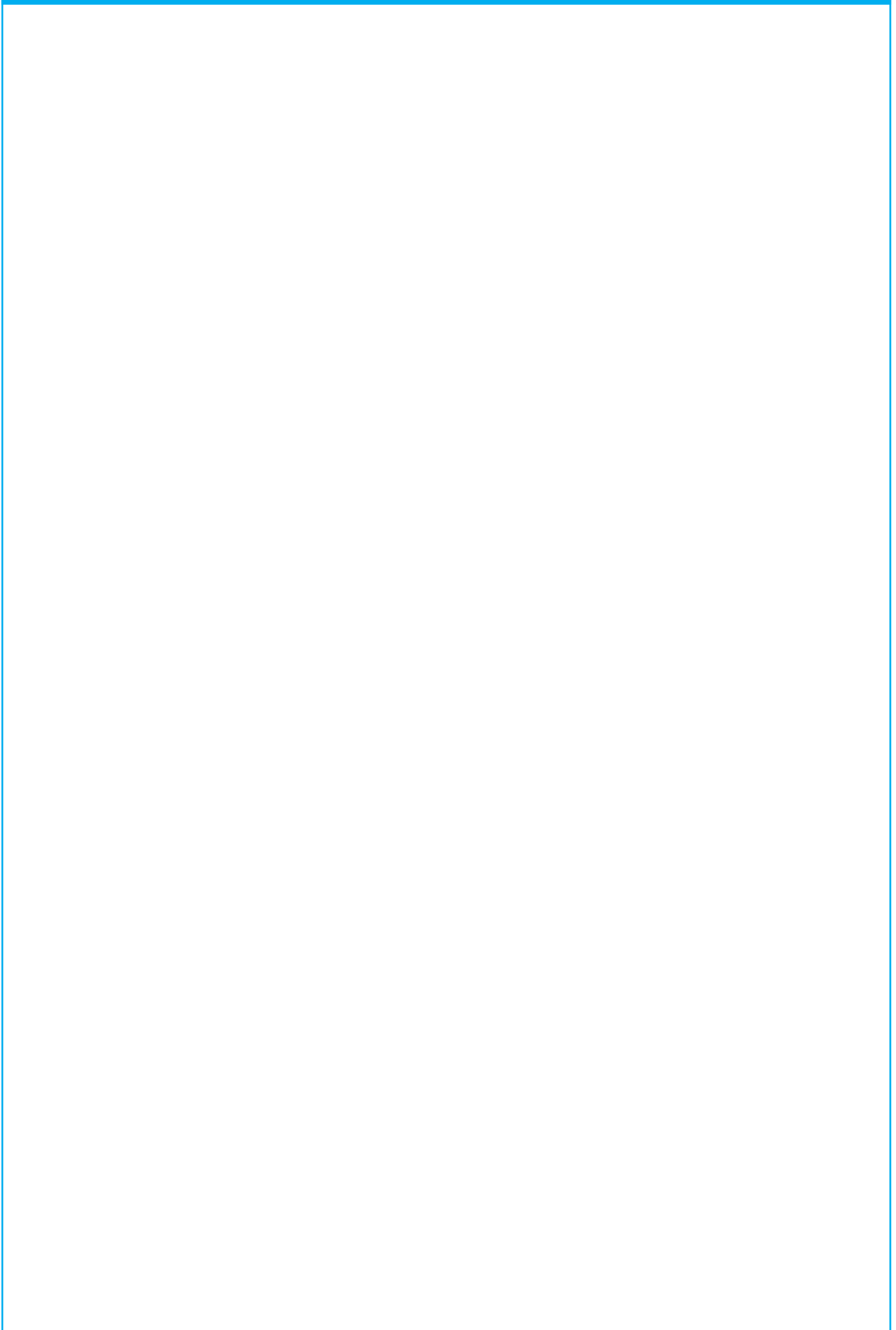


Pilkington and the Flat Glass Industry 2010





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Legal Notice

This document is intended as a briefing on the glass industry and the position within it of NSG Group's Flat Glass Business, trading under the brand 'Pilkington'. The content of the paper is for general information only, and may contain non-audited figures. Every care has been taken in the preparation of this document, but Nippon Sheet Glass Co., Ltd. accepts no liability for any inaccuracies or omissions in it. Nippon Sheet Glass Co., Ltd. makes no representations or warranties about the information provided within the document and any decisions based on information contained in it are the sole responsibility of the user. No information contained in this document constitutes or shall be deemed to constitute an invitation to invest or otherwise deal in shares in Nippon Sheet Glass Co., Ltd.

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Introductory Note and Definitions

The objective of this publication is to provide background information on the world's flat glass industry and, as an industry leader, the position within it of the NSG Group.

In June 2006, Nippon Sheet Glass Co., Ltd acquired Pilkington plc through NSG UK Enterprises Limited; a wholly-owned subsidiary. All of the operations of the former Pilkington plc are now fully integrated into the NSG Group. At the time of the acquisition, the decision was taken to brand the enlarged Group as 'NSG Group' and to use the 'Pilkington' brand for the Group's Flat Glass businesses (Building Products and Automotive). The Pilkington name has also been retained in the title of this publication for historical reasons.

Where the operations of the whole Group are referred to collectively, the terms 'NSG Group' or 'the Group' are used. The Group's Flat Glass businesses comprise Building Products businesses in Europe, Japan, North America, South America, China and South East Asia, which are managed on a regional basis, and the Pilkington Automotive business, which is managed globally.

It should be borne in mind that the Flat Glass businesses of the NSG Group account for just under 90 percent of the NSG Group's business by sales and that the Group also has a third business line, Specialty Glass, accounting for around 12 percent of Group sales, which is not covered by this publication.

Consequently, any figures referring to 'Pilkington' or 'NSG Group Flat Glass' sales and operating income are lower than those for the NSG Group as a whole. The strategic direction of the NSG Group itself is covered in Part Three of this publication.

Readers of this year's report will be well aware that effects of the global downturn are still having a major impact on the world's glass industry, along with many other industries worldwide.

These factors have made the preparation of the 2010 edition of Pilkington and the Flat Glass Industry particularly difficult. Most of the data in this publication relates to calendar year 2009, in which the unprecedented global economic downturn severely affected glass demand in both the building and automotive sectors, leading to major disruptions in global demand, capacity utilization, capital investment and normal growth patterns.

The impact on individual companies, which make up the industry's customer base, has been well documented. The past year has seen an unprecedented level of corporate activity, with some companies closing and others being sold or resorting to Chapter 11 protection.

Although every effort has been made to record and reflect such activity, in some cases it has not been possible to update meaningfully and accurately some figures. Where this is the case, the previous year's figures have been used. At the time of publication, both the automotive and construction flat glass sectors are showing signs of improvement, but this is not uniform across all regions of the world.

The operating currency of the NSG Group is the Japanese yen. However, for ease of reference, some figures are expressed in euro and any figures relating to financial performance are therefore approximate. This publication should be read in conjunction with the NSG Group Annual Report 2009, covering the fiscal year ended 31 March 2009.

This document is also available to download in pdf format from the NSG Group website at www.nsg.com.

Executive Summary

The flat glass industry and global market structure

- The global market for flat glass in 2009 was approximately 52 million tonnes, representing a value at the level of primary manufacture of around euro 22 billion.
- This market has historically been growing in volume terms at 4 percent to 5 percent a year.
- Of total global market demand in 2009, around 29 million tonnes was for high quality float glass, 3 million tonnes for sheet glass and 2 million tonnes for rolled glass. The remaining 19 million tonnes reflects demand for lower quality float, produced mainly in China.
- In 2009, 40 percent of float glass went into new buildings and the same proportion into refurbishment for buildings. Approximately 5 million tonnes of the flat glass produced globally in calendar year 2009 was automotive glass
- Globally, around 83 percent of Automotive glass goes into Original Equipment (OE) supplied to vehicle manufacturers for new vehicles and 17 percent in to the AGR aftermarket.
- Approximately 2.3 million tonnes of flat glass in calendar year 2009 was consumed in special applications. The most notable of these is solar energy.
- Considering high quality float alone, the industry is relatively consolidated, with four companies accounting for a majority of global capacity.
- In terms of the size of their respective flat glass businesses, the world's top four companies are led by the NSG Group and AGC. Saint-Gobain comes in at number three, followed by Guardian Industries.
- NSG Group's share of global float capacity accounts for approximately 16 percent overall.
- Three companies, NSG Group, AGC and Saint-Gobain together supplied around 70 percent of the glass used in the automotive industry during calendar year 2009, according to NSG Group estimates.
- Europe, China and North America, together account for over 70 percent of high quality float demand.

Glass – a Growth Industry

- Over the long term, demand for float glass is growing at almost 5 percent per annum. This growth is fuelled by the demand for building glazing and automotive glass, which in turn is driven by economic growth.
- Over the last 20 years, float demand growth has outpaced real GDP growth. Over the past 10 years, float demand has exceeded GDP growth by around three percentage points.
- Architects are increasingly seeking to bring natural environmental factors into the interior of buildings by maximizing natural daylight. This has been achieved through the use of larger glazed areas in facades and roofs, and through entirely glazed facades where the glass is a structural component of the building.
- Refurbishment of buildings accounts for around 40 percent of glass consumption worldwide. In mature markets, windows in residential buildings are replaced every ten to twenty years.
- Over the past 25 years, in developed regions such as Europe, Japan and North America, the growing need for energy efficiency in buildings has transformed the markets for energy-saving glass and this is now being echoed in developing regions.

Pilkington – a leading brand in a growth industry

- The NSG Group, which operates under the Pilkington brand in Building Products and Automotive, is one of the world's largest manufacturers of glass and glazing products for these markets.
- The Group has manufacturing operations in 29 countries on four continents and sales in around 130 countries.
- In the fiscal year ended 31 March 2010, the NSG Group reported sales of JPY 588,394 million (approximately euro 4.7 billion).
- Of the Group's consolidated sales, 44 percent were generated in Europe, 29 percent in Japan, 13 percent in North America and 14 percent in the rest of the world. Building Products and Automotive together now account for just under 90 percent of NSG Group sales.

Geographic Positioning

- Building Products has manufacturing operations in 23 countries. Its largest operation is in Europe, with major interests in Japan, North and South America, China and South East Asia.
- Pilkington Automotive is one of the world's largest suppliers of automotive glazing products. It operates in three main sectors; supplying original equipment, aftermarket replacement glass and products for specialized transport.
- Its footprint, including fabrication plants, OE satellite facilities and its AGR distribution network encompasses Europe, Japan, North and South America, China, South East Asia and India.
- The NSG Group is one of only four companies in the flat glass industry that can claim to be true global players, the other three being AGC (Asahi), Saint Gobain and Guardian.
- The integration of the Pilkington and NSG business platforms has historically helped mitigate the effects of market cycles in the area of architectural glass and has given the Group a superior presence in developing markets such as South America, China, South East Asia and Russia.
- The NSG Group's manufacturing base includes float glass lines operating in Europe, Japan, the Americas, Southeast Asia and China, with Automotive operations covering all major markets worldwide.
- The Group operates an extensive network of 49 float lines, giving full coverage of the global market and providing advantages in terms of strategy, efficiency and effectiveness.

Technical leadership

- The Pilkington brand is closely identified with technical excellence, having been associated, over the past fifty years, with most major advances in glass technology, including the invention of the Float Process.
- The NSG Group is a global leader in manufacturing excellence and innovation, notably in the areas of glass melting, glass forming by the float process, online coating and complex shaping technology, especially for automotive windshields and backlights.

Strategic Direction

The NSG Group's Strategic Management Plan announced in November 2010 focuses on leveraging the Group's glass-based technologies into existing and new glass market segments. The overall goal of the Plan is to maximize profitable growth while reducing our net debt/EBITDA ratio, while following the highest standards of ethics, safety, environmental responsibility and Sustainability in all activities.

To accelerate implementation of the Plan, the Group announced, in August 2010, a major exercise to issue and sell additional shares in the Company through a global offering (public offering in Japan and international offering to institutional investors). The growth plans this funding exercise

will support involve the NSG Group's plans for further expansion into emerging markets and to capitalize on growth prospects offered by increasing demand for added-value products that help address climate change issues.

Sustainability

- Glass has a unique contribution to make in promoting sustainability, reducing greenhouse gas emissions and mitigating the effects of climate change.
- The 'energy balance' between manufacture of high-performance glazing products and their use means that the energy used and CO₂ emitted in manufacture are quickly paid back through the lifetime of the products. The energy involved in glass-making should therefore be seen as an investment in future energy saving.
- Glass has a key role in attempts to find cheaper and more efficient ways of generating power from the sun. The Group's products support the three leading solar energy technologies; thin film and crystalline solar modules and concentrated solar power applications.
- The NSG Group is fully committed to sustainability. Its policies underline the unique contribution its products can make to addressing climate change and the challenges the Group faces in improving its own energy usage and resource management.

1. Global Flat Glass industry and market structure

1.1. Total World Market for Flat Glass

The global market for flat glass^A in 2009 was approximately 52 million metric tonnes (~6.6 billion sq m)^B. At current price levels, this represents a value at the level of primary manufacture of around euro 22 billion. This market has been growing in volume terms at 4 to 5 percent a year.

Of total global market demand in 2009, it is estimated that 29 million tonnes was for high quality float glass. Approximately 3 million tonnes constituted demand for sheet glass and 2 million tonnes was for rolled glass. The remaining 19 million tonnes represented demand for lower quality float, produced mainly in China.

Generally, flat glass demand growth is a function of economic activity levels. Long-term growth potential for flat glass can be estimated with reference to growth of gross domestic product, or GDP. However, demand for glass may deviate from GDP for a variety of reasons, for

example due to government programs that subsidize certain glass products.

Following manufacture, a portion of the high quality float glass and rolled glass produced globally is further processed by laminating, toughening and coating for use typically in insulating glass units or automotive glazing. When these processed products are also considered, the global market for flat glass in 2009 had a value of approximately euro 51.3 billion.

The global flat glass market is worth around euro 22bn at the primary level and euro 52bn at the level of secondary processing

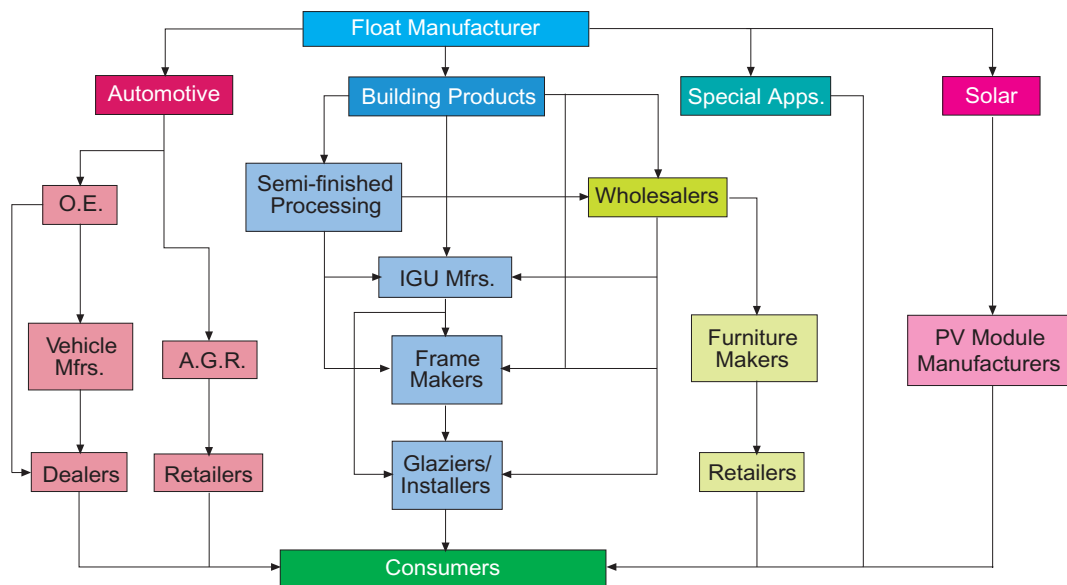
1.2. Routes to Market

The chart below illustrates the main routes to market in the glass industry. In terms of volume of glass consumed, Building Products is by far the largest sector (~45 million tonnes) with ~5 million tonnes going to Automotive. The Special applications segment is very small in volume terms, but significant growth is being driven by the use of glass in Solar Energy generation.

In Building Products, glass can undergo two or more levels of processing before being installed in windows or used as a component in furniture or white goods. Within Automotive, glass is used in original equipment for vehicle manufacturers and in the manufacture of replacement parts for the aftermarket.

In terms of volume of glass consumed, building products is by far the largest sector of the global market for flat

Routes to market



Most glass is used in building, with a further significant portion used in automotive applications and a small but growing amount in other specialist areas

A – Glass manufactured in flat sheets (float, sheet and rolled), which may be further processed. Excludes bottles, containers, fiberglass, rods, and tubes

B – On average 1 tonne is approximately 125 sq m.

glass, accounting for approximately 45 million tonnes in calendar year 2009. Glass is an integral building material for most construction projects. Also, we estimate refurbishment for buildings accounted for approximately 40 percent of flat glass consumption worldwide for calendar year 2009. Building products include float and rolled glass and other processed building glass products (including toughened, coated and silvered glass) for exterior and interior applications.

Approximately 5 million tonnes of the flat glass produced globally for calendar year 2009 was automotive glass, another key sector of the glass industry. Automotive glass products are generally categorized as either OE, supplied to vehicle manufacturers for new vehicles, or as AGR products, which are supplied to the aftermarket for retrofit purposes, usually following damage. Globally, OE glass demand is estimated to be around four times that of the replacement market, though the proportion varies from region to region.

Sector	Volume	
New Build	2,200 million m ²	40%
Refurbishment	2,200 million m ²	40%
Interior	1,100 million m ²	20%
TOTAL	5,400 million m ²	100%

Sector	Volume	
Original Equipment (OE)	320 million m ²	82%
Aftermarket (AGR)	70 million m ²	18%
TOTAL	390 million m ²	100%

Sector	Volume	
Solar Energy	80 million m ²	10%
Other	675 million m ²	90%
TOTAL	750 million m ²	100%

Within the OE glazing market, by far the largest segment is light vehicles, normally defined as those vehicles up to three and a half tons in weight. Light vehicles include all cars, light trucks and the various cross-over vehicle styles such as sport utility vehicles, and accounted for approximately 96 percent of global automobile production in calendar year 2009.

Approximately 2.3 million tonnes of flat glass in calendar year 2009 was consumed in special applications. The most notable of these is solar energy. There are three main types of solar energy generation: crystalline silicon, thin film and solar concentrators. Each of these has demonstrated strong growth in the past several years, and although the global recession has reduced growth rates in the last year, the market is expected to exhibit steady growth in the short term. In the medium-to-long term, growth rates may increase again, as the cost of solar energy generation begins to approach the lower costs of conventional energy.

1.3. Industry Economics

A float plant is highly capital intensive, typically costing around euro 70 million - 200 according to size, location and product complexity. Once operational, it is designed to operate continuously, 365 days per year, throughout its campaign life of between 10 and 15 years. Float lines are normally capable of several campaigns following major rebuild/upgrade programs.

The economics of the continuous-flow float operation require a high capacity utilization rate before a plant becomes profitable. Once that rate (around the 70 percent range) is passed, the inherent operational leverage of the asset base increases profitability rapidly. Product diversity, in terms of both glass composition and thickness, can reduce nominal output as transition product is lost when float production changes from one specification to the next. In the most complex float composition changes, this can amount to as much as seven days' lost production. However, such changeover losses can be minimized through coordinated production scheduling of regional float assets.

The float process is not labor-intensive. Energy and raw material costs are each as significant as factory labor in

the overall delivered cost. Glass is relatively heavy and comparatively cheap, making distribution costs significant; they typically represent around 15 percent of total costs. In most cases, transport costs make it uneconomic for float glass to travel long distances by land.

A float plant is designed to operate continuously, 365 days per year, throughout its campaign life, which is typically between 10 and 15 years

Typically, 200 km would be seen as the norm, and 600 km as the economic limit, for most products, although this varies between markets. It is possible for float glass to be economically transported longer distances by sea provided additional road transportation is not required at both ends. This tends to favor float lines with local port access, unless a local market is available for the line's output.

Investment costs in Automotive, though somewhat lower than in Float, are nevertheless significant. By way of example, investment in a typical European automotive

glazing plant with capacity to fully glaze one million cars per year could cost between euro 42 million and euro 63 million, depending upon the technology employed, the degree of automation and its location. Annual revenue from such an investment would be approximately euro 49 million.

Typically, automotive glass plants are at their most efficient with long production runs. However, bespoke glazings for each aperture of every model tend to militate against this, particularly where model variants are relatively low volume in automotive industry terms. Where production runs are shorter, requiring frequent tooling changes, different automotive shaping technologies will be employed. Therefore, an automotive glass manufacturer requires an appropriate demand and asset mix for optimal operation. As with float, the scale of the major automotive glass processors requires them to leverage their regional facilities in this way.

Overall, automotive glazing production tends to be more labor intensive than float manufacturing, and growth in value-added activities is increasing this requirement.

Automotive glass can and does travel significant distances and, whilst vehicle manufacturers (VMs) are increasingly seeking local service from their suppliers, in the case of glazings this usually takes the form of a small satellite operation rather than a major processing plant.

Investment in a European automotive glazing plant with capacity to fully glaze one million cars per year could be expected to cost between euro 42 million and euro 63 million

1.4. Global Players and Market Shares

Considering high quality float alone, the industry is relatively consolidated, with four companies accounting for a majority of global capacity. The NSG Group's share accounts for approximately 16 percent overall. In addition, there are three companies which together supplied around three-quarters of the glass used in the automotive industry during calendar year 2009, according to NSG Group estimates.

Of the four companies manufacturing most of the world's glass, NSG Group and Asahi Glass are based in Japan, Saint-Gobain is based in France and Guardian Industries Corp, or Guardian, is based in the United States.

