the largest margins between import and export values (per tonne). In terms of export volumes, they accounted for 2%, 11% and 7% respectively in 2007. At the same time, special glass accounted for 1% of import volumes in 2007, with tableware accounting for 14% and fibres 15%. However, note that import penetration was higher in some cases. In the reinforcement fibres sub-sector, for example, imported volumes (443,000 tonnes) equated to 54% of production volumes (815,000) in 2007. For domestic glass, imported volumes equated to 31% of production volumes in 2007.

Container glass and flat glass have the lowest export value per tonne (the low value of basic flat glass outweighs the high value of transformed basic glass) at €825 and €1,100 per tonne respectively. This still generates a small margin over import values.

Container glass accounted for 29% of export volumes in 2007 and total flat glass accounted for 40% (basic flat glass accounted for 31%; transformed flat glass accounted for 9%). In comparison, container glass accounted for 11% of import volumes in 2007 and flat glass accounted for 50% (basic flat glass accounted for 32%; transformed flat glass accounts for 18%).

2.3 Structure

This section outlines the structure of the EU glass industry based on a review of a range of existing conceptual, empirical and analytical contributions made about the industry. The first part of this section details the main EU glass producers and their key product areas, production locations, and performance. The second part identifies the main barriers to entry into the EU glass industry that shield it from new and existing competition. The third part considers the impact that international trade has on the EU glass market. Import and export trends are traced, and the influences they have on competitiveness are considered.

2.3.1 Industry structure and size distribution of companies

The main EU glass market sub-sectors are becoming increasingly controlled by a small number of large, global firms due primarily to pressures to reduce costs to remain competitive in a fierce, cost-driven, global market. The flat glass market is dominated by four firms (NSG (Pilkington), Saint-Gobain, Asahi (Glaverbel) and Guardian).

For container glass, EU27 output is now accounted for by some large groups (Ardagh Glass, BA Vidro, O-I (Owens-Illinois), Saint-Gobain, Vetropack and Vidrala), and many smaller independent companies and groups which continue to compete effectively, due to the existence of regional and niche markets. On the other hand, the increased growth and influence of global food and drink, pharmaceuticals and cosmetics groups has been mirrored over the period 1997 to 2005 by further concentration and internationalisation of glass industry ownership, coupled with greater specialisation in terms of the glass products supplied.

The domestic glass sub-sector is less concentrated: 200 small to medium size firms produce 20-100 tonnes and 100-1000 tonnes of daily output respectively (CPIV). In terms of sales, the EU domestic glass market is relatively diverse, depending on local conditions. Some key players (especially jewellery producers) only account for a small percentage of output tonnage due to the high-value, small size giftware nature of their many of their products. (Some of the larger, better-known firms include Arc International, Swarovski and Bormiolo Rocco & Filio, although Swarovski does not produce any tableware, only ornamentalware.)

The special glass sub-sector is concentrated in certain respects, with a small number of large firms controlling output in certain markets. However, concentration really depends on the product and the market it is sold in. Although a few companies produce the majority of the EU output, the special glass sector has a large number of smaller, less capital intensive installations often specialising in high value, high quality and technically demanding products. Schott Glass is a large diversified German producer that has interests in many special glass sectors producing a diverse range of products from precision glass tubing to radiation shielding glass. It is one of the largest producers in the EU and has considerable market share in the special glass sub-sector. Another major player in the special glass sub-sector is Corning of the US, which has expertise is several types of special glass and has operations spread across Europe. The continuous filament glass fibres sub-sector is occupied by seven large firms, especially Owens Corning, PPG Industries, and Vetrotex (formerly part of Saint Gobain).

Predominantly high concentration has been brought about primarily by consolidation in response to increasing cost pressures. A main driver of cost pressures is new and expanding competition from low-cost producers that are able to offer comparable glass products to the market at lower prices. Many of these low-cost producers are Non-EU based firms that operate in distinctively different economic and political conditions, which allow such firms to bypass many of the costs that EU firms are faced with. The existence of new cost-driven competition from abroad is not a problem that is confined to the EU glass industry; industries such as car production, consumer electronics, airline and retail all face cost pressures from new forms of foreign competition. Critically, these

industries are all direct or indirect customers of EU glass producers in one form or another, and hence the effects of globalisation have a knock-on effect on the demand profile and business models of the EU glass industry.

The only feasible way that EU glass producers can compete on price with cheaper comparable products is to improve productive and allocative efficiency. As mentioned earlier, industry consolidation in the form of mergers and takeovers (and associated integration) has occurred throughout the EU in an attempt to improve efficiency and to reduce costs (Van Houte, 2002). Some major recent examples include:

1. Ardagh's acquisition of Rexam's glass divisions in 2005 and 2007; and Heye in 2003.
2. CVC's acquisition of the food and beverage glass packaging activities of Danone and Gerresheimer (IP/99/460, www.europe.eu).
3. The acquisition of the French glass container manufacturer BSN Glasspack SA by a US competitor Owens-Illinois in 2004 (Bulletin EU 6-2004[a]).
4. The acquisition of Pilkington by Nippon Sheet Glass in 2006 (IP/06/750, www.europa.eu).
5. The acquisition of the reinforcement business of Saint Gobain-Vetrotex by Owens Corning in 2007.

In each of the examples there were concerns that the resultant higher concentration would lead to anti-competitiveness and higher prices due to increased market control. However, in each of the above cases the Commission concluded that the consolidation would not distort competitiveness due to the degree of EU and Non-EU competition already in the markets and felt that the combined market shares would not be detrimental to the consumers. In the case of the acquisition of Pilkington by Nippon Sheet Glass, The Commission identified the existence of, "strong, effective competitors with significant market shares" (www.europa.eu, IP/06/750) as one reason for giving the acquisition the go-ahead.

Although industry consolidation can lead to increased efficiency and lower prices, it can give increased scope and incentive for anti-competitive practices. In November 2007, Asahi, Guardian, Pilkington and Saint-Gobain were found guilty of cartel operation in the flat-glass market, where they organised, "several rounds of price increases, fixed minimum prices and other commercial conditions in an endeavour to raise or otherwise stabilise prices" (www.europe.eu, IP/07/1781). Competition Commissioner (Neelie Kroes) stated that the CARTEL was, 'cheating customers...depriving them of the benefits of the Single Market' (*ibid*). This clearly demonstrates how relatively high concentration could have the potential to hinder internal competition, and emphasises the need for effective monitoring by competition regulators and the encouragement of good corporate governance of firms.

Glass manufacture is a very capital-intensive activity requiring substantial financial resources, long-term investment and high technical skills. This can create a substantial barrier against entry into the market. However, whilst the majority of EU glass production is highly concentrated in the flat glass and, to a lesser degree, the container sub-sectors, there are still a large number of other smaller firms active in the rest of the

market that are predominantly SMEs. This is especially true for the domestic glass sub-sector where there is a large number of smaller, less capital intensive installations often specialising in high value hand-made items or niche markets. An exception is the continuous filament glass fibres sub-sector which is occupied wholly by seven large firms. The capital-intensive nature of the glass industry is also crucial for when reinvestment decisions are made. Glass firms must be confident about future demand and operation conditions if they are to reinvest in European-based plants. Any uncertainty about future legislation, taxes, demand etc makes it harder for glass firms to estimate future returns and serves to discourage investment in the EU. In particular, recent trends in energy prices and developments in the structure of the energy market mean that certainty about future energy prices and security are now a key issue for firms making investment decisions.

2.3.2 Extent and role of SMEs in sector

"SMEs are well equipped to provide innovative solutions and transform challenges into business opportunities" (EC, 2007[a], page 7). However, their role/importance varies across sub-sectors. While they play an important but increasingly diminishing role in container glass, their role in the insulation fibre sub-sector is very limited. That aside, across the glass sector they typically offer specialised glass products that are not supplied by the larger producers due to the economic trade-offs that would be involved. Larger suppliers (especially in the container glass sub-sector) concentrate on the production of large scale, less specialised glass products, with highly productive automated manufacturing process where there is a greater necessity for economies of scale due to the nature of the demand in the market for the end product and its relative substitutability. SMEs do not have the power to compete directly with the large producers due to extensive barriers to entry, primarily due to economies of scale and high initial investment costs. It would clearly also be very difficult for a new SME entrant to gain a sufficient foothold in the end markets for the products given the existing agreements and established brands of the large players.

In domestic glass, SMEs used to account for the majority of production, but their numbers are now falling because tightening operating conditions are forcing many to close. SMEs typically gear their operations towards low-volume, high-value, often very specialised, products, which they can typically produce competitively and compete on. The high product quality and the 'Made in Europe' badge help to make imitation difficult and protect the position of EU producers, however, the competitive advantage offered by these is shrinking as the ability of non-EU producers and the quality of their products improves. This impacts on SMEs ability to compete in the international giftware market for example, where the small size and low weight of many giftware products creates opportunities for them to be transported over long distances. EU based SMEs had been exporting quality products across the Atlantic and to the UAE in increasing volumes. The copying of designs and other intellectual property is also a problem for the reinforcement fibres sub-sector and its downstream composite partners.

Meanwhile, the manufacturers of glass tableware are obliged to invest constantly in new products in order to continually renew their offer to the market and try to be ahead of their competitors outside of the EU. Their customers being wholesale and distributors,

but with contracts with hypermarkets and supermarkets, there is high pressure on margins, on the costs of distribution and on the contribution of advertising, to make sure that the products sold end up on the shelves and are offered to the final consumers. Consolidation in the retail industry in recent years has intensified these pressures and has forced down the prices that glassware producers can get for their products. In some cases the demand can only be satisfied by goods produced outside the EU, which are substantially cheaper. This has been compounded by large falls in the number of independent and boutique retailers, who are more profitable customers for glassware firms but cannot compete with the larger retailers and supermarkets in the current economic climate. These all combine to make it harder for SMEs to survive.
An additional burden for SMEs has come in the form of laws and regulations that firms must comply with. SMEs have struggled to compete with these and remain profitable, especially those with high levels of labour in production. And while conditions have tightened in the EU, the ability of EU producers to expand outside the EU has been limited by trade barriers and the strength of the euro.

In container glass, our own calculations indicate that in the EU12 almost half of the companies producing container glass is small; one third is medium in size. In the Russian Federation and Ukraine, however, there is a more equal distribution between large, medium and small firms, with an emphasis on medium sized firms. Very large firms are rare in both Eastern Europe and its neighbours.

In Romania, the structure of the glass industry is dominated by medium, small and micro-enterprises, which account for 80-90% of enterprises. Large firms account for 14% of the total. However, in terms of employment and export value, large firms account for the highest percentages. Many large firms rely on export companies to broker sales, particularly with larger buyers, while SMEs normally export in small batches directly to clients. There are some signs that SMEs in the glass sector are beginning to collaborate on certain aspects of the selling process; for instance, some firms coordinate to fill orders when a variety of products is desired by the customer.

2.3.3 Identification and ownership of key producers in EU and globally

The tables below illustrates the major EU-based glass producers and major non-EU companies with a major presence in the EU market.

EU-Based Owner	Member State	Sub-sector
Ardagh	Ireland	**Container Glass**
BA Vidro	Portugal	
Saint Gobain	France	
Vidrala	Spain	
Saint Gobain	France	**Flat Glass**
Interpane	Germany	
Sangalli Vetro	Italy	
Arc International	France	**Domestic Glass**
Riedel/Nachtmann	Austria/Germany	
Bormioli Rocco e figli	Italy	
Stölzle-Oberland GmbH	Germany/Austria	
Waterford Crystal	Ireland	
Swarovski & Co KG	Austria	
RCR Cristalleria Italiana	Italy	
Durobor	Belgium	
3B	Belgium - Norway	**Glass Fibres**
PPG Industries	Netherlands/UK	**(Reinforcement)**
Johns Manville	UK; Germany; Slovakia	
Ahlstrom	Finland	
Lanxess	Belgium	
P-D Glasseiden	Germany/Latvia	
Knauf	Germany	**Glass Fibres**
Paroc	Finland	**(Insulation)/ Mineral wool**
Pfleiderer	Germany	
Rockwool	Denmark	
Saint-Gobain	France	
Ursa	Spain	
Schott	Germany	**Special Glass**
Osram	Germany	**Special Glass**
TGI	Germany	**(Tubing)**
Philips	Netherlands	

Non-EU-based owner	Country	Sub-Sector
Owens-Illinois	USA	**Container Glass**
Vetropack	Switzerland	
Pilkington-NSG	Japan	**Flat Glass**
Glaverbel-Asahi	Japan	
Guardian	USA	
Euroglas	Switzerland	
Libbey	USA	**Domestic Glass**
Pasabahce (Sisecam)	Turkey	
Corning	USA	**Special Glass**
Asahi	Japan	
NEG	Japan	
HOYA	Japan	
Owens Corning	USA	**Glass Fibres (Reinforcement)**
Owens Corning	USA	**Glass Fibres (Insulation)**

The table below lists the main producers we have managed to identify in the EU12.

Producer	Member State	Sub-sector
Ardagh	Poland	**Container Glass**
Avirunion	Czech Republic	
O-I Polska	Poland	
Oroshaza – Sajoszentpeter (owned by O-I)	Hungary	
Vetropack Moravia Glass	Czech Republic	
Vetropack Nemsova	Slovakia	
AGC Flat Glass Europe (formerly Glaverbel)	Czech Republic	**Flat Glass**
GES	Romania	
Guardian	Poland	
Hunguard (owned by Guardian)	Hungary	
Pilkington-NSG	Poland	
Saint-Gobain Glass	Poland & Romania	
Sisecam	Bulgaria	

Producer	Member State	Sub-sector
Rona LR Crystal	Slovakia	**Domestic Glass**
Slovglass	Slovakia	
Kelli	Slovakia	
Burson Properties	Czech Republic	
Crystalex	Czech Republic	**Domestic Glass**
Sklarny Bohemia	Czech Republic	
Sklo Bohemia	Czech Republic	
Vetrotex	Czech Republic	**Glass Fibres**
Johns Manville	Slovakia	**(Reinforcement)**
Knauf Insulation	Czech Republic	**Glass Fibres**
Union Lesni Brana	Czech Republic	**(Insulation)**
Salgotarjan Glassfibre (Japanese owners)	Hungary	
Izomat	Slovakia	
Johns Manville Slovakia	Slovakia	
Sklarny Kavalier	Czech Republic	**Special Glass**
Ecoglass	Czech Republic	
Bohemia Optik	Czech Republic	
Nagykanizsa	Hungary	
Medical Glass	Slovakia	
Technicke Sklo	Slovakia	
Sklarny Kavalier	Czech Republic	**Special Glass**
GE Tunsram	Hungary	**(Tubing)**
Preciosa International	Slovakia	
Technicke Sklo	Slovakia	

In the flat glass sub-sector, Saint-Gobain was operating 16 float tanks in the EU in 2007, with four in Germany, three in France, two each in Spain and Belgium, and one each in Italy, the UK, Portugal, Poland and Romania. Pilkington had twelve float tanks and AGC Flat Glass Europe (formerly Glaverbel) had thirteen. Four of Pilkington's twelve are in Germany; three are in the UK, two in Italy and one each in Finland, Sweden and Poland. Of AGC's thirteen, four are in Belgium and three in the Czech Republic; there are two each in France, Italy and the Czech Republic, and one each in the Netherlands and Spain.

Guardian has eight float tanks in the EU, two each Luxembourg and Spain, one each in Germany, the UK, Poland and Hungary.

In the fibre glass sub-sector there are seven reinforcement fibre producers in the EU. The biggest producers in the EU are Owens Corning with plants in Belgium, France and Norway, then PPG with plants in the Netherlands and the UK, and finally Johns Manville with plants in Germany and Slovakia. Vetrotex, which until recently was a subsidiary of Saint-Gobain, has plants in the Czech Republic and Germany.

The main producers of insulation fibres in the EU are Saint-Gobain with 20 installations in 12 Member States; Rockwool International with 10 installations in 5 Member States; Paroc with six installations in two Member States; Pfleiderer with three installations in two Member States.

In special glass, Schott is one of the key producers with interests in many special glass sectors, from precision glass tubing to radiation shielding glass. It has considerable market share in the special glass sub-sector. The main producers in the tubing segment are Osram (Germany), Technische Glaswerke Ilmenau (TGI) (Germany); Philips (Netherlands). There are other producers in Italy, France, Spain, Belgium and Hungary.

In Bulgaria the glass industry has benefited from significant levels of investment in the last ten years.
In container glass, Drujba Glassworks, which was acquired by Yioula Glassworks S.A. (Greece) in 1998, now has two glass melting furnaces (one of which is among the largest in Europe with an annual capacity of 130,000 tonnes), along with nine product formation lines. The second largest production factory of container glass in Bulgaria, the Stind factory, has also benefited from major investment in production renovation and upgrading. Today, Stind's glass melting furnace is one of the most modern in Europe. It delivers to four shaping lines and produces 300m bottles each year.
In the tableware sector, there has also been significant investment at the Kitka plant after Yioula acquired part of the plant as New Glass SA. Its glass melting furnace supplies five product formation lines and yields 100m tableware items annually.
Another big investment in the glass industry has come from Turkey's Sisecam. Its glass facility in Targovishte includes four plants for glass – manufacturing of flat glass, tableware glass, worked glass and glass mirror. The present value of the total investment is estimated to $380m. The second investment phase of Sisecam is now under way and scheduled to finish by the end of 2010. The $415m programme will deliver four new factories, and so glass production in Bulgaria can be expected to develop significantly over the next few years.

2.4 Processes

2.4.1 Production processes

Container glass can be manufactured to suit the size, style or brand image of the final product, as well as being physically strong, transparent and impervious. There are two stages to the large scale glass forming process (a) the initial forming of the blank and (b) the final moulding operation by blowing to obtain a bespoke finished hollow shape (IPPC, 2001), both of which are now highly automated.

The chief raw materials ('formers, fluxes and stabilisers') in the production of container glass are (British Glass, 2003):

- Silicon dioxide (sand/ silica) (70-74%)
- Sodium Oxide (12-16%)
- Calcium Oxide (5-11%)
- Magnesium Oxide (1-3%)
- Aluminium Oxide (1-3%)
- Recycled Glass (this can vary between 0-95% and affect the material shares above accordingly)

The chief raw materials in the production of float glass (soda lime silicate glass) are (GfE):

- Silicon dioxide (sand/ silica) (69-74%)
- Calcium oxide (5-14%)
- Sodium oxide (10-16%)
- Magnesium oxide (0-6%)
- Aluminium oxide (0-3%)
- Others (0-5%)

In domestic glass, product forming methods include manual methods (blowpipes and cutting) and completely automated machines. The majority of products are made from soda-lime glass, which can be clear or coloured. Lead crystal and crystal glass formulations are used to produce glasses, decanters and decorative items with high brilliance and density. Opal glass is used to produce cups, plates, serving dishes, and ovenware. Borosilicate domestic glass is perhaps better known by some of the common trademarks namely Duran (Schott) and Pyrex (Arc International), and the main products are cookware and heat resistant tableware. In some cases, products made of these different glass formulations are tempered in order to increase their resistance to mechanical and thermal shocks. Glass ceramic products are used for high temperature applications, principally cookware, and can withstand high levels of thermal shock. Domestic glass formulations must be tailored to specific product and processing requirements. Even basic soda-lime formulations can show significant differences from other soda-lime formulations such as container or flat glass. Increased mechanisation in lead crystal production has led to the production of cheaper items with quality close to that of hand-made items. The giftware sector benefits from relatively low energy usage, but to achieve the necessary quality and perceived value in their final products (to

differentiate themselves from cheaper foreign imports) production processes are typically very labour intensive.

Reinforcement glass fibres are produced and supplied in a variety of forms: roving, mat, chopped strand, textile (yarn), tissue, and milled fibre. The main end use (approximately 75%) is the reinforcement of composite materials, mainly thermosetting resins but also thermoplastics.

It is difficult to identify a typical composition for any of the main types of insulation fibres, eg. glass wool. The chemical composition can vary widely and is tightly controlled by regulations, which can act as a constraint on the use of inputs. The basic raw materials are selected and blended to give the final desired glass compositions following melting. The percentage of each raw material in the batch can vary significantly particularly where substantial amounts of recycled materials are used. The materials typically used are:

Glass wool: Silica sand, process cullet, external cullet, process wastes, nepheline syenite, sodium carbonate, potassium carbonate, limestone, dolomite, sodium sulphate, borax, colemanite

2.5 Inputs

2.5.1 Raw materials

Responses from the questionnaire survey show quite a variation in the percentage of raw materials imported. It varied from less than 10% to 80%, although this will, in part, reflect the differences in the type and nature of the glass products being produced. Three respondents reported a figure of 35% or more, while another indicated 20-40%. All respondents reported that since 2000 the share of raw materials imported has either increased or not changed. Five expect the share to increase over the next five to ten years. The primary reason for this appears to be poor availability within the EU, although it is not clear from the responses if this relates to raw materials that are not present/ abundant in the EU. Price is also quoted as a motive for importing. The problems and challenges identified with importing included variations in prices due to exchange rate fluctuations, ensuring consistent quality, the effect of distance (on access to supplier and on transport costs), and managing/ planning imports around the manufacturing process (ie a reliable and continuous, yet flexible, supply).

2.5.2 Energy prices

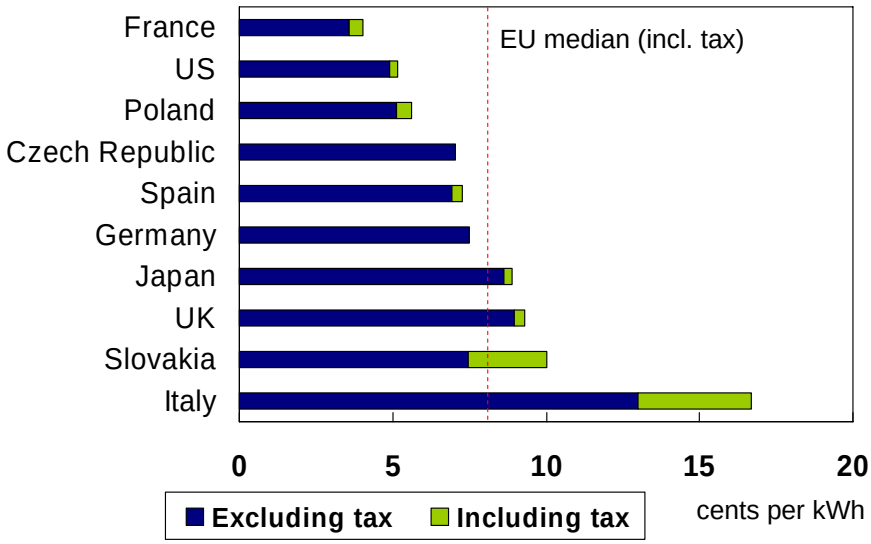
Energy can account for a significant proportion of glass firms production costs. In some sub-sectors which employ mass production techniques, energy could account for over 20% of firms' production costs, even before the sharp increases oil and gas prices in 2007 and 2008. The charts presented below show the electricity and gas prices faced by

industrial uses in a selection of EU countries along with the US and Japan. The data are for 2006 as 2007 data were not complete enough to conduct in similar international comparison.

First of all, the chart for electricity prices gives an indication of the variation in prices paid by producers across the EU and the world, and the impact of tax. There is substantial variation within the EU with France at one extreme, where producers paid just 4 cents per kWh in 2006 (including tax), and Italy at the other where producers paid just under 17 cents per kWh (including tax). The case of Germany and Slovakia illustrates the impact of tax. Before tax, electricity cost producers in Slovakia an average of 7.5 cents per kWh, the same as in Germany. However, producers in German paid no tax, while in Slovakia a tax of around 34% was added, leaving Slovakian producers to pay around 10 cents per kWh.

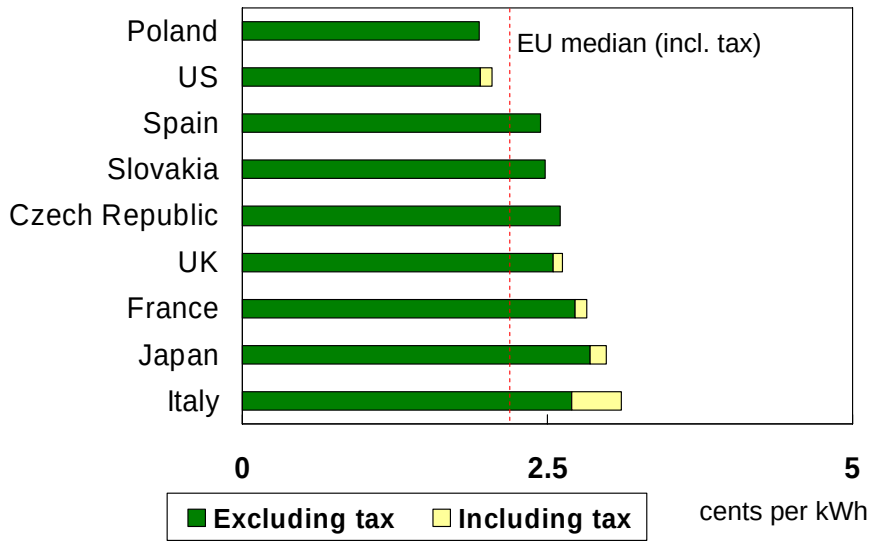
In the US and Japan, producers paid an average of 5.1 and 8.9 cents per kWh respectively. The tax rates on electricity prices the US and Japan were 5% and 3% respectively. By comparison, the median cost in the EU25 in 2006 was 8.1 cents per kWh, with a tax rate of around 8%.

CHART 2.11: INDUSTRIAL ELECTRICITY PRICES, 2006



Source(s) : *Quarterly Energy Prices*, BERR (UK); ECB; and CE calculations.

CHART 2.12: INDUSTRIAL GAS PRICES, 2006



Source(s) : *Quarterly Energy Prices*, BERR (UK); ECB; and CE calculations.

The chart for gas prices shows that compared to electricity prices, industrial gas prices were lower in 2006, at around 2-3 cents per kWh. There is some variation in the prices paid, but not as much as there was with electricity. Similar to prices for electricity, gas prices in the US and Poland were among the cheapest, while Japan and Italy were among the most expensive. A noticeable difference is that while France ranks favourably on electricity prices (ie. industrial electricity prices are among the cheapest) it ranks less favourably for gas prices. Producers in the US and Japan paid an average of 2.1 and 3 cents per kWh respectively in 2006. By comparison, the median EU price was 2.2 cents per kWh.

Both charts also indicate prices in some new Member States, Czech Republic and Poland in this case, are towards the lower end of the scale, thereby enhancing their attractiveness. Italy, meanwhile, remains one of the most expensive places to buy energy in the EU, particularly with regard to electricity, where the before tax price was 45% more than the before tax price in the UK.

The variation in EU energy prices has been reinforced by recent evidence provided by the Energy Intensive Users Group (UK) to the UK government (Department for Business, Enterprise and Regulatory Reform) (July 2008). This showed a wide range in forward wholesale gas and electricity prices between the UK, Europe and the US, and the UK, France and Germany respectively. This showed, for example, that while the forward price for electricity in November 2008 was around €37 per MWH in France, it was around €108 in the UK per MWh; Germany was in-between at around €83 per MWh. The price of electricity in France over 2009-10 was trading stably at around €49 per MWh. In Germany, electricity was trading higher over the same period by roughly 30-

95%; in the UK it was even more, 90-130%. Similarly, while gas in Europe was trading at a stable €1.03 per therm for 2009-10 period, in the UK it was trading across a broad range between €1.06 and €1.37 per therm for the 2009-10 period. In US, by contrast, the forward price fell over the 2009-10 period, from around €0.88 per therm in early 2009 to just over €0.63 per therm for a May 2010 delivery.
As of July 2008, UK gas prices were around 16% above those in continental Europe and UK electricity prices were around 38% higher than those in Germany on a year-ahead basis.

2.5.3 Capital

Container glass

In general, container glass furnaces operate continuously, or with a minor intermediate repair, for up to 20 years, after which time they are rebuilt with either partial or total replacement of the structure depending on its condition. While the cost of a repair would typically be €3-5m, the cost of a straightforward rebuild of a medium sized furnace (around 250 tonnes per day) would be substantially more. A new plant of comparable size on a green field site would cost in the region of €40-50m including infrastructure and services. In all cases the actual expenditure can be significantly higher because it can come at a convenient time to implement any upgrades to the process. For example, the new two furnace Quinn site at Ince, which includes filling operations, the latest environmental abatement equipment and a huge fully automated warehouse, will cost close to €400m.