The NSG Group has 16 percent of global high-quality glass capacity

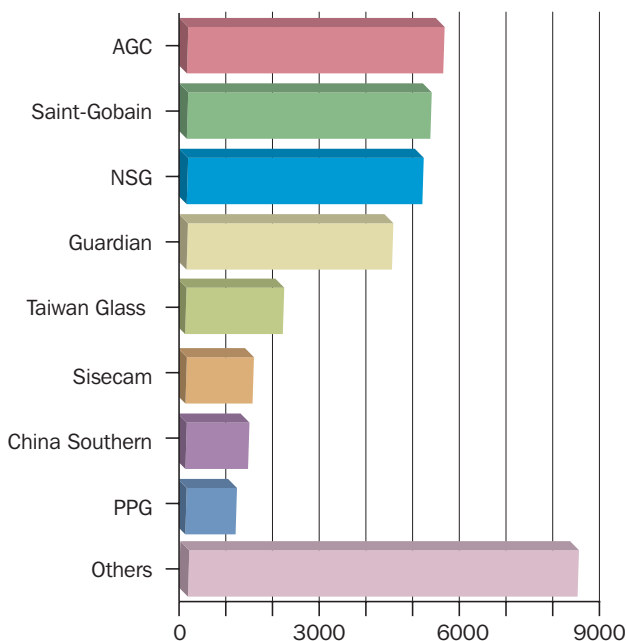
Capacity Share by Company

Company	Country ^a	Percentage of World Capacity
AGC	Japan	17.0
NSG Group	Japan	16.0^b
Saint-Gobain	France	16.0
Guardian	United States	16.0
Others		35.0

a. The country in which the parent company is domiciled.

b. Including affiliates.

World High Quality Float Capacities 2009



Portfolio Comparison of the Major Players

In terms of the size of their respective flat glass businesses, the world's top four companies are led by the NSG Group and AGC. Saint-Gobain comes in at number three, followed by Guardian Industries.

The NSG Group and AGC have the greatest geographic reach of these flat glass companies, followed by Saint-Gobain. Guardian's global coverage in float glass is high, but its limited automotive footprint leaves it in fourth place overall, followed by Taiwan Glass and Siseecam.

Following the acquisition of Pilkington by NSG, just less than 90 percent of the combined entity is concerned with Flat Glass, significantly higher than the nearest rival, Asahi at less than 50 percent. World number three, Saint-Gobain's, flat glass focus is the lowest of all four majors, at about 12 percent.

The NSG Group is the most focused glass company, combined with wide geographic reach.

1.5. World Float/Sheet Glass Markets

In the following analyses the world is segmented into eight regions as follows:

Europe	Japan	South East Asia
North America	South America	China
Russia/Former Soviet Union	Rest of the World	

In this analysis rolled glass is excluded and, unless otherwise stated, market figures are for calendar year 2009, based on company estimates.

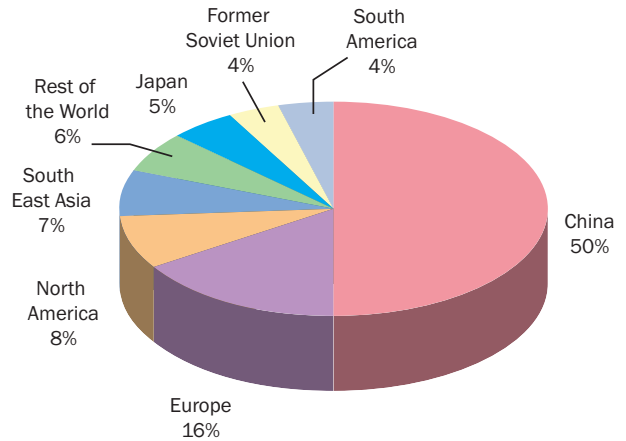
General Overview

The global market for float/sheet glass in 2009 was approximately 50 million tonnes. This is dominated by Europe, China and North America, which together account for over 70 percent of demand.

Europe, China and North America together account for over 70 percent of global demand for glass

The significance of China as a market for glass has been increasing rapidly since the early 1990s, as the country has become more open to foreign investment and the economy has expanded. In the early 1990s China accounted for about one fifth of world glass demand, but now accounts for just over 50 percent.

Regional Float & Sheet Demand 2009



Europe

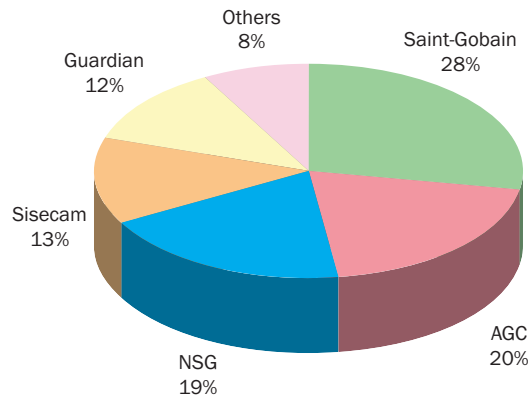
In this definition, Europe includes Turkey, but not Russia, Ukraine and Belarus.

Europe, with a market size of over 8 million tonnes in 2009, is supplied by eight main manufacturers of float glass: Saint-Gobain, NSG Group, Asahi Glass, Guardian, Sisecam, Euroglas, Sangalli and Interpane. Europe is a mature market, with the highest proportion among the eight geographic markets of value-added products, such as coated and laminated glass, which are largely produced by float glass manufacturers. Per capita glass consumption was approximately 14 kg in 2009.

Downstream processing, into insulation glazing units for example, is generally undertaken by smaller independent players. Saint-Gobain, NSG Group and Asahi Glass participate at this level of the market, but with lower market presence than in primary manufacturing.

Europe is the most mature glass market and has the highest proportion of value-added products

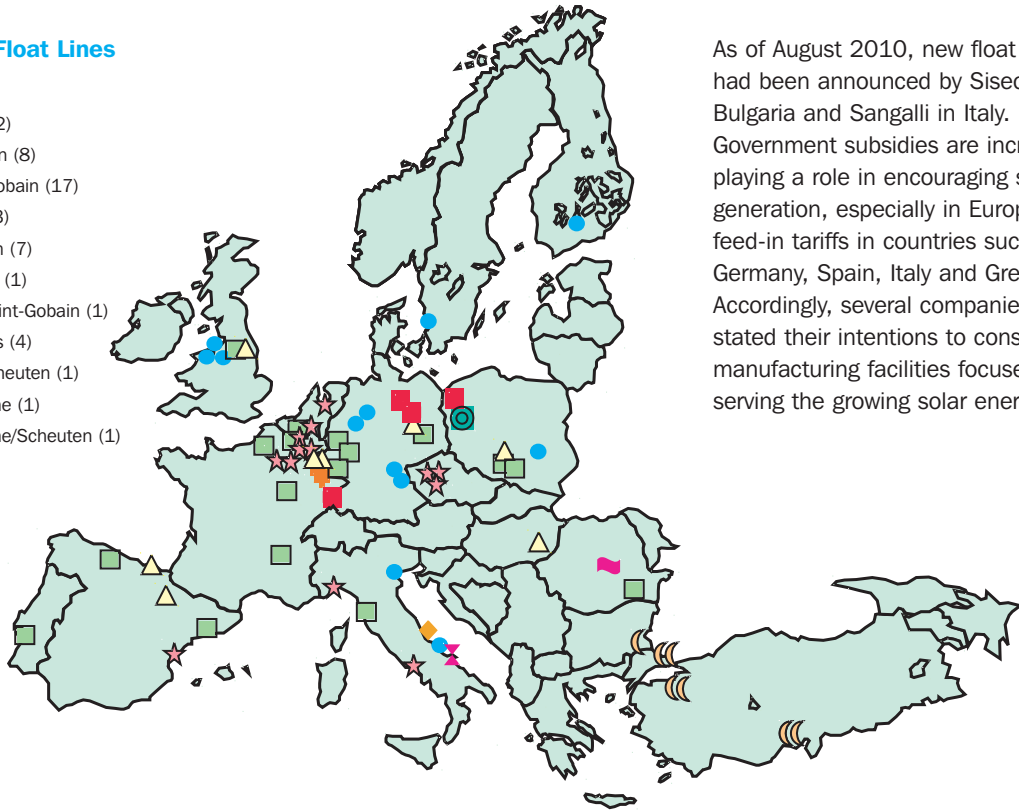
European 2009 Float/Sheet Capacity by Company



Total installed capacity was approximately 11.5 million tonnes in 2009, of which only about 50,000 tonnes was sheet glass.

Europe Float Lines

- NSG (12)
- △ Guardian (8)
- Saint-Gobain (17)
- ★ AGC (13)
- ☾ Siseecam (7)
- ✕ Sangalli (1)
- ◆ NSG/Saint-Gobain (1)
- Euroglas (4)
- ★ AGC/Scheuten (1)
- ⊕ Interpane (1)
- ⊗ Interpane/Scheuten (1)
- ◆ GES (1)



As of August 2010, new float investments had been announced by Siseecam in Bulgaria and Sangalli in Italy. Government subsidies are increasingly playing a role in encouraging solar generation, especially in Europe, with feed-in tariffs in countries such as Germany, Spain, Italy and Greece. Accordingly, several companies have stated their intentions to construct manufacturing facilities focused on serving the growing solar energy sector.

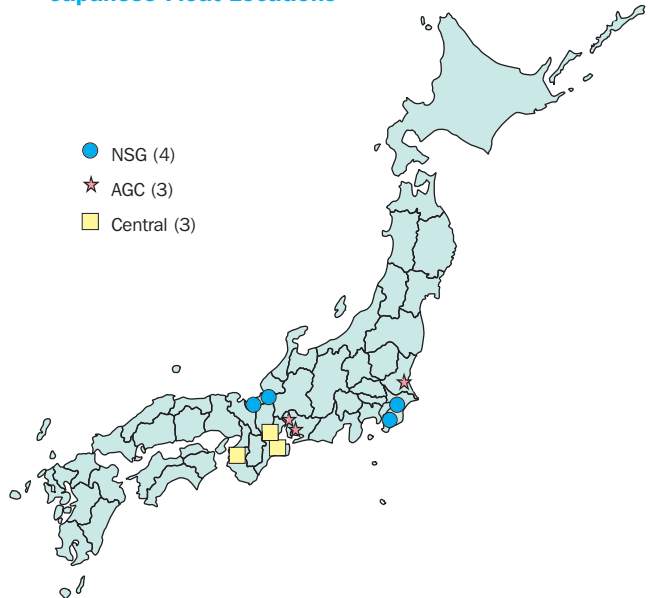
Japan

There are three major float glass manufacturers serving Japan: NSG Group, Asahi Glass and Central Glass.

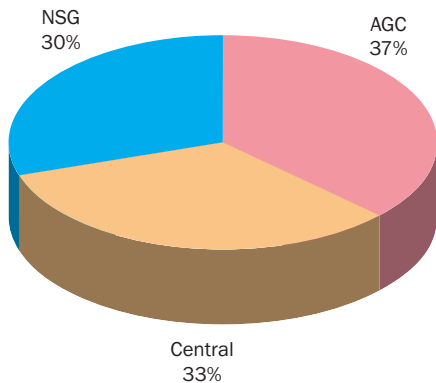
The overall market size for float glass was 836,000 tonnes, and per capita glass consumption was around 7 kg, in each case for 2009.

Japanese Float Locations

- NSG (4)
- ★ AGC (3)
- Central (3)



Japanese 2009 Float Capacity by Company



Total installed float capacity was over 1.3 million tonnes in 2009

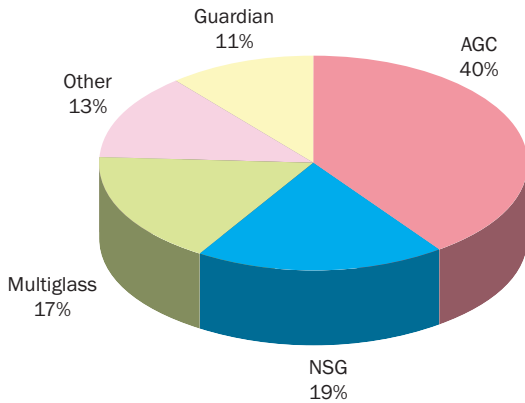
Three float glass manufacturers in Japan, with an overall float market size of 836,000 tonnes.

ASEAN

The ASEAN market described below refers to Brunei, Indonesia, Cambodia, Laos, Myanmar, Malaysia, Philippines, Singapore, Thailand and Vietnam.

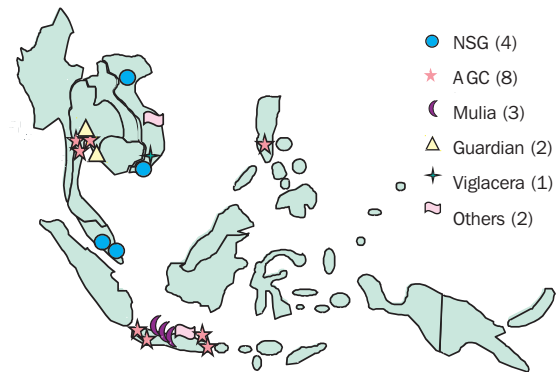
The ASEAN market size was almost 2 million tonnes in 2009. Over 20 float lines were operating in the region as of 2009, which were owned primarily by four main glass manufacturers and several local concerns. Per capita consumption during 2009 was around 3.4 kg.

ASEAN 2009 Float Capacity by Company



20 float lines are installed in the ASEAN region

ASEAN Float Lines



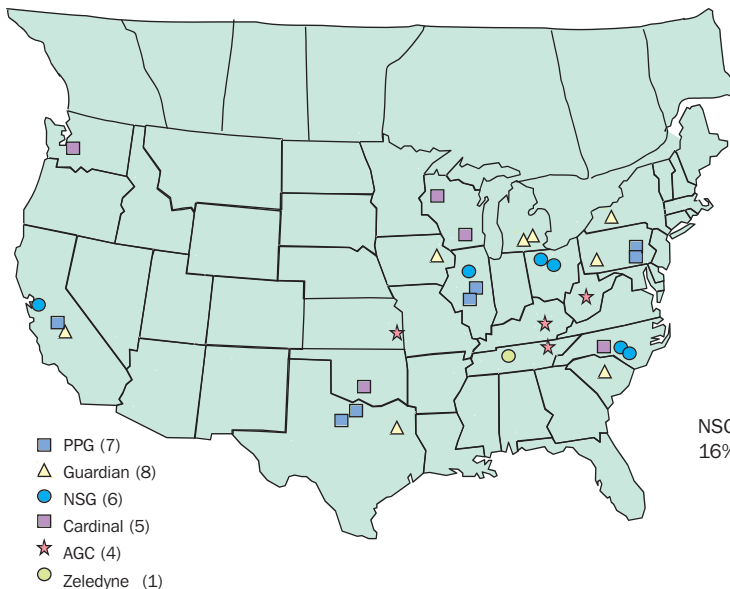
Total installed flat glass capacity was over 2.6 million tonnes in 2009, of which approximately 70,000 tonnes was sheet glass.

US/Canada

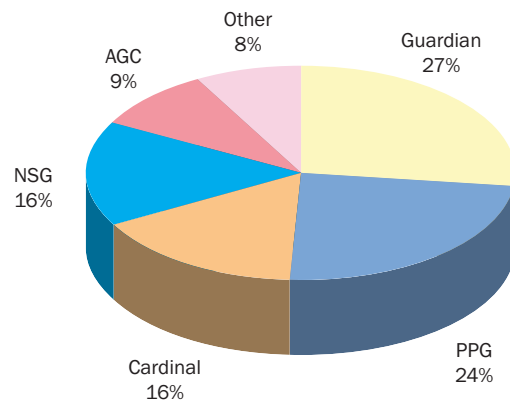
US/Canada is a mature glass market with annual consumption of around 10 kg per capita in calendar year 2009.

The industry at the primary level has eight significant players. Zeledyne, a new participant, emerged in 2008 after acquiring Ford Motor Company's glass business, Automotive Components Holdings.

North American Float Lines



US/Canada 2009 Float Capacity by Company



At a primary level, the Flat Glass industry in US/Canada has six players

Total installed float capacity was approximately 4.6 million tonnes of high quality float glass in 2009.

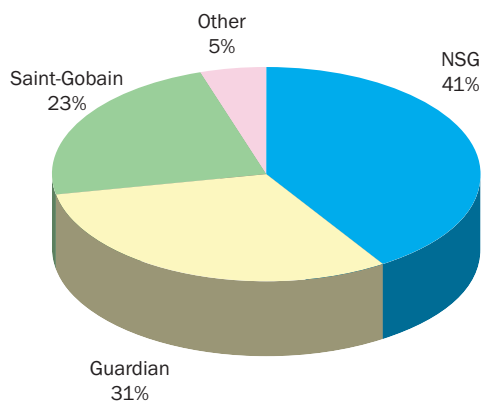
South America

South America had a market size approaching 2 million tonnes in calendar year 2009, and an annual per capita glass consumption of around 5 kg.

There are three manufacturers of high quality float glass: NSG Group, Saint-Gobain and Guardian.

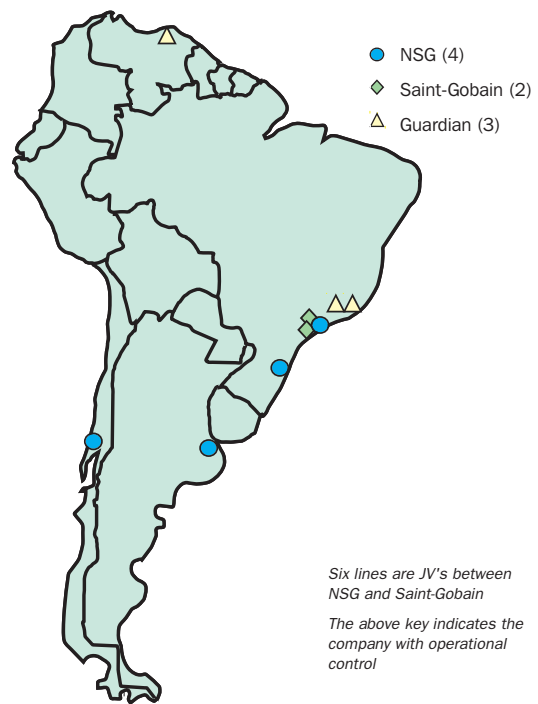
Six of the eight float lines in this region are joint venture operations between NSG Group and Saint-Gobain, of which four are managed by NSG Group.

South American Float/Sheet Glass Capacity by Company



Total capacity was approximately 1.5 million tonnes for calendar year 2009, of which less than 80,000 tonnes was sheet glass.

South American Float Lines



In South America, there are three manufacturers of high quality float glass: the NSG Group, Saint-Gobain and Guardian

China

China is the largest consumer of glass in the world, accounting for 50 percent of global demand in 2009.

China is also the largest producer of glass and glass products, producing over 50 percent of the global output of flat glass in 2009. It has the greatest number of glass producing enterprises, and has the largest number of float-glass production lines in the world.

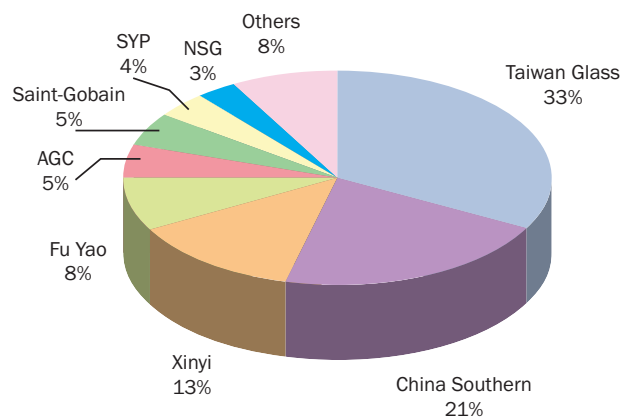
As of 2009, approximately 211 float lines were believed to be installed. Only about 50 of these float lines are equipped to produce high quality float

Nevertheless, the quality and output of Chinese float glass is increasing quickly. In terms of consumption and output, the market had been growing faster than 10 percent per annum during the period from 2000 to 2009, but this growth rate may be affected by the global economic conditions.

Only approximately 1.5 percent of Chinese float glass demand was imported during 2008, consisting primarily of specialized products that are not yet produced in China, while 11 percent of the domestic float glass

output, consisting primarily of standard glazing products, was exported.

China 2009 Float Glass Capacity by Company (High Quality Float Only)



Total capacity, including lower quality float and sheet glass, was around 32 million tonnes in 2009, of which less than 10 percent was sheet glass.

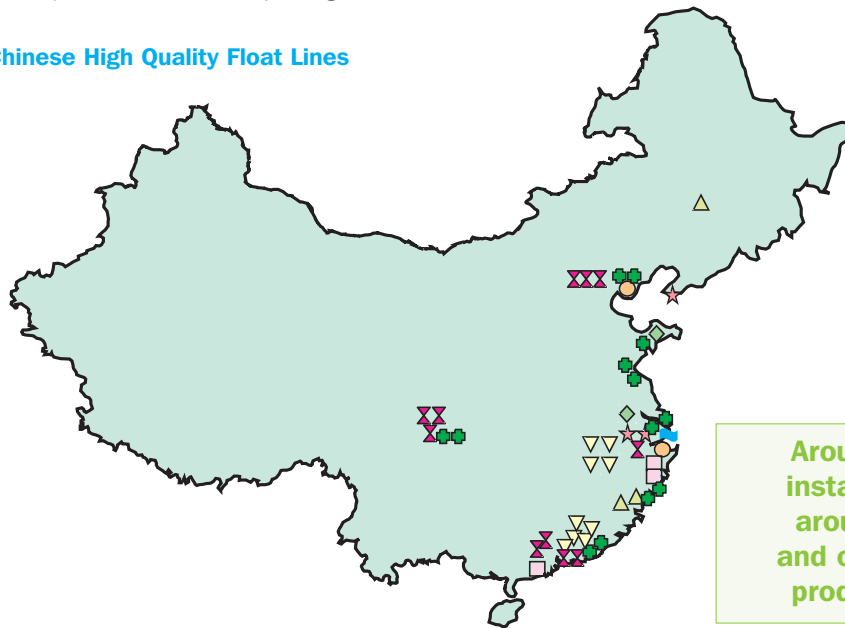
Most Chinese manufacturers are small- and medium-sized enterprises that have begun operations in recent years, which may present challenges for them to realize economies of scale. To this point, many of the domestic flat glass products are commodities, with price being the most critical consumer selection factor.

Accordingly, further processing of flat glass, such as laminating and coating, is still at low levels compared to Europe and North America. The quality of commercial developments has been improving, however, and in

response to the need to cut carbon emissions, building regulations may rapidly increase the use of value-added solar control and thermal insulation glass in many parts of the country.

China produces more than 50 percent of the global output of flat glass.

Chinese High Quality Float Lines



- Taiwan Glass (13)
- △ Fu Yao (3)
- ✕ China Southern (11)
- ▽ Xinyi (9)
- SYP (2)
- ★ AGC (3)
- ◇ Saint-Gobain/ Hanglas (2)
- ▬ NSG/SYP (1)
- Others (3)

Around 211 float lines are installed in China, of which around 173 are operating and only around 50 of these produce high quality float.

Former Soviet Union (FSU)

The Former Soviet Union (FSU) market described below refers to Russia, Ukraine, Belarus plus the former soviet republics of Central Asia and the Caucasus.

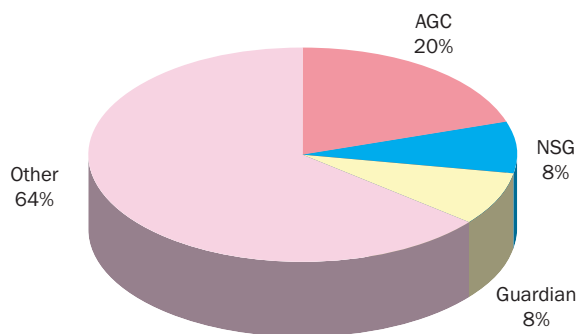
There were 22 flat glass manufacturing operations in the FSU as of 2009, 16 float lines and six still using sheet technology. Most of these plants, including all of the sheet glass operations, produce glass which is generally of a lower quality than the modern float glass production found in Western Europe.

The demand for both high quality float glass and value added glass products, such as products with energy saving features, continues to grow. The total market size in 2009 was approximately 2.2 million tonnes. In response to this growth there is increasing investment in western quality float in Russia. NSG Group started up its float joint venture near Moscow in 2006. Guardian started up their first line near Moscow at the end of 2008 and Asahi started up a new float line in the Moscow region in 2010.

This demand has been mainly fueled by new build activity and residential refurbishment work. The growing quality expectation in the Russian economy, coupled with recent

construction activity, provides considerable opportunity for float glass manufacturers, and competition in this market is expected to increase.

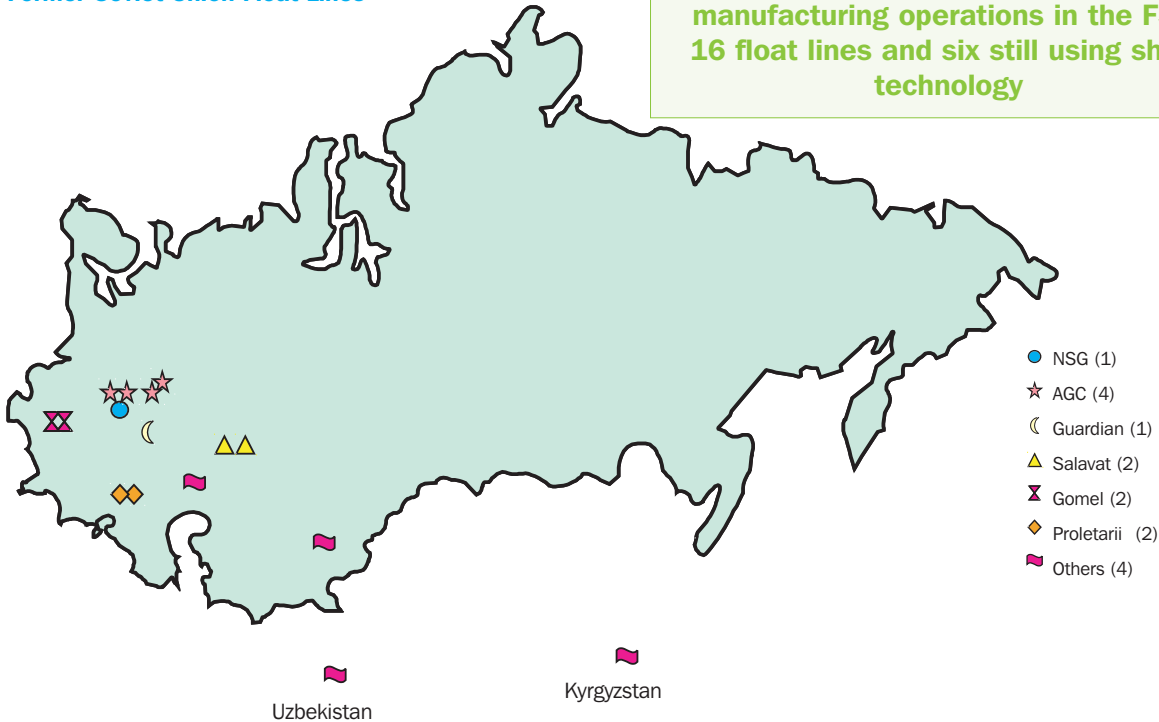
Former Soviet Union 2009 Float/Sheet Glass Capacity by Company



Total installed flat glass capacity in the FSU was 2.4 million tonnes in 2009, of which just over 300,000 tonnes was sheet glass.

Former Soviet Union Float Lines

There are currently 22 flat glass manufacturing operations in the FSU, 16 float lines and six still using sheet technology



Rest of the World

The Rest of the World is defined to include West Asia, Africa and Oceania.

This glass market is generally much less mature, with annual per capita consumption at approximately 1.5 kg in 2009.

Furthermore, there is a greater proportion of sheet and lower quality float capacity, which is expected to be

gradually phased out and replaced by high quality float over the longer term.

In many parts of the world, glass markets are still maturing and adopting value-added products.

1.6 Automotive

Market Overview

There are two routes to market for automotive glass:

- a) Original Equipment (OE) supplied to Vehicle Manufacturers (VMs) for new vehicles.
- b) Automotive Glass Replacement (AGR) product, supplied to the aftermarket for retrofit purposes, usually following damage.

Globally, OE glass demand is estimated to be around five times that of AGR, though the proportion will vary from region to region.

Within the OE glazing market, by far the largest segment is light vehicles, generally defined as those vehicles up to three and a half tonnes in weight. Light vehicles (LV), which include all cars, light trucks and the various cross-over vehicle styles such as sports utility vehicles (SUVs) and people carriers, currently account for around

96 percent of global vehicle build. It is the light vehicle market that is evaluated in the subsequent OE analyses.

In addition to light vehicles there are several niche vehicle segments; medium and heavy trucks, bus and coaches, and off-road vehicles such as tractors, diggers etc., each with distinctive glazing requirements.

Effectively three global automotive glass manufacturers, together with a number of smaller, though in some cases regionally significant players, serve the world's OE and replacement markets.

The largest of the three automotive glass groups is Pilkington Automotive, closely followed by Asahi. Saint-Gobain is the third global player.

Two routes to market for automotive glass; Original Equipment (OE) and Automotive Glass Replacement (AGR)

OE Light Vehicle Market

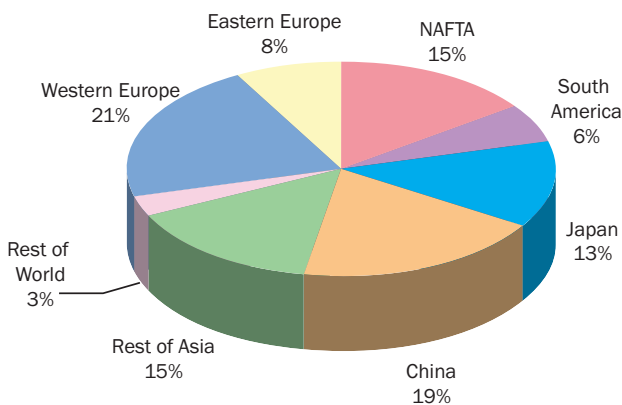
Light vehicle production in 2009 was 57 million, of which 35 percent was in the two main markets of Western Europe and North America. Build in Japan contributed a further 13 percent.

Not only do these three regions account for 67 percent of global LV production, but they are also the domiciles of most of the world's VMs and as such are the centers for new vehicle development.

Glazing continues to play an important part in vehicle design, providing a combination of aesthetic, functional and structural properties. The VMs are increasingly looking to their glazing suppliers to play a key role in the vehicle development process. Few automotive glass manufacturers have the combination of technical capability and the appropriate geographic presence to play this role to the full.

Western Europe and NAFTA produced 35 percent of the world's light vehicles in 2009.

Regional light vehicle build



Reflecting the importance of both technical capability and geographic presence in serving the light vehicle market, around 70 percent of global demand is supplied by the three global automotive groups, the NSG Group, Asahi and Saint-Gobain with its strategic partner Central.

Around 70 percent of global demand is supplied by the three global automotive glazing groups.

Other regionally significant suppliers in 2009 were: Fuyao, the largest Chinese supplier and now growing outside its home market; PGW (formerly PPG) with operations primarily in North America; VVP, the glazing division of Mexican company Vitro; privately held Guardian Industries with operations in the US and Europe, and Zeledyne, the North America-based former Ford Glass/Visteon business.

In addition to the major manufacturers identified, there is also a fairly short industry tail comprising smaller automotive glass manufacturers. Of these smaller players a few independent producers are more focused on specialist/niche OE supply. Others, often affiliated with flat glass manufacturers in developing markets, are more limited to local OE supply. There are also a handful of small automotive glass processors primarily serving the aftermarket.

The last few years have seen a reversal in the trend to customer consolidation, which by 2004 had the top six VMs and their affiliates comprise 80 percent of the market.

Subsequent restructuring at GM and DaimlerChrysler involved divesting their respective stakes in Fiat, Suzuki, Subaru, Isuzu, Mitsubishi and Hyundai. Then came Daimler's sale of its stake in Chrysler and Ford's divestment of the Land Rover and Jaguar marques to the Tata Group. The most recent changes in the wake of the global recession include Fiat's purchase of Chrysler, Ford's sale of Volvo Cars to Chinese VM Geely and GM's divestment of Saab to Spyker.

In 2009, the six largest VMs, with their affiliates, accounted for 60 percent of global production.

In 2009, the six largest VMs with their affiliates accounted for 60 percent of global production. The principal brand memberships of the major VM groupings are listed overleaf.

Automotive Customer Groups

<p>BMW Group</p> <ul style="list-style-type: none"> BMW Mini Rolls Royce 	<p>Fuji Heavy Group</p> <ul style="list-style-type: none"> Subaru 	<p>Hyundai Group</p> <ul style="list-style-type: none"> Hyundai Kia 	<p>Suzuki Group</p> <ul style="list-style-type: none"> Suzuki Maruti-Suzuki
<p>Daimler Group</p> <ul style="list-style-type: none"> Mercedes Maybach Smart 	<p>Geely Group</p> <ul style="list-style-type: none"> Volvo Cars Geely 	<p>Isuzu Group</p> <ul style="list-style-type: none"> Isuzu 	<p>TATA Group</p> <ul style="list-style-type: none"> Tata Land Rover Jaguar
<p>Fiat Group</p> <ul style="list-style-type: none"> Fiat Alfa Romeo Lancia Ferrari Maserati Iveco 	<p>GM Group</p> <ul style="list-style-type: none"> GMC Buick Cadillac Chevrolet Saturn Pontiac Opel Vauxhall Daewoo Holden 	<p>Mitsubishi Group</p> <ul style="list-style-type: none"> Mitsubishi 	<p>Toyota Group</p> <ul style="list-style-type: none"> Toyota Lexus Daihatsu Scion
<p>Ford Group</p> <ul style="list-style-type: none"> Ford Mercury Mazda Lincoln 	<p>Honda Group</p> <ul style="list-style-type: none"> Honda Acura 	<p>PSA Group</p> <ul style="list-style-type: none"> Peugeot Citroen 	<p>VW Group</p> <ul style="list-style-type: none"> VW Lamborghini Audi Bugatti Seat Bentley Skoda
		<p>Renault/Nissan Group</p> <ul style="list-style-type: none"> Renault Nissan Infiniti Dacia Samsung 	
		<p>Saab Spyker Group</p> <ul style="list-style-type: none"> Saab 	

Europe

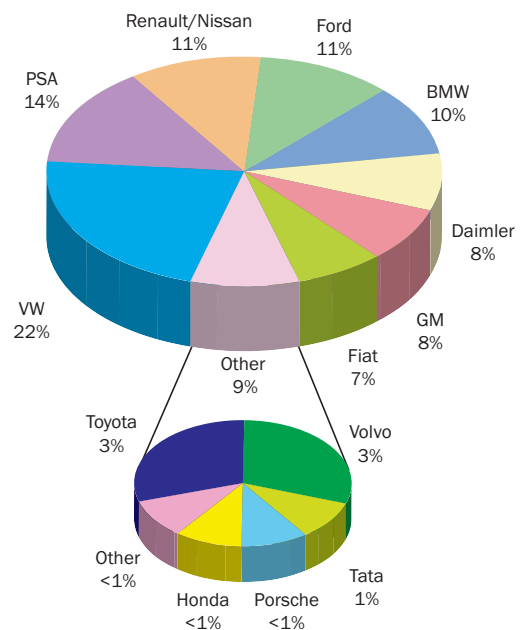
Even with the market turmoil, the European OE market remains the largest (28 percent of global production), and its customer base is the most diverse of any region, with all of the world's major VMs having a production facility there.

In 2009, Western Europe accounted for almost 72 percent of the region's total production, though Eastern European vehicle build, which includes the major vehicle producing countries of Russia, Poland, the Czech Republic and Turkey, continues to increase in significance.

Western Europe has a broad and well-balanced customer base as shown below, with successive Japanese investment in recent years supplementing the existing presence of the traditional European VMs.

Besides the Toyota, Nissan and Honda build separately identified above, other Japanese VMs now present in Western Europe are Mitsubishi, Mazda (part of Ford), and Suzuki.

2009 Light Vehicle Production Western Europe – 11.7 million

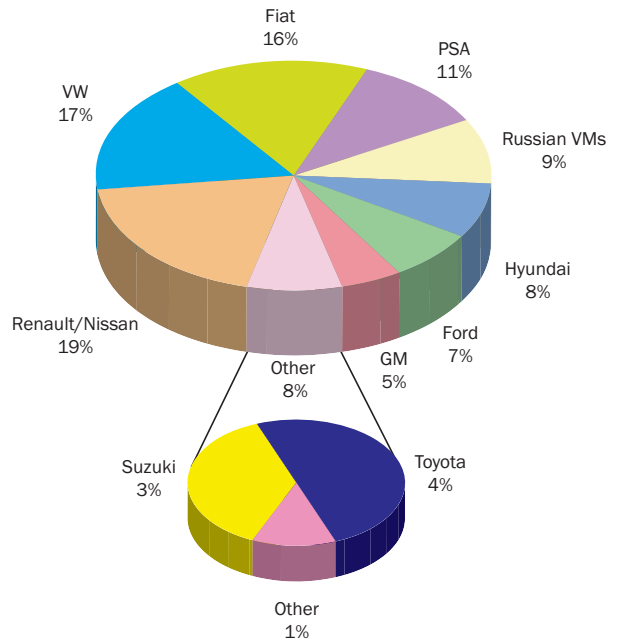


The opening up of the Eastern European market since the 1990s has seen increased investment from Western, Japanese and Korean VMs, following that of companies such as Fiat, GM, Renault and VW.

OE glazing supply in the Western European OE market is predominantly by the local operations of Saint-Gobain, Pilkington Automotive and Asahi. A few smaller manufacturers, including Soliver, Rioglass and Guardian, together with a small amount of imports, supply the remainder of the Western European market (~12 percent). Local independent glass processors are believed to have a larger share of certain Eastern European markets.

The European OE market is not only the largest, but its customer base is also the most diverse of any region, with all of the world's major VMs having a production facility there.

2009 Light Vehicle Production Eastern Europe – 4.5 million



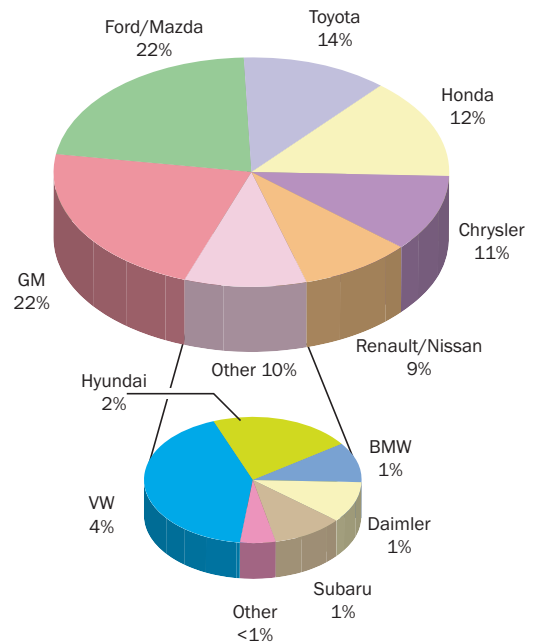
North America

The effects of the recession, together with China's continued growth, saw NAFTA drop to the world number three position in terms of vehicle build, with 8.6 million units built in 2009. Traditionally, this market has been the domain of the 'Big Three' vehicle manufacturers, GM, Ford and Chrysler, though in recent years their share has been eroded by the operations of Asian and European VMs. In 2009, the share of the 'Big Three' VM groups was down to 55 percent of the market.

The OE glazing supply base in NAFTA is one of the most diverse of all regions. Three companies have market shares estimated in excess of 15 percent; three more companies have shares in the range 9 to 14 percent, with all of the remaining suppliers having shares of less than 5 percent.

NAFTA comprises the third largest OE market in the world, with 8.6 million units built in 2009.

2009 Light Vehicle Production NAFTA – 8.6 million



AGC, Pilkington Automotive and PGW are the leading suppliers in NAFTA, with fourth, fifth and sixth spots taken by VVP of Mexico, the strategic partnership of Saint-Gobain's Sekurit business and Central Glass's Carlex subsidiary, and Zeledyne (formerly Ford Glass). Privately-held Guardian, together with imports, account for the remainder of the market.

Japan

In 2009, Japan became the fifth largest automotive market in the world; behind Europe, China, North America and the Rest of Asia, with light vehicle production of 7.5 million

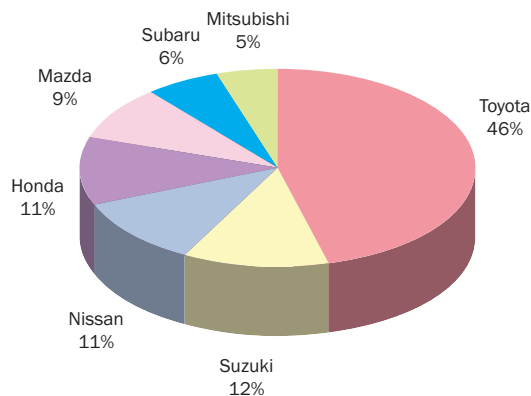
Production in Japan remains the exclusive domain of the domestic VMs, with western VM involvement limited to equity stakes in the domestic producers. This includes Ford's 33 percent in Mazda, Renault's 44 percent in Nissan, and until recently, DaimlerChrysler's holding in Mitsubishi and GM's interests in Subaru, Suzuki and Isuzu. To date, only two of the Japanese VMs, Toyota and Honda, have remained independent of equity investments by US or European VMs.

In the case of Renault's investment in Nissan and Ford's in Mazda, the management influence of the non-Japanese partner is today of great significance. In Japan, as elsewhere in the world, Toyota is by far the largest of the Japanese VMs.

Supply of OE glazings in Japan is in the hands of the three domestic glass companies, Asahi Glass, NSG Group and Central Glass. Asahi is believed to have just over half of the market and the NSG Group around 30 percent, with Central Glass taking the remaining share, except for a small amount of imports.

The need for the domestic glass companies to serve the Japanese VMs as they expanded their operations overseas led, at least in part, to the strategic partnerships and subsequent investments between NSG Group and its now subsidiary Pilkington, and Central with Saint-Gobain.

2009 Light Vehicle Production Japan - 7.5 million



Japan is now the fifth largest Automotive market in the world, with light vehicle production of 7.5 million.

China

Consistent double-digit growth in recent years has seen China rise rapidly to be the second largest 'regional' market, behind Europe, and the largest in individual country terms, overtaking Japan and the US. In 2009, LV production in China grew by almost 52 percent, totalling 11.1 million units.

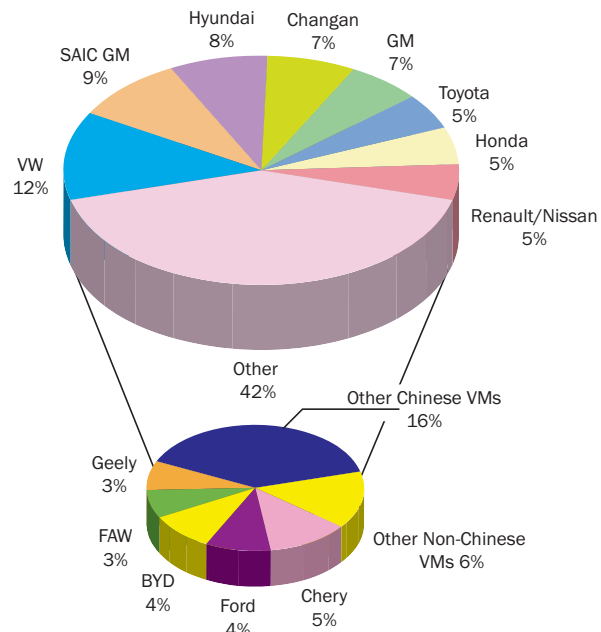
This phenomenal market development is on the back of inward investment by all of the major VMs, as well as organic growth by China's own domestic vehicle manufacturers. The Chinese automotive industry universally benefited from the government's recent stimuli of both the economy and industry, barely faltering as the rest of the world plummeted into recession, though as a group, the domestic VMs fared best, increasing their combined share of the much enlarged market to 47 percent.

China is the second largest 'regional' market and the largest in individual country terms, overtaking Japan and the US.

The leading glazing suppliers in China are; Fuyao, a Chinese company with an established history of serving

overseas aftermarkets through exports, and which latterly has begun to export OE products, Asahi through its now wholly-owned Chinese subsidiary, Saint-Gobain (Sekurit), SYPA, another domestic glazing supplier and Pilkington Automotive, through its three domestic operations.

2009 Light Vehicle Production China - 11.1 million



Rest of Asia (excluding Japan and China)

At 8.6 million vehicles in 2009, Asia, excluding Japan and China, remains the fourth largest regional market. In automotive market terms, the region is not homogeneous, with several sub-market types being evident.

First, there is South Korea, whose well established automotive industry still transcends other regions, both in the form of exports and through vehicle assembly transplant operations elsewhere within and outside the region.

Secondly, there is the fast growing and potentially large market of India. Despite the recent major growth in vehicle production, vehicle ownership rates in India remain well below other developing markets. This market potential attracted some early investors, most notably Suzuki, and these early positions are now growing into a meaningful market presence. Latterly, many more European, Japanese and Korean VMs have invested in India.

The third group of Asian markets comprises the so-called 'Tiger Economies', which exhibited rapid growth through the early/mid 1990s. Vehicle production in Thailand, Indonesia, the Philippines, Malaysia and Taiwan grew significantly, benefiting particularly from inward investment by Japanese VMs.