Flat glass

Flat glass furnaces operate continuously for 12-15 years (or longer in some cases), after which time they are rebuilt with either partial or total replacement of the structure depending on its condition. A major rebuild would cost €30-50m and a new float line (typically 500 tonnes per day) would cost in the region of €100m.

Domestic glass

The domestic glass sector utilises a wide range of furnace sizes and types and the furnace repair interval will vary accordingly. Large fossil fuel furnaces will run for 5 to 8 years before a major repair is needed, for electrically heated furnaces it will be 3 to 6 years, and for pot furnaces 10 to 20 years, with the pots being replaced every 3 to 12 months. For a typical electrically heated 30 tonnes per day lead crystal furnace, a major repair (excluding forming machines) would be in the region of €2m, and a new furnace €8m. For a typical fossil fuel fired 130 tonnes per day soda-lime furnace a major repair (excluding forming machines) would be in the region of €4m, and a new furnace €12m.

Fibre glass: insulation

The insulation fibre sub-sector uses mainly recuperative and electrical furnaces, and to a lesser extent oxy-gas-fired furnaces for glass wool production; and predominately hot blast cupolas for stone wool production. The furnace repair interval will vary accordingly. Recuperative furnaces will run for 8 to 12 years before a major repair is needed, and electrically heated furnaces for 3 to 6 years. The lifetimes of oxy-gas-fired furnaces have not been fully established, but are expected to be comparable to

recuperative furnaces. Cupola furnaces do not operate continuously for such long periods, usually operating for 1 to 3 weeks between shutdowns. In this mature sector new plants are very rare, but a 20,000 tonnes per year glass wool plant was built in 1998 at a cost of €45m. A stone wool plant producing a similar volume (i.e. approximately 40,000 tonnes per year) would represent a similar investment.

Fibre glass: reinforcement

Furnaces in this sector operate continuously for 8 to 12 years, after which time they are rebuilt with either partial or total replacement of the structure depending on its condition. The rebuild of a medium sized furnace (around 75 tonnes per day) will cost in the region of €8m. A new plant of comparable size on a green field site would cost in the region of €75-90m including infrastructure and services.

Special glass

Furnaces range from 20-200 tonnes/day for soda-lime glasses and 20-50 tonnes/day for borosilicate glasses. Soda-lime furnaces are predominantly cross-fired regenerative furnaces and borosilicate furnaces are largely electrically heated furnaces with some recuperative furnaces. The special glass sector utilises a wide range of furnaces and the furnace repair interval will vary accordingly. Large fossil fuel furnaces will run for 6 to 7 years for special glass and 8 to 12 years for water glass, before a major repair is needed. For electrically heated furnaces the rebuild interval is 3 to 4 years. Due to the wide variation within the sector typical costs are difficult to predict, but the following costs have been supplied by the sector: €25m for one 35-40 tonnes per day furnace for borosilicate glass; €30m for two 30-35 tonnes per day furnaces for glass tubes; €175m for two 60 tonnes per day furnaces for glass ceramic oven tops.

2.6 Conclusions

This section has presented an overview of the EU glass industry using a range of sources. Production and capacity is spread out across the EU, due in part to the historic need to be close to local markets. In some sub-sectors production takes place in 20 or more Member States. At the same time, there are a lot of producers, in some sectors more than others. However, it is hard to avoid the conclusion that despite the multitude of producers and their locations, production/capacity in the EU glass industry is concentrated in a few countries and producers. Geographically, production is centred in the EU15, and in particular Germany. Behind Germany, France, the UK, Spain and Italy are all major producers although unlike Germany they tend to have a weak presence in at least one sub-sector. In the EU12, capacity in the Baltic states (Estonia, Latvia, Lithuania) tends to be small; the primary centres of production are Poland and the Czech Republic, with the likes of Hungary, Romania, Slovakia the other, smaller, centres of production. In some sub-sectors capacity in Poland or the Czech Republic exceeds that of some EU15 states.

Production is also concentrated in certain sub-sectors. The largest sub-sector, container glass, accounted for around 58% of total output (by volume) in 2007. The second-largest sub-sector is flat glass which accounted for around 27%. The other sectors made up the remaining 15%.

Typically, extra-EU trade has formed only a small part of the industry, with volumes equating to just 5-10% of production or consumption. In some cases transport costs have restricted how far products can be profitably traded, thereby restricting trade. Nevertheless, import growth has accelerated in recent years, especially in flat and container glass for example, and remains strong. Export growth has not accelerated to the same degree and remains modest by comparison. As a result, import penetration has increased overall, and quite substantially in some sub-sectors, while the proportion of output export is largely unchanged. Consequently, trade, and in particular the terms of trade for EU exporters, have become important issues for the glass industry.

Questionnaire results indicate the financial performance of the glass sector has come under increasing pressure since 2000, with net profit margins falling. Costs in the EU are reported to be significantly higher in the EU than in competitor regions, with labour costs, energy costs and environmental/ pollution compliance the main drivers. Most respondents reported rising labour costs since 2000, weakening the EU's competitive position and most expected the position to deteriorate over the next five to ten years. As a result of these factors the majority of respondents reported that EU-produced goods are typically more expensive than non-EU produced goods, by 10% or more. While expectations on future developments were mixed, the general mood appears to be more pessimistic than optimistic, with compliance costs, for example, expected to increase and disadvantage EU producers further, while labour costs are expected to remain an issue.

With regard to raw materials, the proportion imported by glass firms has risen since 2000. Although there is a fair degree of variation across sub-sectors, a figure of 30% is not unreasonable. Most questionnaire respondents expected this proportion to increase over the next five to ten years. Consequently, the sector has become more dependent on imports to meet its needs and as such more vulnerable to fluctuations in exchange rates and supply. Poor availability of raw materials within the EU appears to be the primary reason driving this trend.

Within the EU there is great variation in the price of energy, with electricity in Italy, for example, three times more expensive than electricity in France. The price across the EU is also distorted by differences in tax, with tax rates of 25-35% in Italy and Slovakia compared to rates of 0% in Germany and the Czech Republic. Gas prices and tax rates also show some variation across the EU, but less than is the case for electricity. This has implications for where firms choose to set up operations and partly explains why glass firms have been leaving the UK and Italy and expanding in the newer Member States. Internationally, EU producers are at a disadvantage compared to the US with regard to electricity prices. The median EU price for electricity was 8.1 cents per kWh in 2006, substantially higher than in the US and slightly lower than in Japan. Gas prices compare better, with a median price of 2.2 cents per kWh, practically the same as in the US and slightly cheaper than in Japan.

The importance of SMEs in the sector is diminishing. A tightening of operating conditions characterised by increasing rules and regulations, stronger downstream bargaining power, and limits on the scope for expansion outside the EU, not to mention rising input costs, are forcing SMEs to out of business. Production is becoming

increasingly concentrated in the hands of a few global producers, either EU-based firms, or non-EU firms with EU-based facilities. This is particularly true for flat glass, where production is concentrated in the hands of just three or four firms.

The EU glass industry has changed considerably in the past decade and this has been largely driven by cost pressures brought about by cheaper imports which the EU public have not been slow to purchase. In recent years, the main competitive threat in domestic and export markets has come from China, in the form of cheaper goods often of comparable quality and which sometimes infringe EU designs. This is especially true for the flat glass sector, where Chinese float glass imports have increased almost tenfold since 2004. Turkey is another country whose cheaper exports, particularly in domestic glass, are increasingly to be found in the EU undercutting EU-produced goods. In several cases, matters are often made worse for EU producers by a range of bureaucratic obstacles put up ostensibly to protect producers and consumers but with the net effect of denying or hindering access to export markets.

Increasing import penetration and excess capacity in some sub-sectors have increased pressure on margins in recent years. Along with environmental regulation this has forced existing EU producers to adapt their behaviour, and those that have not have essentially shut down. The industry response has been consolidation in the form of mergers and acquisitions, focusing on niche, high value-added products, the pursuit of greater economies of scale, significantly lower employment levels (or even outsourcing), increased automation in production and higher productivity.

3 Competitive position of the sector

This section provides an assessment of the glass sector's competitive position on EU and global markets, drawing upon the overview provided in Chapter 2. Where the data and literature permit, we assess the main performance indicators for the EU glass industry, in order to benchmark EU industry against its main competitors. This includes looking at developments in trade and the terms of trade, and global market shares; the strategies of key players in the sector; identifying real and potential barriers to entry and exit; the key customers and supplier markets, and their structure. We also present findings on profitability, margins, and developments in labour productivity. Developments in technology efficiency in relation to, say greenhouse gas emissions, are also covered.

3.1 Performance

3.1.1 In view of the wide range of sub-sectors, identification of significant developments in key product areas

The performance of EU glass producers has varied considerably in the past decade. Whilst many producers have performed poorly and lost market share (and even closed down) many firms, especially the major players, have continued to have a strong hold on world markets.

Firm	Turnover	Operating Income
NSG Pilkington (2007)	€4.23bn	€146m
Saint-Gobain (2007)	€43.4bn	€1.5bn
Vetropack (2007)	€425.9m	€80.4m
O-I (2007)	€5.5bn	€369.6m
Ardagh (2004)	€470.3m	n/a

Source(s) : Company Annual Reports and Accounts and CE calculations.

It must be emphasised that in 2006, only roughly 8% of EU production was exported and sold on markets outside of the EU, mainly as container glass (CPIV). However, total EU glass exports growth generally continues to grow slightly year on year as demonstrated earlier and this is an indicator of healthy performance. Even given the influx of cheap imports from emerging economies, the majority of EU glass production is still sold to firms and consumers within the EU (though a proportion of this will be processed and exported). Notably, many of the large players have continued to prosper and serve traditional markets within the EU. Consolidation, automation, increased labour productivity, product differentiation and innovation, loyalty and experience have allowed the EU producers to remain competitive in certain markets and sub-sectors.

One sub-sector where the performance picture is quite different is in the domestic glass market. This sector has seen many plant closures in the past decade and EU production of domestic glass has fallen over 12% since 2004 and this is chiefly as a direct result of substitutable low-cost non-EU imports. The relative performance of EU domestic glass producers is below par, especially in low end price range of soda lime glass, where import competition is intense. In 2006, import penetration of domestic glass products was 6% (CPIV). The situation now is that in many EU States, such as the UK, it is no longer viable to produce 'every day' domestic glassware (EC, 2006) as the vast majority of EU producers simply cannot compete on the basis of price with low-cost imports that are comparable in quality and design. Whilst low-end price range soda lime glass producers have suffered, new low-cost competition has encouraged specialisation by new and existing firms and in the high-value, high quality end of various domestic glass markets, the EU performs well – in the production of high quality glass crystal for example. Again, much of this competitive advantage boils down to superior product innovation and product uniqueness, labour skills, and the overall marketing package it is sold in.

The performance of special glass is sector specific. Special glass producers of cathode ray tubes for televisions and monitors have struggled due to an increase in demand for flat screen televisions and monitors. The cathode ray tubes segment was traditionally a significant market for EU producers. However, as discussed earlier, they are finding it difficult to gain a foothold in the supply of glass parts to the new, lucrative, global flat screen market. Many of the flat-screen producers are located in Asia (such as Sony, Hitachi and Panasonic) and many of their suppliers are nearby. The special glass section tends to perform well in technology-driven sectors where innovation is paramount.

The container glass sub-sector is a relatively mature industry serving extremely dynamic markets, where demand can change quickly according to consumer tastes and on a localised basis. On top of this, competition from alternative packaging materials is expected to continue to challenge the sector.

With regard to the new Member States that have joined the EU since 2004, the prospects are that the Polish economy will remain in a stage of continuous growth. It is also estimated that this growth will affect the packaging industry positively and relatively strongly. In the short run, paper packaging is expected to be the sub-sector with the largest consumption increase. But also other packaging materials such as plastic and glass will benefit. Despite the competition of plastic packaging, glass sales are expected to increase and due to improving quality of supplied packaging and the increasing role of returnable packaging in line with the adopted pro-ecological regulations, the value of the glass sales is even expected to rise faster than the volume. In the Czech Republic, manufacturers of flat glass and, for example, textile fibres will have an advantage in the glass industry due to the levels of foreign investments; but elsewhere manufacturers of illuminating glassware may have problems since the interest of consumers in these types of products has dropped and competition has increased.

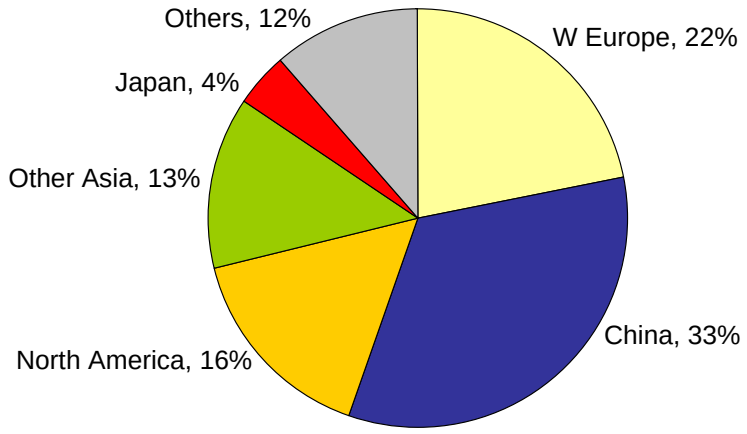
3.1.2 Developments in global market shares and relative prices of exports

The performance of the EU industry on world markets can be judged by reviewing the size of the foothold that the industry has on the world market. In 2003 four companies accounted for 62% of the world flat glass market, three of which were EU based (Hedley, 2003). The following chart shows the global market share by volume and by value, of flat glass production in 2003.

As the chart shows 'Western Europe' (which is crudely assumed to refer to EU15) has a share of 22% by volume and nearly 32% by value in the global flat-glass market. This volume to value ratio is the second highest in the world, closely behind North America, and shows that in terms of producing value added glass items the EU performs very well and is a highly competitive world leader. This also applies to other glass sub-sectors. The EU has a major position in the global lead crystal glassware sector: 85% of *global* lead crystal glassware output is produced in the European Union (EC, 2006), and SMEs play a significant role in this high value segment.

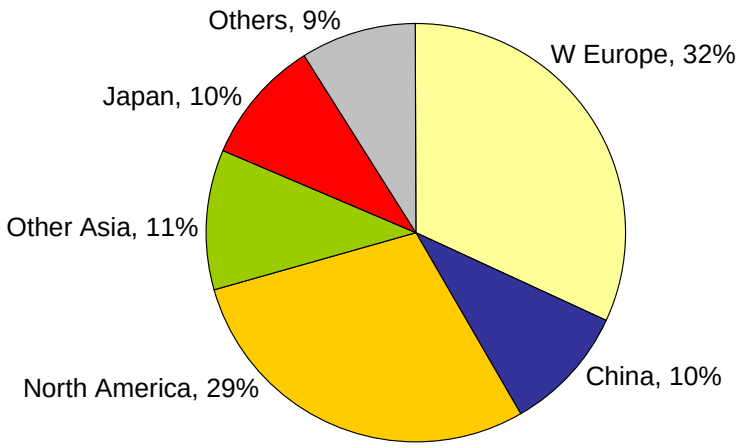
Whilst the EU performs strongly in high value world markets, the chart shows that it performs less well in high volume activities and lags behind the high volume (and

CHART 3.1: REGIONS' SHARES OF GLOBAL FLAT GLASS OUTPUT, BY VOLUME (2003)



Source(s) : CPIV.

CHART 3.2: REGIONS' SHARES OF GLOBAL FLAT GLASS OUTPUT, BY VALUE (2003)



Source(s) : CPIV.

relatively low value) flat glass items produced by China. This shows that in terms of productive performance China is more cost efficient than the EU in low-value items and this is especially true of the low value section of the domestic glass sub-sector. In summary, this demonstrates that the EU has a competitive advantage in value added products and China has a competitive advantage in low-cost products and this is closely linked to the business models and strategies each employs.

3.1.3 Developments in profitability and price-cost margins

Typical cost structures for the glass industry are not easily available in the public domain. In the more broadly defined non-metallic mineral products sector, energy accounted for approximately 6% of costs in the EU25 in 2003, three times as much as the manufacturing average, making this sector relatively energy-intensive. While the share of other goods and services (70% of costs) was 8 pp lower than in manufacturing, personnel costs (24%) were 4 pp higher. Member State-level analysis shows energy costs were above the EU average mainly in southern and eastern Member States. Slovakia and Latvia had the largest percentage of this cost type at 18%.

In the flat glass sector, raw materials and energy are the single largest elements of cost, followed by overheads and prime labour. Energy accounts for around 20% of total cost in the float process. Since the 1960s, the glass industry as a whole has reduced specific energy consumption by approximately 1.5% pa. The rate of reduction is now slowing as the thermodynamic limits of the process are approached. The float process is not labour-intensive. Glass is relatively heavy and comparatively cheap, making distribution costs significant; they typically represent around 10-15% of total costs. Similarly, in container

glass energy accounts for around 20% of total costs. British Glass estimates that between 1980 and 2003 the amount of energy required to melt a tonne of glass fell by 54% to 1.47 MWh. This would have been accompanied by a similar reduction in CO_2 emissions.

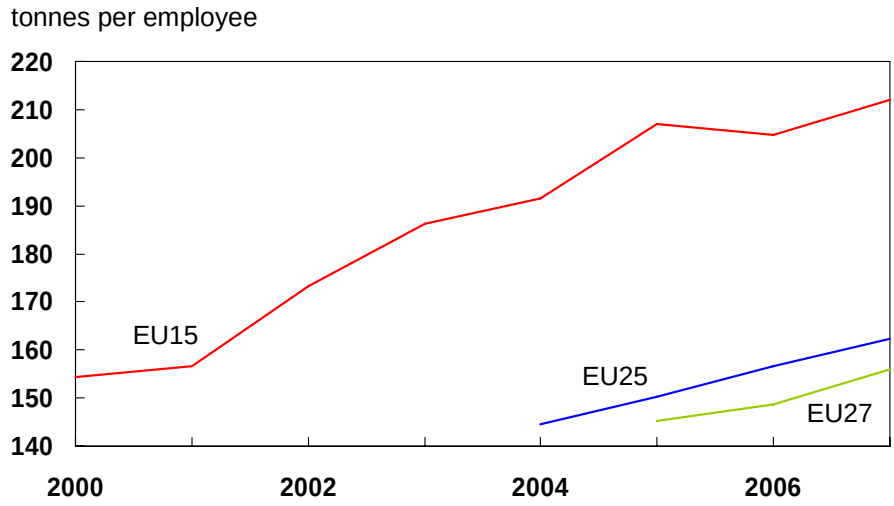
Energy is a key driver for production costs in the glass sector. In Romania, for example, natural gas and electricity costs are no longer subsidized and so energy costs make up a significant proportion of total production costs. The current self-sufficiency rate of between 50-60% in Romania is expected to decrease over the next 10 years. Energy costs are expected to continue to increase as the Romanian government decreases subsidies and more energy, particularly gas, is imported. If industrial energy costs in Romania are raised to European market levels in the short term, the shock to glass companies is likely to be debilitating, especially for small companies. To address the issue of rising energy costs, industry groups have lobbied effectively for volume discounts for high-volume industrial users (defined as greater than 5 million cubic meters/month). This discount benefits large glass producers in particular. In contrast, medium sized firms may use as little as 60-70 cubic meters/month and do not benefit from discounted prices.

3.1.4 Developments in and determinants of labour productivity

Technological innovation and business organisation has had a significant influence on the productivity of EU Glass producers. The decline in employment identified earlier and virtually simultaneous rise in production automation has significantly increased the productivity of each worker. CPIV estimations suggest that productivity per employee grew by 95% between 1991 and 2005 (EC, 2006). Unfortunately, there is a lack of comprehensive literature on the productivity of EU glass producers by *value*, and only the key trends in output productivity per employee are available.

The chart below shows the increase in labour productivity (in terms of output per employee) in the EU over 2000-07. In terms of productivity growth, the overall output per employee has grown by nearly 40% in the EU15. This translates into an average rate of 4.7% pa. The upward trend has continued following the expansion of the EU in 2004 and 2007, but it can also be seen that the expansion has led to a lowering of productivity for the EU glass industry as a whole, reflecting the significantly lower rates of productivity in the countries of the EU12. Since 2004, labour productivity growth in the EU has averaged 3.7-4% pa. It the EU15 it has averaged 3.5% pa, while for the EU12 it has been in the region of 15% pa.

CHART 3.3: EU GLASS INDUSTRY PRODUCTIVITY



Source(s) : CPIV.

One factor that influences productivity is innovation. The EU is a major innovator in the global glass industry and the UK leads the world in flat glass innovation (British Glass, 2007). The high level of UK innovation is largely attributed to the high numbers of Science and Technology graduates, and their relationships with, and proximity to, established glass manufacturers and processors. This continuous innovation stimulates the development of new, unique products and ensures that the UK (and the EU) can differentiate its output from foreign competition and remain dominant players. Also, "investment in R&D and innovation is conducive to boosting productivity" (EC, 2007[c], page 8). A threat to this position is the recent trend for some producers to locate R&D facilities outside the EU, as more production is relocated to lower-cost and/or faster growing markets. A recent example of this is O-I's decision to invest in a new R&D centre in Peru, where it is also doubling the capacity of its glass manufacturing plant in Lurin (operational 2009Q2).

The key factor that has influenced labour productivity is the development of production automation, which critically is driven by technological innovation. Whilst productivity growth brought about through automation is beneficial to producers (and the EU economy) a potential problem is that although the innovative production techniques and technology may require extensive continuous innovation by highly qualified persons, automated production lines do not require a highly skilled workforce to operate them (ifo Institute and Carl Bro Group, 2006). This makes production labour easily substitutable, and gives greater scope to relocate production to countries where labour costs are lower (such as China). The low worker skill requirement in production brought about by automation suits the low-cost business models of emerging economies as it allows them to minimise wage costs in labour markets where cheap labour is usually in ready supply, and hence boosts their relative productivity. A concerning potential by-product of this

trend is that evidence suggests that research into new products and processes needs to be located near to the core glass manufactures (British Glass, 2007). If production continues to move outside the EU, in the medium to long term innovators may follow them and the extent of the EU's competitive advantage in glass product innovation may fall.

Another driving factor behind increases in labour productivity in some new Member States (EU12) has been the privatisation of the glass industry. In the Czech Republic, many industrial firms were restructured and modernised by their private owners, with the result that labour productivity increased and employment fell.

3.1.5 Macroeconomic outlook

At the time of this report (summer 2008) the EU and global macroeconomic outlook has deteriorated. In the wake of the credit crunch of summer 2007, business and consumer confidence has deteriorated in the major economies of the world. Business confidence has fallen in the face of tighter borrowing conditions, falling investment demand and high input prices. Consumer confidence has fallen in the face of the rising living costs and the weaker economic outlook, and the potential impact on employment. In some countries, eg the UK, Ireland, Spain, the US, confidence has been further weakened by a sharp deterioration in the housing market and house prices.

As a result activity in the major world economies is expected to slow over the short to medium term as households rein in their spending, intermediate business demand slows and businesses curb investment demand. As a result, the latest consensus forecast (June 2008) was for world GDP growth to slow from 3.8% in 2007 to 2.9% in 2008 and 2.8% in 2009. GDP growth in the EU is expected to slow from 2.8% in 2007 to 1.9% in 2008 and 1.7% in 2009. Growth in the US is forecast to slow from 2.2% in 2007 to 1.5-1.7% over 2008-09, while Japan should see a similar trend, from 2% in 2007 to 1.3-1.5% in 2008 and 2009.

While the slowdown will affect all industries, some will be affected more than others, and within glass, some sub-sectors are more exposed. The flat glass sub-sector can be expected to suffer badly from the downturn in the housing market and construction sector generally, as lower/ falling activity translates into lower demand for windows and glass panels. Demand from the automotive sector can be expected to remain weak as household spending weakens and EU automotive producers curb production plans.

The domestic glass sub-sector is also exposed to the slowdown in housing markets, where fewer people moving into homes translates into fewer purchases of new household glassware, this will be compounded generally by weaker consumer spending. Domestic glass makers operating at the top end are especially vulnerable as consumers react to the economic uncertainty and delay expensive/ luxury purchases. The ceramics industry faces similar challenges and as such, frits producers face a tough time ahead given their relationship with the ceramics industry.

Demand for healthcare is not cyclical and should remain robust during this downturn. Consequently, in the container glass sub-sector, demand for pharmaceutical-related glass products should hold up. The higher value nature of these products will offer some respite for margins. Elsewhere in container glass, the outlook is not so good. With household spending expected to slow across nearly all expenditure groups over 2007-09, demand for

cosmetics/perfume containers is likely to ease while demand for drinks and food containers can also be expected to weaken as households look to spend less, even here. However, given peoples' need to eat and drink, it is unlikely to be as sharp a slowdown as in say, the flat glass sub-sector. Both fibres sub-sectors are also likely to suffer from a slowdown in construction activity, as lower building activity hits demand for insulation and structural material.

3.1.6 Expansion outside the EU

In discussing trade in chapter two we highlighted the increasing flow of imports generally, and the increasing capacity coming on line in countries surrounding the EU. This is expected to pose a threat to EU producers over the coming years, but this is likely to be exacerbated by the deteriorating economic outlook and slower economic growth expected over 2007-09. EU producers will face a double whammy of weaker domestic demand (and increased pressure on prices) and increasing flows of lower cost imports. The table below is comprehensive but not exhaustive and indicates where capacity has recently been expanded or will come on line in the near future, along with the scale of that capacity.

Sub-sector	Number of new/expanded plants 2004-09	By country	Total capacity of new/expanded plants
Container glass	21	12 Russia 3 Ukraine 1 Albania 1 Croatia 1 Egypt 1 Romania 1 Tajikistan 1 UAE	3,022,000
Flat glass	10	4 Russia 2 Egypt 1 Azerbaijan 1 Belarus 1 Qatar 1 Ukraine	2,405,000
Domestic glass	1	Russia	250,000
Fibre glass	1	Russia	50,000
Total			*5,727,000*

Note(s) : This includes two new container glass facilities to be opened in Russia in 2009 and four new flat glass facilities to be opened in Azerbaijan, Egypt and Russia (2) in 2009.
Source(s) : British Glass.

The figures indicate and increase in production capacity of at least 7.5 mt in countries neighbouring the EU; 2.4 mt have come on line in 2008 or will do in 2009. The table indicates which sub-sectors are being most affected with the largest expansions coming in container and flat glass: an extra 3 mt of capacity in the case of the former and 2.4 mt in the case of the latter. However, the threat seems especially acute for flat glass, given that EU production is typically 9-10 mt. The table also shows that the threat comes from a range of countries, from Russia and Ukraine on the edge of the EU to UAE and Qatar in the Middle East. However, the main threat is likely to come from Russia, with over half of the plants listed and 3.7 mt of the increased capacity. In March 2008 the Chinese glass fibre producer CPIC announced plans to build a new glass fibre plant (aimed at the construction industry) in Bahrain over 2008-12. Production at the first furnace started in summer 2008 and when the plant is complete in 2012 total production capacity will be 200,000 tonnes.

3.1.7 Engaging in the climate change challenge

The prospect of weaker demand in the EU and increasing competition from imports from neighbouring countries in the medium term will make it even harder for EU glass producers to rely on conventional products and revenue streams. This will place increasing pressure on firms to develop new, higher value-added products. The glass industry has been introducing environmentally friendly products for many years but with policy makers embracing the climate change challenge more fully, the glass industry has an opportunity to introduce more new products and educate policy makers on the benefits that glass products can deliver.

For example, studies have demonstrated that the flat glass industry manufactures products that would enable considerable savings in the EU25 when replacing existing single and double glazing with high performance low-e coated glass (140 mt CO_2 per year). A further study has shown that the use of solar control glazing (in conjunction with low-e properties) in air conditioned existing and new residential and non-residential buildings can save 15-80 mt of CO_2 in the EU25 (between 15-85 mt in the EU27) depending on the assumptions made for the uptake of air conditioning in the coming years

To help foster the markets for these products and both help tackle climate change and support the glass sector, it is important for policy makers to consider the environmental and energy benefits that can be delivered by glass when setting policy and taxes on energy/carbon. Consideration also needs to be given to the impact of energy prices. Strong rises raise the cost of producing glass and undermine the competitiveness of EU glass producers.

3.1.8 The EU Emissions Trading Scheme

One mechanism through with the EU glass sector is already engaged with the climate change challenge is EU Emissions Trading Scheme (EU ETS). The EU ETS is an emissions trading scheme designed to bring down the EU's greenhouse gas (GHG) emissions. The first phase of the EU ETS came into force in 2005 and finished in 2007. The second phase (2008-12) is currently under way, while the third phase will commence in 2013 (and finish in 2020). The effectiveness of the scheme depends on how tight the

caps are and how rigorously they are enforced. After rising throughout phase one to €30 per tonne CO_2, the price of allowances fell back to less than €10 per tonne CO_2 because emissions caps were not tight enough in some countries, ie. there were too many allowances. In late 2007, allowances were trading at less than €1 per tonne CO_2. Consequently, verified emissions *increased* over the first phase of the scheme.

Since then, the Commission has looked to broaden the scope of the EU ETS and bring down national emissions caps. Under phase two, for example, emissions caps are on average 7% below 2005 levels while emissions from aviation are expected to be included from 2010 onwards. The Commission has proposed further revisions for the third phase which would broaden the scope of the EU ETS further. Among these are the inclusion of all greenhouse gases and all sectors, including aviation, maritime transport and forestry. There is great concern in the glass sector about the potential impact of phase three on EU glass producers.

To illustrate this, presented below are the results of a British Glass projection (using CE assumptions) of the potential cost of phase three to container and flat glass producers in the UK (these two sub-sectors account for 97% of UK glass sector emissions).

Key assumptions are that the price of allowances in phase three will increase by an average of 2%pa and the average price for the phase three period (2013-20) will be €29.8 per tonne of CO2; that the starting figure for calculating the 2013 allocation is based on the NAP2 allocation (National Allocation Plan for phase two); that the maximum amount of allowances used for calculating allocations to installations which carry out activities in 2013 and received a free allocation in the period 2008 to 2012 shall not exceed the 2005-07 averages (Directive revision: 10a 4); allocations in 2013 are reduced to 80% and fall linearly to 0% in 2020.

Estimated impact of EU ETS Phase III on UK container and flat glass sub-sectors

Container glass

Cost	2013	2014	2015	2016	2017	2018	2019	2020
					€m			
Direct CO_2 purchase	9.8	13.4	17.1	21.0	25.0	29.2	33.5	38.0
Electricity pass through	9.2	9.4	9.6	9.8	10.0	10.2	10.4	10.6
Soda ash pass through	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
Total	*26.8*	*30.6*	*34.5*	*38.6*	*42.8*	*47.2*	*51.8*	*56.5*

Flat glass

Cost	2013	2014	2015	2016	2017	2018	2019	2020
					€m			
Direct CO_2 purchase	7.1	9.4	11.8	14.3	16.9	18.0	22.4	25.3
Electricity pass through	2.2	2.2	2.2	2.3	2.3	2.4	2.4	2.5
Soda ash pass through	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Total	*14.2*	*16.6*	*19.0*	*21.6*	*24.2*	*25.4*	*29.8*	*32.8*

Note(s) : For flat glass, the slowdown in 2018 is thought to reflect a period when rebuilds produce a noticeable impact on overall emissions.
Source(s) : British Glass projection using CE assumptions.

The results show the overall cost impact to the sub-sector, broken down across direct purchases, electricity pass through costs and soda ash pass through costs. The cost to the two sectors in the UK is estimated to be €41m in 2013, with the container glass sub-sector paying around €27m. The overall cost to these sub-sectors (in the UK) rises substantially over phase three to reach just under €90m in 2020: the cost to the container glass sub-sector is estimated to be just over €56m, and just under €33m to the flat glass sub-sector.

Under our assumptions, this increase is driven by the direct CO_2 purchase cost[2]. For the container glass sub-sector, the cost of direct purchases almost quadruples from €9.8m in 2013 to €38m in 2020. For the flat glass sub-sector, the cost increases from €7.1m in 2013

[2] For pass through costs, historical electricity and soda consumption have been used (i.e. without growth) for pass through of production costs. Electricity pass through costs have been based on actual historical sector delivered electricity consumption (i.e. without growth) multiplied by the UK DEFRA Climate Change Agreement factor for primary emissions at the generators. This is then multiplied by the Cambridge Econometrics price factor. Soda ash pass through costs are based on an average increase in cost per tonne for phase three multiplied by sub-sector consumption calculations based on 2005-7 consumption without growth.

to €25.3 in 2020. In the long-term context of increasing competition from overseas producers this increasing cost could curb producers pricing flexibility and support the erosion of EU market share, especially where non-UK or non-EU producers are subject to less stringent rules.

There some caveats to this projection. The cost model for allowances in phase three is considered to underestimate the demand on allowances from obligated sectors against that available. Sector production is uncertain; an increased demand for existing flat and fibre glass products and more energy intensive flat glass products may occur as society responds to climate change initiatives including the use of energy efficient glazing systems and energy generating products involving glass i.e. photovoltaics and solar panels. Meanwhile, glass container production will be subject to demand and possibly changes resulting from life-cycle assessment analyses

3.2 Structure

3.2.1 Identification of key players in the world market and their strategies

In order to review competitive strategies, the main players in the world market need to be considered.

Non-EU-based owner	Country	Sub-Sector
Owens-Illinois	USA	**Container Glass**
Vetropack	Switzerland	
Pilkington-NSG	Japan	**Flat Glass**
Glaverbel-Asahi	Japan	
Guardian	USA	
Euroglas	Switzerland	
Libbey	USA	**Domestic Glass**
Pasabahce (Sisecam)	Turkey	
Corning	USA	**Special Glass**
Asahi	Japan	
NEG	Japan	
HOYA	Japan	
Owens Corning	USA	**Glass Fibres (Reinforcement)**
Owens Corning	USA	**Glass Fibres (Insulation)**

EU-based owner	Country	Sub-Sector
Ardagh	Ireland	**Container Glass**
Saint Gobain	France	
Vidrala	Spain	
Saint Gobain	France	**Flat Glass**
Arc International	France	**Domestic Glass**
Durobor	Belgium	
Johns Manville	UK	**Glass Fibres (Reinforcement)**
PPG Industries	Netherlands/UK	
Rockwool	Denmark	**Glass Fibres (Insulation)**
Saint-Gobain	France	
Osram	Germany	**Special Glass**
Philips	Netherlands	
Schott	Germany	

It can be seen that some glass producers that were established in the EU are now owned (or partly owned) by firms in non-EU countries. This is the case with Pilkington and Glaverbel. The majority of foreign competition amongst large firms is based in Japan and the USA, especially in flat glass and special glass production. The USA dominates the global production of glass fibres for reinforcement, producing a wide product range, and much of its success is attributed to first mover advantages and innovation: Russell Games Slayter of Owens-Corning invented the 'fibreglass' in 1938 – a brand that is now almost synonymous with glass fibre products.

Business Models of EU Producers

The business models and strategies of EU glass producers will clearly vary from firm to firm but there are a number of key trends in strategy that can be explained using economic theory on competitiveness. In the Resource Based View of the firm put forward by Barney (1991), firms base their competitive strategy on their available unique resources and competencies. According to Barney (1991), firms will achieve a competitive advantage if their resources are valuable, rare, imperfectly imitable and non-substitutable. The Resource Based View is used to help to understand the strategies of EU glass producers.

Generally speaking, large foreign direct investments have been made in several EU12 countries. These started after the privatisation process of the early nineties. These investments allowed for several directions of improvement of production, depending on each country's own characteristics: modernisation of production and production processes, new technologies, rationalisation in the use of raw materials and labour force, use of international distribution channels existing in the network of the foreign investor.

The attractiveness of certain EU12 countries to foreign investors depends on a number of aspects, but one very important one is the availability of raw materials like sand mines. Also, the relatively cheap labour costs and the sometimes longstanding experience of the countries in this sector are crucial for investors. Finally, their geographic location allows foreign investors to efficiently export to other eastern European markets.

- *Major Players*

It is difficult to assess the strategies of larger firms as they are involved in such a wide range of sub-sectors and markets, but those large firms that compete primarily on the basis of price have been forced to incorporate increased cost-saving activities into their strategies. This has been especially true for the EU firms that have faced low-cost competition from emerging economies with fundamentally lower cost structures. It has forced EU competitors in these markets to reduce costs primarily by increasing labour productivity and the automation of production. The large EU firms that compete with foreign low-cost competition on the basis of price that have not incorporated cost saving measures into their businesses models have generally suffered. It should be noted that not all large firms have had to cut costs so intensively, especially those that supply products that are *not comparable* with low-cost foreign imports, i.e. that are targeting a distinctively different market. The ability of large EU firms to control the production and distribution of unique, innovative products that cannot be copied is one reason why they continue to be profitable. Foss and Knudsen (2003, page 7) state that, "firms that control valuable and rare resources possess a competitive advantage and will be able to implement superior strategies", and this appears to be the case amongst innovative large firms and emphasises the reward of (and need for) comprehensive Research and Development. Porter (1996) identifies that strategy involves a 'trade-off' and this means that the strategies of large firms cannot cover *all* markets. For example, product diversity (specification and variations) significantly reduces overall output levels when production is continuous and on a large scale, and can amount to as much as seven days' lost production in flat-glass manufacturing (Pilkington, 2006). This implies that if large-scale continuous producers wish to supply a range of very different products it may damage the operational efficiency of core glass producing activities, i.e. there is an opportunity cost involved. This problem leaves 'gaps' in the market for other better-suited firms.

- *Intellectual property rights (IPR) and counterfeiting*

The competitiveness of many EU glass producers (large and small) producing differentiated products such as decorative glass items has suffered due to the counterfeiting of EU-origin designs by non-EU firms. Tableware and ornamental-ware producers have been particularly affected by the import of comparable and substitutable glass products, (that are effectively 'copies' of EU products) which have entered the EU and are sold at much lower prices than those of domestic producers. There is evidence to suggest that foreign counterfeiters are involved in sophisticated production of everyday glassware with high volumes of consumption. Hence this counterfeiting has had a significant impact on the prosperity of domestic glass producers. This intellectual property issue is something that the relevant authorities have tried to clamp down on, but sophisticated counterfeiting has to be a serious concern to any glass producers that sell products and designs that can be easily duplicated.

- *Product Substitutability*

Another challenge comes from alternative materials which can be used in place of glass. In some product markets glass faces strong competition from alternative materials such as plastic, metal and cardboard. In some cases glass producers are disadvantaged by having to comply with environmental regulations that non-glass producers do not have to comply with, or the regulations have an unintended consequence of favouring alternatives, e.g. weight-based regulations which favour lighter materials. Regulations which look at the environmental impact of materials across the whole product lifecycle, rather than just production, or consider other, non-weight-based measures would help to even the playing field.

3.2.2 Identification of potential barriers to entry and exit

International Trade Restrictions

The first potential barrier to an EU glass producer wishing to sell its output outside of the EU is the existence of tariffs, i.e. taxes placed on imports arriving into a country so that its price becomes less competitive with domestically produced goods (Cook and Farquharson, 1998). Many export markets impose tariffs on EU produced goods. Arguably the most formidable example is the high rate of duty imposed on EU products (especially giftware) that are sold in the USA.

The second potential barrier to an EU glass producer wishing to sell his output outside of the EU is the existence on non-tariff barriers which in essence are any barrier to trade which is *not* in the form of a tariff. Quotas are one example of such a barrier where a home nation will limit the quantity of certain products that can be imported. The glass sector can also be affected indirectly by such barriers, where, for example, barriers to an end product containing glass exist; an example of this might be the restrictions placed on whisky imports into India. Political relations can also act as a barrier to trade and there is evidence that EU glass producers have had difficulty exporting to some countries (to Saudi Arabia for example) due the destination country favouring imports from political allies. There is also evidence of a ban of imports of certain EU products into countries such as Syria.

There are reports of compulsory testing, and certification schemes in export destinations such as Turkey. In a recent conference regarding the principal challenges facing the European glass and ceramics industries, it was implied that such certification and testing is a virtual barrier to trade:

> "The principal reason given for the introduction of such systems by most trading partners is the concern for public safety, which is presumably the reason why ceramic wall and floor tiles are the products most usually covered by them (but also some glass products). It seems, however, that the real reason is protection of domestic manufacture" (EC, 2007, page 6).

Cook and Farquharson, (1998) identify local health and safety regulations as an increasingly significant non-tariff barrier to trade, and the implications of this, and other trade restrictions on competitiveness are discussed in chapter four.

Economies of Scale

Economies of Scale occur when the long run average costs of the firm decline as output expands. In order to achieve significant economies of scale in production output needs to be on a mass scale and high labour and capital productivity is usually required. Many large EU glass producers are able to operate with low costs because they can earn significant economies of scale through high plant utilisation (a furnace can run continuously for over eight years) and large plant sizes. Thus economies of scale place potential entrants at an immediate cost-disadvantage and act as a significant barrier to entry as new firms cannot earn the necessary economies of scale in the short term at least to be competitive. A challenge for incumbent firms and newcomers in recent years has been the increasing heterogeneity of consumer demand. Consumers are asking for a greater number of products and models to match their changing lifestyles and individual needs. It is a challenge to keep up with these trends. While improvements in technology and supply chains make this more possible, it makes it harder to produce glass products on a mass scale and reduces the potential for economies of scale to be achieved. This makes it harder to turn a profit.

Setup Costs and Required Length of Investment

As a consequence of the economies of scale entry barrier above, high initial setup costs in areas such as container glass production can shield existing firms from new competition. According to British Glass (2003) the cost of a furnace is approximately €10-20m, but this could be substantially higher depending on what upgrades or innovations are included. There is also an element of risk involved with the purchase of a furnace. Once installed it will usually operate day and night for 10-12 years, and will not easily be modifiable or replaceable (ifo Institute and Carl Bro Group, 2006). This high capital intensity and associated financial and economic costs and risks together act as a significant barrier to entry.

Access to Markets and Tied Distribution Channels

Even if the new entrant can somehow overcome the two high entry barriers above, it must still be confident that there is room in the market for its new capacity. Given the longevity of many of the existing glass producers, it is likely that many of them have long-standing production agreements and enjoy loyalty from purchasers of their output. In theory, when distribution channels are 'tied' (Bain, 1956) as described above and there is no route for the product to market; it significantly heightens entry barriers. In Poland, it is generally the case that large packaging producers benefit from long-term contracts for delivery of packaging concluded with major buyers. This leads to gradual consolidation of the packaging market and is the key reason for the decrease in the number of producers on the market. This also affects the glass packaging industry.

Differentiation and Branding

Differentiation and branding further protect incumbent glass producers from new entry, making access to large markets even more of a challenge for new entrants. This is a challenge for regions as well firms or sectors. In the marketing area some regions face a considerable barrier in building regional brand awareness in the marketplace. A regional brand identity based on quality and value is important because it helps firms to command a premium for their products. While large-scale buyers may know that firms form a

specific region produce high value products, the end customer does not. Identifying and exploiting niche markets will be important in achieving this and supporting the growth of SMEs in these sectors. But market demand is extremely varied and the distribution channels to reach customers are also fragmented, so identifying which markets are most receptive to your products is a challenge.

Legal Barriers

Health and Safety legislation, environmental regulations, fiscal laws, building planning and regulations, and competition policy are examples of factors that can create artificial barriers to entry. These are considered in section 4.

Research and Development

In some very specialised sub-sectors, high levels of continuous Research and Development (and knowledge) are required in the production and design of products, in a continuously evolving industry. This can act as a barrier to entry if new entrants are unable to conduct sufficient Research and Development and/or employ the advanced production or design techniques of incumbents.

Geographical

The geographical location of production can affect which markets are accessible to a producer. Some products are only normally transported over small distances to be economically viable and this can act as a barrier to entry and restrict market access. Conversely high value glass products can be transported over longer distances (such as the trend of European giftware producers exporting their products to the USA) and in this case geographical barriers are lower. There is evidence in the industry that despite globalisation bringing markets closer together, in some circumstances purchasers of glass products prefer to be nearer to the source of production. This is very much the case in the production of flat-screen television parts, where EU firms are finding it difficult to overcome this barrier and enter into the lucrative market because most flat-screen television production is in Asia.

Macroeconomic Uncertainty

The final barrier to entry which applies to almost any industry is macroeconomic uncertainty. Uncertainty over inflation, interest rates, currency values, energy prices, political relations, stock market performance, house prices, credit availability and employment rates all potentially increase the barriers to entry into the EU glass market.

3.2.3 Market structure of suppliers and customers

Distribution Channels and Integration

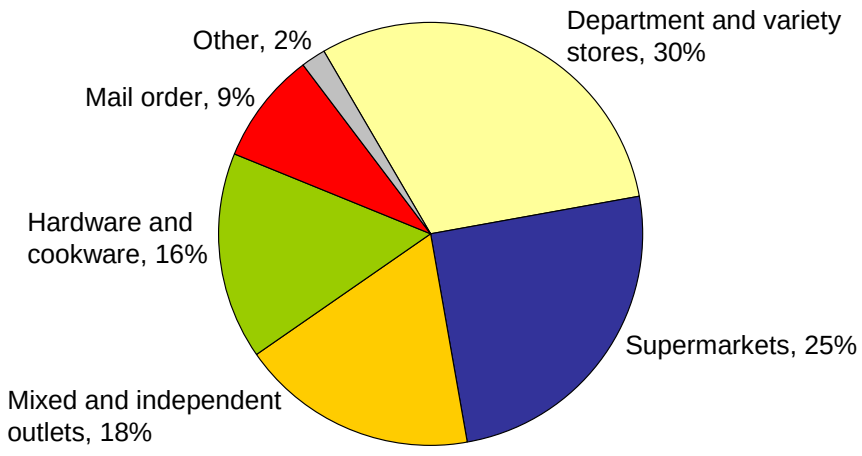
Domestic glass

Different parts of the market are affected by a wide range of factors. Customer tastes and social trends are very important. For example, the trend towards more casual dining has resulted in a higher demand for cheaper medium quality items, and the demand for coloured glass varies with time and region. It is important for the manufacturer to keep ahead of these changes and to respond accordingly; therefore flexibility is an important part of the manufacturing operation.

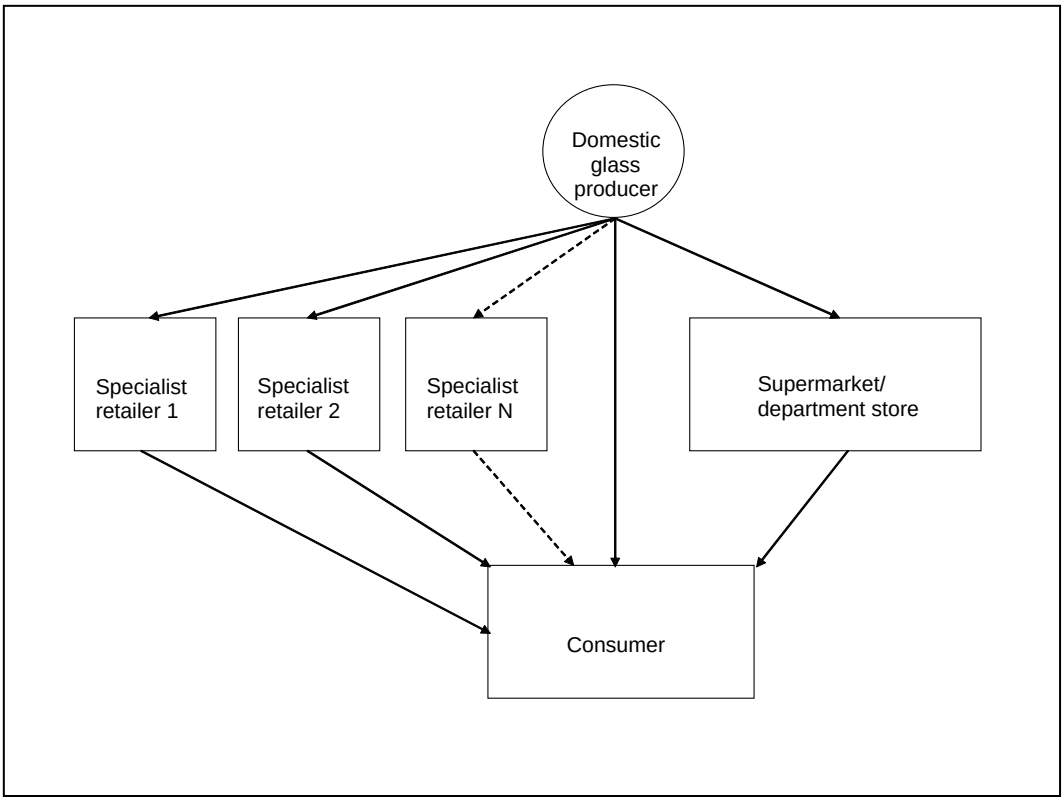
There can be several routes to market for domestic glass producers. The chart below, for example, shows the principal selling outlets for UK domestic glass production. However, it also indicates the importance of supermarkets and department stores. Domestic glass producers have two traditional distribution channels via, (1) large department stores and supermarkets, and (2) via specialised retailers that are usually small and have varied bargaining power. However, they are also increasingly selling direct to the consumer. This is summarised in the diagram below.

When domestic glass producers sell to specialist retailers, such as small hardware stores, they incur the distribution costs involved with visiting and investigating suitable retailers. Conversely, the relatively large size of the glass producer compared to the size of the specialist retailers gives the glass producer greater selling power (ifo Institute and Carl Bro Group, 2006), and hence it is able to widen its margins. When domestic glass producers sell to large supermarkets and department stores the roles are reversed. The supermarket is usually larger than the domestic glass producer and hence is able to exert significant bargaining power over glass producers, narrowing their margins, but reducing distribution costs. Another complication for domestic glass producers is the increased diversity of supermarkets in the past decade and the increased emphasis on non-food products. In the UK at least, supermarkets have taken market share from a number of traditional smaller non-food retail outlets as they are able to sell their products at lower

CHART 3.4: UK SALES CHANNELS OF DOMESTIC GLASS PRODUCTION



Note(s) : Percentage of value sold.
Source(s) : ifo Institute and Carl Bro Group (2006).



prices and 'under one roof'. This reduces the distribution options for domestic glass producers and serves to fuel the bargaining power of supermarkets further over domestic glass producers.

When the domestic glass producer selects its distribution channels there are different opportunity and distribution costs involved. Some domestic glass suppliers have tried to minimise such costs by forward integration; Swarovski have set up their own retail outlets to sell directly to the public. This allows them to bypass the profit intermediaries that would usually be specialist retail outlets and supermarkets. The domestic glass producer also benefits from being able to engage closely with product marketing and positioning (ifo Institute and Carl Bro Group, 2006). It must be noted however, that such integration can incur costs, for instance, those involved with managing a larger organisation for example (Carlton and Perloff, 1999). These costs have to be weighed up against the benefits that downstream integration brings, however it is especially suited to many high quality domestic glass-producing SMEs that want to position themselves in distinct areas of a market.

A number of domestic glass producers are using new distribution channels to access the market for their products and this is largely in response to changes in the nature of market demand. One avenue is the internet. At the end of 2005, "visits to jewellery and luxury goods websites grew faster than any other internet category and visits are being translated into sales" (Reiter, 2006, page 1). This form of direct selling allows domestic glass producers to expose their products internationally in a very cost effective and professional manner. However, while the internet has allowed some producers to market and sell directly, ICF estimates that overall only around 3% of revenues for the domestic glass

sub-sector come from internet sales. Despite the logic of the proposition offered by the internet, the vast majority of the sub-sector struggles to afford internet sales on a large scale due to the logistical costs associated with processing transactions, returns, breakages etc. The considerable success of Swarovski (which benefits from a long-established and reputable brand) in this field is an exception rather than the rule. Generally it is very difficult to sell expensive high-end glassware due to the risk of breakage (which can be high) and the fact that many customers still prefer to see and handle the items in a shop.

Nevertheless, the internet does offer opportunities and some advantages. The flexibility that internet selling brings allows domestic glass producers to change prices and product details instantly, hence reducing marketing costs which traditionally account for a major share of the total cost of domestic glass sales (ifo Institute and Carl Bro Group, 2006). It can also be used to access the more price sensitive areas of their product markets, i.e. allow them to engage in price discrimination, and bypass some of the entry barriers surrounding new markets or competing products. Another key advantage is that having a direct channel to customers allows accurate and rapid customer feedback to be made and it reduces the bargaining power of other distribution channels (Porter, 2001) as discussed above. Perhaps Swarovski's success suggests that the dominance of the traditional transaction can be broken, with the internet becoming more important as a sales channel.

Container glass

There are three broad customer industry sectors. The beverage sector accounts for approximately 75% of the total tonnage of glass packaging containers. This includes still and sparkling wines, fortified wines, spirits, beers and ciders, flavoured alcoholic beverages, soft drinks, fruit juices and mineral waters. The food sector accounts for about 20% of the tonnage (mostly jars). This covers a wide range of products, such as: wet and dry preserves, milk and milk products, jams and spreads, sauces and dressings, oil, vinegar, etc. Perfumery, pharmaceuticals and technical product containers (flaconnage), which are generally small bottles, account for the remaining 5% or so of container glass tonnage. The majority of production is sold to customer industries within the EU, which then sell their packaged products into markets in the EU and the rest of the world. The relative importance of the various customer industries varies considerably between Member States. This is reflected in the great diversity of national markets for glass containers and the products they require, particularly in terms of colour, shape, size and design.

Flat glass

The two main types of flat glass produced in the EU are rolled glass and float glass. The majority of rolled glass is patterned or wired glass and accounts for around 5% of the total sector output. Patterned glass is used for horticultural greenhouses, for decorative purposes and in applications where light is dispersed, for example for glass partitions, bathroom windows and for photovoltaic panels. Float glass makes up the bulk of the other 95% of output. The most important markets for float glass are the building and automotive industries. The largest of these markets is the building industry which accounts for 75-85% of demand, and the majority of the remaining 15-25% is processed into glazings for the automotive industry. Some glass is simply cut to size and used directly, but the majority of flat glass production is processed into other products. Thus, customers are to a large degree processing companies. For the automotive industry these

are laminated windscreens, side and rear glazings, and sunroofs. The main processed product for the building industry is insulated glazing in the form of double or triple glazed units, often with one layer of coated glass. These glazed units account for 40-50% of the building market with the remainder being made up of silvered, coated, toughened, and laminated products which each make up 10 to 15 %. Distribution costs are a significant cost of production and typically represent around 10-15% of total costs (Pilkington, 2006).

Reinforcement fibres

The sector has a wide and increasingly diverse customer base with substantial international trade. This means it is not as vulnerable as some other sectors of the glass industry, to economic problems in specific markets or geographical regions. The main markets for composite materials are the building industry, the automotive and transport sectors (around 50% of sector output), and the electrical and electronics industry. Other uses are in pipes and tanks, agricultural equipment, industrial machinery, and in the sports, leisure and marine sectors. The second most important end use is the manufacture of textiles that are used in similar markets to composites though clearly for different applications. The main market for glass textiles is the electronics industry where they are used in the production of printed circuit boards.

Insulation fibres (mineral wool)

The main products are low density insulation rolls, medium and high density slabs, loose wool for blowing, and pipe insulation. The main markets for these products are: building thermal insulation (walls, roofs, floors etc.); heating and ventilation applications; industrial (technical) installations (process pipework, vessels, chemical plant, offshore and marine); fire protection; acoustics (sound absorption and insulation); inert growing media and soil conditioning. As such, the most important market for mineral wool is the building industry, which takes up to 70% of output and is very dependent on the prevailing economic climate. Glass wool and stone wool are interchangeable in many applications, but some applications demand one product in preference to another. Stone wool is usually favoured for high temperature or fire protection applications, and glass wool is frequently used where lightweight is critical.

Frits

Enamel frits are used in the manufacture of enamel glazes, the principal application of which is the coating of metal surfaces to provide a chemically and physically resistant covering. Frits may be sold in the pure form to the ceramic ware manufacturers who create their own glazes, or the frit manufacturers may produce and supply the glazes themselves. Across the sector typically over half the frit manufactured is used internally in the production of glazes. The principal market for enamels is in the manufacture of cooking equipment, and as a coating for hobs, ovens, grills etc. Other applications for enamels include storage tanks, silos, baths, electronic components and signs.

Special glass

Demand for glass tubes is driven mainly by pharmaceutical and medical applications. The major market for glass ceramics is cook-top and fireplace windows. Borosilicate glass has for many years been used in consumer products (eg. coffee pots, cookware, microwave trays), laboratory vessels, and components for chemical plants. Part of the

market is increasingly jeopardised by polymers and disposable alternatives. Borosilicate tubing now finds a growing market in hosting solar energy receivers, either directly or after concentrating the solar energy by reflecting panels in solar power plants.

Survey evidence on bargaining power

Our questionnaire survey asked sub-sectors to describe the market place with respect to bargaining power vis-à-vis suppliers and customers. The responses indicated that, generally speaking, glass sub-sectors are stuck between more powerful agents on both sides (suppliers and customers). None of the responses reported any clear or significant bargaining power lying with glass firms/ sub-sectors.