Other sub-markets in Asia include the small mature Australian market and the new developing markets of Pakistan, Vietnam and Kazakhstan.

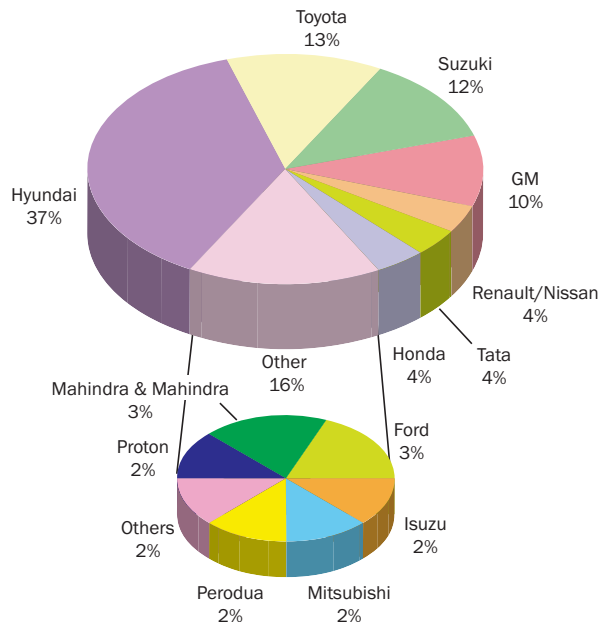
The Asian OE glazing supply base has its origins in local independent glassmakers. Whilst some still remain, increasingly these local players are now partnered with the major international glass companies.

Asahi led the way as far back as the 1970s, when it began to establish partnerships with local glass companies or investors. Such strategic investments were made in Thailand, Indonesia, India, the Philippines, Malaysia, Taiwan, China and most recently South Korea. Latterly, Asahi has increased its stakes in several of these companies, moving to majority ownership positions. To a lesser extent, the other two Japanese glass makers, the NSG Group and Central, both followed suit, with NSG investing in automotive glass affiliates in Malaysia, Taiwan and China, and Central having a Taiwanese joint venture.

Before the acquisition, Pilkington had originally focused on China, where today Pilkington Automotive has three operations. Latterly it has also invested in India and the ongoing regional footprint is further enhanced by the other Pilkington Automotive interests of the NSG Group mentioned above. Saint-Gobain's investments were initially targeted on India and China, in partnership with local glass processors.

Saint-Gobain also has a presence in the Thai market, in partnership with a local company Toa. However, its most significant Asian position results from the stake in Hankuk, the South Korean market leader, taken in 1997 and now grown to majority share ownership.

2009 Light Vehicle Production Asia (excl. Japan & China) – 8.6 million



The Asian OE glazing supply base has its origins in local independent glassmakers, increasingly now partnered with the major international glass companies

South America

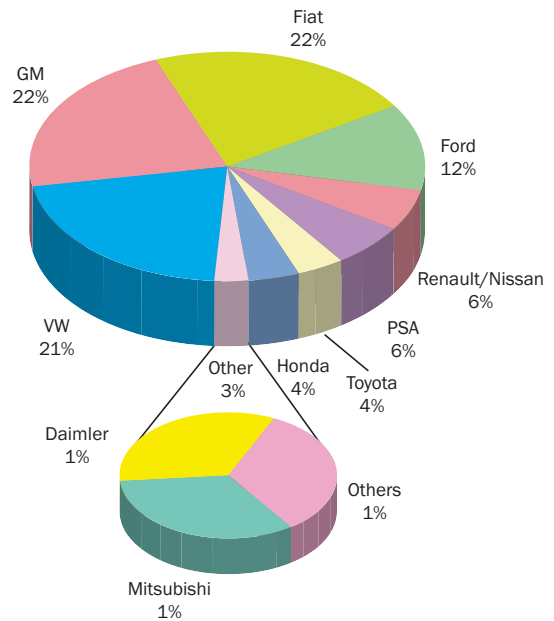
South America is the sixth largest vehicle-producing region in the world, with Brazil and Argentina together accounting for around 94 percent of regional volume. Brazil remains by far the most significant vehicle producing country in South America.

Traditionally, the South American market has comprised mainly European VMs, though an Asian presence is being built, principally by Japanese VMs. Three VMs together, VW, GM and Fiat, make up almost two thirds of the market.

The NSG Group, through its Pilkington Automotive operations in Brazil, Argentina and Chile, and Saint-Gobain, through its Brazilian and Colombian subsidiaries, together account for around 90 percent of South American glazing demand with the remaining supply coming from independent domestic processors and from imports.

South America is the world's sixth largest vehicle-producing region. Brazil and Argentina account for around 94 percent of regional volume.

2009 Light Vehicle Production South America – 3.7million

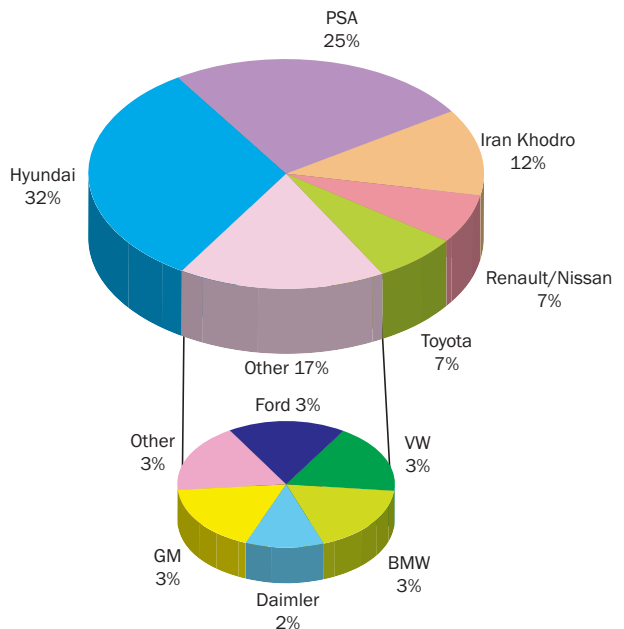


Rest of the World

Iran, South Africa, Egypt and Morocco comprise the principal OE markets elsewhere in the world, accounting for just 3 percent of global volume.

The South African market is principally served by Shatterprufe, the automotive glass subsidiary of domestic flat glass manufacturer, the PG Group.

2009 Light Vehicle Production Rest of World – 1.8 million



2. Glass – A Growth Industry

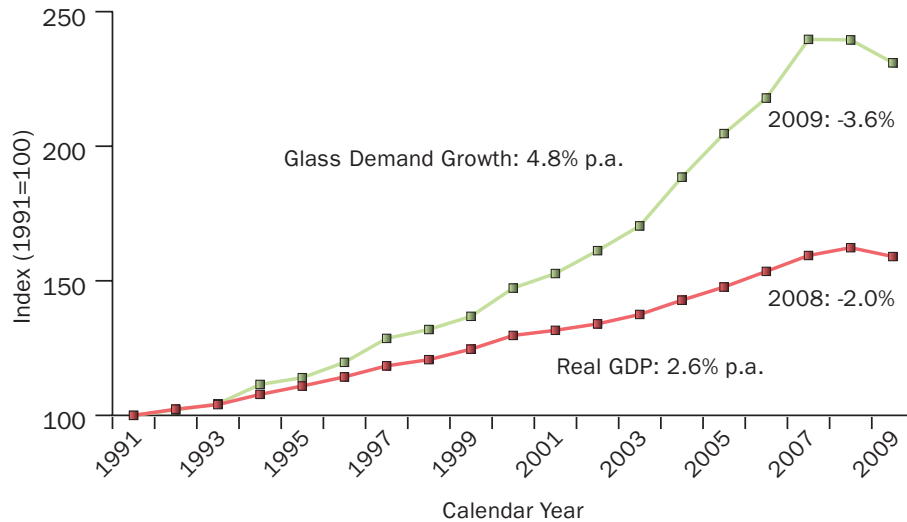
2.1. Global Demand for Flat Glass

Over the long term, demand for float glass is growing at almost 5 percent per annum.

This growth is fuelled by the demand for building glass and automotive glass, which in turn is driven by economic growth.

Over the last 20 years, float demand growth has outpaced real GDP growth. Over the past 10 years, float demand has exceeded GDP growth by around three percentage points.

Global Float Demand Grows c. 4.8 percent p.a. In 2009 Demand Contracts by 3.6 percent



In the last 20 years, float demand growth has outpaced real GDP growth

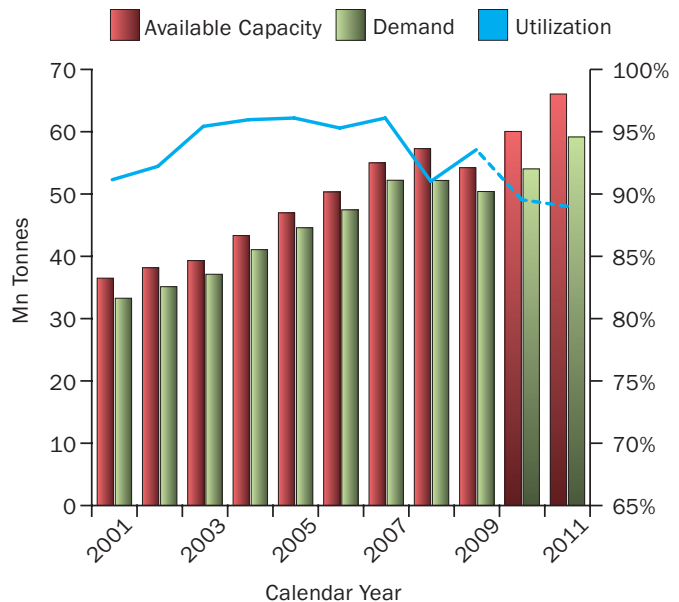
The world flat glass market is expected to recover to over 57 million tonnes in 2010, including 2 million tonnes of rolled glass, from the recession-hit 2009 level of 52 million tonnes.

Until this year, global float capacity utilization has ranged between 90 and 95 percent (virtually the practical limit for a network of float plants, since having all of the right thicknesses in the right place at the right time is not generally achievable).

In 2008, global capacity utilization dropped significantly towards the lower end of this range, after a sharp tightening of demand due to the global recession. Some recovery was seen in 2009, supported particularly by strong demand growth in China and capacity reduction measures taken by the industry.

Despite further demand recovery expected in 2010, utilization is expected to dip again due to further new capacity being brought on stream, especially in China. In practice the industry may again choose to impose capacity reduction measures to support utilization.

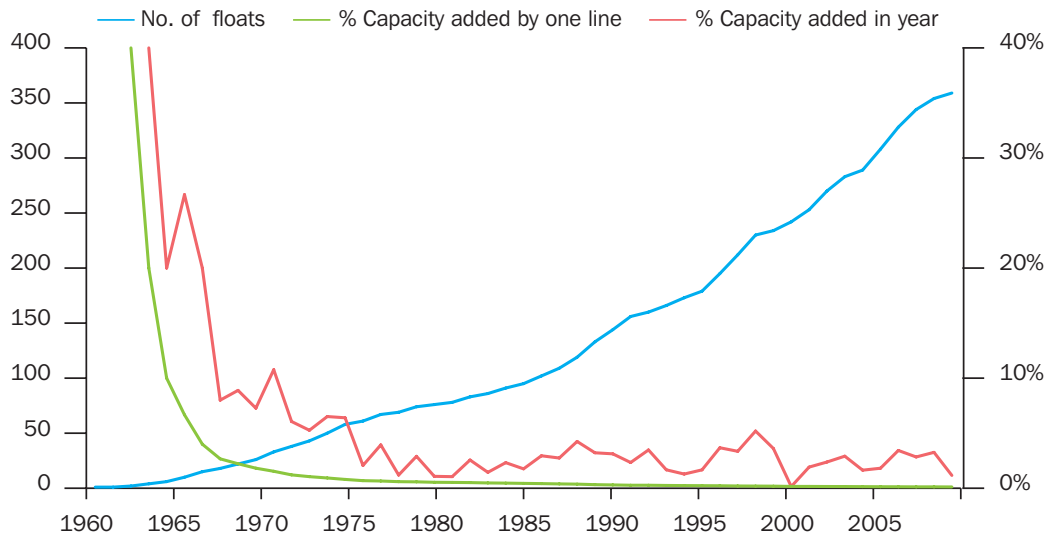
Global Capacity Utilization



A further significant point is that each new float line that is added to the installed base represents a smaller percentage of installed capacity and is therefore likely to cause less of a disturbance to the supply demand balance. This can be illustrated by the following chart showing the effect of additional float capacity since the construction of the world's second line in 1962.

In 2010, a new float line represented less than 0.3 percent of global installed capacity

Incremental Capacity – Global



A new float line added in 1970 represented more than 3 percent of global float capacity. A new line in 2010 represents less than 0.3 percent of global installed capacity. Nevertheless, the impact of a new float line in certain territories can still be quite marked, at least in the short term, until the new capacity is fully absorbed by market growth.

Global glass industry summary

- Over the long term demand is growing steadily in most regions.
- The global recession has caused a demand contraction in 2009. Recovery is uncertain and return to 2007 levels is not expected until 2012
- Growth of coated glass has the effect of reducing float capacity as output is effectively lower
- Global capacity utilization is expected to be around 90 percent in the medium term.
- The pace of capacity addition outside China has moderated recently, with eight new lines on stream in 2009 and a further eight expected in 2010.

New float build program

The following table shows lines that have come on stream in 2009, and those planned to start-up in 2010. In addition, it is believed that 43 float lines will have come on stream in China in 2009 and 2010.

New Float Build Program

Country	Company	Start Year
India	Gold Plus	2009
India	Sejal	2009
Poland	Euroglas	2009
Germany	F Glas	2009
Russia	Saratov	2009
UAE	Emirates Glass	2009
Iran	Ghazvin Glass	2009
Brazil	Guardian	2009
Belarus	Gomel	2010
Russia	AGC	2010
Russia	Kirishi	2010
Bulgaria	Sisecam	2010
Egypt	Ain El Sokhna	2010
Egypt	Sphinx Glass	2010
India	HNG Float Glass	2010
Vietnam	Chu Lai	2010

Regional Analysis

In the following analysis of regional glass markets the world is segmented into seven regions as follows:

- Europe
- Japan
- ASEAN
- US/Canada
- South America
- China
- Former Soviet Union

Analysis of demand and capacity utilization is on the basis of all sheet and float production.

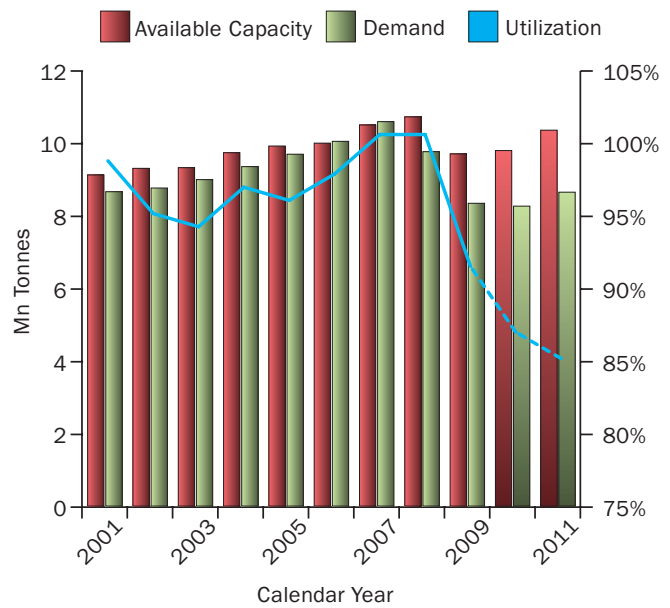
Europe

Europe is defined as extending as far east as, but excluding, Russia, Ukraine and Belarus. To the south it includes Turkey.

Capacity utilization remained in the high 90 percent range from 2000 to 2007, but the recession which hit in the second half of 2008 led to a contraction in demand, while significant new capacity came on stream. Further new capacity, from projects begun prior to the recession, came on stream in 2009 and 2010, but the industry has moved to reduce overall capacity through extended repairs and other shut downs.

As a result, the unprecedented fall in demand by 2010, expected to be 20 percent from the peak of 2007, is anticipated to drive utilization down to around 85 percent

Europe Capacity Utilization



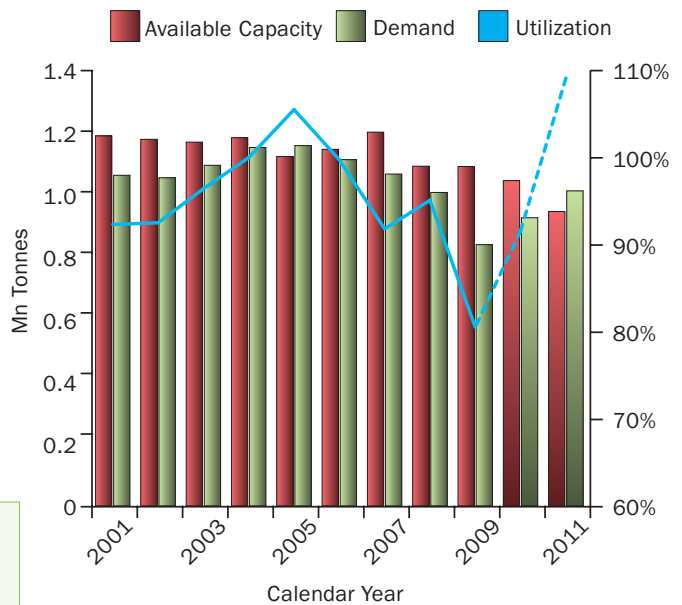
Japan

Demand in Japan has been essentially flat during this decade at just over one million tonnes. The global recession drove demand below 850,000 tonnes in 2009 but recovery to well over 900,000 tonnes is expected in 2010, driven by strong demand in automotive and specialty glass sectors

Available capacity has been in decline throughout the decade as lines were mothballed, or converted to produce glass for specialist applications.

Nevertheless, the fall in demand drove utilization below 80 percent in 2009. A float closure in 2010, repair activity in 2011 and continued demand recovery will drive utilization above 100 percent by 2011

Japan Capacity Utilization



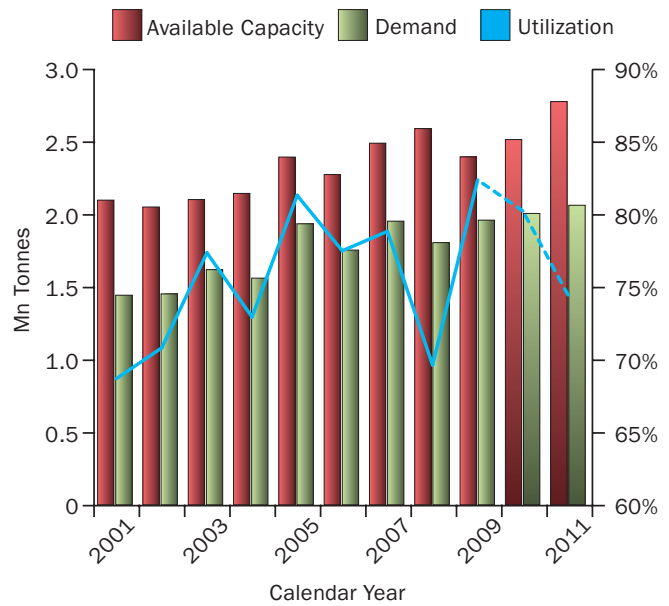
In Japan, capacity Reductions are expected to push utilization above 100% beyond 2010.

ASEAN

Demand has been volatile in the ASEAN region throughout the decade. The recent recession hit the market hardest in 2008, but recovery since then is expected to push demand above pre-recession levels in 2010

Capacity was adjusted in 2009 and over-compensated for the fall in demand, driving utilization to historically high levels by the end of the year. New capacity in 2010 and 2011 is expected to bring utilization back down to regional average levels

South-East Asia Capacity Utilization



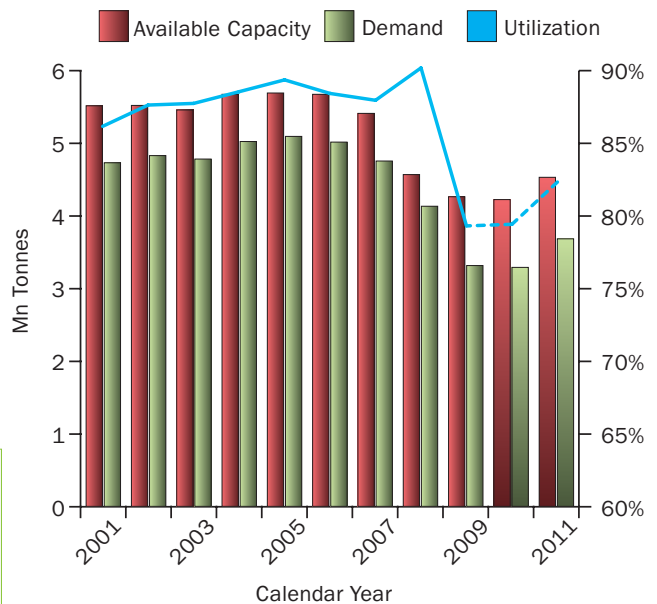
US/Canada

North America was the first region to fall victim to recession and demand has contracted since the peak of 2006.

This is a similar demand picture to Europe but the crucial difference has been the corresponding reduction in capacity as lines have been taken out of action. Several facilities also underwent lengthy repairs or other forms of capacity reduction during 2009.

Regional capacity utilization is believed to have bottomed out in 2009 and 2010 and a long-term recovery is expected to begin in 2011.

North America Capacity Utilization



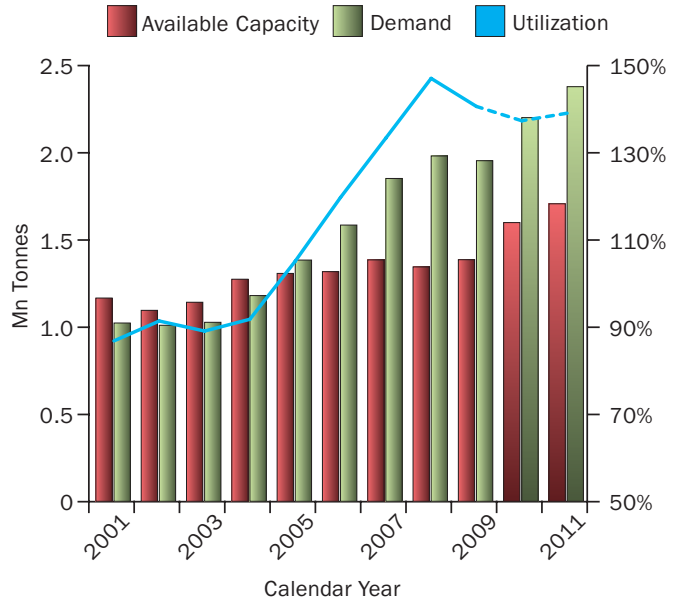
In North America, regional capacity utilization has dipped below 80 percent

South America

South American glass demand has been steadily growing since 2003. This growth was interrupted temporarily by the recession in 2009 but normal growth rates have resumed quickly in 2010.