The major input costs are energy, raw materials and packaging. Survey responses reported limited or diminishing power at best when it came to negotiating supply contracts. The international nature of the markets for those inputs means prices are determined globally. In most cases glass firms are faced with a few powerful multinational suppliers, against whom glass firms struggle to match up to (with respect to bargaining power). In the case of materials some glass firms/ sub-sectors are hampered by the fact that their demand is a small share of suppliers' output (ie. suppliers are not too dependent on glass firms and this undermines glass firms' bargaining power) and because in some cases they are limited in their ability to shop around due to limitations in quality, which means they can be very dependent on a few suppliers.

With regard to customers glass firms are, on the whole, in a weak position. The general (or common) feature is that that glass firms are faced with larger, more powerful firms. In some sub-sectors this has been reinforced by consolidation among customers, which weakens glass firms' positions further. The power of these firms means they dictate prices, making it hard or impossible for glass firms to pass cost increases on to customers. In some cases glass firms are faced with major multinationals with global networks (supply, production, distribution). This is increasing the tendency among these suppliers to find (source) local producers, which strengthens their bargaining power in relation to EU glass producers. This position is strengthened in some cases by the heavy dependence of some glass firms/ sub-sectors on a few sectors (which account for a high share of output). This reliance weakens the position of glass firms. A final feature that appears to disadvantage some glass sub-sectors is the level of competition. The suggestion is that strong competition between glass firms (in a sub-sector) gives customers a chance to shop around and bargain harder.

Looking ahead, the view among the respondents seemed to be that conditions would become more difficult for the glass sector as these features remain and intensify and so squeeze profit margins further. This is expected to be exacerbated by increasing competition, characterised in part by globalised firms willing to buy anywhere in the world and so apply more downward pressure on prices.

3.3 Inputs

3.3.1 Energy

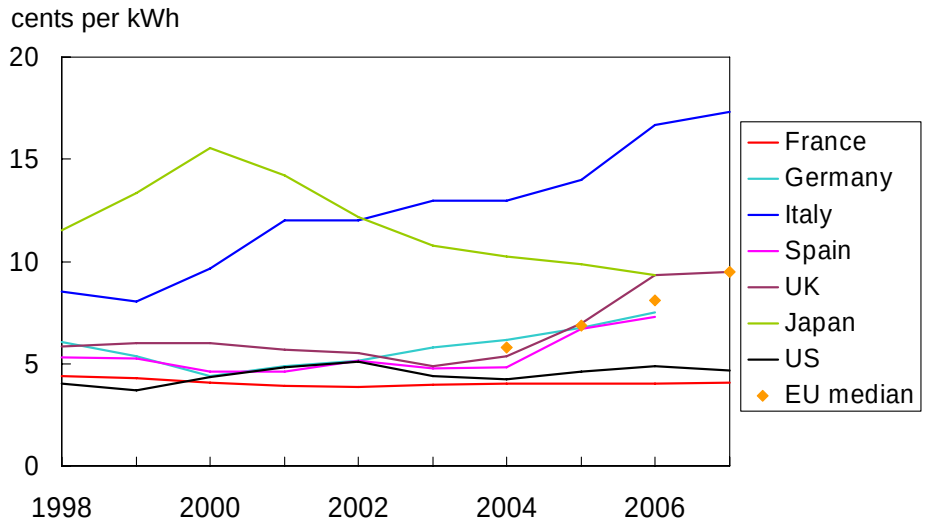
Trends in energy prices

Section 2.5.2 discussed industrial energy prices in 2006. It indicated that while median electricity and gas prices in the EU were 8.1 cents and 2.2 cents respectively, there was great variation in prices across Member States. Median EU prices compared unfavourably against US prices but favourably compared to prices in Japan. The charts below present recent trends in industrial gas and electricity prices in the major EU producers along with the US and Japan.

In broad terms, the charts show the sharp rise in energy costs experienced by the glass sector in recent years. The median electricity price increased by 64% between 2004 and 2007 while for gas it increased by 50%, although the median gas prices eased very slightly in 2007.

Looking at electricity prices first, it is important to note that the figures in the chart for the US are excluding tax (all other series include tax), due to difficulties with collection. However, the tax rate in the US is typically 2-6% and at 6% US industrial electricity prices are in the range of 4-5.5 (euro) cents per kWh. One of the interesting features of the chart is the relative stability of US and French prices. In the case of the US the variation in price since 1998 has been less than 1.5 cents, in France it is less than 0.5 cents. In Japan the price has fallen substantially, falling from around 15 cents per kWh in 2000 to just over 9 cents per kWh in 2006 (2007 figures not available). In contrast to the stability of prices in the US and fall in prices in Japan, the median EU price for electricity has shot up, from just over 5 cents per kWh to just under 10 cents per kWh, putting EU producers at a relative disadvantage. While price in France is both low and stable, this cannot be said for every Member State. Italy, for example, not only has one of the highest prices in the EU but industrial electricity prices there have risen by almost 80% since 2000. The UK enjoyed relatively cheap electricity until 2004. Italy and the UK, however, have seen strong rises in electricity prices over 2004-07, with prices in the UK almost doubling and prices in Italy increasing by around a third. Thus, there is great variation in the level of prices in the EU and their stability. While the EU compares favourably against Japan, it does less well against the US.

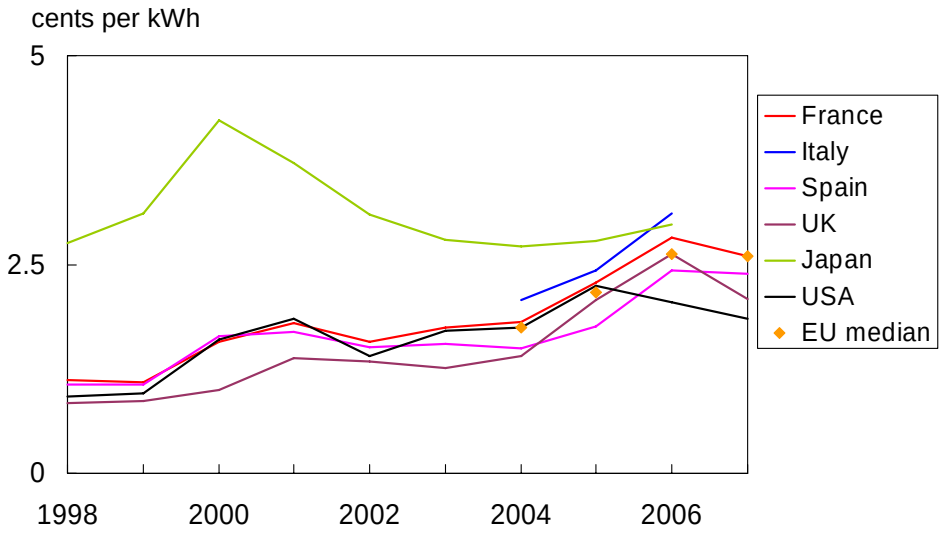
CHART 3.5: ANNUAL INDUSTRIAL ELECTRICITY PRICES



Note(s) : All prices except US include tax; US unavailable. US tax typically 2-6%.
Source(s) : *Quarterly Energy Prices*, BERR (UK); ECB; and CE calculations.

With the exception of Japan (4.2 cents per kWh), gas prices in all the countries presented were 1.5-2 cents per kWh in 2000. Since then, prices have fallen in Japan and risen in the other countries. Prices in Japan did pick up slightly in 2005 and 2006, but they remain considerably lower than in 2000. Gas prices in the US have moved much more in line with EU prices than in the case of electricity, rising from 1.6 cents per kWh in 2000 to 2.3 cents in 2005 before falling back to 1.8 cents in 2007. EU prices were broadly flat or rose slightly between 2000 and 20004, but after 2004 prices rose more steeply. In France, for example, the prices rose from 1.8 cents per kWh in 2004 to 2.6 cents; in Spain it increased from 1.5 cents per kWh to 2.4 cents; and so the median price for gas in the EU has risen from 1.7 cents per kWh in 2004 to 2.6 cents per kWh in 2007. There is much less variation in gas prices across these countries, and they all seemed to experience the same surge in prices over 2004-07 (although much less in the case of Japan). The EU compares favourably against both the US and Japan, although one concern is that US prices have eased back since peaking in 2005 while the EU median has not and was 40% higher in 2007.

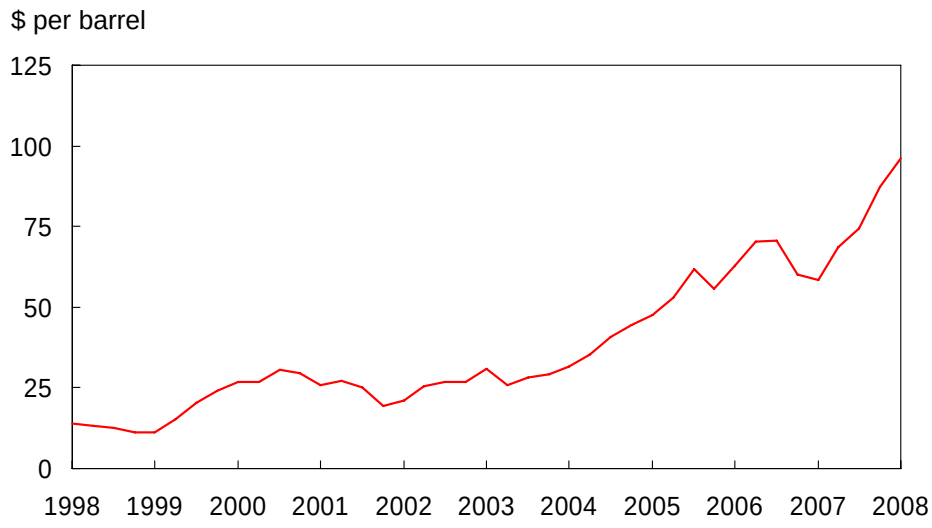
CHART 3.6: ANNUAL INDUSTRIAL GAS PRICES



Note(s) : All prices inlude tax; no data for Germany; data for Italy 2004-06 only.
Source(s) : *Quarterly Energy Prices*, BERR (UK); ECB; and CE calculations.

The recent changes seen in gas and electricity prices mirror to a large extent the trend in the price of crude oil (see chart below).

CHART 3.7: CRUDE OIL PRICE (BRENT), 1998-2008



Note(s) : Prices are quarterly averages calculated by CE.
Source(s) : FT, Petroleum Argus.

The price rose steadily between 2000 and 2004, from around $28 pb to about $38 pb and then surged over 2004-07 to reach an average of $72 pb in 2007. The trend has continued, with the price of oil breaching $100 pb in the first half of 2008 and reaching almost $150 at one point. A consequence of this is that energy costs are likely to account for a far larger share of operating costs than the roughly 20% estimated a few years ago. In the UK, there are cases of firms' total energy spend expected to quadruple between 2004 and 2009, while some firms have faced a doubling in the cost of renewing gas contracts in 2008.

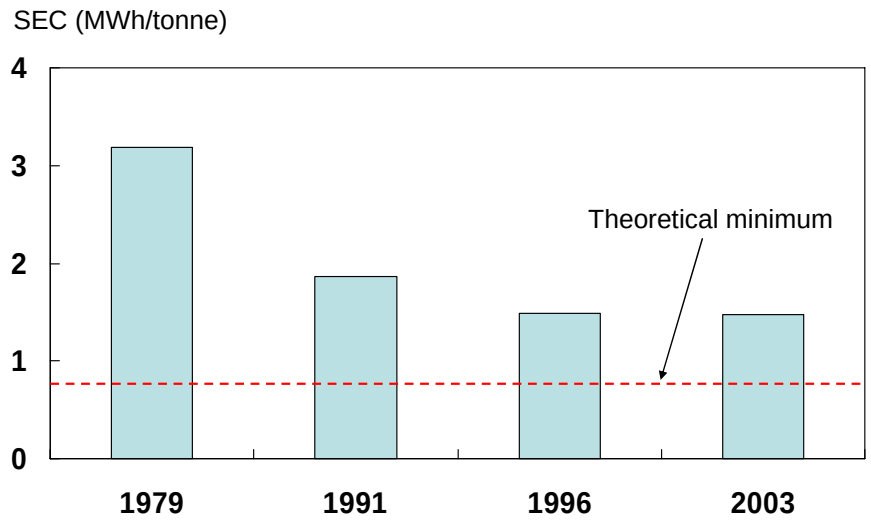
3.3.2 Knowledge and technology

Production Technology

The importance of technology on labour productivity has been highlighted but technology plays another important part in the production process. Technology increases the efficiency of energy usage in production, and given the relatively high energy intensity of glass producers it has lead to considerable savings. The technology has also served to cut carbon dioxide emissions to encourage efficiency and comply with EC Directive 96/61/EC – IPPC (Integrated Pollution Prevention And Control), identified and discussed in Section 4. As seen earlier, in container glass production the furnace accounts for around 80% of total energy use. As the Carbon Trust (2005, page 1) remarks, "the glass container industry has made excellent progress in reducing energy use". British Glass estimates that between 1980 and 2003 the amount of energy required to melt a tonne of glass in the container sector fell by 54% to 1.47 MWh. This would have been accompanied by a larger reduction in CO_2 emissions. Meanwhile, in the flat glass sector, Pilkington estimates that its specific CO_2 emissions (excludes CO_2 emitted during electricity generation) fell by 3% in 2007 and that the adjustment of its total CO_2 emissions (includes emissions associated with the generation of electricity used in production) for the surrender of certified carbon dioxide allowances resulted in a net reduction of 3.7% in 2007 (Pilkington (2007)).

Between 1996 and 2003 UK container glass energy use has fallen by around 4% to 4,640 GWh/year and at the same time the quantity of saleable product has risen by over 7% and the number of containers produced has increased by over 13% (Carbon Trust, 2005). Although this has benefited the environment and cut production costs over time the rate of high efficiency progress has meant that, "much of Western Europe's glass manufacture is now close to the physical limits of efficiency according to the laws of thermodynamics and the limitations of the modern materials available for furnace construction" (British Glass, 2007). This limits the ability of EU glass producers to reduce carbon dioxide emissions through efficiency (as the EU propose), in the short term at least.

CHART 3.8: FURNACE MELTING EFFICIENCY



Source(s) : Carbon Trust (2005).

The theoretical minimum for glass melting is 0.76MWh/tonne (*ibid*) and significant rapid advances in technology would be needed to achieve such a figure, especially given the time length of past improvements. Nevertheless, "the scope for further improvement should not yet be ruled out" (Carbon Trust, 2005, page 7) but short-term marginal reductions in melting efficiency are likely to be relatively small. Significant gains are only likely to occur in the long run, once carbon-capture technology has evolved and as non-fossil fuels become economically viable.

In flat glass, new and evolving Building Regulations that specify the use of low-emissivity glazing and associated performance requirements for new houses and refurbishments have forced flat glass producers to revise their operational processes and pursue continuous innovation in production techniques. Flat glass producers are driven by the fact that, "higher energy efficiency requirements in building regulation substantially increase the demand" (DTI and British Glass, page 34) for glass products such as glazing.

Important technologies for the future

The questionnaire asked participants on the importance and impact of technologies on production, competition and energy use. In many cases the impact of a piece of technology cuts across these topics. However, for production, continued automation of production was seen as important, to bring more flexibility to production and lower labour costs. The other key technologies were considered to be those that improve energy efficiency and reduce energy costs/ dependency. With regard to competition, technological innovation in production process and product design was seen as key. This

might include new melting processes or improved processes to finish the glass product and enhance the finish itself. New melting process and improved furnace designs were seen as the key technologies to reduce energy use, but the use of renewable energies was also mentioned.

R & D

Responses to the questionnaire survey paint a mixed picture on R&D spending in the EU glass sector. In 2000, spending on R&D across the sub-sectors varied considerably, from 0.1% of revenues to 7% (two responses gave monetary values). Since 2000, however, spending on R&D in the EU has risen in most cases: two respondents reported no change in R&D spending between 2000 and 2007 while all others said that R&D spending had risen. Where spending had increased, it was in the order of 30-50% higher in 2007 than in 2000. The future of R&D spending in the EU is less certain however: only two respondents expect further increases in R&D spending over the next 5-10 years; the remainder expected no change or were unsure. At the same time, while only one respondent reported an increase in the share of R&D spending taking place outside the EU since 2000, four of the respondents expect this share to increase over the next 5-10 years.

3.3.3 Developments in international technology efficiency, with special emphasis on reducing greenhouse gas emissions

Potential to increase energy savings and reduce CO2 emissions

- *Increasing the use of cullet (recycling)*

The biggest potential to increase energy and CO_2 savings is by increasing the recycling rate for glass. In the case of container glass, remelting waste glass (cullet) uses 25% less energy than making glass from raw materials. Each tonne of cullet used saves 1.2 tonnes of raw materials from being extracted. Glass produced from recycled glass reduces related air pollution by 20%. After accounting for transport and processing needs, 0.32 tonne of CO_2 is saved per tonne of glass remelted. It is also important to remember that container glass (and flat glass to a lesser extent) can be recycled several times over so that the environmental benefits can be sustained. Higher recycling rates seem feasible, as in some regions there is an excess availability of waste glass or recovery rates are low.

However, it must be borne in mind that even with increased recycling rates there are limits to the use of recycled glass because of purity standards, the impact on product life and other demands imposed by the market, such as the colour of the glass. Meanwhile, in some sub-sectors, such as container glass, early action on recycling has resulted in relatively high rates now and so further gains through this route are likely to be limited. Another challenge is weight-based targets for recycling and waste management that disadvantage glass. The result of such legislation is that although the level of recycling is rising, the amount and quality of furnace ready cullet being returned is falling. As a result, the benefits of closed loop recycling (with respect to reducing CO_2 emissions) are being missed. The declining availability and use of cullet in some areas implications for how far the glass sector can go with respect to reducing energy intensity and CO_2 emissions further.

Barriers

The main reasons for the underperformance in some of the countries are due to the following:

- The low density of bottle banks and other recycling facilities.
- The absence of statutory targets.
- Lack of education and awareness.
- Extra burden on households and businesses, some of which struggle to accommodate recycling containers.
- Legislation at national or regional level with unintended consequences, eg. recycling targets based on mass, which result in the mixing of waste, making it harder to separate and recycle.
- Diversion of cullet to non-remelt activities, such as aggregates.
- Collection methodologies which provide cullet of the inadequate quality to the remelt industry.

Several, mainly governmental initiatives in response to EU Directives, are now in place designed to increase the volume of glass collected and recycled. The measures are designed to promote a more sustainable use of resources and comprise a mixture of legal obligations and economic instruments. Some of the main measures include:

- The Packaging Waste Regulations;
- The Aggregates Tax;
- The Integrated Pollution and Prevention Control [IPPC];
- Waste Strategy 2000 incorporating Best Value Performance Indicators;
- Waste Minimisation Act.

Some of the other main energy efficiency opportunities include: improved process control, increased furnace size, use of regenerative heating, oxy-fuel technology, batch and cullet pre-heating and reduction of reject rates. The energy efficiency improvement potential is estimated to be 10-20%. CO_2 emissions can be reduced by the use of natural gas instead of fuel oil and CO_2 capture for large oxy-fuel furnaces.

Near market and commercially proven technologies for energy saving and CO_2 reduction

- *Improved melting techniques and furnace design*

The choice of melting technique can have a great effect on energy efficiency. The choice is largely determined by a range of economic considerations. The main factor is the desired production rate and the associated capital and operating cost over the life of the furnace. Regenerative furnaces are more efficient than recuperative furnaces due to the higher preheat temperature and are generally also used for larger size furnaces. Other types of furnaces, like electrical melting and in some cases oxy-combustion technology, can also provide an improvement in energy efficiency. However, power generation efficiency and distribution losses or energy required for oxygen production must be taken into consideration, resulting in a less clear CO_2 and energy balance.

Electric melting - An electric furnace consists 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. The energy for melting is provided by resistive heating as the current passes through the molten glass. It is, however, necessary to use fossil fuels when the furnace is started up at the beginning of each campaign. The furnace is operated continuously and has a lifetime of between 2 and 7 years.

Environmental Performance: The complete replacement of fossil fuels in the furnace eliminates the formation of combustion products; namely oxides of sulphur, thermal NOx, and CO_2.

Financial considerations: The economic viability of electric melting depends mainly on the price differential between electricity and fossil fuels. At the time of writing, average electricity costs per unit energy are 4 to 5 times the cost of fuel oil. Electricity costs can vary by up to 100% between Member States but fossil fuel prices tend to show less difference. Electric furnaces have much lower capital costs than conventional furnaces which when annualised partially compensate for the higher operating costs.
However, the furnaces have shorter campaign lives before they require rebuild or repair, i.e. 2 to 6 years compared to 10 to 12 years for conventional furnaces. Based on current practice, the following is proposed as a very general indicative guide to the size of electrical furnaces which may be viable, i.e. those which can potentially be a practicable alternative. There are inevitably exceptions due to local circumstances.

- Furnaces below 75 tonnes per day are generally viable.
- Furnaces in the range 75-150 may be viable in some circumstances.
- Furnaces greater than 150 tonnes per day are generally unlikely to be viable.

Oxy-fuel melting – Oxy-fuel melting involves the replacement of the combustion air with oxygen (>90% purity). The technique can be used with either natural gas or oil as the fuel, although the use of gas is more common. The elimination of the majority of the nitrogen from the combustion atmosphere reduces the volume of the waste gases (composed mainly of CO_2 and water vapour) by 70-85% depending on oxygen purity. However, one must also take into consideration the resources involved in, and the environmental impact of, producing the oxygen.

Financial consideration – An important factor in the capital cost is that oxy-fuel furnaces do not have a conventional combustion gas preheat system and so the capital cost is generally lower than for a regenerative or recuperative furnace of comparable pull-rate. This is most evident for new plants where the total cost of the pre-heating system is saved. The most advanced oxy-fuel burners are generally more expensive than advanced low NOx burners and the costs of the oxygen control system are quite substantial (€0.3-0.45m): the operating costs for generating oxygen must be borne in mind. However, for most furnaces the extra costs of the oxy-fuel burners and control system are significantly lower than the savings for the pre-heater. Note, that batch pre-heating was not successful in the flat glass sector, due primarily to the very high engineering costs in order to prevent "bottlenecking".

- *Batch and cullet preheating*

Batch and cullet is normally introduced cold into the furnace, but by using the residual heat of the waste gases to preheat the batch and cullet, significant energy savings can be possible. This only applies to fossil fuel fired glass furnaces.

Environmental Performance – These techniques have a number of environmental effects, which can vary from case to case. In general, the following benefits have been experienced:

- Energy savings of 10-20%;
- Reduction in NOx emission (due to lower fuel requirements and lower furnace temperatures).

Financial Considerations – The economics of batch/cullet preheaters are strongly dependent on the capacity of the furnace and the preheater. As an indicative example for costs, an indirect preheater for a 370 tonnes/day container furnace had a total capital cost (including EP) of €2.5m. Of this €0.8m was for the preheater. If significant energy savings can be achieved, a pay back of 3-10 years may be gained.

3.4 Conclusions

The competitiveness of EU glass producers varies by segment but in many specific areas the EU is a world leader, in the production of crystal class for example, but in others its dominance is falling rapidly due to globalisation such as in the production of every day low-value tableware. The overall competitiveness of EU glass products on world markets is difficult to judge as it is very difficult to obtain relevant data. The influence of EU competition law means there is only so much data firms can provide. In terms of volume, the EU continues to see an upward trend in export growth, which is a sign that some of the EU's glass products remain competitive on world markets. However, import volumes are also showing an upward trend, particularly low value domestic glass products from Turkey and China, and flat glass from China. The volume of European flat glass products on world markets lags behind only that produced by China, but it exceeds that of developed economies such as the USA and Japan. However, in terms of value, European flat glass products have the most significant market share, accounting for almost a third of world output and this suggests that Europe is a world leader in producing this value-added glass product.

The role of SMEs varies across sub-sectors and even where they do or once played a major role, eg, domestic glass, this is declining rapidly in the face of stiff import competition and increasing compliance costs. Those that do remain, can often play an important role by serving the markets that the larger firms choose to avoid on efficiency and marketing grounds. SMEs use their unique resources and competencies such as high skills, bespoke products and high levels of customer service to make differentiated, typically high quality glass products that are in increasing demand. Without SMEs it is conceivable that foreign competitors could supply these products to EU markets and damage EU competitiveness globally.

Typical cost structures for the glass industry are not easily available in the public domain. The more broadly defined non-metallic mineral products sector is a relatively energy-intensive, with the proportion of energy costs in total costs around three times that for manufacturing as a whole in 2003. In the flat glass sector energy accounted for around 20% of total cost in the float process before the recent rises in oil prices.

The price of energy in the EU has risen substantially since 2004 mirroring to a large extent the rise in the price of crude oil, which has risen steadily from around $38 pb in 2004 to reach almost $150 pb in the first half of 2008. A consequence of this is that energy costs are likely to account for a far larger share of operating costs than the roughly 20% estimated before oil prices surged. As a result, with regard to energy prices, the EU compares favourably against Japan, but less so against the US. There is great variation in the level and stability of electricity prices in the EU, which will have a major influence on firms' decisions on whether to invest and where. There is much less variation in gas. The industry would benefit form a better functioning, more competitive energy market to bring about more harmonised pricing and free firms from the decision of where to locate.

In the EU12, the outlook for energy prices is not good as self-sufficiency declines and imports increase, and subsidies are phased out. This has the potential to undermine the competitiveness of the EU12 against non-EU producers, and diminish the competitiveness of the EU as a whole. In some new Member States, if industrial energy costs are raised to European market levels, the shock to glass companies is likely to be debilitating in the short term, especially for small companies.

While glass industry faces a tough challenge to make further reductions in energy intensity and GHG emissions. It has made significant improvements since the 1950s but as a result the scope for further improvements is diminishing, as the thermodynamic limits of the process are reached. While recycling offers an opportunity of further reduction in GHG emissions, there are limits and obstacles to what can be achieved. However, many of the barriers seem to be within the control of policy makers and authorities rather than the industry. If policy makers could be more aggressive in setting targets and standards, and authorities make more effort to recycle glass properly, much more could be achieved with, for example, much less glass leaving the system. Policy makers need to be aware of how far the glass industry has come, particularly compared to other producers, such as plastics, and appreciate that further significant gains are unlikely without major investment, which itself is threatened by relatively high and variable energy costs across the EU, the feeling of the industry that it is seen as a soft target for paying environmental costs and that there is an uneven playing field between EU and non-EU producers.

Distribution costs can be significant. The recent rises in the price of crude and fuel oil will raise transport costs higher and erode the competitiveness of EU exports further. This will restrict their ability to compete in the export markets at a time when they most need to as the EU economy slows down over 2007-09 and demand conditions weaken.

Innovation in new production technologies and products is a significant driver of EU glass products and this translates into yearly output productivity growth and is the source of much of the 'value' embedded in EU glass products. In order for the EU to hold on to

its innovative bases it is claimed that core glass production activities must remain with the EU (British Glass, 2007).

Many of the competitiveness issues highlighted have arisen due to globalisation. The increasing availability of cheaper imports, the outsourcing of production, job losses, and high energy prices are examples of how globalisation has negatively affected the EU glass industry. However, globalisation is, "a major driver for increased economic efficiency" (EC, 2007[b], page 10) and this has been witnessed to a large degree in the EU glass industry. Globalisation has brought a number of benefits such as greater export potential, access to new foreign innovations and best practices, new markets, new distribution channels, and it has encouraged greater productive efficiency and product specialisation in value added products.

Nevertheless, the EU glass industry faces a challenging period over 2007-09 as economic activity slows in the wake of the credit crunch and demand slows. GDP growth in the EU is expected to slow from 2.8% in 2007 to 1.9% in 2008 and 1.7% in 2009. The construction sector looks to be especially vulnerable as household confidence and spending weakens, and investment demand is curbed. Interventions by governments to shore up national housing markets could go some way to restoring consumer confidence but it represents a major challenge and seems unlikely. As such the outlook for several glass sub-sectors is not good. The flat glass sub-sector looks to be the most exposed, as the housing sector enters a downturn while weaker household spending forces automotive producers to curb production plans further. A slowdown in the housing sector and household spending would also hit the domestic glass sub-sector where it results in fewer purchases of new household glassware. Domestic glass makers operating at the top end are especially vulnerable as consumers react to the economic uncertainty and delay expensive/ luxury purchases. The frits sub-sector is similarly exposed through its connection to the ceramics sector. Both fibres sub-sectors are also likely to suffer from a slowdown in construction activity, as lower building activity hits demand for insulation and structural material. Container glass firms producing health-related glassware are less exposed but those producing containers for food and drink can expect to see demand weaken as households rein in their spending across all expenditure groups. The outturn for the construction sector appears to be central to the outlook for the glass sector, with most of the sub-sectors reliant on it (and consumer confidence) in some direct or indirect manner. While initiatives to support the housing market and the construction market would feed through to the glass sector, it is difficult to implement them without distorting the market.