Regional capacity utilization reached its peak in 2008 at around 150 percent. Since then utilization has eroded slightly, as new capacity came on stream in Brazil, but it is expected to remain well above 100 percent despite further capacity additions planned over the next years.

South America Capacity Utilization

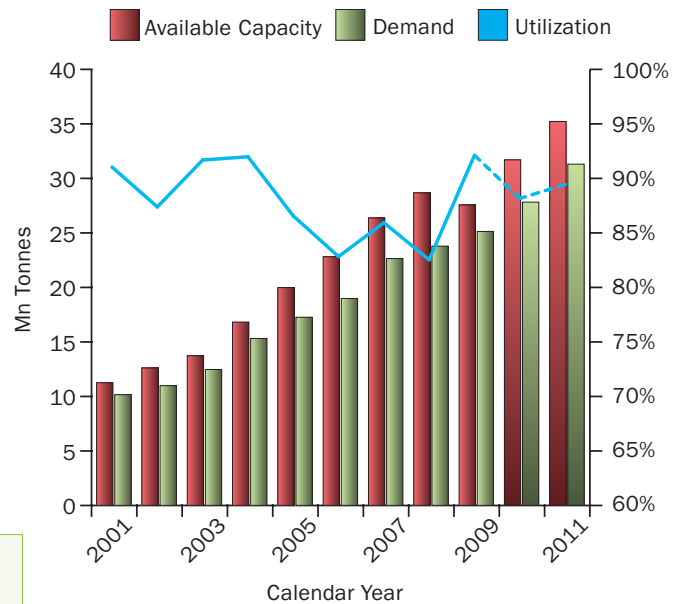


China

Since 2000, there has been a major float build program in China, and the number of float lines has increased to around two hundred. This resulted in a downturn in utilization to around 85 percent between 2005 and 2008.

Significant capacity reduction measures were taken in 2009, along with the deferral of several new float start-ups, in response to the global recession but in reality domestic demand growth continued, albeit it at a lower pace. This resulted in a strong increase in utilization and, as a result, the addition of new capacity has gathered pace in 2010, when around 25 new lines are expected to come on stream. Further strong demand growth is expected in 2011, which will maintain utilization at around 90 percent.

China Capacity Utilization

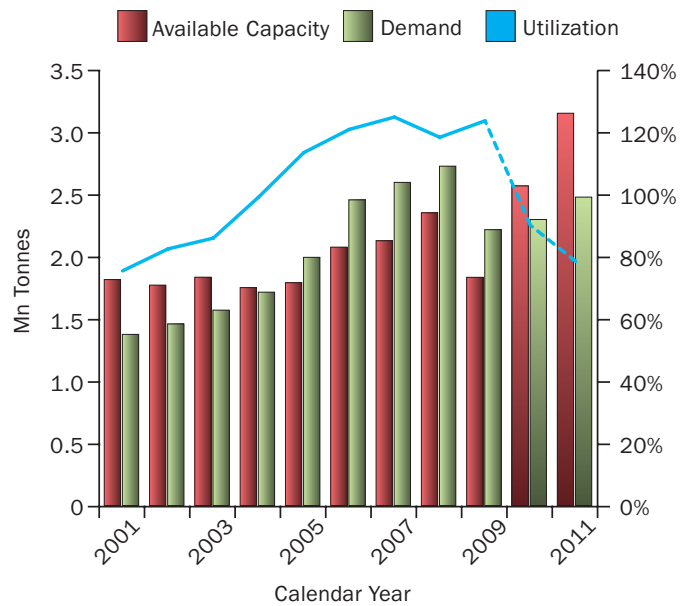


In China, utilization is expected to stabilize as strong demand growth resumes.

Former Soviet Union

Flat glass demand grew robustly since the relative low point of 2000 up until 2008, with the market size more than doubling in eight years. As a consequence of global recession, market demand fell sharply in 2009 and despite a return to growth in 2011 a glut of new floats will depress utilization to around 80 percent. Trend growth rates should quickly rebalance the situation thereafter.

Former Soviet Union Capacity Utilization



2.2. Growth in Building Products

Growth in Building Products is fuelled by a number of drivers:

Construction

Glass is an integral building material for most construction projects. Virtually every new building requires glass. Both new building projects and the refurbishment of existing buildings call for large quantities of glass products.

Architectural trends

Architects are increasingly seeking to bring natural environmental factors into the interior of buildings by maximizing natural daylight. This has been achieved through the use of larger glazed areas in facades and roofs, and through entirely glazed facades where the glass is a structural component of the building.

In sunnier climates, the reliance on air conditioning, which would otherwise be increased by such larger glazed areas, is mitigated by the use of advanced solar control products which allow the sun's light into the building while keeping much of its heat out.

Refurbishment

Refurbishment of buildings accounts for around 40 percent of glass consumption worldwide. In mature markets, windows in residential buildings are replaced every ten to twenty years.

Value Growth – Building Products

Demand	Growth drivers
Energy-saving (heating)	Energy-saving legislation and building regulations; reduction of energy loss from buildings, energy labeling of windows.
Energy-saving (cooling)	Energy-saving legislation, reduction of air-conditioning load in buildings, preventing non-air-conditioned buildings from over-heating
Safety/ security	Increasing legislative requirement for safety glass in certain applications. Requirement for transparency combined with security features
Fire	Requirement for good light transmission and protection compliance with regulations on fire protection
Acoustic	Increasing noise levels caused by traffic, aircraft, etc., progressively backed by legislation.
Self-cleaning	Reduction in use of detergents, safety at heights, extension of product range and features to increase functionality in commercial and domestic applications.
Solar Energy	Demand for renewable energy, stimulated by government support and feed-in tariffs

Energy Efficiency

Over the past 25 years, in developed regions such as Europe, Japan and North America, the growing need for energy efficiency in buildings has transformed the markets for energy saving glass and this is now being echoed in developing regions.

Targets for reducing CO₂ emissions have driven tougher legislation for energy saving glass. Building regulations in many countries now require insulating glass units (also known as double glazing) as standard, with energy efficient low emissivity (low-e) coated glass often necessary.

In hot climates, there is an increasing recognition that reliance on air-conditioning can be mitigated by the use of advanced solar control glass.

Window energy labeling systems have been established to promote energy saving glass to the consumer and provide a mechanism for financial incentives. There is also growing governmental support worldwide for renewable energy generation, including solar energy.

Energy Legislation

As buildings account for around half of all energy consumed in developed countries, they have become the prime focus of attention in terms of legislation. In the EU, for example, targets have been set for reducing energy consumption by 20 percent, reducing greenhouse gas emissions by 20 percent and producing 20 percent of energy from renewable sources.

European building regulations continue to be the major driver for high performance and added-value glass, particularly in the area of energy efficiency

The recast of the EU Directive on Energy Performance of Buildings imposes a raft of obligations on Member States, including the requirement to upgrade their building regulations for energy at least once every five years. Furthermore, it requires all new buildings across Europe to be built to very high energy efficiency standards ('nearly zero') by 2020 and all existing buildings undergoing major renovation to meet minimum energy performance requirements.

Building regulations continue to be the major driver for high performance and added-value glass, particularly in the area of energy efficiency. In most countries there have been major changes to building regulations for energy efficiency, creating opportunities for added-value glass, and this is anticipated to continue in the future.

Low-Emissivity Glass

All central and northern European countries, and indeed some southern countries (such as Italy), have legislation requiring low emissivity glass in new buildings. Several countries also have legislation requiring low-e glass in all replacement windows.

In the USA, the International Energy Conservation Code, which impacts on energy efficiency for buildings and specifically glass, was revised in 2009 and is due to change again in 2012. This is complemented by initiatives such as the US Green Building Code's environmental building rating system (LEED).

In China, the government has already introduced building regulations to improve the energy efficiency of new buildings, which should help to significantly increase the share of low-e glass in an insulating glass unit market of over 200 million sq m. In 2009, South Korea introduced a new regulation which effectively makes low-e glass standard in new buildings.

In Northern European countries, triple glazing or '2 + 1' double window has become the norm. In some central European countries, the longer term plans of most governments include progress towards triple glazing as the regulatory norm, as zero and low energy buildings become common.

At a primary level, low-e glass earns revenues 40 percent higher than ordinary float glass

An example of the market-transforming effect of building regulations is the sharp increase in demand for low-emissivity glass in Germany in the 1990s from less than 2 million to over 25 million sq m. Even before it came into force in 1995, knowledge of the legislation drove the penetration of low-e glass in insulating glass units to around 50 percent. Low-e glass has now been standard in Germany for many years and the experience has been repeated in other countries such as the UK. The trend is being repeated across the globe, dramatically increasing the demand for low-e glass.

For the primary manufacturer, low-e glass typically earns revenues 40 percent higher than ordinary float glass so this substitution effect greatly improves the value added.

Solar Control Glass

Around the world, countries are increasingly turning their attention to air-conditioned buildings, in order to reduce energy usage and CO₂ emissions, thereby creating opportunities for solar control glass. These products have special coatings applied to their surface that reflect up to 75 percent of the solar heat whilst transmitting the majority of the visible light. This allows a bright and cool

environment to be maintained inside a building with reduced requirement for air-conditioning. Products such as this can earn up to ten times the revenue per square meter of basic float glass. Their use will increase as climate change results in increased ambient temperatures, thus imposing greater demands on air-conditioning in buildings.

The Energy Conservation Building Code in India has introduced specific requirements for high performance solar control glass. Although currently voluntary, it is widely adopted in major cities and will become mandatory for all new and refurbished buildings in 2013. Japan, Italy, Poland and parts of the USA have also addressed this issue in some way within their regulations.

Energy Labeling

Window energy labeling systems, which evaluate the total energy performance of windows, have been established in many regions, including the UK, Finland, Denmark, Australia and North America. These allow the consumer to identify the best-performing products - stimulating the demand for energy saving glass - and provide governments with a criterion by which financial incentives can be linked. The introduction of a window energy rating system in Japan is anticipated in 2011.

Renewable Energy

The same energy efficiency drivers are also resulting in the increased demand for photovoltaic and solar thermal energy panels, in which glass is an essential integral component. The EU Renewable Energy Directive sets a

requirement for 20 percent of energy across the EU to be produced from renewable sources by 2020. It also includes mandatory targets for each EU Member State.

Feed-in tariffs in countries such as Germany, Spain, Italy and Greece have made it economically attractive to feed power into national grid systems. Authorities in Japan have indicated likely support for homeowner solar installations and US tax incentives are adding further impetus.

Safety - Toughened, Laminated and Fire Protection

Growing awareness of safety has also driven building regulations for laminated, toughened and fire protection glass, which further enriches the product mix of the industry. Growth in use of laminated glass has also been driven by developments of improved sound insulation of some laminated products.

Technical Applications

Glass is increasingly being used in a range of applications which require a high degree of functionality.

One of these fast growing applications is Thin Film Photovoltaic (PV) panels for Solar Energy, where coated glass is used as an integral active component of the device. Other consumer applications, such as touch screen devices, again use glass as an active integral component.

Although small today, in comparison with glass demand for mainstream building applications, these applications require glass of much higher value and have the potential to achieve significant scale.

2.3. Growth in Automotive

Structural Trends

Various structural trends have affected the automotive glazing industry in recent years, both from the customer and the supply side.

One such trend had been the consolidation in the OE customer base; the vehicle manufacturers. VM mergers and acquisitions, together with some organic growth, saw the top six VM groups in 1992; (GM, Ford, Toyota, VW, Nissan and Chrysler) increase their combined global market share from 57 percent to 80 percent by 2004. However, industry restructurings over the last few years now see a slightly differently constituted group of the six largest VMs accounting for 60 percent of global light vehicle build.

The concentration of the customer base historically has been mirrored on the supply side and automotive glass is no exception. Here, acquisitions, strategic partnerships and organic growth have resulted in the three global glass supplier groupings, the NSG Group, Asahi and

Saint-Gobain/Central, increasing their combined global market share from 49 percent to an estimated 68 percent.

Alternative consolidation trends can be expected as VMs seek to maximize leverage of their assets through partnerships, as well as taking strategic opportunities in developing markets. VMs will continue to look to their key suppliers to support them as they move into new markets.

Increased requirements by the VMs on automotive glazing suppliers favor those, such as Pilkington Automotive, able to offer:

- technical capabilities - shaping, optics, design feasibility/simulation
- global reach
- capital investment in support of both volume and developing technologies

A further industry trend, resulting from the VMs' drive to reduce costs in their core assembly operations, is the assumption by suppliers of activities previously undertaken by the VM.

Increasingly, automotive glass suppliers are becoming involved in the sequencing of product for 'just in time' delivery to the VM's assembly line. In some cases this may even involve the supplier working on the VM's line.

Demands on the glazing manufacturers are also becoming more intense, as VMs seek both to update their product ranges more frequently and to shorten the time taken to develop and bring their new models to market. To this end, major suppliers are today playing a key role in the design process, working closely with the VM in the early stages of development.

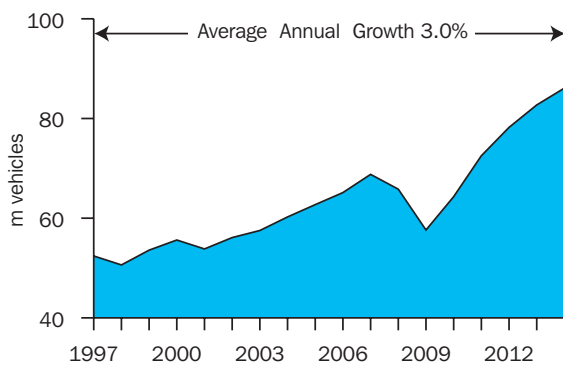
One aspect of the VMs' consolidation and globalization is the additional purchasing pressure this can exert on the supply base, particularly in an environment where cost reductions are a priority. Whilst not immune from such pressure, the glazing suppliers, such as Pilkington, increasingly work constructively with the VMs to identify areas of potential savings, ultimately providing benefits to both parties.

Automotive Glazing Demand Drivers

OE Market

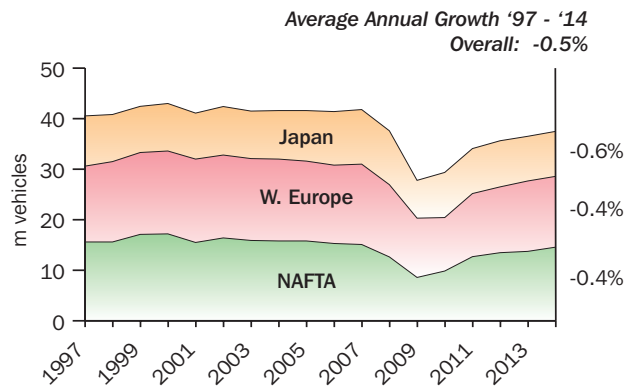
The basic driver of demand for any supplier to the OE industry is vehicle build. As can be seen in the chart below, historically the industry has exhibited steady growth, averaging 2 percent per annum in the 11 years through to 2008.

Global Light Vehicle Build - 1997 to 2014



However the unprecedented downturn that hit the industry in the last two years was so severe as to take global demand down to levels experienced in 2001, effectively reducing the historical growth rate to closer to 1 percent. Recovery is now underway in most markets. That, together with natural growth in developing markets, is currently expected to restore long term average annual industry growth to approaching 3 percent by 2014.

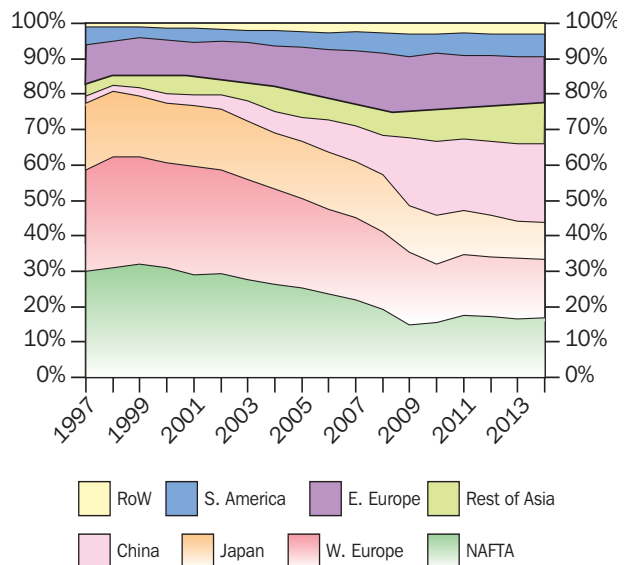
Light Vehicle Build 1997 - 2014 NAFTA, Western Europe & Japan



Despite the higher growth of the newer, developing markets, the three large developed markets; Western Europe, NAFTA and Japan, will retain a fundamental importance to the automotive industry for many years to come; not only because of their size, but also because they remain principal centers for new model development for all of the major VMs. The impact of the economic crisis on these mature markets was so severe that the volumes lost during 2008 and 2009 are unlikely to be fully recovered within the next four years.

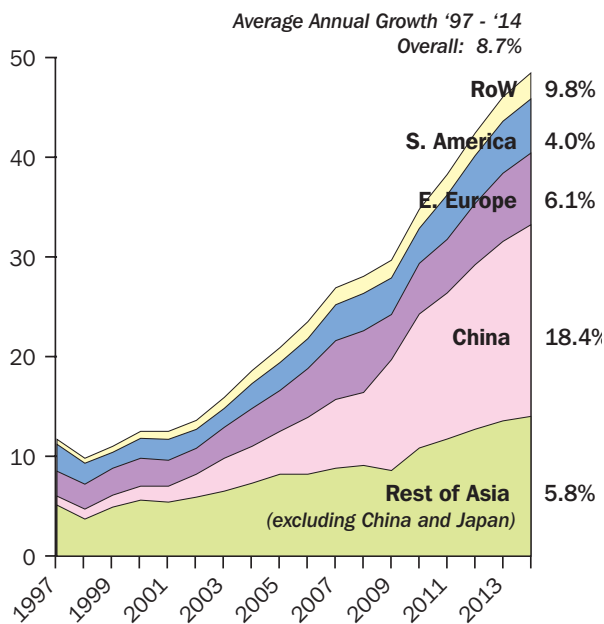
The increasing relative importance of developing automotive markets is evident from the chart below. Together, the developing regions of Asia (excluding Japan), Eastern Europe, South America and the Rest of the World comprised 22 percent of global vehicle production in 1991. By 2009 their share had risen to 52 percent and is expected to increase to 56 percent by 2014.

Global Light Vehicle Build 1997 - 2014



The annual average growth of these combined developing regions between 1997 and 2009 was over 8 percent, a rate that is currently expected to be maintained on average going forward.

Light Vehicle Build 1997 – 2014 Developing Markets



Of the developing regions, China has been the best performer to date, exhibiting average growth of 23 percent per annum since 1997. Vehicle build in Eastern Europe has also shown good growth averaging 5 percent since 1997, followed by the rest of Asia at around 4 percent per annum.

All of the developing markets will continue to be the source of the global industry's growth. Though future rates will reduce from the routine double-digit figures previously experienced in some markets, the combined average growth across these markets is currently expected to exceed 10 percent per annum over the five years to 2014.

However, glazing demand driven by vehicle build growth is only part of the automotive story. There are three other drivers of the automotive glazing industry, the first two of which directly impact the OE market, both in terms of volume, and importantly, value.

The first of these additional drivers is the growth in the amount of glass used per vehicle. Key to understanding this trend is recognition of the change in vehicle styling and features as a result of technology advances and public opinion. Generally, larger vehicles for replacement models, taller vehicles, new vehicle apertures and new market segments have brought about an increase in the amount of glazing used. The global growth for the midsize vehicle segments has led to vehicle manufacturers using more glass to generate a greater impression of light and space within smaller vehicles

Over the last 35 years, glazing area on equivalent models has increased in the order of 50 percent. Average windshield glazed area has increased by over 60 percent over the same period. With the use of large area

rooflights increasing significantly year on year, it is clear that glazing is being used as an exterior styling feature in addition to a tool to increase the feeling of light and space within a vehicle.

Due to the constantly rising expectations of consumers and increased focus on environmental responsibility throughout the major global markets, small SUVs, cross-over type vehicles and small/mid-sized cars are growing in popularity. A greater number of vehicle models with lower volumes per model means that greater differentiation is happening. Increased flexibility is needed as the market evolves and VMs are using styling as a vital selling tool.

Glazing is critical to vehicle styling and offers stylists a fantastic opportunity to influence the appearance of a vehicle and fundamentally, vehicle side glazing is being used to develop clear design aspects for the side of passenger vehicles.

There can be anything from six to more than 13 glazed apertures on current light vehicles, many fundamental to the overall style and appearance of a new vehicle

There can be anything from six to more than 13 glazed apertures on current light vehicles, many of which are fundamental to the overall style and appearance of a new vehicle. In particular, a vehicle's frontal aspect plays a huge role in terms of styling and the increasing use of panoramic and cielo windshields and rooflights is a key differentiating feature to bring value back into the glazing.

Europe and North America are currently leading the way with the adoption of laminated side-glazings for increased vehicle comfort and security. This increases glass usage through the replacement of monolithic side glazings by two plies of glass in each aperture and contributes significantly to the sales value of side glazings.

The second additional driver of business growth in automotive glazing is the increase in value-added content now being delivered by the leading suppliers to the OE industry.

Vehicle manufacturers are looking at ways for profit improvement and differentiation through products and features that the end user finds value in. Value-added also covers features in the glazing that allow a vehicle manufacturer to improve design, water management or make assembly operations easier or quicker.

Value-added product features would include: advanced acoustic control; solar control properties reducing solar heat gain; de-icing and de-misting capabilities; integrated antennas for radio, TV, cell phone, navigation etc.; integrated rain and light sensors for automatic wiper or headlight activation; hydrophobic and hydrophilic coatings for improved visibility, to name but some.

Value-added activity includes the supply of a complete glazing solution rather than just a piece of glass. Such systems use innovative finishing technologies, including encapsulation, extrusion and aesthetic functional trims, which enhance the vehicle’s styling and in certain cases, aerodynamics, as well as adding functionality and improving the VM’s productivity when glazing the vehicle. Today, glazing manufacturers are increasingly taking responsibility for the design and assembly of such complex glazing modules, for example, integrated tailgates for estate, crossover, MPV and SUV vehicles, including the glass, hinges, struts, wiper and latching mechanisms. Equally, the glazing installation may simply require the prior fitting of locating clips to the glass. Again, this ‘assembly’ activity is increasingly being undertaken by the glazing supplier.

As environmental responsibility plays a greater role in world affairs, regulatory requirements are likely to push the value of a vehicle glazing set up significantly through the introduction of high performance solar control glass products, including infra-red reflective windscreens and very high performance solar absorbing glass compositions. How regions of the world adopt CO₂ reduction glass technologies is yet to be fully understood.

The objective of the glazing standards is to help decrease in-vehicle temperatures and directly reduce the CO₂ output by having a lower requirement on the engine-driven mobile air conditioning unit. These regulatory requirements push the value of a vehicle glazing set up significantly through the introduction of high performance solar control glass products, including infra-red reflective windshields

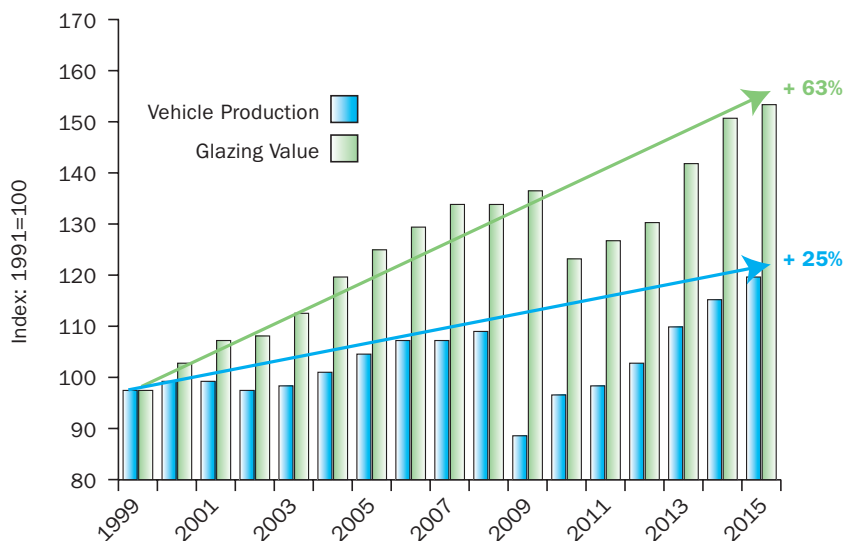
and very high performance solar absorbing glass compositions. How other regions of the world adopt CO₂ reduction glass technologies is yet to be fully understood.

Value Growth – Automotive

Demand	Growth drivers
Styling	Designers see glazing as a crucial element in designs to differentiate vehicles.
Curvature	Geometric demands increase the complexity and depth of curves in vehicle glazing.
Surface tolerance	Increasing depth and complexity of curvature makes surface tolerances critical, e.g. for efficient windshield wiper operation.
Security	Crime and vandalism increase the need for security, provided by laminated side, roof and rear glazings.
Solar control	Larger glass areas require tinted and coated glazing to reduce solar gain and air-conditioning load.
Glazing systems	Lean manufacturing require modularized glazing including trim and other fittings in one unit.
Integrated systems	Complex antenna arrays and electronics systems integrated into glazing

By way of illustration, the chart below shows the relationship between the growth in the number of vehicles built in the main European markets since 1999 and the growth in the value of the glazing in those vehicles.

European Light Vehicle Production versus Glazing Value – 1999 to 2014



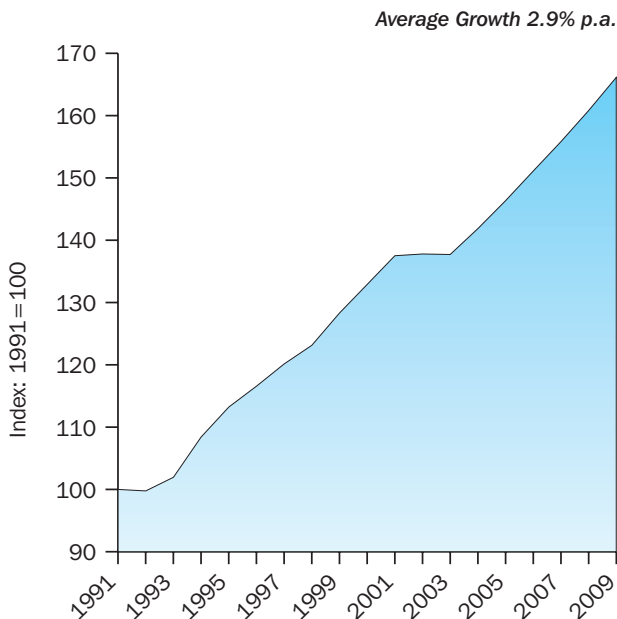
By 2008, vehicle growth and glazing value growth has been 13 percent and 41 percent respectively. By 2015, equivalent growth numbers are estimated to reach 25 percent and 63 percent. The rate of adoption of the different types of value added features will however vary from region to region. In North America, for example, glazing systems are likely to be of greater importance, whilst Japan will lead on certain kinds of integrated antennas.

A more detailed explanation of Automotive value-added products and services can be found in section 3.4.

AGR Market Drivers

The third area driving overall automotive glazing demand is the replacement (AGR) aftermarket market. Here, market demand is determined by the number of vehicles in use and a replacement rate, which in itself will vary from one geographic market to another, depending upon the combination of a range of factors.

Global AGR Demand – 1991 to 2009



Principal influences on replacement rates are: average miles driven, speed, road surface conditions, climate, disposable income, vehicle crime levels, national legislation, repair/replacement ratio and insurance company policy.

Glazing replacement tends to be greatest within the well-developed markets of Western Europe and North America, often driven by annual vehicle roadworthiness inspections, typically with rates in the 6 to 8 percent range. By way of contrast, the replacement rate in Japan is lower, particularly for windshields, due to the country's lower vehicle usage as opposed to its relatively high vehicle ownership.

Due to the relatively higher levels of accidental breakage of windshields from objects thrown up by vehicle wheels versus breakages of other glazings resulting from collisions or theft, aftermarket demand is normally heavily biased towards laminated rather than toughened glass, typically a ratio of around 3:1. This leads to a higher average value per piece of glass than in the OE market.

Long term growth in AGR volumes estimated at around of 2.9 percent p.a.

Additionally, the styling/design influences and value-added features previously described as driving glass business in the original equipment market, are increasingly having a positive impact on the aftermarket. As can be seen from the chart (left), long term industry growth in AGR volumes alone is estimated at around 2.9 percent per annum.

Specialized Transport

The Specialized Transport market comprises a number of sectors:

- Truck (greater than 3.5 tonnes)
- Bus and Coach (including recreational vehicles)
- Off-road (including agricultural and construction vehicles)
- Railway (including tram, light rail and high speed locomotive)
- Marine (including small leisure craft to luxury cruise liners)
- Micro cars

These sectors are made up of a consolidating base of regional vehicle makers and assemblers and some are now major players on a global scale.

Global Truck Build 2009 ~2.5 million

The Truck sector is by far the most consolidated and, of all the sectors, can be most closely compared with the OE customer base in terms of its global spread and organization. The largest global manufacturer is Daimler, who recently formed a joint venture with the highest volume Chinese truck maker Beiqi Foton. This is the latest development in a trend that is seeing OEMs expand globally through JVs, but also by shifting their export production away from their traditional Western European locations closer to their global markets. Glazing requirements are becoming more complex as new fleet design incorporates improved visibility, safety and driver comfort features.

Truck production stalled as fleet replacement was delayed in response to the economic downturn, but recovery is now in evidence. The mature markets have begun, what is expected to be, a slow recovery back to pre-recession levels, while the emerging markets are showing much stronger growth. China and South America in particular are increasing rapidly, supported by investment in infrastructure, government incentives, the introduction of 'clean' legislation and the increase in freight.

Global Bus & Coach Build 2009 ~ 400,000

The Bus and Coach sector has a relatively small number of chassis and engine suppliers, such as Daimler, Scania and MAN, which are strongly linked to the Truck sector. However, the assembly of the coachwork and body building is significantly more fragmented: There are a few large regional assemblers such as Evobus and MAN in

Europe and Navistar in North America, and a large number of smaller independent companies usually supplying local markets. Some of the larger European manufacturers such as Daimler, Volvo Bus, MAN and Scania Bus are starting to expand operations into emerging markets through JVs and in the long-term this is likely to bring about more consolidation of the market.

The global Bus and Coach market is expected to grow at a steady but moderate rate, with significant regional variation characterized by strong growth in Asia and South America compared with relatively flat growth in the more mature markets such as Europe.

Large bus and coach production represents around 15 percent of annual truck production volumes but the build rates alone do not truly represent the sector's worth; the amount of glass in a 12-meter long bus or coach is typically ten-times that for a truck. Glazed areas have increased significantly with styling trends; the area of a windscreen alone can now exceed six square meters and glass is being incorporated into more areas of the bus such as roof lights above passenger seating to add more clarity in the models. The market drive for style differentiation and improved levels of driver and passenger comfort means that the trend for adoption of more value-added glazing applications is expected to continue in the developed markets and rise rapidly within the emerging markets.

Global Off-Road Vehicles (glazed) ~ 1.5 million

The Off-road Agricultural sector is characterized by three major global players, John Deere, Case New Holland and AGCO. In contrast, the construction sector is still considerably more fragmented although there are some large global manufacturers such as Caterpillar, JCB and Komatsu. The off-road agricultural sector remains depressed and recovery will be slow, possibly never returning to the record highs that were driven by high oil prices and resultant demand for bio-fuel commodities. The construction sector is recovering more quickly as economic recovery re-starts building projects. Longer-term demand will grow across all regions, but with particular strength in South America and Asia where major construction and infrastructure improvement projects are planned.

The pressure to globalize further still exists in these major sectors. Western OEMs are shifting from their traditional bases to be closer to their customers. In addition, emerging markets are demanding higher quality and more complex products, which may be beyond the capability of the smaller, fragmented, domestic OEMs.

The Railway sector comprises a small number of rail transport and rail infrastructure manufacturers such as Alstom Transport, Bombardier, Siemens and Kawasaki Heavy Industries. Railway demand is governed by national and municipal public transport policies and is project

based. Higher fuel prices and the trend for more environmentally responsible mass transport systems is likely to lead to steady growth in demand for rail transport in the long-term.

The Marine sector covers leisure boats from 5.5 meters up to luxury cruise liners. Leisure boats are manufactured by a small number of regional manufacturers such as Bella Boats, Fiskars, Nimbus and Windy, who take complex tempered or laminated glass directly from glass manufacturers or via aluminium/stainless steel framers. The demand for leisure boats is sensitive to economic conditions and reduced consumer confidence. Future growth will be closely linked to rate of the economic recovery in each region.

Luxury cruise liners are built by a small number of shipyards, based mainly in Europe. Although part of the marine sector, the glazing is more aligned to building products, typically comprising large glass panels and roofs and fire-resistant structures. Existing projects sustained the cruise liner market throughout the recession, but new orders were delayed as the companies owning and operating the ships waited to assess market conditions. Signs of market recovery can now be seen, with European shipyards, such as Fincantieri and STX-France, reporting that new contracts have restarted. Traditionally, ship building capacity has been centered in Europe, but Korea is beginning to challenge this dominance.

Most of the major vehicle manufacturers are extending their range to include vehicles from the electric micro car sector. In addition, the sector has attracted many new entrants to the automotive business. Government incentives for cleaner cities are expected to promote high growth in this area in the coming years. Although the micro cars have a small vehicle footprint, they typically incorporate large and complex glazing areas.

The number of sectors in the Specialized Transport market and their relative lack of consolidation on the demand side have led to a preponderance of regional suppliers, with Pilkington Automotive being the only truly global supply option.

3. Pilkington – a leading brand in a growth industry

3.1 Corporate Overview

The NSG Group, which operates under the Pilkington brand in Building Products and Automotive, is one of the world's largest manufacturers of glass and glazing products for the building and automotive markets, with manufacturing operations in 29 countries on four continents and sales in around 130 countries.

In the fiscal year ended 31 March 2010, the NSG Group reported sales of JPY 588,394 million (approximately euro 4.7 billion). Of the Group's consolidated sales, 44 percent were generated in Europe, 29 percent in Japan, 13 percent in North America and 14 percent in the rest of the world.

The Pilkington brand in Flat Glass

Pilkington was founded in 1826 as a partnership and became a private company in 1894. It remained a private company until 1970 when its shares were listed on the London Stock Exchange. Pilkington plc was de-listed from the London Stock Exchange in June 2006 on becoming a wholly-owned subsidiary of the NSG Group; itself established in 1918.

The NSG Group has major market shares in most building and automotive product markets of the world, with a broad geographic reach, enabling it to respond to customers whose operations, particularly in the case of Automotive OE, are increasingly global.

Flat Glass businesses of the NSG Group

Building Products and Automotive now account for just under 90 percent of NSG Group sales. In the financial year ended 31 March 2010, Building Products accounted for 42 percent of Group sales and Automotive for 46 percent of Group sales. In Building Products, the largest business is in Europe (accounting for 51 percent of the business line's sales).

The next largest business is in Japan, with 31 percent of Building Products sales, the rest of the world with 10 percent and North America with 8 percent of Building Products sales. In the case of Automotive, Europe is also the largest business, with 51 percent of the business line's sales, followed by North America with 21 percent, Japan with 16 percent and 12 percent in the rest of the world.

Building Products

Building Products has manufacturing operations in 23 countries. Its largest operation is in Europe, but it also has major interests in Japan, North and South America, China and South East Asia.

This business encompasses the NSG Group's activity in manufacturing float and rolled glass, coating, toughening and silvering, the production of other processed building glass products for exterior and interior applications and glass for the growing solar energy sector.

Automotive

Pilkington Automotive is one of the world's largest suppliers of automotive glazing products. It operates in three main sectors; supplying original equipment, aftermarket replacement glass and products for specialized transport.

Its footprint, including fabrication plants, OE satellite facilities and its AGR distribution network encompasses Europe, Japan, North and South America, China, South East Asia and India.

Employees

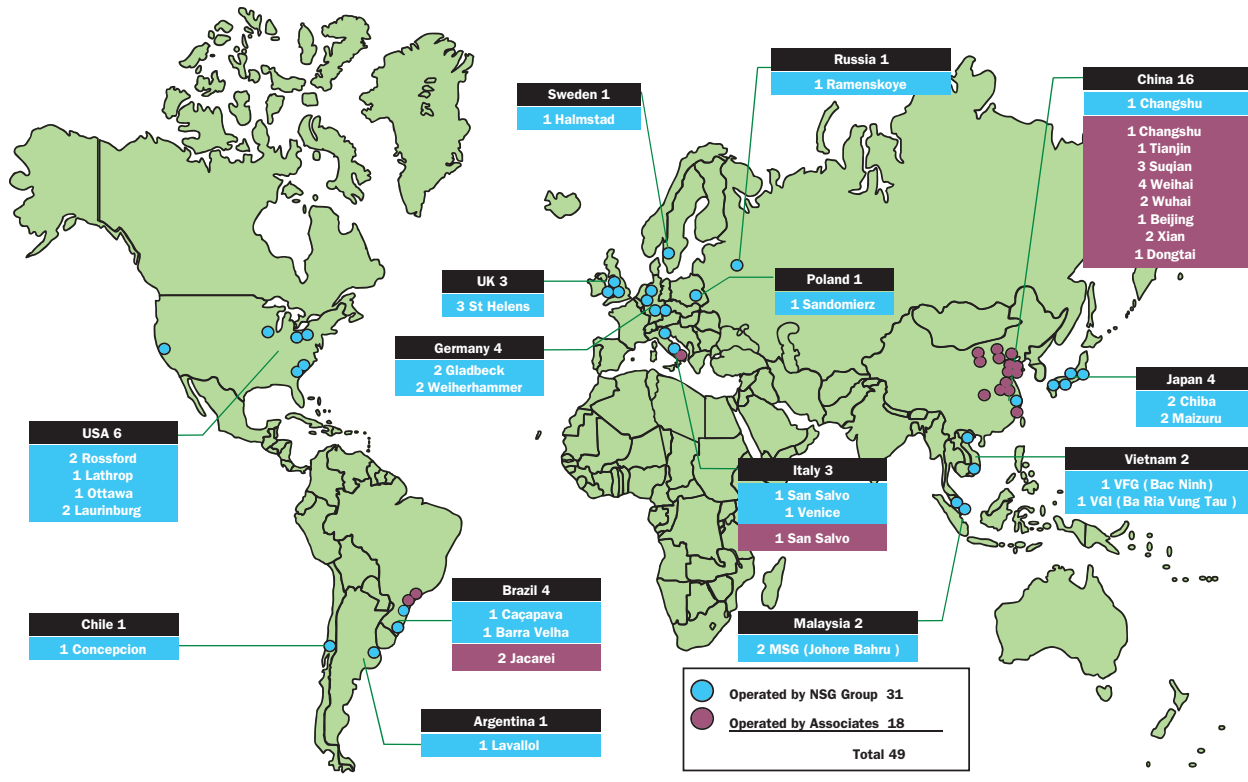
At 31 March 2010, the NSG Group had around 28,300 permanent employees working worldwide.

Management Structure

The Chairman of the NSG Group is Katsuji Fujimoto. The President and CEO, responsible for managing the operations of the Group, is Craig Naylor. The Group Finance Director is Mike Powell.

The worldwide Building Products business is managed by Mark Lyons, with regional Building Products managing directors for Europe, Japan, North America, South America, China and South East Asia. The worldwide Automotive business is managed on a global basis by Mike Fallon. The Specialty Glass business is managed by Keiji Yoshikawa.

NSG Group Global Float Manufacturing Operations



3.2 Business Profile

Global Reach

The NSG Group has a broad geographic reach. This global presence enables the Group to take advantage of diversified sources of raw materials and to capitalize on the advantages of the best local labor forces available. It also enables the NSG Group to provide excellent responsiveness in terms of product range, quality and delivery times to its customers, who, in the case of Automotive OE, have themselves become increasingly global.

The NSG Group is one of only four companies in the flat glass industry that can claim to be true global players, the other three being AGC (Asahi), Saint Gobain and Guardian. The Group is either already established or is developing operations in leading emerging markets, with key target markets such as China and India.

Broad Manufacturing Base

The NSG Group's manufacturing base includes float glass lines operating in Europe, Japan, the Americas, Southeast Asia and China, with Automotive operations covering all major markets worldwide.

The Group operates an extensive network of 49 float lines, giving full coverage of the global market and providing the Group with advantages in terms of strategy, efficiency and effectiveness. As part of the Group's restructuring program, float capacity has been reduced to match market demand. Some of the Group's float lines have been mothballed, with others on temporary hold awaiting the upturn.

Strong Market Positions

The integration of the Pilkington and NSG business platforms has historically helped mitigate the effects of market cycles in the area of architectural glass and has given the Group a superior presence in developing markets such as South America, China, South East Asia and Russia.

The integration has moved the NSG Group to a leading global position in the automotive glass market and, despite the current downturn, the Group remains well positioned to meet the overseas production needs of Japanese automakers.

Restructuring

In January 2009, the Company announced restructuring initiatives designed to address the economic downturn and to improve profitability going forward. These built on action already taken in response to sudden and rapid changes in the global economic environment. The overall objective of the program was to protect the business in the short term and to re-establish profit growth from FY2011 onwards.

The restructuring program was completed as planned during FY2010. 2,200 employees left the Group during FY2010, bringing the total headcount reduction to 6,700.

The restructuring included management headcount reduction through reorganization, shift reductions and line closures in some plants, and temporary and permanent plant closures throughout the Group's global operations. The restructuring produced cost savings of ¥16 billion during FY2010. The cost of the restructuring program charged to the income statement during FY2010 was ¥6.6 billion, as anticipated.

Strategic Direction

The NSG Group is following a 3-phase strategy. We have completed Phase 1; integrating the business and strengthening competitiveness, improving our financial strength and preparing for future growth.

Our new Strategic Management Plan, announced in November 2010, marks our transition into the next four years and Phase 2. Our strategic focus in the period is on leveraging our glass-based technologies into existing and new glass market segments. We are expanding into emerging markets and added-value products; particularly those concerned with the conservation and generation of energy.

The overall goal of the Plan is to maximize profitable growth while reducing our net debt/EBITDA ratio, ensuring that we operate to the highest standards of ethics, safety, environmental responsibility and Sustainability in everything we do.

To achieve our business objectives of profitable growth and creation of shareholder value under the Plan, we will be:

- Creating a thriving global enterprise, capitalizing on the widened international scope of the Group, operating a meritocracy without barriers.

We aim to ensure that all employees in the Group have the opportunity to contribute to the success of the business and to fulfill their potential, regardless of nationality or country of operation.

- Widening further our geographical spread, with major expansion in emerging markets with high growth potential.

Key markets identified for expansion are South America, Mexico, Eastern Europe, South East Asia and China.

- Operating in those sectors in which we can add the most value to our customers and the markets they serve, while making a positive environmental sustainability contribution to the key value chains in which we participate.
- Sharpening the focus of our product range, moving increasingly from commoditizing products to value-added products incorporating our proprietary technologies, to meet increasing global demand for products addressing climate change issues.

Key products identified for expansion are our low-e energy-saving glass, solar energy glass for photovoltaics, solar heat management in vehicles and our glass fiber technology for use in advanced batteries for the next generation of vehicles.

- Leveraging our glass-based technologies into existing and new glass market segment, using existing technology, manufacturing capability and capacity, strategic partnerships and product range to address energy conservation and generation.
- Capitalizing on the restructuring actions we announced in 2009 and completed in 2010, which have improved operational leverage and re-focused resources.
- Further strengthening our financial position.

To accelerate these plans, the Group announced, in August 2010, a major exercise to issue and sell additional shares in the Company through a global offering (public offering in Japan and international offering to institutional investors). The specific growth plans this funding exercise will support involve the NSG Group's further expansion into emerging markets with high growth potential, particularly South America, Mexico, Eastern Europe, South East Asia and China. It will also enable the Group to capitalize on growth prospects offered by what we see as increasing demand for added-value products that help address climate change issues.

Strategic Alliances/Joint Ventures

In addition to its substantial owned capacity, the NSG Group uses manufacturing and other joint ventures as a key strategic tool, promoting market development, business growth and risk sharing. In common with other major players in the industry, the NSG Group has also used technical alliances with other glassmakers in order to promote and develop specific technologies and/or gain access to certain markets.