These challenging conditions will be exacerbated by the expansion of capacity in countries neighbouring the EU. Over 2004-09 an estimated 7.3 mt of production capacity will be added across several countries, including Russia, Ukraine, Belarus, Qatar, UAE and Egypt. Most of this increase will come in flat glass and container glass. Flat glass seems especially exposed given capacity in the EU and the increase in capacity in these countries. With such expansion trade can be expected to grow and this reinforces the need for policy makers to ensure that EU glass producers are operating on the same terms.

Weaker demand in the EU and increasing competition from imports from neighbouring countries in the medium term will make it harder for EU glass producers to rely on conventional products and revenue streams. This will place increasing pressure on firms to develop new, higher value-added products. With policy makers embracing the climate change challenge more fully, the glass industry has an opportunity to introduce more new products and educate policy makers on the benefits that glass products can deliver. To help foster the markets for these products and both help tackle climate change and support the glass sector, it is important for policy makers to consider the environmental and energy benefits that can be delivered by glass when setting policy and taxes on energy/carbon.

4 Horizontal aspects affecting competitiveness

4.1 Introduction

Task 4 of the glass sectoral competitiveness study focuses on the regulatory and framework conditions. The goals are twofold:

1. To identify the key sectoral issues of the regulatory environment and the framework conditions which influence sectoral performance and the competitive position of the glass sector;
2. To provide a comprehensive and structural assessment of the relevant regulatory conditions and framework conditions that determines the growth and competitive position of the glass sector.

The framework conditions covered include, geographical structure and cohesion, labour force and knowledge skills, access to third country markets, competition from third country imports on EU markets and cost and availability of supply of energy.

4.2 The framework grid

The overall aim of the framework grid is to provide a general synthesis of regulations, conditions and effects from literature and from previous sector analyses in order to generate a clear and accurate view on the framework within which the glass industry operates. This synthesis should subsequently allow us to identify the most relevant indicators for the completion of the competitiveness grid in relation to task 3. Furthermore, it will lead to the formulation of a number of both general and sub-sector-specific conclusions.

The framework grid is divided into three parts:

1. Regulatory conditions;
2. Framework conditions; and
3. Exogenous conditions.

For each type of conditions, a list of items and sub-items is listed, according to the regulations and topics that are applicable to the EU glass industry.

It is at this level of sub-items that the grid is filled in, namely that importance, trend, geographical concentration and specific sub-sectors affected are identified. Another column is added during the process to map the potential effects of each of the conditions on the competitiveness of the EU glass sector.

To comprehend the conditions and their effects described in the framework grid, it is important to point out the specific interpretation of each of the columns and the way they have been filled in.

Importance

The column "Importance" aims to indicate the importance of the condition for the glass sector and its sub-sectors by means of a score between 1 and 10, 10 being most important. To grade the importance of the condition, a number of characteristics and issues were taken into account:

- Does the condition apply to the glass industry more than to other industries due to its characteristics (cost structure, labour skills, energy intensity of the production process, use of raw materials, industry structure, etc.)?
- Does the condition apply to the glass industry in a way that influences its competitive position relative to non-EU countries?
- Does the condition apply to the glass industry in a way that influences its competitive position relative to substitute products?

Trend

The column "Trend" refers to the expectations stated in literature regarding the evolution of the condition's impact. Will the impact of this regulation or issue increase/decrease/stay the same in the future? The underlying reasons for this trend can be, e.g. an increasing importance of the characteristic to which the condition refers, or a strengthening of the regulation or condition.

Geographical concentration

As opposed to describe the region to which the condition applies, the column "Geographical concentration" aims to show the EU Member States that are likely to be most affected by the condition. A criterion for this is that the sub-sectors affected are concentrated in these Member States. The list is not exhaustive, in the sense that it does not include all Member States with plants in a particular sub-sector. Only the Member States in which a substantial share of the activities is concentrated, are listed.

Specific sub-sectors

The column "Specific sub-sectors" lists all sub-sectors of the glass industry that might be affected by or that are the aim of the regulation or condition in question. As mentioned before, this list is at the basis of the identification of the geographical concentration.

Potential effects

In the column "Potential effects", a review of the most important potential effects of the conditions for the specified sub-sectors is presented. This review includes the effects that are found in empirical literature, indicated by [1], the effects that are described as 'potential' in literature [2] and the effects that on the base of our own assessments have a potential impact [3].

GLASS INDUSTRY	Importance 1-10	Trend < / = / >	Geographical concentration	Specific sub-sectors affected	Potential effects [1]=empirical literature; [2]=theoretical literature; [3]=own appreciation based on economic theory
I Regulatory conditions					
• Labour market regulations • Exposure to physical agents [i]	7	=	All France, Italy, UK, Germany Czech Republic	• All • Domestic glass, which is most labour intensive	• Production costs increase due to additional safety regulations [3] • Competitive position weakens because this legislation does not apply outside EU (e.g. EU cannot compete with low social costs in China) [2] • Distortion of competition between countries that have different production practices (e.g. hand-made vs. automated) [2]
• Good handling and use of sand and products containing it [ii]	7	=	All France, Italy, UK, Germany Czech Republic	• All • Domestic glass, which is most labour intensive	• Production costs increase due to additional safety regulations [3] • Competitive position weakens because this legislation does not apply outside EU (e.g. EU cannot compete with low social costs in China) [2] • Distortion of competition between countries that have different production practices (e.g. hand-made vs. automated) [2]

GLASS INDUSTRY	Importance 1-10	Trend < / = / >	Geographical concentration	Specific sub-sectors affected	Potential effects [1]=empirical literature; [2]=theoretical literature; [3]=own appreciation based on economic theory
• Intellectual property right issues					
• Design protection [iii]	8	=	All	• All	• Decrease of counterfeited imports, especially important because of the increasing counterfeiting activities from competitors [2] • Increase of competitiveness [3]
• Enforcement of IPR [iv]	8	=	All	• All	• Decrease of counterfeited imports, especially important because of the increasing counterfeiting activities from competitors [2] • Increase of competitiveness [3]
• Customs action [v]	8	=	All	• All	• Decrease of counterfeited imports, especially important because of the increasing counterfeiting activities from competitors [2] • Increase of competitiveness [3]
• Protocols on restructuring in accession treaties NMS				•	•
• Competition Policy	8	=		• All	• Merger & acquisition dynamics in the glass industry [1] • A case of price fixing [1]

GLASS INDUSTRY	Importance 1-10	Trend < / = / >	Geographical concentration	Specific sub-sectors affected	Potential effects [1]=empirical literature; [2]=theoretical literature; [3]=own appreciation based on economic theory
• Industry-specific regulations and standards					
• Regulation concerning lead content in crystal glass [vi]	3	=		• All sub-sectors that produce crystal glass	• Improves branding, information for the consumer, and may act against counterfeiting [3]
• Regulations concerning construction products [vii]	6	=	Germany, France, Italy, Belgium, UK, Spain	• All glass used as construction products • Especially flat glass	• Increase of regulation increases production costs [3] • Importance of innovation increases [2] • Production of specialised products increases, in which EU is relatively competitive [2]
• Consumer standards (health and safety)					
• Regulations for materials intended for contact with food [viii]	8	=	France, Italy, UK, Germany, France, Spain	• Domestic glass • Container glass • Reinforcement glass fibre	• Competitive position weakens if this legislation does not apply outside EU [3]
• Building regulations (safety)	9	>		• Insulation fibre glass	• Importance of innovation increases [2] • Production of specialised products increases, in which EU is relatively competitive [2]
• Environmental regulations and issues (IPPC, NAP, relation with permitting authorities)					

GLASS INDUSTRY	Importance 1-10	Trend < / = / >	Geographical concentration	Specific sub-sectors affected	Potential effects [1]=empirical literature; [2]=theoretical literature; [3]=own appreciation based on economic theory
• Packaging regulations [ix]	10	=	Germany, France, Italy, UK, Spain	• Container glass	• Production costs increase [3] • Distortion of competition between countries because the regulation does not take into account country specific differences related to recycling infrastructure and population concentration and it is estimated that the main burden will fall on only a few MS (Spain, Italy, UK) [2] • Distortion of competition between materials because plastics, as an alternative for glass packaging, face less requirements than glass [2]
• Higher energy efficiency requirements in building products	10	>	Germany, France, Italy, Belgium, UK, Spain	• Flat glass • Insulation glass fibres	• Importance of innovation increases [2] • Production of specialised products increases, in which EU is relatively competitive [2]
• Energy end-use efficiency and energy services [x]	8	>	Germany, France, Italy, Belgium, UK, Spain, Netherlands	• Flat glass • Special glass • Glass fibres	• Systematic stimulation in Member States of efficient energy use and energy services might increase demand for specific types of glass (lighting, windows, glass fibres, insulation, information technology,…) [3]
• Restriction of hazardous substance in electrical and	8	=	All Germany, France,	• All • Especially special	• Increase of production costs due to the use of alternative inputs and/or higher

GLASS INDUSTRY	Importance 1-10	Trend < / = / >	Geographical concentration	Specific sub-sectors affected	Potential effects [1]=empirical literature; [2]=theoretical literature; [3]=own appreciation based on economic theory
electronic equipment [xi]			Italy, UK, Netherlands, Belgium	glass and glass fibres	levels of control [3] • Competitive position weakens due to the fact that this legislation does not apply outside EU [3]
• Technical requirements for treatment of end-of-life vehicles [xii]	8	=	Germany, France, UK, Netherlands, Belgium, Italy, Spain	• Flat glass • Special glass • Glass fibre	• Development of knowledge and technology because glass removal is not easy, taking into account also the high quality needed for recycled glass [2] • Distortion of competition due to the lack of standardised systems for the treatment of ELV's [2] • ?
• Eco-design requirements for energy-using products [xiii]	9	>	Germany, France, UK, Netherlands, Belgium	• Special glass	• Increase of production costs [3] • Distortion of competition between products and changes in specialisation due to the fact that not all products need to comply with this regulation [2] • Development of a specific niche market for energy-efficient products [3] • Development of know-how and innovation [3]
• Greenhouse gas emission [xiv] and proposal for EU ETS revision	10	>	All	• All	• Competitive position weakens due to the fact that this legislation does not apply outside EU in this form [3]

GLASS INDUSTRY	Importance 1-10	Trend < / = / >	Geographical concentration	Specific sub-sectors affected	Potential effects [1]=empirical literature; [2]=theoretical literature; [3]=own appreciation based on economic theory
					• Profitability decreases due to the administrative burden and the investments in environmental issues and due to the fact that the industry is a big consumer of energy [3] • Production processes change to lower the energy consumption [2] • Specialisations might change towards less energy-consuming types of glass [2] • The EU ETS revision will be stricter than before, so that the glass industry that already has invested in cleaner technologies, will now have to turn to secondary measures that are relatively more expensive for the same emission reduction. • The EU ETS revision increases the share of allowances that will be traded, thereby increasing uncertainty for firms and creating reluctance to plan ahead and invest for the long term.
• Water policy [xv]	8	=	Germany, France, UK, Netherlands, Belgium, Italy	• Special glass • Crystal glass	• ?
• IPPC directive [xvi]	10	=		• All	• Recycling of glass increases, which

GLASS INDUSTRY	Importance 1-10	Trend < / = / >	Geographical concentration	Specific sub-sectors affected	Potential effects [1]=empirical literature; [2]=theoretical literature; [3]=own appreciation based on economic theory
• REACH [xvii]	10	=		• Companies that produce more than 20 tonnes of output per day • All	decreases the production costs (thanks to cheaper input materials and energy savings in the production process) [2] • Competitive position weakens due to the fact that this legislation does not apply outside EU [3] • Competitive position weakens due to the fact that this legislation does not apply outside EU, although imported products into the EU do have to comply with REACH as well [3] • Profitability decreases due to the administrative burden and the investments in environmental issues [3] • Specialisation might change due to the possible phasing-out of speciality chemicals [2] • The scope of potential innovations in the sector might be limited due to the restriction on use of chemicals
II Framework conditions					
• Geographical location and cohesion				•	•
• Labour force & knowledge skills	8	>	All Germany, France	• All	• The automated production lines require low skilled labour, which makes it easier to move the production to cheaper

GLASS INDUSTRY	Importance 1-10	Trend < / = / >	Geographical concentration	Specific sub-sectors affected	Potential effects [1]=empirical literature; [2]=theoretical literature; [3]=own appreciation based on economic theory
			Czech Republic		locations outside EU [2]
• Access to third countries / EU market access (trade and investment) • Tariffs [xviii]	8	=		• All	• Negative effect on export to e.g. USA [2] • Negative effect on the exploration of potential, interesting markets e.g. India, Mexico, Argentina, South East Asia [2]
• Non-tariff barriers [xix]	8	=		• All	• Negative effect on export to e.g. Turkey, Saudi Arabia, Syria [2]
• Transport	8	=		• All	• Some products are more transportable than others, so that trade differs strongly between sub-sectors, depending on their product(s) [2] • E.g. container glass is not frequently traded empty over long-distances whereas domestic glass is often traded over long distances [2]
• Knowledge base development • High levels of R&D	5	>		• Very specialised sub-sectors	• Differentiation from low-cost producers outside EU decreases competition [2]
• Physical aspects and infrastructure • Economies of scale and high	8	=		• All	• Global players go where they can get the

GLASS INDUSTRY	Importance 1-10	Trend < / = / >	Geographical concentration	Specific sub-sectors affected	Potential effects [1]=empirical literature; [2]=theoretical literature; [3]=own appreciation based on economic theory
setup costs (capital intensive due to furnace)					best return on investment, which provides potential threats to the EU glass industry [2]
• Cost and availability of energy	10	>	All Energy price increase especially in UK	• All	• The energy intensive production process of glass results in a large effect of the energy price increases on total production costs [2] • Disparity between countries on energy costs due to different contractual conditions, might lead to shifts in geographical concentration [3]
III Exogenous conditions					
• Credit crunch	8	>	All	• All, especially flat glass and glass fibres	• The credit crunch has an overall impact on economy, but more particularly also puts pressure on the building sector, a direct purchaser from the glass industry, so that also the glass industry faces growing pressure. [3]
• Cost and availability of energy and raw materials	8	=		• All	• Price variations have a substantial impact on production costs [2]
• Soda ash	8	=		•	• Upward pressure on soda ash prices (due to high concentration of suppliers and high import duties from outside the EU) decreases profitability [2]
• Sand	8	=	Germany, France,	• All	• Upward pressure on sand prices (due to

GLASS INDUSTRY	Importance 1-10	Trend < / = / >	Geographical concentration	Specific sub-sectors affected	Potential effects [1]=empirical literature; [2]=theoretical literature; [3]=own appreciation based on economic theory
• Cullet	8	=	Italy, UK, Spain, Belgium	•	high concentration of suppliers) decreases profitability [32] • Switching costs due to quality problems increases bargaining power of suppliers and decreases profitability of producers [2] • Decreases production costs (due to cheaper raw material and due to lower energy costs for the production) [2] • In many countries, the right type of cullet is not available to the extent it could be used, which limits the possibilities of using cullet as an input [2]
• Technological change					
• Automation of the production process	8	=	France, Italy, UK, Germany	• All, especially domestic glass	• Employment decreases [3] • Production costs decrease [3]
• Production process is at a mature stage	8	=		• All	• This reduces the magnitude of the effects of all technological changes somewhat [2]
• Energy-saving technologies	10	= (ST) > (LT)		• All	• Production costs decrease [3]
• Flat screens replacing monitors	10	=	Germany, France, UK, Netherlands, Belgium	• Special glass	• Demand decreases [2]

GLASS INDUSTRY	Importance 1-10	Trend < / = / >	Geographical concentration	Specific sub-sectors affected	Potential effects [1]=empirical literature; [2]=theoretical literature; [3]=own appreciation based on economic theory
• Socio-political developments	7	=		• All	• Negative effect on demand [2]
• Downstream bargaining power	8	?	Germany, France, UK, Netherlands, Belgium, Italy, Spain	• All, especially domestic glass and suppliers to the automotive industry (flat glass, special glass, glass fibres)	• For domestic glass: negative effect on profitability from increasing bargaining power of distribution channels (which are increasingly supermarkets) [2] • This pressure leads producers to use new distribution channels, such as own outlets and internet sales, which increase profitability again and decreases the bargaining power of the traditional distribution channels [2] • For suppliers to automotive industry: large bargaining power reduces margins in the glass sub-sectors [3]
• Global competition					
• Increasing counterfeiting activities	7	>	France, Italy, UK, Germany	• All, especially domestic glass	• Demand for EU products decreases because of high import volumes of cheap production by counterfeiters [2]
• Mergers and acquisitions	3	=		• All	• Mergers and acquisitions are frequent, but there is relatively small effect from competition policy since global competition is strong enough [2]
• New and expanding competition from low-cost producers (also because of the excess capacity	10	>	France, Italy, UK, Germany, Belgium,	• All, especially (low value) domestic glass and	• Cost pressure increases in glass sector [2] • Cost pressure increases in other customer

GLASS INDUSTRY	Importance 1-10	Trend < / = / >	Geographical concentration	Specific sub-sectors affected	Potential effects [1]=empirical literature; [2]=theoretical literature; [3]=own appreciation based on economic theory
that arises due to investment levels in Middle Eastern countries)			Spain	(low value) flat glass	industries such as car production, consumer electronics, airline, retail,… [2] • => Need for greater automation and associated productivity gains [2] • => Consolidation [2] • => Outsourcing of production away from EU to achieve lower costs [2] • => Differentiation to more value-added production [2] • Import increases more than export for domestic glass => deterioration of competitive position in this sub-sector [2]
• Competition from substitutes (plastic, steel, aluminium, carton)	10	=	Germany, France, Italy, UK, Spain,…	• Especially container glass but also domestic glass and glass fibres	• Reduces the competitive position of the glass sector with respect to other sectors (in all countries) [2]

4.2.1 *Conclusions from the framework grid*

The systematic analysis of the framework profile of the glass sector indicates that the key sectoral issues are:

- Environmental regulations
- Regulations on working conditions
- Intellectual property right issues and counterfeiting
- Globalisation
- Competition from substitutes

These correspond to a large extent with the findings of the EU Mid-term Review of Industrial Policy[3]. The Mid-term Review indicated that horizontal policy initiatives with the highest priority were:

- Knowledge: initiatives related to IPR and counterfeiting
- Environment and energy: initiatives related to climate change, waste, air and intensive energy use
- Trade: access to markets.

The next step of the project, described in paragraph 4.6, is to connect the findings from the framework grid to the competitiveness grid in order to qualify the significance of the various regulations and conditions. In the following paragraphs an explanation of the external key drivers of the European glass industry is presented, followed by a more in depth analysis of the most relevant framework conditions for the glass industry in the EU.

Regulatory conditions

Within the field of the regulatory conditions, the **environmental regulations and issues** are of primary importance for the glass sector. This is because the issues affect the sector in several ways and respond to some typical characteristics of the sector.

- First, there are several restricting regulations affecting the **production process**. Glass production is a very energy-intensive process in all sub-sectors of the industry. Pollution and greenhouse gas emission regulations create substantial costs and administrative burdens. This effect is all the more important, given the fact that production process in the glass industry is already at a fairly mature stage.
- Second, a number of regulations affect the **input materials** and the way they are stored, handled and used in production. The restrictions of hazardous substances lead to conversions in the production and to stricter control of input materials, which bring along additional costs for the plant.
- Third, regulation may promote the introduction of **new products**. Examples are energy-efficient building materials, packaging glass that is recyclable and the recycling of glass from end-of-life vehicles. The regulations relating to these products stimulate the industry to engage in innovation and know-how creation, leading to the potential development of new markets.

In the short run, these environmental issues may bring about substantial conversion and investment costs. The competitive position of the EU plants is due to be affected, as these regulations are not always applicable outside EU. Yet, in the long run, these issues might

[3] EuropeanCommission (2007) Mid-term review of industrial policy. A contribution to the EU's Growth and Jobs Strategy, {SEC(2007)917, COM(2007)374, Brussels 04-07-2007.

also stimulate the industry towards the development of niche markets with specialized products, know-how and innovation. Ultimately this may lead to a competitive advantage for the EU plants that strengthens the competitive position again, even though the short-term adjustment and compliance costs are hard-felt and substantial.

The working conditions and the intellectual property rights are also important issues. The **working condition regulations** refer mostly to the handling of input materials. They are particularly relevant because the industry, especially the domestic glass sub-sector, is labour intensive, meaning that a stricter regulation of handling materials by workers requires greater changes. The **intellectual property rights issues** are relevant in the light of the counterfeiting activities by low-cost countries in a number of sub-sectors of the glass industry, especially in domestic glass. A stronger enforcement of intellectual property rights could rebuild the competitive position of EU products in these sectors.

Framework conditions

Just like the regulatory conditions, the framework conditions reflect the high energy intensity of the production process, in the sense that the cost of energy affects the production costs strongly. Recent oil price increases therefore have an important impact on the industry.

Yet the framework conditions, together with the exogenous conditions, also emphasize the effect of **globalisation** on the competitive position of EU products. Some reasons are summed up why global players might shift production away from EU:

- Production is to a great extent automated, so that low skilled labour is required. This low skilled labour is often cheaper outside EU.
- Building a plant is very capital intensive, due to the furnace and its set up costs. Global players will therefore tend to go where the returns on investment are relatively high.
- A number of tariffs and non-tariff-barriers on the one side and transport issues on the other side, might make it less attractive to invest in an EU plant.
- Counterfeiting activities by low-cost countries are increasing, especially in the sub-sector of domestic glass. This deteriorates the competitive position of the more expensive EU products.
- Some low-cost countries face excess capacity due to high level investments. Both the lower costs and the excess capacity have a downward pressure on the price for glass products. In all sub-sectors, but especially in domestic glass and low value flat glass, this creates a strong competition for the EU based companies.

Regulations that apply to the glass industry do not necessarily apply to the industries where these substitutes are produced. Capturing the market share that is prone to be taken over by substitutes creates in the short run switching costs, which in turn increase the production costs and which may eventually make it more difficult to compete with the substitute materials.

Framework conditions at the sub-sector level

In the paragraph, an overview of the framework conditions with the largest impact on the different glass sub-sectors is given.

- *Specific issues in domestic glass:*
  - Working condition regulations
  - Regulation concerning lead content in crystal glass
  - Regulation for materials intended for contact with food
  - Technological change for automation of the production process
  - Relatively weak downstream bargaining power
  - Increasing counterfeiting activities
  - Competition from low-cost countries
  - Water policy

- *Specific issues in container glass:*
  - Regulation for materials intended for contact with food
  - Packaging regulations
  - Upward pressure on crystalline silica (sand) prices
  - Competition from substitutes

- *Specific issues in insulation glass fibres:*
  - Regulation concerning construction products
  - Regulation concerning retrofitting housing to tackle climate change
  - Building regulations on safety
  - Substitution by alternative insulation materials

- *Specific issues in reinforcement glass fibres:*
  - Regulation concerning construction products
  - Building regulations on safety
  - Restriction of hazardous substances in electrical and electronic equipment
  - Regulation of the technical requirements for the treatment of end-of-life vehicles

- *Specific issues in special glass:*
  - Restriction of hazardous substances in electrical and electronic equipment
  - Regulation of the technical requirements for the treatment of end-of-life vehicles
  - Eco-design requirements for energy-using products
  - Water policy
  - Flat screens replacing monitors, so that the demand for tubes for monitors decreases

- *Specific issues in flat glass:*
  - Regulation concerning construction products
  - Regulation on higher energy efficiency of building products
  - Regulation of the technical requirements for the treatment of end-of-life vehicles
  - Strong downstream bargaining power
  - Upward pressure on crystalline silica (sand) prices
  - Competition from low-cost countries

In the following section we describe in more detail how the most relevant regulatory and framework conditions affect the glass sector, together with the more general issues

described above. We focus on the consequences of and reactions to these conditions in several aspects of the glass industry.

4.3 Regulatory conditions

4.3.1 Environmental issues

This section outlines the key competitiveness challenges that the EU glass industry faces in the light of climate change and increased environmental regulation. A review is made of the extent to which environmental regulation is challenging the competitiveness of the EU glass industry.

There are a number of pieces of environmental legislation that especially affect the EU glass industry, and Directive 96/61/EC is particularly influential over EU glass producer activities. This is discussed in the following paragraph, focusing on the increasing role that glass recycling plays in glass production. Another issue we want to highlight here is the proposal for revision of the EU Emission Trading System. Emphasis is on the changes of this regulatory condition and on their effects on the glass industry.

Complying With IPPC Directive

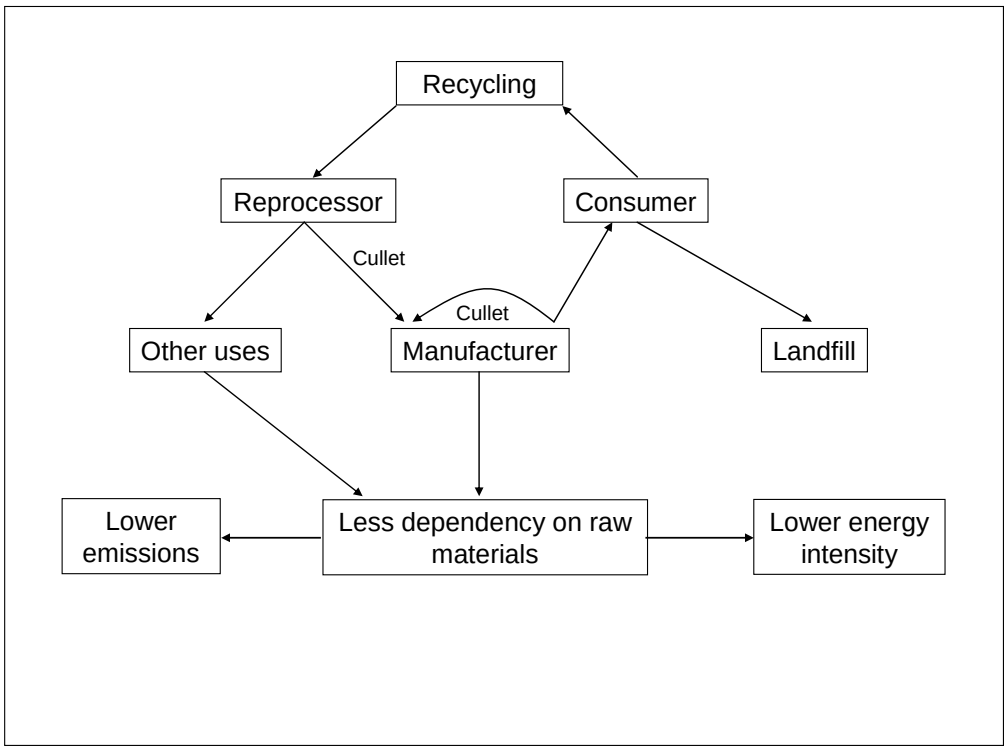
Directive 96/61/EC – IPPC (Integrated Pollution Prevention and Control)

"The aim [of IPPC] is to prevent or reduce pollution of the atmosphere, water and soil, as well as the quantities of waste arising from industrial and agricultural installations to ensure a high level of environmental protection" (www.europa.eu).

The Directive sets 'mandatory environmental conditions' that must be met in order for a permit to be issued. The most applicable condition to the EU glass industry is the requirement to adopt the Best Available Technique, i.e. procedures and methods must be in place that, "produce the least waste, use less hazardous substances, enable the recovery and recycling of substances generated" (*ibid*). Producers must also, "use energy efficiently" (*ibid*).

One way in which the EU glass industry embraces the IPPC directive is by actively encouraging glass recycling, and where possible using recycled glass (cullet) in production. The percentage of glass recycled varies considerably by Member State. In 2005 the average glass recycling rate in the EU was roughly 55% (DTI and British Glass, 2005) and at the same time it was 34% in the UK and over 80% in five of the EU15 states. Recycling appears very much to be a cultural issue. In countries such as Finland and Sweden recycling is very much the norm whereas in the UK widespread 'kerbside' recycling is something relatively new, but in the relatively short time it has been in use it has proven to very successful at increasing recycling rates (British Glass, 2003).