There are many examples of glass manufacturers sharing the risk of new float investments, either with other manufacturers or with financial partners in emerging

markets, or in developed markets with secondary processors who wish to backward integrate to secure float purchases.

The NSG Group is no exception to this trend and the strategy of entering new markets and/or expanding existing operations in emerging markets has been prudent. Historically, there has been a preference for venture partners in countries it does not know well or where risk-sharing is important.

Technical Leadership

Before the acquisition, the Pilkington/NSG relationship had centered on a cooperation agreement between the two companies' automotive R&D activities, enabling joint automotive technology development and implementation.

Both companies were founded on technological innovation in Flat Glass and the NSG Group intends to invest in sustaining this technology to create shareholder value and to be technological leader in the global glass industry.

Pilkington played a key role in the industry's technological advances in the 20th century, including Sir Alastair Pilkington's invention of the Float Process, announced in 1959. This centered on the idea of forming a ribbon of glass by 'floating' the melted raw materials at high temperature over a bath of molten tin. The float glass process eventually replaced the twin grinding and polishing process for making plate glass to become the universal process for the manufacture of high quality glass. See Appendix 1 for more details.

Today, the NSG Group's technical and manufacturing resources are well integrated into global programs that

identify and respond to market needs and increase the efficiency of production. The technology function has been developed to meet the needs of the building and automotive products business lines, ensuring that each has access to its unique technologies as well as those (such as glass composition and coating) which are common to both.

Each business line operates a globally managed R&D program with strong links between them. The NSG Group is thus able to prioritize objectives on a global basis and rationalize its resources to remain cost efficient while maintaining its responsiveness to the need for cost reductions and new products.

Intellectual Capital

The NSG Group is a global leader in manufacturing excellence and innovation, notably in the areas of glass melting, glass forming by the float process, online coating and complex shaping technology, especially for automotive windshields and backlights. The Group invested JPY12,071 million in R&D in FY2010.

The NSG Group owns or controls approximately 4,000 patents and patent applications, predominantly in the fields of float glass production and processing and automotive glazing and also in the Information Technology field, and has access under license to patents held by third parties. The Group has also been active in selective licensing of its patents and technology, in the areas of online coating, encapsulation (of automotive glazing) and rain sensors for automotive glazing.

Innovation

The Pilkington brand is closely identified with technical excellence, having been associated, over the past fifty years, with most major advances in glass technology, including the invention of the Float Process. Notable Pilkington and NSG innovations over the years include:

- Energy-saving products such as Pilkington **K Glass™** and Pilkington **Energy Advantage™**
- Advanced bending processes for making car windshields in complex shapes to fine tolerances.
- Pilkington **Pyrostop™** advanced fire-resistant glass.
- EZKOOL®, Sundym™ and Galaxsee™ solar control glass for cars.
- Solar reflective automotive glazing.
- Pilkington **Solar E™**, clear solar control glass, preventing heat buildup in buildings.
- Pilkington **Planar™** structural glazing system.
- Pilkington **Spacia™**, vacuum glazing, high performance energy saving in a very thin unit.
- UMU™, switchable privacy glazing for internal partitions.
- The 3R™ clean air process for reducing nitrogen oxide emissions from glass furnaces.
- Pilkington **Activ™** dual-action self-cleaning glass.
- NSG **TEC™** range of glass for Thin Film Solar and Pilkington **Sunplus™** for the CSi Solar sector.

Competitiveness

The NSG Group operates in two of the most competitive markets in the world; float glass production and automotive component supply, and is well aware of the commitment and effort needed to stay ahead. The delivered cost of float glass is fundamental to success and management intend to take every opportunity to reduce costs further.

To consolidate the NSG Group's position as the lowest cost producer of float, and to remain competitive in Automotive, the Group aims to achieve a continuous reduction in its cost base.

Growth Strategies

Despite the downturn, the NSG Group is continuing with the strategy of pursuing carefully selected opportunities for profitable growth in Flat Glass. Recent growth strategies have fallen into three broad categories. Examples of each are listed below.

Growth of Existing Products in Established Markets

Investments have been completed in Pilkington Automotive's plant in Sandomierz, Poland, to provide additional capacity and capability to manufacture the range of value enhancing products required by VMs.

Pilkington Automotive's Specialized Transport business, supplying glazing systems to buses trucks, trains and ships, continues to grow market share in a sector in which the Group is already a world market leader. A new fully integrated windshield line was launched in Italy.

New Products and Value-Chain Growth

The Group stands to benefit from the growing need to conserve energy. Its added value products, such as low-e glass, solar control glass and glass for photovoltaics have the principal purpose of reducing energy consumption in buildings and generating energy from the sun.

In every region of the world in which the Group operates, the need to save energy is a political priority. Buildings account for almost 50 percent of the energy consumed in developed countries.

Governments are putting increased focus on legislation and policies to improve their energy efficiency. In North America, initiatives such as the environmental building rating system (LEED) run by the US Green Building Council are helping to transform the market for added-value glazing, and this will continue.

Similar opportunities are anticipated in Europe, for example, through the development of an EU-wide Energy Labeling system for windows. In China, legislation is at an earlier stage, but the government has already introduced building regulations to improve the energy efficiency of new buildings.

Over the past year, the Group's Building Products business line has launched a number of energy-efficient products across Europe. These include Pilkington **Suncool™** 70/35, offering a solution to an ever-increasing need to achieve outstanding energy efficiency within buildings without compromising levels of natural daylight.

Its very low total heat gain and extremely high light transmission maximize the thermal comfort and aesthetics of a working or living environment.

The Group has also seen excellent growth in the sales of the range of energy efficient products launched in 2008 under the Pilkington **energiKare™** brand, offering home owners the opportunity to improve the efficiency of their windows by up to 90 percent.

Glass has an important role to play in the development of the growing Solar Energy sector. The NSG Group is well placed to supply products for all three of the leading technologies, converting power from the sun into clean renewable energy.

Geographic Expansion

The Group's first Automotive plant in India has been constructed at Vizag in southern India and started production at the end of 2008. The plant is initially concentrating on the production of Aftermarket (AGR) parts for export.

A new low iron rolled line in Taicang China started production in June 2008.

The integration of the aftermarket businesses of GIMA, a leading supplier of automotive aftermarket glazing, with operations in Hungary and Romania, has further enhanced Pilkington Automotive's European AGR network.

In China, the new on-line coating system at the Group's JSYP joint venture plant in Jiangsu was commissioned in October 2009. The Group plans to expand further its capability to produce low-e products, such as Pilkington **Energy Advantage™**, in China.

In May 2009, the Group's Malaysian operations started production of its medium-performance solar control glass range, Pilkington **Reflite™**, for both domestic and export markets.

Proactive use of eCommerce

The NSG Group has been active in developing a platform to exploit eCommerce, particularly in the business to business (B2B) sector. It has developed and introduced eCommerce solutions that are both standardized and tailored to local languages and business methods. Most customers and suppliers in the Building Products and Automotive businesses are now able to do business online.

3.3 Building Products Overview

Building Products represented 42 percent of the NSG Group's revenue in FY2009/2010. Its operations are organized into six businesses; Building Products Europe, Building Products Japan, Building Products North America, Building Products South America, Building Products China and Building Products South East Asia.

Float glass for the building market is sold without further processing or processed into products with additional properties. Pilkington branded products help control energy usage, protect against fire, insulate against noise, provide safety and security, afford decoration and privacy, self-cleanse, are used to build all glass facades and include glass for specialized applications.

Large-scale coating, laminating, and silvering processes are used to make these products. BP has float glass manufacturing or processing operations in the following 21 countries; United Kingdom, Germany, Japan, Malaysia, Vietnam, China, Austria, France, Netherlands, Italy, Denmark, Norway, Sweden, Finland, Czech Republic, Poland, Russia, United States, Argentina, Chile and Brazil.

Building Products' main activities include:

- Float manufacturing: 0.4 mm to 25 mm, clear, tinted, extra clear, on-line coated
- Rolled manufacturing
- Semi-finished products: off-line coated, laminated, silvered
- Processing: toughening, insulating glass units, merchandising, fire protection
- Glazing systems: e.g. Pilkington **Planar™** (frameless glazing system).
- Products for the Solar Energy sector

Product Range & Brands

Pilkington branded products are designed to create the ideal environment in which to live and work. Coated and tinted products, and Insulating Glass Units, help control the flow of energy into and out of buildings.

Solar Control

Solar control is a key issue in terms of energy saving. In hot conditions or for buildings with high internal loads, solar control glass is used to minimize solar heat gain by rejecting solar radiation and help control glare. In more temperate conditions it can be used to balance solar control with high levels of natural light. The correct choice of glass can help to reduce the capital outlay, running costs and associated carbon emissions of a building throughout the year.

Given the variety of building designs and climatic conditions and the different levels of exposure to solar radiation during the year, the choice of glass must be able to protect the inside of the building to ensure maximum comfort, minimize energy consumption, guarantee safety and, not least, provide the optical and aesthetic qualities that satisfy the designer.

The NSG Group is continually innovating and developing products that satisfy the full range of architectural requirements. Pilkington innovative solar control products cover the whole range:

- From the highest performing, off-line coated, solar control and low-emissivity products within the Pilkington **Suncool™** range;
- through on-line environmental control glasses that combine medium performance solar control with low-emissivity such as Pilkington **Eclipse Advantage™** and Pilkington **Solar-E™** ;
- to medium performance reflective glasses such as Pilkington **SunShade™**, Pilkington **Reflite™** and high performance tints such as Pilkington **Arctic Blue™**;- To low-performance, body-tinted glass in the Pilkington **Optifloat™** Tint range;
- and even to solar control glass combined with the revolutionary, self-cleaning Pilkington **Activ™**.

In addition to the above ranges, the Pilkington Solar Control range can be used with many other Pilkington solutions, to achieve countless benefits in terms of safety, functionality and cost-efficiency.

Thermal Insulation

Advances in low-e glass technology have made windows an essential contributor to energy conservation and comfort, minimizing heat loss and internal condensation.

Low-e glass reflects energy back into a building, to achieve much lower heat loss than ordinary float glass. Different types of low-e glass allow different amounts of passive solar heat gain, which helps reduce heating requirements and costs, especially in colder months.

Pilkington's low-emissivity range covers all levels of requirements:

- from on-line products such as Pilkington **K Glass™** and Pilkington **Energy Advantage™**;
- to extremely low Ug-value off-line solutions in the Pilkington **Optitherm™** range;
- through to Pilkington **Suncool™**, Pilkington **Solar-E™** and Pilkington **Eclipse Advantage™** which are primarily solar control products that also offer low-emissivity properties.

Pilkington **Spacia™** is the world's first commercially-available vacuum glazing, offering the thermal performance of conventional double glazing in only the same thickness as single glass. Pilkington **Spacia™** is available in laminated form for additional safety performance. It has a low overall thickness as well as a good acoustic performance, and is ideal for use in historic buildings, offering replacement windows more in keeping with the original design.

Pilkington **Spacia™** may even allow the use of the original frames. Already successful in Japan, sales are developing worldwide, particularly within historic buildings.

Pilkington **energikare™** is a family of energy efficient Insulating Glass Units innovatively using low iron float glass Pilkington **Optiwhite™** in combination with Pilkington **K Glass™**, to provide the best possible energy efficient performance. Sales are now developing in the UK where this exceptional combination of thermal insulation and passive solar gain helps domestic window companies meet homeowner demand for more energy efficient windows. The product is being used in both replacement windows for homes and in newly built dwellings utilizing both double and advanced triple glazing technology.

Fire Protection

The Pilkington brand has been at the forefront of fire-resistant glass innovation since 1896, when Pilkington first introduced wired glass. As a leading manufacturer of fire-resistant glass and a pioneer in the market for transparent fire protection, the NSG Group sets particularly high standards in level and consistency of performance and visual quality.

As a pioneer in the market for transparent fire protection, Pilkington sets particularly high standards in level and consistency of performance and visual quality. Pilkington employs three product lines and technologies to protect people and property against fire

- Pilkington **Pyroshield™** 2 (wired glass),
- Pilkington **Pyroclear®** (basic integrity with the superior edge system), and
- Pilkington **Pyrostop®** and Pilkington **Pyrodur®** (a special proprietary clear intumescent interlayer technology).

The range of transparent interlayer products is the global market leader in high performance fire-resistant glazing, combining additional functional properties if required.

The products in that range provide not only protection against flames and smoke but also a high degree of protection against the heat of a fire, by all transfer mechanisms (i.e. conduction, convection, and radiation). Pilkington **Pyrostop®** and Pilkington **Pyrodur®** have

been tested in more fire doors, fire protection framing and façade systems than any other fire-resistant glass products, covering vertical, horizontal and inclined glazed situations.

As an example of the high level capability of the intumescent interlayer system, the tested range of approvals includes many high performance constructions used in sensitive buildings and areas such as schools, hospitals, commercial and retail buildings, and airports.

The emphasis of the Pilkington intumescent technology is on fitness for purpose, reliability and repeatability of performance. Today, Pilkington's fire-resistant glasses are well respected and used in various building, marine, and rail transport applications all over the world.

Noise Control

With increasing traffic on the road, rail and in the air, noise insulation has become a very important topic. It is not a question of it being a luxury anymore it is essential that noise reduction is considered in the specification of the glazing. With regard to employment law, comfort and medical necessity, noise insulation in building construction is an undisputed requirement to decrease stress and noise-related illnesses.

Pilkington **Optiphon™** is the ideal choice of glass in situations where there is excess noise from road, rail or air traffic, or various other sources, for example factories or nightclubs. By using a special PVB (Poly Vinyl Butyral) interlayer, Pilkington **Optiphon™** is a high quality acoustic laminated glass that offers excellent noise reduction without compromising on light transmittance or impact performance. The desired acoustic performance can be achieved through combining various thicknesses of glass with a PVB interlayer. With a large variety of product combinations, Pilkington **Optiphon™** offers the opportunity to achieve specific noise reduction requirements.

Safety and Security

Innovations in the development of safety and security glasses have opened up new avenues of design, allowing both people to be protected from personal injury and in the most extreme cases, buildings to be protected from various forms of attack without compromising levels of natural light and visibility.

The term 'safety' is applied to glazing used to reduce the risk of accident by impact, fracture, shattering, or in a fire. The term 'security' is applied to glazing which is also able to withstand deliberate attack of various kinds (physical or armed). Specialist glass of this type must be combined with high performance glazing and framing systems, capable of offering the necessary resistance to the severe loads that could be imposed.

Parallel to this, stringent safety legislation has been implemented which stipulates the critical areas where safety glazing must be installed to comply with required safe practice.

Pilkington has developed a wide range of sophisticated glasses to meet these increasing demands for protection of both people and property.

Pilkington Toughened Safety Glass is a glass that has been subjected to a heating and cooling treatment whereby high compressive stresses are set up at the surfaces with balancing tensile stresses in the centre. The high compressive surface stresses give the Pilkington Toughened Glass its increased strength (up to five times stronger than ordinary glass of the same thickness).

Pilkington **Optilam™** is a laminated glass that provides both impact resistance and security since it may break on impact, but the glass is held in place thus preventing injury or intrusion. The performance of Pilkington **Optilam™** can be varied by changing the number and thickness of glass panes and interlayers in combination.

Self-Cleaning Glass

Pilkington **Activ™** is the world's first dual-action self-cleaning glass. Its unique coating uses the forces of nature to help keep the glass clear of dirt, giving not only the practical benefit of less cleaning, but also clearer, better looking windows.

It works in two ways: first it uses daylight to break down organic dirt and then it uses rain to wash any loosened dirt away. Pilkington **Activ™** also dries off faster leaving the glass cleaner and with reduced streaks, which gives beautiful clear views and makes it ideal for various applications, from building façades to conservatory windows.

Pilkington **Activ™** is an on-line coated product and therefore can be toughened, processed and handled using standard techniques. The Pilkington **Activ™** Solar Control range combines the benefits of self-cleaning with varying degrees of solar control performance to offer the ultimate range of solar control solutions for hard to reach places that are difficult to clean.

Pilkington **Activ™ Blue** and Pilkington **Activ™ Neutral** are colored tinted glass combined with Pilkington **Activ™** coating and are perfect for use in conservatories and glass roof structures. Pilkington **Activ Suncool™** is a range of glass products with a coating on both surfaces; it combines self-cleaning, thermal insulation and the highest solar control performance. Pilkington **Activ™** can be further enhanced when combined with other Pilkington products to offer additional advantages such as thermal control, noise control or safety.

Decoration

As well as offering functional benefits, glass is also used to enhance the appearance of the environment.

The Pilkington range of decorative glass turns it from a basic construction material into a means of adding style and elegance. By incorporating decorative glass, you can add privacy and meet any requirements, aesthetic or practical.

The Pilkington Texture (Patterned) Glass offers privacy and style throughout the home. The range is continually updated to introduce new and exciting patterns.

Pilkington Screen Printed Glass is a clear or tinted float glass, which has been printed with ceramic ink designs and subsequently toughened, a process which also fires ceramic paint into the glass surface.

Pilkington Screen Printed Glass is available in wide range of colors and designs that fully or partially cover the surface of the glass.

Pilkington Spandrel Glass is a toughened safety glass mostly used in non-vision area of the façade. The extensive range of products that has been developed for use as spandrel panel includes: Pilkington Spandrel Glass Enamelled, Pilkington Spandrel Glass Silicon and Pilkington Spandrel Glass Coated.

Pilkington **Optimirror™**, the best quality mirror is produced using the latest environmentally friendly processes and materials. This is now available in a safety backed version in the Pilkington **Optimirror™** Protect range.

Glass Systems

Pilkington **Planar™** is a structural glazing system, allowing architects immense flexibility in the appearance of façades, whilst incorporating all of the functionality required from windows in today's buildings. Pilkington **Planar™** can incorporate most Pilkington glass types - which includes the range of solar control products, low emissivity glass, screen printed glass and Pilkington **Activ™** self-cleaning glass.

Another popular product, Pilkington **Profilit™** is a range of alkali cast glasses in U-shape, produced using the machine rolling process. It is translucent, but not transparent, with a patterned surface on the outside and has the quality features of cast glass. This highly durable product allows light to enter buildings whilst presenting a translucent external appearance. A wide range of fitting options provides considerable flexibility.

Special Applications

Glass for Special Applications provides unique characteristics used in both building and non-building applications:

- Pilkington **Optiwhite™** is an extra-clear, low-iron float glass; it is practically colorless, and the green cast inherent to other glasses is not present. It is therefore ideal for use where glass edges are visible or here a neutral color is desired. As its light transmission is a lot higher than clear float glass, it is perfect for applications where transparency and purity of color are required.
- Pilkington **OptiView™** is an anti-reflective glass that combines two proprietary pyrolytic surfaces in a single laminated glass. It reduces interior and exterior light reflectance to around 2 percent and allows more visible light to pass through, compared to clear float glass. As a consequence, views from both inside and out are clear, un-obscured and virtually reflection-free. Pilkington **OptiView™** offers all the traditional benefits of laminated glass, such as improved safety, enhanced security, durability and acoustic properties. Furthermore, it provides protection from UV radiation (UVA and UVB) by blocking over 99 percent of UV transmittance, helping to prevent fading of the contents and interiors of a building.
- Pilkington **Microfloat™** and Pilkington **Microwhite™** are extremely thin, high-grade float glass manufactured to precise standards. Pilkington **Microfloat™** has traditionally been used for the production of microscope slides, cosmetic mirrors, chromatographic plates, LCD photo masks, automotive and technical glass, PC display screens and tablet PCs. Its low iron composition version, Pilkington **Microwhite™** is well suited for many applications and is also ideal for use in solar concentrator applications.
- Pilkington **Mirropane™** is a coated glass product developed for use as a one-way mirror where total clear vision is required and specific lighting conditions can be achieved. Under specified lighting conditions it offers an effective means of providing undetected surveillance and high quality one-way vision to achieve complete privacy.

Solar Energy

Solar energy panels offer alternative solutions for a range of energy requirements, from small scale domestic applications to large scale solar power stations, from cloudy northern rooftops to hot sunny deserts. Glass is an integral and important element of these solar panels.

The NSG Group's wide range of high quality products are used in the three leading solar technologies aimed at converting solar energy into electricity: thin film photovoltaics, crystalline silicon photovoltaics and concentrated solar power applications. In addition to the generation of electricity, the Group's glass products are also used in solar applications that generate hot water. NSG TEC™ is a high performance, highly durable, electrically conductive glass used in a wide range of markets including photovoltaics, where it is used to construct thin film PV modules.

With the Group's advanced technology, the coating properties can be 'tuned' to a wide variety of Thin Film PV technologies, both Silicon and Cadmium Telluride based.

Pilkington **Sunplus™** is a high performance, low iron glass designed to maximize solar energy collection through very high light and solar transmission. The high solar energy transmission of Pilkington **Sunplus™** makes it an ideal choice for Crystalline PV photovoltaic solar cells.

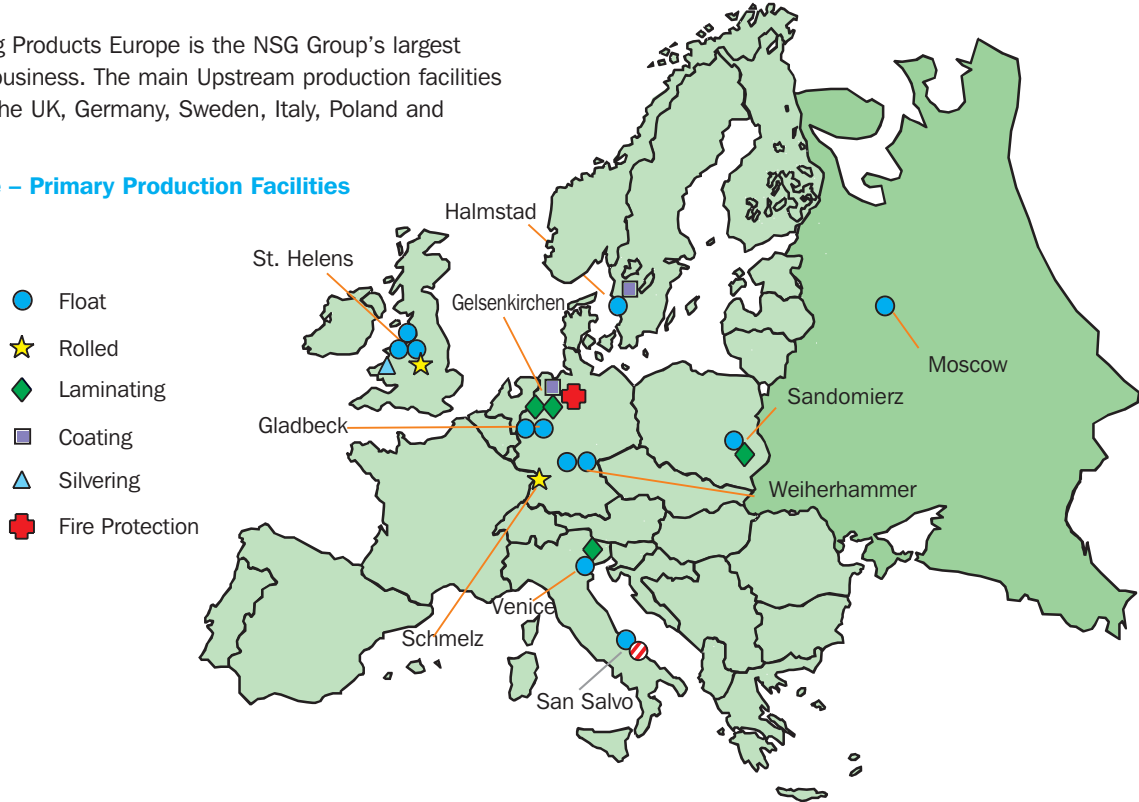
Pilkington **Optiwhite™** is an ultra- clear float glass with very low iron content and its high solar energy transmittance makes it ideal for Concentrated Solar Power applications and PV module cover plates. Additionally, it can also be used as a substrate for off-line transparent conductive coating (TCO) deposition

Building Products Businesses

Building Products Europe

Building Products Europe is the NSG Group's largest single business. The main Upstream production facilities are in the UK, Germany, Sweden, Italy, Poland and Russia.