The recycling of glass is central to complying with the IPPC Directive, and other forms of regulation. The diagram below identifies the importance of recycling, its main flows, and the benefits it can bring to glass producers and society in general.



Not only does the use of cullet reduce the quantity of scarce virgin raw material required, but it also results in significant energy savings in production as it does not have to be heated to as higher temperatures to process it as virgin raw materials do. According to a survey by the Carbon Trust (2005) container manufacturers achieve an energy saving of 337kWh for each tonne of cullet recycled, which equates to a 2.5% energy saving per 10% cullet addition. Similarly, the DTI and British Glass (2005) estimate that for every tonne of cullet used in the production process 0.45 tonnes of carbon dioxide emissions are saved.

Although glass is infinitely recyclable, one limitation of the recycling process is the colour of the output glass that can be reproduced since it depends of the colour the cullet used in production. Cullet needs to be separated by colour prior to or within the recycling process in most cases, otherwise later separation can be costly. In the UK, the structure of international trade in container glass items is such that there is a shortage of clear glass for recycling. In the UK 66% of container glass production is clear, but a large proportion of this is exported in the form of spirit bottles hence only 41% of recycled glass is clear (DTI and British Glass, 2005), i.e. clear glass is leaving the system. Also, given the UK's imports of wine from Europe, Australia and the USA, mostly in green bottles, almost half of recycled glass is green, whereas only 18% of EU container glass production is green tinted, i.e. green glass is entering into the system. These trends ultimately limit the usefulness and flexibility of cullet within glass manufacture.

Whilst there are a number of benefits that the IPPC Directive brings for the EU glass industry and society, the IPPC Directive, along with other forms of environmental regulation such as REACH (Regulation Concerning the Registration, Evaluation and Authorisation of Chemicals) Directives regarding pollution allowances and packaging

waste have created a number of competitiveness challenges for EU glass producers. The main problem is that the increased regulation has meant that in world markets, where producers have significantly less strict environmental legislation (especially in developing countries), the EU is not operating on a level playing field due to the costs and inconveniences it accrues from EU legislation. In addition, under the IPPC the abatement costs (associated with permitting) incurred by the EU glass sector have run into hundreds of millions euros. Any further tightening of limits and/ or the introduction of NOx and SOx emissions trading brought about by the review of the IPPC, with the implications for further abatement-related investment, would damage the relative profitability and viability of the sector in the EU further. These issues are summarised by DTI and British Glass (2005, page 25):

> "It is suggested that as a direct consequence of the rising business costs associated with the implementation of EU regulations…production will be and is being switched to areas outside of the EU where both the regulatory costs human resource costs are lower."

The impact of the Renewables Obligation could hit the EU glass sector further. The pass through costs associated with reaching these targets could have severe knock-on effects for energy prices, especially where Member States set very high targets, eg. the UK. It is also argued that the pollution legislation unfairly targets the glass industry that plays an active role in producing products that are specifically designed to benefit the environment, yet it is their own production pollution that is closely regulated. Examples of such products include double-glazing, solar control glass, insulating fibres and self-clean glass, all of which are designed to be environmentally beneficial in one way or another. In addition, some glass products are also used to manufacture environmental technologies, such as reinforcement glass fibres in wind turbines and other environmentally-friendly composite products. This may act as a disincentive for EU firms to engage in environmentally friendly product innovation, something where the EU has a competitive advantage. Nevertheless, the increase in demand for environmentally friendly glass products will create new opportunities and markets for EU glass producers – *the challenge is keeping innovation and production within the EU*.

European Commission's proposal to revise the EU Emissions Trading System

A revision of the EU Emission Trading System is proposed by the EC for the period 2013-2020. We refer here only to the main features of this proposal that will affect the glass industry to a large extent.

First, the revision tends to become stricter overall, thereby also pressuring the glass industry to a larger extent. In the proposal, the aim is to achieve one EU wide cap on the number of emission allowances, instead of individual national caps. This cap will follow a decreasing linear trend, thus becoming more limiting every year. Even more importantly is that a larger share of the allowances will have to be traded, and will thus no longer be free. The allocation of the decreasing number of free allowances will be governed by harmonized EU rules.

The effect of this kind of revision on the glass industry is double negative. First, the glass industry has already invested in alternative production features and cleaner technologies

in order to reduce emissions. The effects of these technologies were still relatively large, so that investments paid off. To further decrease emissions in the next phase, will require much larger efforts. The fear is that further decreasing the energy needed for production will not be enough to reach the even stricter objectives. Secondary measures will have to be turned to, even though these are less effective and thus often relatively more expensive.

Another issue with regard to the proposed revision, is the increased importance of auctioning. If this becomes reality, a great part of the allowances will no longer be free and even worse, are uncertain in price at this time. This increased production cost uncertainty automatically leads firms to hesitate about taking long term decisions. Reluctance to plan ahead and to invest in the future is thus created within the industry.

Study on the sectoral costs of environmental policy in the EU

As a general remark regarding the effects of environmental policy on the costs of manufacturing firms in the EU, we refer to a study by VITO under the authority of DG Environment of the European Commission[4]. This study concludes that in general:

- the annualised environmental costs in the sectors in question are typically less than 2% of production value, even though the perception is much higher.
- there seem to be comparable levels of costs for firms in the Australia and the US.
- innovation and integrated investments partly stabilise the unit costs of environmental protection.
- the cumulative effect of the different environmental policies is less than the costs would be of individual policies, thus there are synergies for the implementing firms.

The effect of environmental policy on the competitive position of EU manufacturing firms therefore seems to be limited. However, it would be wrong to conclude that no impact is felt by industry, as passing on costs to consumers is not automatically possible. The extent to which costs can be passed on, depends on the price elasticity of demand for glass products and will thus also differ across sub-sectors.

4.4 Other framework conditions

4.4.1 Cost and availability of supply of energy

As discussed earlier, energy intensity varies by glass sub-sector or product, but it can account for over 20% of production costs in the mass produced container glass sector, hence any fluctuations in energy prices can have a significant impact on overall cost levels. The vast majority of energy used in the production of glass is used to heat furnaces. As the chart below shows, the chief source of energy supply is natural gas and the reasons for this choice boil down to cost, ease of control, lack of required storage space, high purity and low sulphur dioxide emissions (IPPC, 2001).

[4] P. Vercaemst, S. Vanassche, P. Campling, L. Vranken, P. Agnolucci, R. Salmons, B. Shaw, J. Jantzen, H. van der Woerd, M. Grünig and A. Best, *"Sectoral Costs of Environmental Policy"*, VITO for EC DG Environment, 2007.

In the UK, roughly two thirds of the gas consumed by glass producers is *interruptible* (Carbon Trust, 2005). Interruptible tariffs are a pricing option offered to industrial producers that involves temporarily interrupting their activity during peak demand, in return for a discount on the standard tariff assisting the load management of the producer (United Nations, Economic and Social Council, 2002). For this reason a number of glass production plants are designed to run on both gas and heavy fuel oil.

The cost of energy has soared in recent years, and this has created serious problems for the EU glass industry (as discussed in chapter three) and many other energy intensive industries.
The dramatic increase in energy prices, coupled with environmental legislation discussed above, has emphasised the need for glass producers to improve efficiency and reduce the energy required to produce glass, and the carbon dioxide produced in the process. As discussed earlier, furnace technology is at its mature stage and in the short term reducing energy intensity and cost very much relies on the increased use of cullet. "As a general rule each 10% of extra cullet results in a 2.5-3.0% reduction in furnace energy consumption" (IPPC, 2001, page 215).

The Structure Of Energy Markets

There have been a number of calls from the glass industry and other energy intensive industries to liberalise competition in energy markets, and encourage new entry in an industry that is dominated by established incumbents with significant market power. Neelie Kroes, member of the European Commission in charge of competition policy (EC Press Release 06/159, 2006), identifies five 'obstacles to competition' in energy markets as, market concentration, vertical foreclosure (long term contracts restrict new entry), market integration, lack of transparency and price formulation (the prospect of anti-competitive behaviour). These factors contribute to the soaring energy prices that are added straight to the bottom lines of EU glass producers' cost bases. There are also concerns about the future supply of gas to the EU, given that most of it is imported from non-EU countries such as Russia as North Sea gas production declines.

4.5 Framework conditions in the new Member States

4.5.1 General framework conditions in the new Member States

In many aspects, the new Member States still differ substantially from the Western European countries. An essential causing factor for these differences is the evolution from centralised planning economies towards market economies in the 1990s in several of the central eastern European countries (CEECs). This evolution has demanded great efforts and dynamism in these countries, but it has also started a change process in many aspects of the economy, enforced by accession to the EU.

Production plants were privatised and have since attracted many foreign investors. With these foreign investors, a process of modernisation and rationalisation was triggered, having an effect on productivity, employment, innovation… These countries have long traditions of glass production involving manual working skills, but automation is introduced by the foreign investors, not only altering the required labour skills, but also

the number of workers per unit output. The new technologies introduced are modern and take into account the European Union's ideas on environmental protection, waste handling, recycling etc. Therefore, these investments have started a catching up process as compared to EU-15 economies.

A number of framework conditions are at the base of the growing foreign direct investments in the CEECs. First, production costs are generally lower than in Western Europe, thanks to cheaper labour and the availability of raw materials of high quality for the glass industry. Second, the proximity of the large Eastern European market with still great growth potential makes these countries the ideal operating base to develop new markets.

Moreover, for the NMS producers the potential market increased also, and a more intense competition with the EU-15 was bound to arise. This was an enforcing factor for investments in technology and alterations in products and production processes. In the Czech Republic for example, the opening of the borders after joining the EU in 2004 (in combination with the discouragement of price regulation) has lead to a substantial growth of the packaging sector. An important factor in this is the increased competition with the EU-15 where variety of pack types is greater. To withstand this diversity of imports, domestic manufacturers have had to improve their technologies, thus incurring vast investments, as well as to implement new pack types into their production. *("Packaging Industry in the Czech Republic – Executive Summary", Euromonitor International, 2007.)*

Generally, there has been a concentration process in the European glass industry. Next to productivity considerations, this is also a survival strategy in response to the evolution of client industries. These have started to concentrate, thus achieving larger bargaining power and concentrating demand to larger volumes. Concentration is thus crucial for the glass industry in order to withstand the increased downstream bargaining power and to be able to supply larger volumes quickly. This evolution is also observed in the new Member States.

These effects of the privatisation, accession and the growth dynamics have also triggered an evolution in the consumption patterns of inhabitants. Yet, consumption is still much lower (in relative terms) than in EU-15. A relatively large share of production is therefore used for exports.

4.5.2 Implementation of the EU regulatory conditions in the new Member States

A consequence of accession to the EU for CEECs is convergence to the EU regulations. This process of convergence has started long before the actual accession and generally, the CEECs had to implement the acquis communautaire by the time of accession. The candidate countries had to define realistic national strategies that included priority areas of action, key objectives to be attained by the date of accession, and timetables for the subsequent achievement of compliance. For example with regard to competition, these countries had to lay down competition laws mirroring those found in the acquis and had to show that competent competition authorities had been set up with a credible enforcement power. *(http://europa.eu/scadplus/leg/en/lvb/l28057.htm and "Competition*

Law in the New Member States: Where do we come from? Where do we go?", D. Geradin & D. Henry, in: Modernisation and Enlargement: Two Major Challenges for EU Competition Law, 2005)

This convergence to EU law created two challenges for the NMS. The first was that the adoption of more strict regulations has altered the rules of the game for competition with neighbouring non-EU countries like Russia & Ukraine. The second challenge is the additional investments needed to implement the new rules. The main sector-specific challenges for the acceding countries in this respect were waste management, water pollution and industrial pollution control and risk management. The candidate countries thus had to fill in the gaps in their legislation and administrative rules to improve the environment while at the same time improving the economy and competitiveness.

One of the main influencing regulations for the glass sector is the IPPC Directive. This was already installed by the time of accession and demanded a number of developments from NMS, both on the authority side and on the industrial side. On the authority side, there was need of a solid institutional background, information on new aspects like energy efficiency and cost-effectiveness, software development for the data supply, guidance on best available techniques,… On the industrial side, the cost of complying with the best available techniques requirements was a primary aspect, next to investments for competitiveness on the international markets. *("IPPC implementation in Hungary, Points of special interest", Ildikó Babcsány, Head of Department, National Directorate for Environment, Nature and Water, Directorate for Environment, 2004.)*

After the implementation of the acquis communautaire, additional efforts were needed to implement the REACH regulation in the NMS. Yet, depending on the price elasticity of demand for glass products, some of the costs of REACH implementation at company level can be passed down the supply chain. DG Environment therefore estimates that the impact of the REACH regulation is mitigated to some extent *("New EU states coping with REACH legislation", EC, DG Environment, 2008*). Nevertheless, the implementation of REACH is in its early days and an assessment of the initial assumptions about its impact on costs and operations will provide clearer conclusions.

One of the aims and thus potential impacts of this increased environmental legislation in the NMS is to help individuals think in a more environment-friendly way when purchasing goods. Because of this, they are expected to opt for products and packaging with less harmful effects on the environment. In Hungary, demand seems indeed to be shifting towards packaging materials that are easier to collect and recycle. *("Hungarian glass industry continues its uphill journey", Katalin Zimanyi, 1998.)*

Just like for all EU countries, it is an important question whether the EU regulation decreases the competitive position of NMS compared to non-EU countries. In this respect, the NMS face competition in the glass industry from neighbouring countries like Russia and Ukraine, which do not need to comply with EU legislation. Also, like in the EU-15, Asia is an important competitor in the international field.

4.5.3 *The effect of accession on the glass industry in the Western European Member States*

As we have mentioned, the main competitors of the EU-15 are eastern Europe and Asia. Even though the eastern European countries need to comply with EU regulation just like the EU15, there remain a number of factors that increase the fierceness of competition from these countries.

In the Eastern European countries, labour is generally cheaper and raw materials are well available. This decreases general production costs as compared to the Western European countries.

Some negative factors for the competitive position of Eastern European countries, like the more dispersed production in smaller units, labour intensive production processes or obsolete technologies are tending to disappear thanks to modernisation and concentration. However, for a large part the modernisation is due to foreign direct investments (as explained before).

Next to the threat of increased competition, accession of the NMS also created investment opportunities. Western European producers have taken over production plants in these areas that are cheaper and that can efficiently and effectively supply Eastern European clients. For Western Europe, the accession is thus a relatively safe opportunity to develop new markets.

4.6 Effect of the framework conditions on the competitive position

4.6.1 *Competitiveness grid*

In what follows, a competitiveness grid is drawn up to present potential impacts of the framework conditions on indicators of the economic and competitive position of the glass sector in the EU. These impacts are indicated by means of light or dark grey crossing between the condition and the indicator in question (depending on the intensity of the effect). For each shadowed crossing, the direction of the effect (+ or -) and the source through which we have identified the effect[5] is given.

First, the regulatory conditions are shown, followed by the grid of the other framework conditions and finally of the exogenous conditions. After presenting the competitiveness

[5] This indication is consistent with the one in the framework grid and is thus defined as [1]: effects that are found in empirical literature; [2]: the effects that are described as 'potential' in literature; and [3]: the effects that on the base of our own assessments have a potential impact.

grid as a whole we focus in more detail on the effects that each individual competitiveness indicator encounters through the framework conditions.

Regulatory conditions:

Glass sector

	Indicators	Labour market regulations	Knowledge (e.g. IPR)	Competition policy	Industry specific regulation: lead content	Industry specific standards: construction products	Consumer standards: materials food	Consumer standards: building regulations	Energy & Environment: packaging	Energy & Environment: building products	Energy & Environment: energy end-use efficiency	Energy & Environment: electrical and electronic equipment	Energy & Environment: EOL vehicles	Energy & Environment: eco-design	Energy & Environment: EU ETS and revision	Energy & Environment: water policy	Energy & Environment: IPPC directive	Energy & Environment: REACH
Outcomes	Production and Value added		[+] [3]			[+] [3]		[+] [3]			[+] [3]			[+] [3]	[+] [3]			
	Employment																	
	Capital																	
	Productivity																	
	Profitability	[-] [3]	[+] [3]		[3]	[-] [3]			[-] [3]			[-] [3]		[-] [3]	[-] [3]		[+] [2]	[-] [3]
	Exports and Trade	[-] [2]	[+] [2]		[3]	[+-] [2]	[-] [3]	[+] [2]	[-] [2]	[+] [2]		[-] [3]	[-] [2]	[+-] [2]	[-] [3]		[-] [3]	[-] [3]
Processes	Intra-industry relations				[3]				[-] [2]									
	Production processes	[2]										[3]			[+] [2]			
	Organisation														[-] [3]		[-] [3]	[-] [3]
Structure	Industrial structure	[2]		[1]	[3]				[2]				[2]	[2]				
	Size of enterprises			[1]														
	Level of specialisation		[+] [3]			[+] [2]		[+] [2]		[+] [2]	[+] [3]			[2]	[+] [2]			[2]
	Segmentation													[+] [3]	[+] [2]			
Inputs	Labour	[3]																
	Capital														[+] [3]		[+] [2]	[+] [3]
	Intermediate goods & services											[3]			[-] [2]		[-] [2]	
	Knowledge & technology		[+] [2]			[+] [2]		[+] [2]		[+] [2]	[+] [3]		[+] [2]	[+] [3]	[+] [2]		[+] [2]	

Framework conditions

Regulatory conditions

Other framework conditions:

Glass sector

	Indicators	Labour force & skills	EU Market access (Trade & FDI)	Knowledge base development	Physical aspects & Infrastructure	Energy & Environment	Access to finance	Geographic cohesion
Outcomes	Production and Value added			[+] [3]				
	Employment							
	Capital							
	Productivity	[+] [2]						
	Profitability			[+] [2]	[-] [3]	[-] [2]		
	Exports and Trade	[-] [2]	[-] [2]	[+] [2]	[-] [2]			
Processes	Intra-industry relations							
	Production processes							
	Organisation							
Structure	Industrial structure	[2]	[2]					
	Size of enterprises							
	Level of specialisation			[+] [2]				
	Segmentation			[+] [3]				
Inputs	Labour	[2]		[3]				
	Capital				[+] [2]			
	Intermediate goods & services				[+] [2]	[3]		
	Knowledge & technology			[+] [2]				

Framework conditions

Other framework conditions

Exogenous conditions:

Glass sector

	Indicators	Credit crunch	Availability of energy and raw materials: soda ash and crystalline silica	Availability of energy and raw materials: cullet	Technological change: automation	Technological change: engery-saving technologies	Technological change: flat screens	Socio-political developments	Downstream bargaining power	Global competition: counterfeiting activities	Global competition: mergers and acquisitions	Global competition: competition low-cost producers	Global competition: competition from substitutes
Outcomes	Production and Value added	[-] [3]					[-] [2]	[-] [2]		[-] [2]		[+] [2]	
	Employment	[-] [3]			[-] [3]		[-] [2]	[-] [2]					
	Capital												
	Productivity				[+] [3]								
	Profitability	[-] [3]	[-] [2]	[+] [2]	[+] [3]	[+] [3]			[-] [2]	[-] [2]	[+] [3]	[-] [2]	[-] [2]
	Exports and Trade	[-] [3]			[+] [3]			[-] [2]		[-] [2]		[-] [2]	
Processes	Intra-industry relations		[-] [2]						[2]				[-] [2]
	Production processes				[3]								
	Organisation								[+] [2]				
Structure	Industrial structure						[-] [3]		[+] [2]				
	Size of enterprises										[+] [2]		
	Level of specialisation											[+] [2]	
	Segmentation												
Inputs	Labour				[3]								
	Capital				[+] [3]								
	Intermediate goods & services		[-] [2]	[2]									
	Knowledge & technology			[+] [2]	[+] [3]	[+] [3]						[+] [2]	

Framework conditions

Exogenous conditions

4.6.2 *Conclusions from the competitiveness grid*

Production and value added

Value added is influenced mainly by innovation and its related conditions.

First, there is the **IPR legislation** and its enforcement. Thanks to the fact that innovations can be protected from counterfeiting, they pay off for the producers and allow them to effectively differentiate from competitors in terms of production process or product types.

Second, **consumer and producer standards from EU regulations**, mainly concerning energy and environmental policies, give a boost to research and development of new, high value products. Also more **general environmental issues**, like the emission regulation, the eco-design regulation and potentially the energy end-use efficiency directive, push EU producers in the direction of innovation and value added.

EU producers have therefore become increasingly specialised in value added products. Their knowledge base is strong, which gives them a competitive advantage in this respect. Product choices are tuned to this advantage.

Production in quantitative terms is negatively affected by **global competition** from counterfeiters and by socio-political developments where foreign countries set up explicit or implicit barriers to import from the EU. Yet the sub-sector of special glass products, especially in technology-driven sectors, is performing well. Also in domestic glass, high value products from the EU are competitive. Therefore, also global competition tends to have a positive effect on the value added of production in the EU.

Employment

Employment is mainly affected in a direct manner by the exogenous conditions. Naturally, many of the other indicators relate to employment effects in an indirect manner.

The **automation** of the production process in reaction to cost pressure from global competition has decreased the employment needed to produce the same output. This does increase the productivity of employment.

Factors influencing **demand**, such as overall competition, the credit crunch, the decrease of demand for cathode ray tube monitors or socio-political developments restricting output, also decrease demand for labour in the glass sector.

Productivity

As mentioned under the employment indicator, productivity has increased thanks to automation of the production process. **Globalisation** as a driving force behind this automation process is therefore the underlying driver for the increased economic efficiency in the EU glass sector.

Profitability

Profitability is affected in many different ways and by many different framework conditions. This is almost always connected to the effect of these conditions on production costs, but sometimes also to a direct effect on the competitive position.

On the one hand, regulations can increase costs for producers directly, for example because **additional investments** are necessary. This is the case with the labour market regulations and various environmental regulations. On the other hand, also **administrative costs of reporting** in compliance with the regulations (e.g. IPPC) can influence the profitability of EU producers. Since these regulations affect only EU producers, their non-EU competitors have a comparative advantage in terms of costs.

Yet regulations can also have a positive impact on profitability. The IPPC Directive, for example, increases the **recycling of glass** and the use of cullet. The increased use of cullet reduces production costs. Another example is the regulation concerning the **lead content** in crystal glass. This leads to the possibility for industry to label its products and thus to differentiate and possibly to act against cheaper imported or even counterfeited products. This additional information for consumers thus has a positive influence on profitability of EU producers.

Knowledge creation and the protection thereof are important for profitability, for they decrease counterfeited imports and increase the competitiveness of EU producers. Also, R&D on the technological production process can decrease costs, even though this effect is estimated to be relatively small in the future since production processes in the glass industry are already at a mature stage.

However, the fact that the production process of glass remains **energy intensive**, together with the fact that energy prices are rising substantially, has a negative impact on the profitability of glass relative to that of substitute products, like plastics in the packaging industry. Another exogenous condition affecting profitability negatively is the recent **credit crunch**. This has an important impact on economy as a whole, but especially on the building industry. Since the building industry is an important purchaser for the glass industry, the latter is affected substantially as well.

The physical aspects and infrastructure of the glass industry are characterised by **large set up costs**. This leads global players to be very sensitive to costs in their location choice. They go where they can get the best return on investment, often where other production costs are lower. This then decreases the entry barrier of the high set-up costs and increases the confidence to be able to produce in a cost-effective and profitable manner. Because of the fact that competing countries outside of the EU often face lower labour and/or raw material costs, this framework condition forms a threat for the profitability and competitiveness of the EU glass industry.

Exports and Trade

Exports and trade depend on the relative competitive position of the EU producers as compared to competing producers. Naturally, this is affected by all measures and

conditions that affect relative profitability and costs. Therefore, many of the effect described under the indicator "Profitability" have a derived effect on exports and trade.

In particular, legislation applying only within the EU can negatively affect the competitive position with regard to non-EU countries. For example, the regulation concerning **end-of-life vehicles** is distorting competition, because there is no standardised system for the treatment of ELV's. Some have to comply with more strict rules than others.

To the contrary, the fact that building products are required to become more energy-efficient, benefits EU producers that have a comparative advantage in specialised products. In general, measures and conditions affecting the **value added** of EU production in a positive way will also influence the competitive position of EU producers and thus their exports in a positive way. This is the case for the regulations concerning building standards. One condition for this effect to be substantial is that IPR can be protected in an effective way.

When both the cost argument and the value added argument apply, it depends on their relative importance how exports will be affected. Examples are the regulations on construction products standards and eco-design.

Due to the **changing needs of labour skills**, which will be lower in a more automated environment, it is more profitable for producers to move to countries with cheaper low skilled labour. However, this does not only apply to the glass industry and it is observed that the glass industry's client industries are also shifting outside the EU. This is a threat to EU glass production as a whole, because producers and purchasers prefer to be in each others neighbourhood and these client industries might thus go looking for glass suppliers in their vicinity there. This, together with **natural and forced trade barriers** for European producers, also deteriorates the trade position of EU countries.

Intra-industry relations

The intra-industry relations refer to substitute industries, and upstream and downstream industries. With regard to substitute industries, any regulation affecting only glass will trigger a change in its competitive position with respect to these substitutes. This, just like any change in bargaining power towards the upstream or downstream industries, will affect profitability and competitiveness of the industry.

Competition from substitutes has become fiercer, especially in the packaging industry. On the one hand, the glass industry faces competition from a variety of industries in this sub-sector: plastic, steel, aluminium, and carton. Plastic in particular is a serious upcoming competitor and it often depends on consumer preferences whether glass or plastic is chosen as a packaging material. However, plastic is transported more than glass and also depends on oil as a raw material. In this respect, the plastic packaging industries competitive position has worsened due to the increasing **oil prices**. The glass industry on the other hand, is very energy-intensive and thus depends to a large extent on the **energy costs**. Since these have been increasing in recent years, its relative competitiveness has for its part deteriorated. Finally, there is also an effect of the specific **packaging**

regulation. This regulation concerns recycling of materials and distorts competition between materials because glass faces more requirements than plastic.

Another regulatory issue is the regulation concerning **lead content in glass**. The possibility to label products increases the importance of high-quality crystal glass with regard to lower quality or substitutes and has the advantage of creating better information for consumers, increasing consumer confidence.

Next to substitutes, also raw materials affect the intra-industry relations of the glass industry. The energy intensity of the production process and the use of raw materials like soda ash and crystalline silica (sand), make the glass industry relatively dependent on its input channels. **Upstream bargaining power** is thus limited.

The **downstream bargaining power** is limited in most glass sub-sectors as well. Examples of customer industries with large bargaining power are the distribution and automotive industry. This limited bargaining power of glass producers leads to lower margins, leaving little breathing space for the glass industry when costs increase. Yet the domestic glass sub-sector has found its way to alternative channels and forward integration, increasing its bargaining power again relative to the distribution sector.

Production processes

Many changes in the production processes of the glass industry have come about due to automation, but also regulation has increasingly stimulated changes.

Due to the **automation process**, the technological complexity of production has increased. This automation is a consequence of the urge for cost-efficiency and the related need to reduce production costs in order to remain competitive in the global playing field.

Related to cost-efficiency, there was also a trend towards **larger energy-efficiency**. Part of this is inspired by cost-related motives, part by regulation. In general, **environment- and energy-related regulations** have thus also paved the way to technological changes in the production process. A special case is the restriction of hazardous substances in electrical and electronic equipment. This legislation has lead to the use of alternative inputs and has thus required the adaptation of the production process to these new inputs.

Also compliance with **labour regulations** like the protection of workers from exposure to physical agents and the good handling and use of crystalline silica have demanded changes in the production process and in the safety regulations.

Organisation

The main impact of regulatory conditions on the organisation is the increased **administrative burden** due to additional control mechanisms or reporting requirements. This is the case with the greenhouse gas emission legislation, the IPPC directive and the REACH directive.

Yet an effect of different order is the reaction to the increased bargaining power of downstream channels. This reaction has consisted of **forward integration** in a number of glass sub-sectors, affecting the organisation in these sub-sectors' firms substantially. The advantage of forward integration is that bargaining power of distribution channels is slightly decreased, while the supplier has the possibility to price discriminate and thus to optimise its profits.

Industrial structure

A large number of framework conditions affect the industrial structure of the glass sector. This is in particular due to the fact that the glass industry consists of many different sub-sectors. Where a regulation does not regard all sub-sectors or where other conditions do not affect all sub-sectors in the same way, the structure between glass sub-sectors is influenced. Moreover, when specific sub-sectors are affected, this is also reflected in a geographically concentrated impact, since most sub-sectors are concentrated in only a few Member States.

A clear example is the directive on **lead content labels**, which applies generally to tableware but in reality only affects the crystal glass industry. Also the **labour market regulations** are an example. The effect of this regulation, increasing safety measures to the benefit of the workers, depends on the production process characteristics e.g. hand-made versus automated. Domestic glass is the most labour intensive sub-sector, still delivering an important share of hand-made production. Therefore, this sub-sector and the countries in which it is concentrated (France, Italy, Germany and the Czech Republic) are affected to a larger extent than the others.

The **packaging directive**, however, does not only focus on one specific sub-sector, but additionally, it does not account for country-specific differences related to recycling infrastructure and population concentration. Therefore, it leads to a concentration of the burden of this legislation in a few Member States (Spain, Italy and the UK). Similarly, the **end-of-life vehicles directive** does not only affect one specific sub-sector while leaving the others out of sight, but it also influences competition within this sub-sector due to the lack of standardised systems. Finally, the **eco-design requirements** for energy-using products do not include all products and thus leaves space for distortion of competition between these products.

Competition policies refer to the regulations on mergers and acquisitions. Given the evolution towards concentration in the glass-sector, this policy has an important effect on its industrial structure.

Next to regulation, the **other framework conditions** also affect the industrial structure of the glass industry. For example, the different levels of labour skill requirements influence the extent to which production each of the sub-sectors is shifted to countries where low-skilled labour is cheaper. Also the specific product characteristics of the sub-sectors determine the possibilities for transport and thus for trade. Therefore, fierceness of competition is partly determined by the transportability of the products.

Two specific **exogenous evolutions**, leading to a shift in industrial structure are the introduction of flat screens, replacing cathode ray tube monitors, and the forward integration in some sub-sectors as a response to decreased downstream bargaining power.

Size of enterprises

The average size of a glass producing enterprise depends strongly on the sub-sector in which it operates. It is however a general trend to **concentrate** and thus evolve towards larger production units. The driving force behind this is the existence of economies of scale in the glass production, urging it towards more efficient and unit cost-reducing scales. Another factor can be the parallel concentration in client industries, leading to larger orders and larger bargaining power from these clients, which are difficult to face for a small company. **Competition policy** is the main regulatory condition mitigating this concentration trend and thus also affecting the size of enterprises.

The exceptions to this concentration trend are industries where smaller, independent companies and groups can compete effectively thanks to the existence of regional and niche markets (for example part of the container glass sub-sector; high value, high quality and technically demanding products in special glass).

Level of specialisation

Many framework conditions have a positive effect on the level of specialisation in the EU glass production. As mentioned before, specialisation is often a reaction to fierce competition from low-cost countries. Also EU regulation in several areas has increased the need for knowledge development and research, automatically leading to higher specialisation levels.

Examples of **regulations** that have required or that will require R&D are the building standards, building products regulations, eco-design requirements, energy end-use efficiency directive and greenhouse gas emission regulation. These regulations have often led to specialisation in more environment-friendly and less energy-consuming types of glass and products.

The **REACH regulation** leads to the phasing out of speciality chemicals, which also affects the products in the glass industry. Specialisation might therefore change, yet it is not necessarily so that the level of specialisation will increase (or decrease).

Specialisation is also a solution to withstand **competition from low-cost producers**. Differentiation can allow EU producers in this respect to remain profitable. Yet, an important prerequisite for profitability of high levels of specialisation is the enforcement of **IPR protection** regulations. The evolutions in this area thus also influence specialisation in a positive way.

Segmentation

Segmentation in the glass industry is related closely to the increasing level of specialisation. The same regulations concerning **eco-design** and **greenhouse gas emissions** are responsible for the development of niche markets for energy-efficient

products. In these markets, the EU has a comparative advantage thanks to its strong **knowledge base**.

Labour

Labour as an input for the glass production, is liable to a great deal of the evolutions in the production process and in competition.

On the one hand, the technical evolution of **automation** of the production process has lead to a decrease in the quantity of labour required. On the other, it has altered the labour skills needed to produce glass. Next to engineers thinking through the technical process, low-skilled workers are needed to operate the machines. Related to this, also the increased specialisation and the development of the **knowledge base** are factors influencing the type of labour required.

Finally, the **labour market regulations** increasing safety measures for glass workers might also have an impact on labour cost and consequently on the quantitative labour demand.

Capital

The production of glass is generally a very **capital intensive process**. Set up costs are high due to the capital needed for the purchase of the installations. The **automation process** has increased investments in new technologies and thus the capital required. Also a number of framework conditions increase this capital needed, due to the additional investments required for compliance with the regulations. This is especially true for the **greenhouse gas emission**, the **IPPC** and the **REACH** regulations. It is expected by the sector representatives that the revision of EU ETS will increase capital costs further, since the proposal is stricter than before and therefore pushes the glass industry towards more expensive but relatively less efficient emission reducing techniques.

Intermediate goods & services

Under this indicator, we have regarded the input of raw materials and energy into the glass production process.

Glass production is a very intensive user of energy. This makes the industry relatively dependent on energy prices. Since energy prices have soared in recent years, this was felt in all glass sub-sectors. Moreover, new equipment that is installed to implement regulations like the IPPC directive and the greenhouse gas emission regulation also requires energy to run, additional to the energy input in classic production. Yet, on the positive side, these regulations together with the technological evolution of the production process have equally lead to the development of more **energy-efficient products**.

Concerning the input of raw materials, a number of regulations have a clear impact on which materials and how much of them are used in the production process. The **restriction of hazardous substance in electrical and electronic equipment** has limited

the use of certain input materials and the shift towards others. Furthermore, thanks to the **IPPC directive**, a shift towards the use of recycled glass as a raw material is observed. Clearly this increases the demand for appropriate cullet and decreases the demand for the 'original' inputs like soda ash and crystalline silica (sand).

Knowledge & technology

Knowledge and technology have grown for a large part thanks to regulations.

First, the EU **environmental regulations** have lead to research on how to increase the energy-efficiency of the production process and on how to optimize the products in terms of environment-friendliness. New techniques were also developed to process cullet and to treat end-of-life vehicles. Moreover, industry and consumer standards on construction products, building regulations and building products have had this same effect. Yet, restrictions on use of input materials, like in REACH, can also have a limiting effect on the scope of potential innovations. Even though innovation in general is stimulated, not all possible lines of reasoning can be investigated to the full due to these restrictions.

The **fierce global competition of low-cost producers** has driven the industry towards many technological evolutions for a more cost-friendly production and consequently for automation. This reinforced the energy-saving measures as well.

Finally, the **IPR enforcement** that protects knowledge was necessary to allow for the previous evolutions to have a substantial effect.

4.6.3 Concluding summary from the competitiveness grid

The two most fundamental conditions in the European glass sector are globalisation and the increased environmental regulation.

Globalisation has lead to fiercer price competition and therefore indirectly to a large part of the cost-reducing measures and trends in the glass industry. Increasing environmental awareness and regulation also affected the glass industry in a wide range of aspects: energy-saving production processes, energy-saving products, recycling, questioning of the use of (potentially) harming raw materials like lead and hazardous substances.

Globalisation

EU producers have reacted to the increasing imports from low-cost countries in different ways. Some producers have specialised in high value and niche products that leave more space for profit margins, while others have tried to decrease costs by means of further automation of the production process, and concentration to realise economies of scale. The most appropriate reaction depended on the specific sub-sector in which the producer was active and on the characteristics of the producer itself.

The production of high value products leaves better margins for the producers, and the EU is performing relatively well in this market, thanks to its solid knowledge base and continuous further research. The enforcement of IPR legislation is however crucial to the

specialisation in high value and niche products. For example, counterfeit is a major problem for the domestic glass sector. To become less dependent on price competition from low-cost countries, the domestic glass sector is evolving towards higher value products, but it can only achieve profit margins on these when counterfeit is limited.

Automation requires advanced technological innovations and increases productivity. It is thus also thanks to globalisation that the production process has become more and more efficient and energy-saving. However, automation also leads to job losses and a shift in the required labour skills to high engineering skills and low manual skills.

Another cost-reducing reaction was the triggering of a concentration process, leading to a few large producers that take up the majority in the market shares.

Environmental regulations

Next to the globalisation process, the glass industry also faced the challenge of increased environmental regulations at the EU level.

Many of these regulations have lead to additional investments and to an increase in the administrative burden for firms. Moreover, regulations that only apply to EU producers can worsen the competitive position of these firms as compared to their non EU competitors, although the VITO study[6] mentioned in paragraph 4.3.1 moderates this reasoning.

Environmental regulations increase the entry barrier further when they increase the set up costs further. A producer has to be efficient enough to produce output in a profit-gaining way, under the limitation of regulations becoming more and more strict. The fact that R&D can become necessary to survive is a similar increase to the entry barrier of high set up costs.

Yet, the industry also in part benefits from these restrictions and requirements. Regulation has lead to increased research on energy-saving production processes and energy-saving products, on recycling and on alternative raw materials. Thanks to these evolutions, EU production has not only become more environment-friendly, but also more cost-effective due to the use of cullet as a raw material and due to the decrease of input of energy. And while the EU has performed well in these high value products in comparison to the non EU competitors, the competitive advantage tends to be eroded quickly as competitors with a lower cost base learn to imitate the products produced in the EU.

[6] P. Vercaemst, S. Vanassche, P. Campling, L. Vranken, P. Agnolucci, R. Salmons, B. Shaw, J. Jantzen, H. van der Woerd, M. Grünig and A. Best, *"Sectoral Costs of Environmental Policy"*, VITO for EC DG Environment, 2007.

5 Strategic outlook

This chapter presents a strategic outlook for the EU glass industry in the medium to long term based on an in-depth assessment of underlying trends, future competitiveness drivers, and challenges for the sector and its sub-sectors. The chapter identifies the main implications for development of investment strategies and industrial policies to strengthen the competitiveness of the EU glass industry. The strategic outlook is based on the challenges and trends identified in chapters 2-4 in the report.

The chapter is divided in three sections. First, we give a brief overview of the global position of the EU glass sector and its sub-sectors. Second, we carry out an analysis of strengths, weaknesses, opportunities, and threats (a SWOT analysis) in order to arrive at an overview of the competitive position of the EU glass industry. Thirdly, we use information of the SWOT analysis to point to possible strategic responses for the industry and policy makers in the Member States and at EU level.

5.1 The global position of EU glass sector

The EU is a major player in the world glass market. In 2007, the European glass industry produced around 37.5 mt of final product glass in various forms. The main part of the production is traded within the EU but some of the production is exported to non-EU countries. The main export markets are the USA, Russia and Turkey, along with other countries on the periphery of the EU. After years of trading at a surplus (by volume), the EU glass industry recorded a deficit for the first time in 2007 due to very strong growth in imports, particularly from China; although some sub-sectors still trade at a surplus. By value the EU glass industry continues to trade at a surplus thanks to its exports having a higher per tonne value than imports.

The European glass industry produces glass for many different markets, cf. chapter 2. The container glass industry is the largest sub-sector and accounts for around 58% of the sector's total output (by volume), and its products are mainly sold to the beverage and food sectors. The flat glass sub-sector accounts for around 27%. Its main products being windows sold to the construction industry, and car-glass sold to for the automotive industries. The domestic glass sub-sector, insulation and reinforcement fibreglass sub-sectors, and special glass sub-sector account for the remaining 15%. The domestic glass sub-sector produces and sells drinking glasses, giftware, lead crystal glasses, etc., to customers. The fibreglass sub-sectors produces reinforcement fibres for the composite industry, and insulation fibres for the construction industry. The special glass sector produces a range of different products sold for many different purposes. Cf. table 1.1 for a brief overview of the five sub-sectors.

Table 1.1.: The glass industry and its sub-sectors

	Percent of total output	Customers	Net export	Origin of import
Container glass	58%	Beverage and food sector	Positive (export 4-5%)	Countries at the EU-border
Flat glass	27%	Construction and automotive industry	Slightly positive (export 10-15%)	China, Eastern Europe, USA
Domestic glass	4%	Retailers, end-consumer	Negative	China, Middle East and Eastern Europe
Fibre glass	Insulating 6% Reinforcement 2%	Composite and construction industry		USA, Asia/ China
Special glass	3%	A wide range of sectors	Negative	Japan, USA and Eastern Europe

Source: This report, chapter 2.

The sub-sectors are quite diverse regarding markets, industry structure, technology and business models. Hence, beneath the total picture of the European glass industry that we will be painting in the subsequent sections, lies a richness of details and sometimes, what is relevant when considering the whole sector would be less relevant for one sub-sector. Differences between sub-sector will however be highlighted where such differences are considered to be of strategic importance and if data exists to support conclusions.

5.2 SWOT analysis

As a platform for discussion strategic option to meet the identified challenges, this section presents a preliminary SWOT analysis on the competitive position of the European glass industry.

SWOT is the abbreviation for Strengths, Weaknesses, Opportunities, and Threats. The SWOT analysis seeks to identify the main internal (Strengths and Weaknesses) and external (Opportunities and Threats) factors that a company, industry, or sector face and which it should take into account when developing its strategy. The four dimensions provide a framework for conducting a structured analysis of the European glass industry's competitive situation.

The SWOT analysis in table 1.2. gives a quick overview of the results of the analysis of each of the four factors. Each bullet point in the boxes is explained in more detail with reference to sources of the observations and conclusions. There might be differences between sub-sectors, which we will address whenever data allows it.

Table 5.2: SWOT of the EU glass industry

STRENGTHS	OPPORTUNITIES
▪ **Several large EU-based companies.** The companies are competitive on the world market ▪ **Economies of scale.** In most sub-sectors, economies of scale ensure efficient production. ▪ **High quality products.** The quality of the products of the European glass industry is an important parameter of competition. Glass is virtually inert, especially important for packaging. ▪ **High technological innovation capacity.** The European glass industries have continually been able to raise productivity through use of automation technology. ▪ **A skilled labour force.** A well-trained and skilled labour force helps the industry to produce efficiently.	▪ **New market opportunities**. Opening of new markets increase export potential. ▪ **Increasing demand for innovative and specialised products.** ▪ **Increased research and development** may foster process and product development. ▪ **Liberalisation of the EU energy markets.** ▪ **Switching to renewable energy.** ▪ **Integration of the value chain** offer new opportunities to glass producers. ▪ **Mergers and acquisitions** may improve labour productivity. ▪ **Stronger enforcement of intellectual property rights (IPR).** ▪ **Substitution of wood/metals with glass fibre.** ▪ **Glass as an energy friendly product.**
WEAKNESSES	**THREATS**
▪ **Mature production process**. The glass production process is at a mature stage and close to its limits and the industry's ability to improve efficiency and reduce CO_2 emission further is limited in the short term. ▪ **High entry barriers** for new companies due to high start-up costs, economies of scale, and tied distribution channels that may hinder innovation ▪ **High sunk costs** due to capital-intensive production facilities. May impede restructuring to meet the market shift in production from low-price to high-price products. ▪ **Long investment cycle in glass production.** ▪ **Diverse line of products in some sub-sectors**. In some sub-sectors, the line of products is very diverse, making it difficult to obtain high sufficient volume in production to secure profit margins.	▪ **Global competition and consolidation.** The global market for glass products is increasingly becoming dominated by a small number of large global companies ▪ **Low cost competition.** The EU increasingly faces competition from low-cost countries. ▪ **Downstream cost-cutting demands.** Globalisation may have a knock-on effect on the European glass industry. ▪ **Excess production capacity in the market,** a threat several glass sub-sectors faces. ▪ **Upward pressure on energy (and inputs) prices.** Globally, the demand for energy increases and this places an upward pressure on energy prices. ▪ **Environmental regulations** Environmental regulations exclusively in the EU. ▪ **Substitution of glass products by non-glass products.** Competition from non-glass products, e.g. plastic steel, aluminium, carton in container and domestic glass sub-sector. ▪ **Trade restrictions.** Trade restrictions may hinder exports to non-EU markets, e.g., the USA, Turkey, Saudi Arabia, and Syria. ▪ **Counterfeiting** of EU-origin designs by non-EU firms ▪ **Downstream bargaining power.**

5.2.1 Strengths for the EU glass sector and its sub-sectors

Strengths	Container glass	Flat glass	Domestic glass	Fibre glass	Special glass
Several large EU-based companies	●	●	●	●	●
Economies of scale	●	●	●	●	●
High-quality products	●	●	●	●	●
High technological innovation capacity	●	●	●	●	●
A skilled labour force	●	●	●	●	●
Glass is inert in nearly all applications	●				

Several large companies. In the market for mass produced glass products size matters due to the capital-intensive technology involved. Consequently, a relatively small number of large companies, mainly companies based in EU, USA and Japan, increasingly dominate the global market for glass products. For example, the container glass sub-sector is dominated by a few large companies out of which more companies are based in Europe, and also the flat glass sub-sector is dominated by a small number of large companies of which more are based in Europe, cf. chapter 2. The presence of several large European based companies in all sub-sectors is a strength since large companies have the ability to control production and distribution and may also have a broad product portfolio, R&D resources, etc.

Economies of scale. Many large EU glass producers are able to operate with low costs because they can reap significant economies of scale through high plant utilisation. This is for example the case in the flat glass industry, where plant utilisation is very high (500 tonnes per day in float glass). However, in some sub-sectors, it is difficult to obtain economies of scale. In the lead crystal glass sub-sector (domestic glass), the production is only around 30 tonnes per day. Furthermore, the volume per product is low due to a diverse product portfolio.

High quality products. As the figures in previous sections have demonstrated, the EU glass industry is a major innovator in the global glass industry, and that the EU glass industry is a main supplier of high-quality and high-value products so that EU producers are able to command a higher price for their products in the market. In terms of value, one indication is that in the fibreglass sub-sector the value per ton of glass exports is higher than the value per ton of glass imports.

High technological innovation capacity. So far, the EU glass industry has improved succeeded in continually improving labour productivity by investing heavily in automation technology. This indicates a high capacity in the sector for taking up and utilising new technology.

A skilled workforce. The size of the workforce in the sector has been steadily decreasing like in many other manufacturing industries. However, the skill level in the industry has increased, as the remaining workforce has been trained and skilled for several years. The relatively high skill levels of the labour force is most probably a major reason that the European glass industry remains competitive in spite of higher wages in Europe than elsewhere.

Glass is inert in nearly all applications. For many packaging alternatives the leaching effect, and the issue of consumer health, is an important issue. This is not the case in the container glass industry, as glass is inert in nearly all applications.

5.2.2 Weaknesses of the EU glass sector and its sub-sectors

Weaknesses	Container glass	Flat glass	Domestic glass	Fibre glass	Special glass
Mature production process	●	●	●		●
High entry barriers	●	●	●	●	●
High sunk costs	●	●	●	●	●
Long investment cycles	●	●	●	●	●
Diverse line of production in sub-sectors			●		

Mature production process. Over time, technological innovation has increased the efficiency of energy usage in production, and given the relatively high energy intensity of glass producers it has lead to considerable savings and served to cut carbon dioxide emissions. In most glass sub-sectors, the manufacturers seem, however, close to the physical limits of efficiency due to the laws of thermodynamics and the limitations of the modern materials available for furnace construction. This limits the ability of EU glass producers to reduce their use of energy and carbon dioxide emissions through efficiency in the short term. One exception may be the fibreglass sub-sector where the production process is less mature.

High entry barriers. The glass industry is characterised by high entry barriers due to the importance of economies of scale, high set-up costs, and the required length of investment. The high capital intensity and associated financial and economic costs and risks act as a significant barrier to entry. This may prevent new firms from starting up and hinder the innovative input from such new firms.

High sunk costs. To achieve significant economies of scale in production, the output needs to be on a mass scale, and high labour and capital productivity is usually required. Whilst this supports effectiveness and low price, it may impede restructuring in

production from low-price to high-price products due to the high sunk costs connected with abandoning existing production equipment.

Long investment cycle in glass production. In most glass sub-sectors high investments are needed and long investment cycles are to be expected. It takes time to gain revenue from an investment.

Diverse line of products in some sub-sectors. In some sub-sectors, e.g. domestic glass and lead crystals, the range of products is extremely diverse, making production runs shorter and rendering it difficult, using traditional technologies and processes, to obtain sufficient volume in production to secure profit margins.

5.2.3 Opportunities to the EU glass sector and its sub-sectors

Opportunities	Container glass	Flat glass	Domestic glass	Fibre glass	Special glass
New market opportunities	●	●	●	●	●
Increasing demand for innovative and specialised products.	●	●	●	●	●
New distribution channels	●		●		●
Increased research and development	●	●	●	●	●
Liberalisation of the EU energy market	●	●	●	●	●
Switch from fossil to non-fossil energy	●	●	●	●	●
Integration of the value chain	●	●			
Mergers and acquisitions	●	●	●		●
Stronger enforcement of IPR			●		
Substitutions of wood/metals with glass fibre				●	
Glass as an energy friendly product	●	●		●	●

New market opportunities. The increasing globalisation means improved access to new markets, e.g. in The Middle East and Asia. This offers new opportunities for export of the products of the EU glass industry.

Increasing demand for innovative and specialised products. Widening the market and creating new specialised products may give the EU glass industry new opportunities. In the glass industry segments where products are less of a commodity and technical aspects are more important, price competition is weaker and margins are better. It is expected that the demand for high-quality products will increase in the future, such as in the flat glass sub-sector in respect of laminated, tempered, mirrored glass, solar control glass, double-glazed insulating glass units, etc. At the same time, new products may open new markets

and export opportunities, e.g., heat resistant glass, photosensitive glass, and fibre optics. In this respect, it is interesting that the EU has a relatively large SME sector in the glass industry as SMEs often gear their production away from the core activities and markets of the major players and base their strategy on their unique resources and competencies.

New distribution channels. Some European glass sub-sectors, e.g. the container glass and domestic glass sub-sectors, serves dynamic markets where demand can change quickly according to consumer tastes. A number of domestic glass producers are using new distribution channels to access the market for their products, e.g., using the Internet as an additional distribution channel, which allows the producers to expose their products internationally in a cost effective manner. It also allows accurate and rapid customer feedback to the producer. However, it should be noted that the use of these distribution channels today are of limited importance.

Increased research and development. R&D may give new opportunities to the European glass industry. In respect to product development, R&D may open up new opportunities, e.g., from cross-disciplinary research, exploitation of new converging technologies, new materials, new functionalities of materials, etc. In respect to new production technologies, introduction of still more sophisticated manufacturing systems and energy efficient techniques may alter the cost structure of the production process.

Liberalisation of competition in EU energy markets. There have been a number of calls from the glass industry and other energy intensive industries to liberalise competition. More competition may help to lower energy prices, which is relevant to all glass sub-sectors.

The glass industry is generally able to use renewable energy. The ability to switch from fossil to non-fossil energy sources would enable the glass industry towards being carbon neutral

Switch from fossil to non-fossil energy. The ability to switch from fossil to non-fossil energy sources would enable the glass industry towards being carbon neutral

Integration of the value chain. The European glass industry is strongly dependent on upstream ties to customers and downstream ties to suppliers. The container glass sub-sector sells the main part of the total tonnage of glass packaging containers to the beverage sector and the food industry. The flat glass sub-sector sells more than three-forth of output of float glass to the building industry whilst the remaining output is processed into glazing for the automotive industry. A higher integration of the value chain might give the glass producers new opportunities, e.g., stronger bargaining power, joint product development, etc. The opportunity of integration of the value chain seems less important in the domestic glass sub-sector due to customers with a very strong bargaining power and in the fibreglass sub-sector where the value chain is highly integrated already.

Mergers and acquisitions. There is a large gap in productivity between the European countries that are most productive in terms of output per employee and the remaining countries. The gap in productivity is partly due to large-scale and scope of output and

high automation but also experience effects and labour skills play a role. Mergers and acquisitions may help to close the productivity gap between EU-countries. In some sectors, however, the scope for further consolidation is to some extent limited, e.g. in the glass fibre sub-sector.

Stronger enforcement of IPR. The intellectual property rights issues are relevant in the light of the counterfeiting activities taking place in some of the low-cost countries in a number of sub-sectors, especially in domestic glass. A heavier enforcement of intellectual property rights could rebuild the competitive position of EU products in these sectors.

Substitution of wood/metals by glass fibre. Environmental regulations and increasing energy prices might increase the attractiveness of glass fibres as opposed to steel and aluminium as it enhances energy reduction through the light weight of the product.

Glass as an energy friendly product. The glass industry produces are range of advanced products that deliver energy savings and environmental benefits. Examples include low-e and solar glazing, solar panels, insulation products, fibre for light weighting (notably wind turbine blades), low-energy long-life light bulbs and recyclable packaging materials. Photovoltaic development is another area with the potential to deliver significant benefits in electricity generation. The challenge for the glass sector is to better communicate these developments and their merits, and in so doing let policymakers and consumers see that glass can be a relatively low-cost solution to climate change.

5.2.4 Threats for the EU glass sector and its sub-sectors

Threats	Container glass	Flat glass	Domestic glass	Fibre glass	Special glass
Global competition and consolidation	●	●	●	●	●
Low cost competition	●	●	●		
Downstream cost-cutting demands	●	●	●	●	●
Excess production capacity in the sector		●	●		●
Upward pressure on energy prices	●	●	●	●	●
Environmental regulations	●	●	●	●	●
Working condition regulations	●	●	●	●	●
Substitution of glass by non-glass products	●		●		●
Trade restrictions	●	●	●	●	●
Counterfeiting	●		●		
Downstream bargaining power	●		●		

Global competition and consolidation. The global market for glass products is increasingly dominated by a small number of large global companies, cf. chapter 3. Many of these companies own glass production facilities in Europe, in some cases due to the takeover of European companies. The foreign competition is largely based in Japan and the US, especially in the flat glass and special glass production. Foreign companies dominate a few sub-sectors, e.g., the US based company Owens-Corning dominates the global production of glass fibres for reinforcement. Whilst the main competition to the EU glass industry comes from foreign owned companies producing inside the EU, the EU also faces some competition from imports of high value glass products, especially from the US and Switzerland.

Low cost competition. Globalisation puts cost pressure on several European industrial sectors, one of them being the glass sector. In terms of productive performance China seems to b more efficient than the EU at producing low-value items and this is especially true for the low-value section of the domestic glass sub-sector. Apart from the competition from China, the EU also faces low-cost competition from countries near the EU-border, e.g., in the container glass and flat glass sub-sectors, where production costs as well as transport costs into the EU are low. It is expected that the competition from production facilities in the Middle East will increase. The competition will most probably continue to post a severe threat for all sub-sectors, but especially to domestic glass and low-value flat glass.

Downstream cost-cutting demands. The cost pressure resulting from intensified global competition in European industries, such as car production, consumer electronics, airline and retail, may affect the glass industry negatively. These industries are all direct or indirect customers of EU glass producers in one form or another, and hence globalisation has a knock-on effect on the demand profile of the EU glass industry, and this, for example, may affect the producers of flat glass for use in the automotive industry.

Excess production capacity in the sector. In general, there is excess production capacity in the glass market. This may affect the European glass industry negatively as it cuts profit margins. The European glass industry has excess capacity in several glass sub-sectors, e.g., flat glass, insulation fibres, cathode ray tube, tubes, and bulbs, and operates below the level required to ensure long-term profitability. In the container-glass sub-sector, however, excess capacity tends to the localised and short-term. In the insulation fibre sub-sector capacity utilisation in 2005 was almost 100 %.

Upward pressure on energy prices (and inputs) prices. Globally, the demand for energy increases and affects long-term supply and costs in the EU glass industry. This is a very severe threat to the glass industry since the glass industry is one of the most energy intensive industries and as energy costs make up a high share of total production costs. The energy intensity varies by glass sub-sector but in some instances, it may account for more than one fifths of production costs in the mass produced container glass industry, and it figure may be even higher in the future. Furthermore the security of supply of energy may be a challenge in the future.

Working condition regulations. A number of regulations with respect to working conditions affect input materials and the way they are stored, handled and used in production. Legislation regulating lead concentration and hazardous substances require conversions in the production and stricter control of input materials. These regulations are significant, as the industry, especially the domestic glass industry, is labour intensive. Many countries outside EU have less strict regulation and consequently lower production costs.

Environmental regulations. The glass sector faces environmental regulation concerning its energy use, CO_2 emission, pollution prevention and waste as well as other environmental regulations (CO_2-emission limits) that are exclusive to the EU. The environmental regulation is a major cost component in most sub-sectors. Whilst there are a number of benefits of the IPPC directive to the glass industry and society, the IPPC directive along with other forms of environmental regulations have created a number of competitive challenges for EU glass producers. The main challenge is that non-EU producers, especially from developing countries, have significantly less strict environmental legislation and thereby fewer production constraints and lower production costs, cf. chapter 4. This is especially a threat to the producers of mass produced low cost products, e.g. container glass and domestic glass products, and to producers with high emissions per ton glass, e.g. lead crystal glass.

Substitution of glass by non-glass products. Most glass products are consumed by other industries in the business-to-business market. This is important as consumers and consuming industries may choose to substitute glass products by non-glass products, e.g., polymers, plastic, steel, aluminium or carton products. Substitution is potentially a severe challenge to the sector, as plastic products are often lighter than glass products and thus the transportation costs are lower. These threats affect the container glass, domestic glass and special glass sub-sectors in particular.

Trade restrictions. Trade restrictions may hinder export to non-EU markets. Many export markets impose tariffs on goods from the EU. The most formidable example is arguably the high rate of duty imposed on EU products sold in the US. Political relations can also act as a barrier to trade and there is evidence that EU glass producers have had difficulty exporting to some countries (i.e., Saudi Arabia) because the destination country favours imports from political allies. There is also evidence of a ban on imports of certain EU products into countries such as Syria. Furthermore, there are reports of compulsory testing and certification schemes favouring indigenous products in some markets, for example Turkey.

Counterfeiting. The competitiveness of many EU glass manufacturers has suffered due to the counterfeiting of EU-origin designs by non-EU firms. Producers of container glass and domestic glass have been particularly affected by the import of comparable and sustainable glass products that have entered the EU and are sold at much lower prices than those of the European products. This is a severe problem for many producers, and is also expected to be in the future.

Downstream bargaining power. In many industries, the companies size-up to be able to compete in an increasingly fierce global market. One consequence may be that companies

gain a stronger downstream bargaining power towards suppliers. For example, domestic glass producers have two traditional distribution channels via either large department stores and supermarkets or specialised retailers. These customers are usually larger than the domestic glass producers are and they are therefore able to exert significant bargaining power over glass producers. Similarly, the food and beverage companies are amalgamating rapidly and increasing their buying power. Many EU-based glass manufacturers may find it difficult to comply with the demands of the large volume customers.

5.3 Possible strategic responses

The European glass industry faces a number of challenges, many of which are driven by globalisation and environmental issues, cf. the SWOT analysis above. These challenges affect all sub-sectors in the industry. These challenges affect all sub-sectors in the industry, albeit in different ways.

The statistical and economic mapping of the sector and the SWOT analysis demonstrated that the European glass industry is still a major player in the world market for glass products and has good prospects for continuing to be so. However, the gradual increase in the number of comparatively cheap glass products being imported from emerging economies is a sign that in some sub-sectors, especially in the low-value end of the domestic glass market, the EU's competitive advantage is put under pressure.

European glass producers competing in the low-value end of the glass market have been forced to incorporate a strong focus on cost-reduction in their strategies, cf. chapter 3. This has especially been true for EU companies that have faced low-cost competition from emerging economies. They have been forced to consolidate via mergers and acquisitions and to reduce costs primarily by increasing labour productivity and automating production.

The European glass industry further faces a number of threats related to its competitiveness related to environmental issues causing increased environmental regulation. The relatively high energy intensity of glass production makes it difficult to reduce carbon emissions. Furthermore, the technologies used in glass production to minimise energy use by furnaces are already mature and therefore short-term future increases in efficiency are unlikely. At the same time, glass producers are disadvantaged by increasing prices on energy and other inputs for glass production. In some sub-sectors, e.g., domestic glass, this is a severe threat that may force the manufactures to move production away from Europe.

Turning to the European glass industry's strengths and opportunities, the most obvious opportunities seem to be most relevant to the parts of the industry producing high-value products, regardless of sub-sector. Firms producing glass products with high knowledge content have potentially a good chance to maintain and extend their position as a world leader in the market for high-value glass products. Currently, the European glass industry is a world leader in some areas of all glass-sub-sectors, especially in flat glass production.

The European glass industry may build on its strengths as a world leader in the market for high-value glass products, giving higher priority to customers, branding, product development, cooperation, and R&D. The European glass industry may also respond to the growing demand for energy-saving products and processes, and engage more proactively in the climate change challenge and adapt a strategy to become a greener industry. The constant investment in production efficiency and maintaining a skilled, trained, and motivated workforce must be continued and encouraged.

In total, based on the SWOT analysis of the entire European glass sector and its sub-sectors, we indicate some of the key fields for strategic responses for EU policy makers and industry:

1. Seek product leadership
2. Take advantage of the climate change challenge
3. Increase efficiency and flexibility in production
4. Improve the skill base
5. Support a level playing field.

Below, we have developed more concrete suggestions for possible strategic responses to the challenges facing the industry. The possible responses should be considered as points of discussion. Moreover, some options are relevant both at sector level and at political level.

5.3.1 Seek product leadership

The European glass industry still has a competitive advantage in more value-added products, whilst China and other low-cost countries have a competitive advantage in the low end of the market. It is, however, expected that the competition in high-value products will become fiercer as China and other countries are steadily improving their technical know-how day by day. Already today, the quality of many product segments is close to European standards.

The answer for the European glass sector and its sub-sectors must be to build on their competitive advantages to gain product leadership in value-added glass products. This means the European glass producers should deliver products with superior brands, marketing, design, quality, service, etc. They should be able to continuously introduce new products on the markets and their ability to develop new products in cooperation with customers and suppliers in the supply chain should be strengthened. These objectives can be underpinned by increasing R&D efforts concerning new materials to foster new functionalities, characteristics, etc.

Possible strategic actions are listed in the table below and will be described in more detail in the following section.

	Level of response		
	Industry	Member State	EU
Product leadership			
Explore customer's needs	●		
Develop brands, designs and service	●		
Improve product innovation	●	●	●
Strengthen of ties in the value chain	●	●	●
Increased R&D in new materials	●	●	●

Explore customer's needs

To companies in the glass sector it may be of great importance to be aware of future market demands, e.g., changes in consumer trends, to enable them to meet their customers' requirements and to gear product development. This may be of special interest to companies with a high focus on the end-user, e.g., the container glass and domestic glass sub-sectors, which are directly influenced by footloose and diverse consumer trends related to consumption of food and other household products. But also companies selling to the business-to-business market, e.g., the flat glass sub-sector, where a share of products end up in private homes, are well advised to be aware of consumer preferences, just like trends in the market for glazing in public and corporate buildings may be of great relevance to the industry.

Develop brands, designs and service

In the glass sector and its sub-sectors, companies may gain competitive advantages by focusing on developing stronger brands, designs, and services. It was indicated earlier in this report that being an EU brand may be a competitive advantage for EU glass producers. And the fact that non-EU companies find it attractive to copy EU-brands and EU-designs illegally and sell them also is testimony of the strong position of EU glass brands. The companies may also focus on proposing to customers more integrated service concepts, including, for example, collaboration on product development, quality assurance systems, access to product information, logistics and delivery, product support, etc. These efforts might make it easier for EU glass manufacturers to compete with non-EU manufacturers, to sell products at a higher price on the market and to improve the industry's profit margins.

Product innovation

The EU is a market leader in some segments of all glass sub-sectors. It is important to expand this strong position by continuous focus on widening the marketplace and creating new products, as the demand for high-quality products can be expected to rise in the future. Such products include solar control glass, heat resistant glass, fibre optics, etc. SMEs in the glass sector can play a role in creating new products, as many SMEs gear their products away from markets characterised by cost-competition and into niche-markets where price competition is less important and profit margins typically higher. EU

and the Member States may consider strengthening *innovation* programmes (e.g. the CIP programme supporting innovation in SMEs) within the field of glass.

Strengthen of ties in the value chain

The European glass industry strongly depends on upstream ties to customers and downstream ties to suppliers. A higher integration of the value chain may give glass producers new opportunities, e.g. joint product development. This will probably yield most benefits in the flat glass sector and the part of the fibreglass sector that delivers to the construction industry, as well as in those parts of the flat glass sector selling to the automotive industry. In the domestic glass sub-sector the customers (for instance retail chains) are deemed to have too strong barging power, and in the reinforcement fibreglass sectors ties are assessed as strong already. EU and the Member States may consider strengthening *innovation* programmes (e.g. the CIP programme supporting innovation in SMEs) to support collaboration through the value chain. .

Increased R&D in new materials

Research and development in new materials, new material functionality, etc., are required to maintain and expand the competitive advantages in producing high-quality products. It is important to uphold high levels of investment both at the EU level, Member State level and industry level. Intensified research and development programmes will also make it more attractive for high-tech firms and employees to stay and work in Europe. The EU and the Member States could consider strengthening *research and development* programmes (e.g., the Framework Programmes) in materials used in the glass industry.

5.3.2 Take advantage of the climate change challenge

The climate change challenge is one of the most important issues on the political agenda, globally, and in the EU and in the Member States. This is also reflected in the increased amount of environmental EU legislation. Furthermore, energy prices are expected to increase due to the increased demand for energy.

The compliance costs due to environmental legislation and the increasing energy prices represent a severe challenge for the European glass industry. The industry is highly energy-intensive as much energy is needed in the furnaces for melting. Furthermore, large efforts have for some decades already been made to improve energy efficiency and the marginal benefits of improving efficiency further are rapidly decreasing in most glass sub-sectors. On the other hand, the growing demand for energy-saving products, may give new opportunities to the glass industry, as many glass products have sustainable characteristics.

The industry may seek to use the intensified environmental regulation as a driver for innovation and at the same time still improve the energy efficiency in production. In spite of the energy input many glass products have other advantages seen from a sustainability viewpoint, as they are durable, fairly inert (do not let toxic substances slip out into the environment or the human body), and recyclable. From society's point of view, it seems important to improve the functioning of EU energy market to lower prices and ensure stability, increase research and development in renewable energy, energy efficiency, etc., and improve recycling of glass to decrease the total energy consumption

of our society. Possible strategic actions are listed in the table below and will be described in more detail in the following.

	Level of response		
	Industry	Member State	EU
Take advantage of the climate change challenge			
Environmental-driven innovation	●		
Branding glass as a energy-friendly product	●		
Cleaner technology	●		
Increased R&D in energy	●	●	●
Improve the functioning of EU energy market			●
Improve recycling.		●	●

Environmental-driven innovation. The demand for low-energy products is expected to grow, partly due to new legislation introduced in the EU and the Member States. This puts pressure on European glass producers to develop more innovative solutions. For example, building regulations specify the use of low-emissivity glazing and associated performance requirements for new houses and refurbishments. This has forced flat glass producers to revise their operational processes and pursue continuous innovation in production techniques. Flat glass producers are driven by the fact that higher energy efficiency requirements in building regulations substantially increase the demand. It may be easier for European glass producers than, e.g., Chinese glass producers to meet these challenges and thereby gain a competitive advantage. However, the competitive advantage tends to last only in the early stages of the product's life-cycle as non-EU producers soon become able to manufacture the product.

Branding glass as a energy-friendly product

The glass industry may contribute to improving the image of glass by focusing on and promoting the availability of the many glass products with energy-saving or energy-generating impact, such as e-windows, solar control glass, self-cleaning glass, etc., (flat glass industry) as well as insulation, lightweight composites etc. (fibreglass industry), together with an increase in the viability of recycling programmes and promotion of glass as a recyclable product.

Cleaner technology

The increased regulations and the increasing prices of energy may force glass manufacturers to continue to develop cleaner technology. This involves changing the product or the production process so that the total environmental impact from the circulation of materials through society is reduced as much as possible. Environmental management systems, energy management systems and a lifecycle perspective on products are important tools readily available to companies in the glass sector. In the light of the challenges to the energy consuming industries from environmental regulation and

emission control, part of the answer for the glass industries could be to apply cleaner technology processes and management. The industries could exploit existing environmental management systems and call for help in the Member States or the EU to identify the best available technologies or to provide a more diverse eco-label scheme..

Increased R&D in energy

The increase in environmental regulation and increasing energy prices may also force the industry to continue R&D investments in improving energy efficiency in the production process. Some of the main energy opportunities may include improved process control, increased furnace size, use of regenerative heating, batch and cullet pre-heating, and reduction of reject rates. However, the scope of improving energy efficiency in production radically is limited and it is therefore important to invest in development of new energy sources, renewable energy, more energy-efficient production, etc. The EU and the Member States could consider strengthening research and development programmes (e.g. the Framework Programmes) within energy efficiency toward the glass industry. The aim of the research should be to obtain radical new solutions for energy savings in the production.

Improve the functioning of the EU energy market.

Environmental regulations, in particular the EU's Emission Trading Scheme, are of considerable significance for the competitiveness of the EU glass sector due to the energy intensity of glass production. Environmental regulations, such as the scheme for greenhouse gas emissions (ETC), IPPC regulations and REACH, have a significant impact on the competitiveness of the EU glass sector due to the energy intensity of the production. The industry's reaction should be to increase energy efficiency and reduce the environmental impact by investing energy saving systems, techniques, etc. At the same time, it will be important to ensure international coordination of the regulation of CO_2 beyond the EU. Unilateral environmental regulations are putting the sector under pressure. The EU and the Member States could increase their efforts to establish a global CO_2 emission trading scheme and perhaps find other ways to offset the competitive disadvantage for the industry. One possible instrument could be to explore a trade policy where it is possible to act within the framework of the WTO agreement.

Improve recycling.

One way in which the EU glass industry may embrace the IPPC directive and lower its energy consumption is by actively encouraging glass recycling and, where possible, using recycled glass in production. The percentage of glass recycled varies considerably from Member State to Member State. In 2007, the average EU container glass-recycling rate was roughly 61 % in EU27. However, it differs a lot from country to country.. Recycling appears very much to be a cultural issue. For example, in countries like Sweden recycling is very much the norm. This indicates an unused potential for improving recycling in the EU and Member States and thereby save energy. Improved recycling of glass products helps the European glass industry to build a stronger brand as a more green industry. Recycling may also have a direct effect on the companies' profitability, as recycling decreases energy intensity in production, decreases emissions and decreases dependency on input of raw materials from suppliers.

5.3.3 An efficient and flexible production process

The European glass industry has retained its competitive advantage in most glass sub-sectors due to an increase in productivity obtained partly by the introduction of new automation technology in the production process. The industry's capability for developing and implementing new technology is among its strengths and should be developed further in the future. The ability to produce in a flexible way is a strength in some sub-sectors, e.g., the domestic glass sub-sectors where a wide product portfolio is needed and consumers demand new products constantly.

	Level of response		
	Industry	Member State	EU
Increase efficiency and flexibility in production			
Increased R&D in automation technology	●		

Increase R&D in automation technology: Further investments in efficient and flexible production facilities appear to be needed due to the external cost pressures facing the European industry. Efficiency will be needed to drive down costs, energy use, transportation costs, and environmental impact in order to deliver fast and cheap products. It is also expected that flexibility, customisation, or even personalisation, will be in demand, at least in some sub-sectors. Firms with flexible production and distribution systems that can deliver high-quality products to many different customers in different places on time may have a competitive advantage in these sub-sectors. An increase in R&D-investments in product technology must primarily be the industry's responsibility.

5.3.4 Increase skill base

The European core competencies in the glass sector might still give the EU a competitive advantage over other regions. It therefore appears to be important to build on this strength, e.g., through improvement of lifelong learning for the employees in the glass industry.

	Level of response		
	Industry	Member State	EU
Increase skill base			
Improve life-long learning	●	●	●

Improve life-long learning
The number of employees in the European glass industry has dropped, partly due to investments in automation technology. The demand for low-skilled labour has decreased as well. However, it may be expected that the glass industry will still need skilled labour

to carry out jobs associated with a flexible and specialised production. Access to skilled labour is a challenge for the EU glass industry and is likely to become even more important in the future, with a shrinking European workforce and competition for the most skilled persons. Both the EU, the Member States and the industry could increase their efforts to maintain and develop a base of highly skilled employees, for instance via targeted training programmes for low skilled workers, investment in new education and training programmes, investment in the mobility of workers, easy access to recognition of qualifications and efforts to improve the image of the industry among young skilled people.

5.3.5 Support a level playing field

It is necessary to improve the competitive environment of the European glass industry so that EU companies and non-EU companies have equal opportunity to compete. If all the sub-sectors were to secure a level playing field, it would increase the industry's competitiveness. For some glass sub-sectors, e.g. the domestic glass sub-sector, securing a level playing field seems necessary if the sub-sector is to remain able to produce in Europe in the future.

Currently, the playing field is not level to non-EU producers often produce their products with occupational health and safety standards and environmental regulations well below EU standards. Some countries also subsidise their industries through either direct subsidies or low taxes. This makes it ever harder for European companies to enter into price competition. European companies may also have problems accessing certain markets due to tariff and non-tariff barriers, and finally some glass sub-sectors face problems with counterfeiting.

Possible strategic actions are listed in the table below and subsequently described in more details.

	Level of response		
	Industry	Member State	EU
Support a level playing field			
Reduce tariff and non-tariff barriers			●
Foster market pull for sustainable products	●	●	●
Evaluation of potential effects of new regulation		●	●
Fighting counterfeiting		●	●

Reduce tariff and non-tariff barriers. Market access to export markets must be improved to create equal opportunities for competitors in the market, and the EU Commission could increase its efforts to achieve reciprocity with the main trading partners. The EU Commission and the Member States should work for a reduction in tariffs and actions on non-tariff barriers in the ongoing WTO Doha Round. Such actions

would be important for all European glass sub-sectors. This may help to create a level playing field.

Foster market pull for sustainable products. The political debate around the climate change challenge may lead to a greater awareness among consumers on social an environmental issues and a demand for sustainable products, also for products originating from China. The industry itself should be aware of these new market opportunities. The EU and the Member States may enhance consumers' awareness by, for example, campaigns, information or labelling of green glass products. The EU could also consider requesting that the application of the social and environmental clauses are included in future WTO and ILO agreements. This may help to create a level playing field.

Evaluation of potential effects of new regulation. Implementation of new (e.g. environmental) regulation can potentially have negative impacts on the European glass industry's competitiveness. In seems important to assess this impact on industry before implementing new legislation to be able to balance industrial and other aims.

Fighting counterfeiting. In some glass sub-sectors, especially the container and domestic glass sub-sectors, it is difficult to combat counterfeiting and low-cost "copies" of products originally developed in the EU. The crime is that the traders and manufacturers of copies are "stealing" the original manufacturer's investment in innovation. Original manufacturers are not in a position to control imports at the border, and it is very difficult to survey overseas markets for illegal copies. One measure against counterfeiting would be to provide glass products with a mark of origin. Marks of origin give clear information to consumers, improve the brand of the European glass industry, and support the manufacturers in building a brand for their products. Member states and the EU could also increase their efforts to take action on illegal traders and producers and to increase their efforts to make agreement of enforcement with countries of origin.

6 Conclusions

In the last five to ten years the EU glass industry has come under increasing pressure from the forces of globalisation (although it has also benefited), environmental-based legislation (and to a lesser extent, employment and Health & Safety legislation) and, more recently, sharp rises in energy and raw material costs. The adverse impact of these forces on the EU glass industry have been exacerbated by an uneven playing field between the EU glass producers and both non-EU glass producers and producers of competing substitute materials.

Although globalisation opened up new markets from which EU firms are benefiting, it has also resulted in increased capacity in non-EU countries, which are typically lower-cost developing countries. The consequence of this has been an increase in the flow of imports into the EU. These compete favourably on price and although the quality is not always as good as EU-produced goods, the gap is closing quickly. The growth of exports has failed to keep up (in volume terms) and in 2007 the EU glass industry recorded a trade deficit for the first time. In the short to medium term, this trend looks set to continue. There are several factors that have disadvantaged the EU and driven this trend.

First of all, the quality of imports into the EU from developing countries is improving quickly but in some cases this is achieved by copying EU designs and infringing intellectual property (IP) rights. Firms can respond by developing more sophisticated designs that make copying harder (and more expensive) and introduce new designs on a regular basis, but there is a risk that firms start to spend too much time and money on such 'defensive' innovation, and damage the competitiveness of the industry in the long-term. The challenge for affected firms will be to avoid this and focus on more positive forms of innovation. A stronger framework for enforcing IP rights would support this.

A second driving factor is the asymmetry of market access conditions that seem to exist for EU-based producers in developing countries. They are faced with regulatory and tariff barriers that hinder access to foreign markets or undermine the competitiveness of products in these markets. The persistence of these obstacles will act as a disincentive to EU producers to increase production for export. Instead, it could encourage the relocation of production to these countries and diminish the industry in the EU. While it is understandable that developing countries seek to protect their own industries until they have reached a desired stage of development, in a globalised economy it is not efficient or desirable as a permanent feature. Efforts should be made to encourage greater access to markets for EU firms.

The third driving factor is price. Most imports into the EU are cheaper than EU-produced goods, while EU exports must also compete with these lower prices. There are several factors at play. Firstly, the sustained and gradual increase in the strength of the euro

against several currencies since 2001, along with the weakening of the US dollar against all EU currencies, has made EU-produced goods relatively more expensive and this has served to undermine the competitiveness of EU-produced glass products. In this free-floating era, most exchange rates are market driven, based on the macroeconomic conditions and outlooks for countries. Without intervening in the financial markets to manipulate euro-based exchange rates, which would not be desirable and against current policy, there is little firms or policymakers can do about it.

The other factors driving price differences are input related. Minimum wage legislation and social security contributions make EU wage costs high by international standards, and make it very difficult, if not impossible, for EU glass producers to compete on labour costs. It is likely to be some time before this disadvantage disappears. Even if lower wages were an option for EU producers to boost competitiveness, it would make the industry less attractive to jobseekers. Despite increasing levels of automation, the industry still cannot get enough skilled staff. The very difficult challenge for the glass industry, therefore, is to raise the wage levels relative to EU averages to attract and retain workers, and remain internationally competitive. One avenue that might offer hope is the recycling of environmental tax revenues to reduce employers' social security contributions for employees. Otherwise, without help from policymakers future wage growth in the EU glass industry will most likely have to be driven by productivity gains. However, there is concern that while environmental taxes will be sector specific, any rebate mechanism will not be, making the glass industry (and other intensive users of energy) a net loser and less competitive.

The recent increases in the price of raw materials has to some extent been driven by market conditions. To that extent, all producers are affected in the same way; although the strengthening of the euro against the US dollar provides a mitigating force for EU producers buying dollar-priced inputs. However, EU producers have been disadvantaged by sourcing EU-derived inputs that are subject to legislation and levies that do not necessarily apply in other countries. Health and safety legislation to protect workers and consumers ultimately increases compliance and operating costs, while levies on the extractive industries to reduce the damage they do to the environment has the effect of raising the price paid by the glass industry for its inputs. This increases the cost of its inputs relative to other producers in countries with less stringent regulation, or producers of substitute materials.

An additional burden on glass producers is imposed by the EU ETS and other environmental regulation aimed at increasing energy efficiency and reducing greenhouse gas (GHG) emissions. These burdens also disadvantage glass against substitute materials, whose environmental impact over full product lifecycles can be underestimated. This is a challenge. The Gothenburg summit in 2004 gave the environmental and social policy pillars equal weighting with the economic pillar. In trying to live up to this, EU leaders are keen to exploit it as a base for innovation and new technologies that might allow the EU to become a world leader in new industries and environmental technologies. The glass industry has made significant progress over the last 40-50 years (accelerated by the oil shocks of the 1970s) to improve efficiency and reduce GHG emissions. Even though the scope for further significant improvements appears limited, any reduction in these environmental-based costs for the glass industry seems unlikely. Meanwhile, legislation to protect peoples' health is a good thing and no one would argue against it. There may

be challenges in implementing it, but it can be used in marketing products to people to win their trust and loyalty; and in making the working environment safer could help glass producers to attract and retain staff.

The final factor affecting the price competitiveness of glass products has been the strong increases in energy prices since 2004. To the extent that this is driven by market forces and increases power generation costs, all producers should be equally affected. However, the lack of competition in EU energy markets appears to have contributed to the increases and disadvantaged EU glass producers, compared non-EU producers and other EU producers in different countries. This is compounded by the fact that in some countries (EU and non-EU) the environmental taxes imposed on power consumption are lower. It is unlikely the glass industry will be able to receive any special exemption from energy taxes to lower its power costs. A more fruitful strategy will be to push on with promoting competition in energy markets and the fuller development of a pan-EU electricity grid.

Looking at the European glass industry's strengths and opportunities, the most obvious opportunities seem to be most relevant to the parts of the industry producing high-value products, regardless of sub-sector. The European glass industry may also respond to the growing demand for energy-saving products and processes. The constant investment in production efficiency and maintaining a skilled, trained, and motivated workforce must be continued and encouraged. A SWOT analysis of the entire European glass sector and its sub-sectors indicated the following as key fields for strategic responses for EU policy makers and industry:

1. Seek product leadership
2. Taking advantage of the climate change challenge
3. Increase efficiency and flexibility in production
4. Improve the skill base
5. Support a level playing field.

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7.4 Notes for framework grid

[i] Directive 2003/10/EC: minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise, optical radiation, electro-magnetic fields and vibrations), which applies to all glass industries and other industries as well.

[ii] Negotiating Platform for Silica: multi-sectoral platform for the negotiation of a social dialogue agreement on workers' health protection through the good handling and use of crystalline silica an products containing it, which applies to all glass industries and other industries as well.

[iii] Directive 98/71/EC of the European Parliament and of the Council of 13 October 1998: design protection. This applies to all glass industries and other sectors as well.

[iv] Directive 2004/48/EC of the European Parliament and of the Council of 29 April 2004: enforcement of intellectual property rights, which applies to all glass industries and other.

[v] Council Regulation (EC) No 1383/2003 of 22 July 2003: customs action against goods that (are suspected to) infringe intellectual property rights. This applies to all glass industries and other.

[vi] Directive 69/493/EEC of December 1969: the approximation of laws relating to crystal glass, setting out categories of crystal according to their lead content and labelling and testing methods. This applies to all glass industries producing crystal glass.

[vii] Directive 89/106/EEC: the approximation of law, regulations, administrative provisions relating to construction products, e.g. first harmonised standards for 9 glass products for applications in buildings. This applies to all glass industries and other industries.

[viii] Framework Directive 89/109/EC and Regulation No 1935/2004/EC on materials and articles intended to come into contact with foodstuffs. It applies especially to container glass and domestic glass sub-sectors, yet to other sectors as well.

[ix] Directive 94/62/EC of 20 December 1994 on packaging and packaging waste – recycling, reusing, recovering; amended by Directive 2006/340/EC of 19 February 2006 on heavy metals concentration in packaging. It applies to all glass industries and other, although it has mainly an effect on the container glass sub-sector.

[x] Directive 2006/32/EC of 5 April 2006 on energy end-use efficiency and energy services. It applies to all glass industries and other, although it has mainly an effect on the flat glass, special glass and glass fibres industries.

[xi] Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of certain hazardous substances in electrical and electronic equipment and Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on the reduction of the amount of waste electrical and electronic equipment. They apply to all glass industries, as well as others. It mainly affects the sub-sectors special glass and glass fibres. An exemption has been requested for the domestic glass sub-sector, because lead is needed to obtain the required properties of brilliance and sonority to crystal.

[xii] Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000: end-of-life vehicles, minimum technical requirements for treatment, e.g. removal of glass from ELV's, applies to flat glass, container glass, special glass, glass fibres and other sectors.

[xiii] Directive 2005/32/EC of the European Parliament and of the Council of 6 July 2005: eco-design requirements for energy-using products; aims to increase energy efficiency and the level of environmental protection while increasing the security of energy supply. It applies to special glass sub-sector and all sectors producing products which use energy, yet only for those products that meet certain criteria such as environmental impact and the volume of trade in the internal market and where a clear potential for improvement is perceived.

[xiv] Directive 2003/87/EC: greenhouse gas emission allowance trading scheme within the EC, which applies to all glass industries and other industries.

[xv] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000, establishing a framework for Community action in the field of water policy. With regard to the application of this directive, the sectors possibly affected are crystal and special glass.

[xvi] Directive 96/61/EC: integrated pollution prevention and control, which applies to all glass industries and other industries.

[xvii] REACH: registration, evaluation, authorisation, and restriction of chemicals and the establishment of a European chemicals agency; aims at improving the protection of human health and the environment, while maintaining the competitiveness and enhancing the innovative capacity of the EU chemicals industry. It applies to all glass industries and other industries.

[xviii] There are high tariffs on glass in countries with trading potential for EU glass industry such as India, Mexico, Argentina and most countries in South East Asia. High import tariffs exist on tableware in USA, despite being the EU's number one destination for

tableware. Also tariffs on raw materials prevail: 5.5% duty on soda ash (the principal raw material for most types of glass).

[xix] Non-tariff barriers include: The introduction of compulsory testing and certification schemes (e.g. in Turkey); Preferential treatment for certain exporters to Saudi Arabia; Bans of imports of certain products to protect domestic production (e.g. in Syria)