Europe – Primary Production Facilities



The Downstream part of the business includes all of the glass processing and wholesaling operations, serving the European market through a network of forty-seven branches across ten countries (Austria, Czech Republic, Denmark, Finland, France, Netherlands, Norway, Poland, Sweden and the United Kingdom). The extensive range of products and services includes merchandising, the manufacture of safety glass, and the complete range of (Pilkington **Insulight™**) glass units.

The downstream business has developed over the last ten years into a significant contributor to European profits

through its culture of service to customers, and continuous improvement of productivity and safety for the employees.

Europe: Distribution of Downstream Operations

Downstream branches

- UK
- Netherlands
- France
- Austria
- Czech Republic
- Sweden
- Norway
- Denmark
- Poland
- Finland



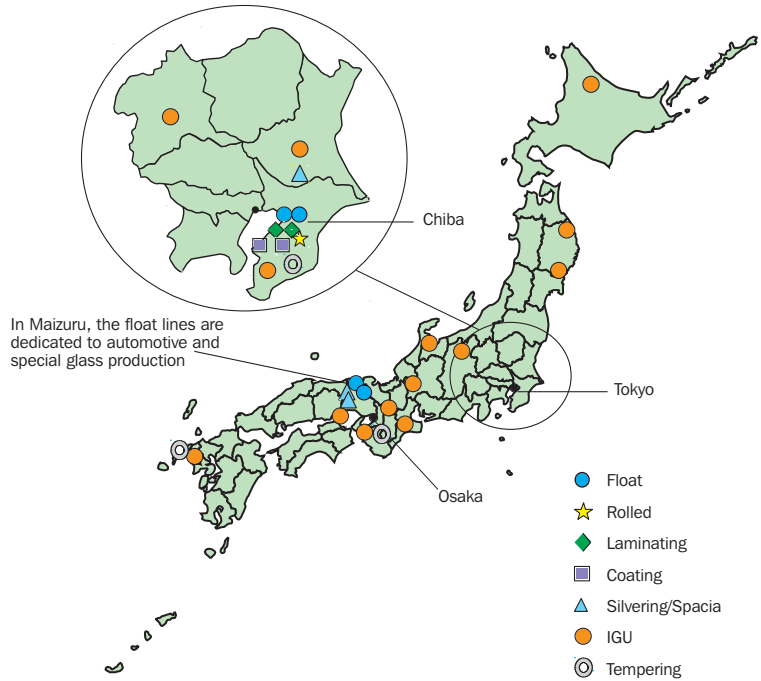
Building Products Japan

Building Products Japan has its main Upstream production site in Chiba (two float lines and one rolled line).

The downstream business, represented mainly by offline coating, insulating glass, laminated glass, tempered glass, fire protection glass and vacuum glazing glass production, is spread around 21 different sites across the country. Japan is also the only location where the NSG Group manufactures Spacia – the world’s first commercialized vacuum glazing product.

With four regional sales offices, the business offers a full range of products and services to its customers.

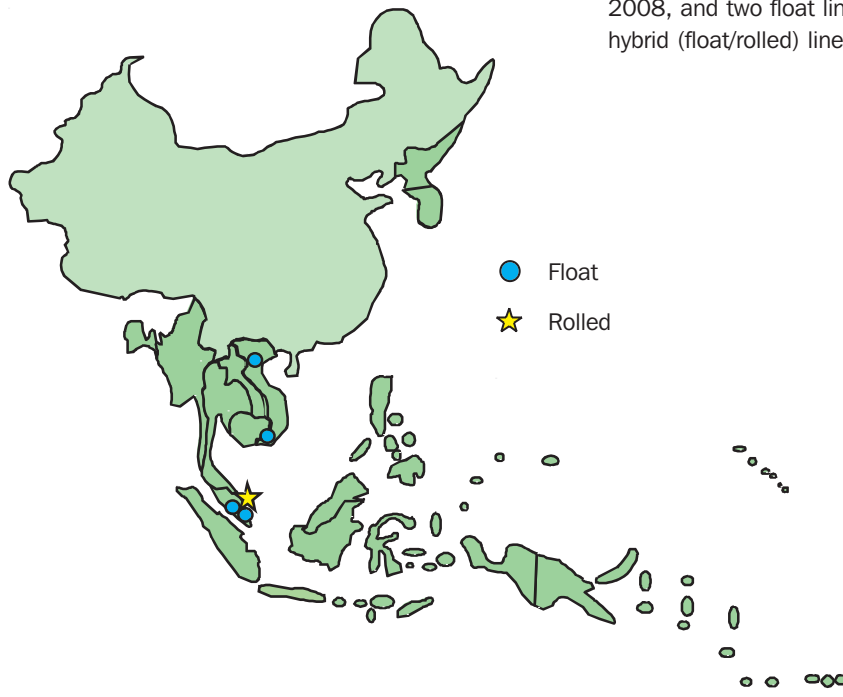
Japan - Production Facilities



Building Products South East Asia

South East Asia - Production Facilities

Building Products South East Asia is represented by two float lines in Vietnam, one of which was commissioned in 2008, and two float lines in Malaysia, one of which is a hybrid (float/rolled) line.



Building Products China

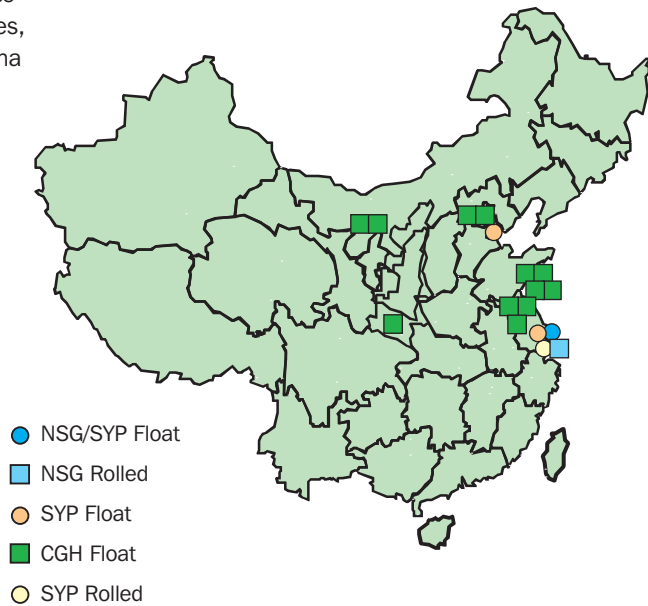
The NSG Group has minority interests in two major glass manufacturing businesses in China – SYP (two float lines, one rolled line and extensive glass processing) and China Glass Holdings (12 float lines).

SYP's two Shanghai float lines were closed in December 2008 but one replacement line is now operating and another is under construction in nearby Changshu

In addition, NSG itself operates a float in Changshu, in a 50:50 JV with SYP. Advanced on-line coating was installed on the line in 2009 which is enabling it to respond to the rapidly growing, regulation driven market for value-added low-e glass.

NSG operates a further rolled line which produces low-iron cover plates for the Solar Energy sector.

China – Production Facilities



Building Products North America

Building Products North America manufactures and distributes products for the architectural/commercial market (exterior and interior), residential market, specialty glass market and fire-rated glass market for a diverse range of applications.

In addition to sales offices and float glass plants across the country, the business also has a Technical Services Department committed to working with customers to answer any glass-related technical and performance questions. The business has four float lines across the USA, in California (Lathrop), Illinois (Ottawa), and two in North Carolina (Laurinburg), three of which have on-line coating capability.

North America - Production Facilities



In Rossford (Ohio) two floats are dedicated to Automotive.

Building Products South America

The Group's strategy in South America has for many years concentrated around operating jointly owned float facilities with Saint-Gobain, a relationship furthered in 2004 with the completion of the fourth joint venture line in Barra Velha, Brazil. This partnership is set to continue with the joint commissioning of a fifth facility in Brazil.

There is only one other float glass manufacturer in South America, besides the NSG Group and Saint-Gobain, namely Guardian with one line in Venezuela and two in Brazil. NSG Group and Saint-Gobain together operate four lines in Brazil and NSG Group operates one in Argentina and one in Chile. The Group also has warehousing activities in Colombia, Venezuela, Uruguay and Peru.

The South American region traditionally has a higher growth rate than the northern hemisphere although it is occasionally disrupted by economic instability in particular countries.

South America - Production Facilities



3.4 Automotive Overview

The Automotive business of the NSG Group operates under the Pilkington Automotive name and is one of the world's largest suppliers of automotive glazing products.

In serving this market, Pilkington Automotive operates a global key account network, matched to the individual VM's own organizational requirements. Within the automotive glazing industry, Pilkington led the way in globalizing its account management and presenting a single face to the customer.

Pilkington Automotive operates automotive glass fabrication plants and satellite facilities throughout Europe, Japan, NAFTA, South America, China, Malaysia and India; 32 locations in total in 16 different countries.

Through restructuring of its established facilities and the establishment of new ones in the fast developing markets, Pilkington Automotive continues to match its asset base to regional demand, both in terms of volume and, equally as important, technical capability and service.

The Pilkington Automotive global business line was formed in the mid-1990s in recognition of the automotive industry's own increasing globalization. The business is now fully integrated and managed on a global basis, subsuming all of the former Pilkington and NSG Automotive operations worldwide.

This new organization enables optimization of the NSG Group's global asset base and its exploitation of available synergies across its business segments.

As well as its major OE businesses within each region, Pilkington Automotive also supplies replacement glazings into the independent aftermarket. Pilkington Automotive has developed extensive AGR network throughout NAFTA (120 wholesale locations) and both Western and Eastern Europe (75 service facilities). It also serves the aftermarkets in Japan, South America, China and South East Asia.

NSG Group Automotive global presence

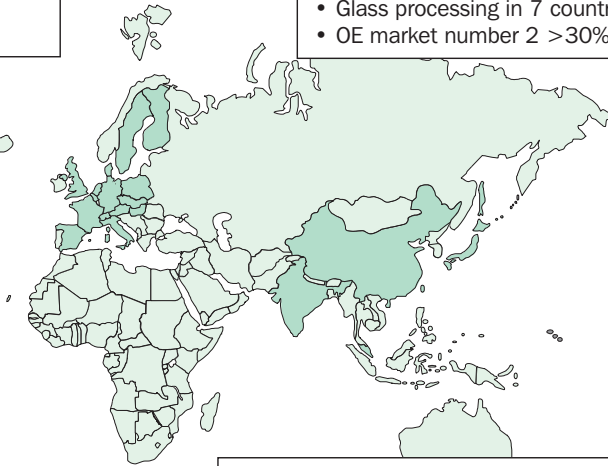
N.America:

- Glass processing in US, Canada & Mexico
- OE market number 2 ~20% share



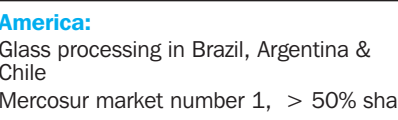
Europe:

- Glass processing in 7 countries
- OE market number 2 >30% share



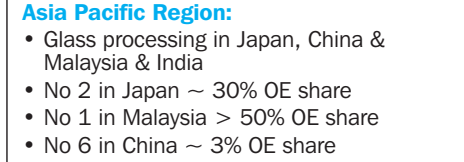
S.America:

- Glass processing in Brazil, Argentina & Chile
- Mercosur market number 1, > 50% share



Asia Pacific Region:

- Glass processing in Japan, China & Malaysia & India
- No 2 in Japan ~ 30% OE share
- No 1 in Malaysia > 50% OE share
- No 6 in China ~ 3% OE share



Pilkington Automotive's Markets

Original Equipment (OE)

The vast majority of Pilkington Automotive's OE production is focused on the volume light vehicle industry, serving all of the world's major VMs.

Of all such vehicles built in the world last year, more than one in three contained glazing manufactured by Pilkington Automotive businesses. Additionally, Pilkington Automotive globally coordinates its approach to the specialist/niche vehicle makers and roof-system manufacturers.

Aftermarket (AGR)

Pilkington Automotive aftermarket products can reach the end user by one of two main routes; the VMs' own dealer networks or independent AGR distribution chains, including Pilkington Automotive's own, supplying the retail fitter.

Pilkington Automotive itself has well developed aftermarket distribution and wholesale networks throughout Europe and North America with estimated market shares around 20 percent. It is also well established in serving the aftermarkets in Japan, South America and South East Asia.

Specialized Transport

Pilkington Automotive provides high quality glazing solutions and value-added products to the Original Equipment manufacturers of specialized transport and utility vehicles. These include buses and coaches, trucks, trams and metro systems, locomotives, train carriages,

special cars and vans, recreational vehicles, tractors and combine harvesters, construction vehicles as well as ships and pleasure craft (Pilkington Marine). Pilkington Automotive's customers are recognized as world leading manufacturers, with many operating on a global basis.

Pilkington Automotive Products and Services

Pilkington Automotive makes a wide range of automotive glazings for new vehicles and for replacement markets, offering full systems capability to customers, from initial design to final product. Pilkington Automotive products include solar control glass for passenger comfort, glass heating systems to control condensation and icing, security glazing, and glazing systems, including encapsulations, extrusions, and components such as rain sensors, hinges and clips, added after basic manufacturing.

The Group aims to provide a full range of glazing solutions on a global basis to its automotive customers, drawing heavily on its advanced technology, continuous improvement and standardization activities.

Just as in buildings, glass today is an integral part of a vehicle's body and fulfils many functions. Design trends point to still greater usage of glass in the future; tighter tolerances, yet deeper and more complex curves.

The glass manufacturer must be able to control very closely the pattern of temperatures in the glass throughout the shaping process if overall shape, optical quality and stress patterns are to be achieved consistently.

Utilizing its global R&D and global account management structure, Pilkington Automotive's market-focused approach to the development of products and services ensures that it delivers the glazing solutions its customers want, in a timely fashion to the appropriate regions.

Design Facilities

The growing complexity of glazings has increased the need for integrating simulation within the shaping processes. Pilkington Automotive is recognized as a leader in the development and use of computer simulation for advanced glazing technology, providing customers with the best possible glazing solutions with which to achieve their styling intent.

Pilkington Automotive's computer simulation centre team predicts the optical properties of a particular shape of windshield, how closely any of the bending processes will achieve the required shape and tolerances, and how difficult manufacturing challenges may be overcome. This virtual reality product development approach reduces both tooling and manufacturing costs and dramatically reduces the time between design and manufacture. Pilkington Automotive simulation techniques have been empirically tested and shown to give excellent correlation actual manufacturing processes and continuous benchmarking ensures ongoing improvements.

Pilkington Automotive has wide-ranging experience in design integration, where Pilkington engineers work side by side with customers to achieve the optimum design for function and manufacture. Involvement of Pilkington Automotive personnel at the very earliest stage in the design of the vehicle helps the customer identify potential manufacturing or design problems, thereby avoiding expensive redesign at a later stage. It also ensures that glasses meet legislative requirements for optics and enables Pilkington Automotive to recommend benchmark styling modifications leading to more cost-effective products and other glazing systems (e.g. encapsulation and extrusion) design. Data is transferred between Pilkington Automotive and its customers electronically, avoiding the need for drawings and physical fixtures in the design of new glazings.

Glass Shaping

Numerous market factors affect glazing design and performance, including cost reduction, tighter tolerances, high optical quality, design complexity and weight considerations. To meet these stringent market requirements, Pilkington Automotive continues to develop and invest in leading-edge glass shaping and fabricating technology. Changes in styling and the need for lighter, thinner glazings to reduce weight are pushing manufacturing processes. Pilkington Automotive maintains an extensive program of process development

to keep abreast of the latest design trends. For instance, new styling requirements for windshields that extend into the roof of the vehicle, or wrap around into the side of the vehicle, demand significant extension of both gravity sag and press bending technologies. Pilkington Automotive has developed Advanced Sag and Press Bending processes to secure its position as a supplier of the most advanced products.

In support of its manufacturing processes, Pilkington Automotive is continually developing powerful new on-line inspection techniques, capable of analyzing every aspect curvature, optical distortion, edge quality and scratches as the component takes shape. These systems will provide real time feedback for process control to increase yields and so reduce costs.

Glazing Systems

The task of the glazing supplier does not end when the glass is shaped. Pilkington Automotive is a world leader in the design and manufacture of a variety of glazing systems, each designed to simplify the glazing installation process. As well as the efficiencies provided at the vehicle assembly plant, these modular product solutions are also viewed by the VMs as a practical way of enhancing both a vehicle's styling and aerodynamics.

Encapsulation, or molding, provides a modular glass assembly with a multifunctional gasket around the rim of the glass, utilizing injection-molding technology. This gasket can provide many features from a single molding process, including an aesthetic finish to the glazing, water management, integrated attachment pins or clips, and mounting brackets or hinges.

Alternative sealing systems involve the use of a robotic extrusion process to apply a seal or attachment mechanism to the periphery of the glass.

Glazing systems also encompasses the 'assembly' activity where various hardware attachments, designed to locate correctly the glass within the vehicle, are fixed to the glass, either mechanically or by the use of adhesive technology.

With more than 20 years glazing systems experience behind it, Pilkington Automotive is a market leader in all of these technologies, in terms of both product and process development and global market share.

Solar Control Glazing

The last decade has seen significant improvements in the design and application of solar control glazings in vehicles. The major drivers are passenger comfort, minimizing the degrading effects of the sun's radiation on interior trims and fabrics, and improving fuel consumption by lowering the load on the vehicle's air-conditioning unit. Additionally, vehicle styling is impacted by the choice of solar control

glazing, from dark tints in the rear of the vehicle, to the differentiated color of infrared reflective windshields.

Solar radiation is partly reflected, partly transmitted and partly absorbed by glazing, the degree of each depending on the glazing fitted. Body-tinted glasses can selectively absorb the sun's energy, whilst glazings with specially designed coatings can be used to reflect solar radiation.

Absorbing Solar Control

Pilkington Automotive has long been a market leader in body-tinted glass compositions. Optikool™, EZKOOL® and UV Cut are green, optimized solar-absorbing glasses, providing significant improvement to occupant comfort. The products, designed for the European, North American and Japanese markets respectively, reduce the heat entering through a vehicle's glazed area by approximately 20 percent when compared to a car equipped with standard tinted glass. Pilkington Automotive is also a market leader in the development of dark tinted automotive glazings, and today produces two such suites of glasses, both of which provide significant benefits to solar control, privacy and overall vehicle styling.

Due to vehicle safety legislation, requiring adequate light to provide clear driver vision, use of these dark tinted glazings is restricted to rear passenger compartments and to roof glazings.

The Galaxsee™ glass suite is a major player in the privacy glazing segment. Originally developed for the North American market, it now finds global applications. This grey glass has a low light transmission (13-26 percent depending on thickness selection) and an even lower transmitted energy value. It reduces the transmitted heat to the interior of the vehicle by approximately 65 percent in comparison to an optimized green glass used in the front of the vehicle. It also prevents more than 95 percent of ultraviolet radiation from entering the passenger compartment. Consequently, this glass is increasingly the choice for 'dark tail' SUVs and MPVs, in addition to being suitable for roof glazing applications.

Sundym™ and the Legart range form a suite of neutral green privacy glasses that blends with the green front door glass to allow both a design choice and an improvement to solar loading.

The Sundym™ glass has a light transmission in the range 26-45 percent over a 3-5 mm glass thickness range. In a vehicle equipped with Sundym™, the heat entering the rear of the vehicle is reduced by 45 percent when compared to that at the front of the car.

The market continues to adopt these glasses due to the valuable combination of both physical and aesthetic benefits.

Reflective Solar Control

Pilkington Automotive possesses the technology and capability to deliver a coated windshield product that reflects more than 30 percent of the sun's energy (more than five times that of a standard glass). This particularly benefits the new generation of vehicles that are commonly designed with larger glass areas.

Significantly, the Pilkington coating technique is advantageous in the pursuit of improved vehicle styling, as it can deliver highly complex shapes with exceptional optical quality.

Pilkington Automotive also offers a solar reflective product, Pilkington Siglasol™ utilizing infra red reflecting film within the laminate. Reflective glazings have now been successfully integrated into large area rooflights. This application is the most significant for solar control in a vehicle, as the sun's radiation is minimized, irrespective of the vehicle's direction of travel.

Laminated Sideglazings

For over 25 years, the standard glazing constructions for automotive vehicles have been laminated glass for the windshield and toughened glass for the side and rear glazings.

Over the next ten years it is expected that as new car models are introduced, the type of glazings used in the side windows (sidelights) of cars will move from toughened glass to laminated glass.

The trend to fit laminated sidelights started in Europe, but there is now global interest with US and Japanese vehicle manufacturers launching models fitted with side laminates. The move to laminated side and rear glazings represents a turning point for advanced vehicle design opportunities and is more significant than the volume change from toughened to laminated windshields in 1970.

Extensive consumer market research has confirmed that consumers are very interested in laminated sidelights and prepared to pay a premium to have them fitted to the vehicle. The consumer sees benefits in two areas:

Security

- Personal security
- Reduction in theft from cars

Comfort

- Solar control improvement
- Reduction in extraneous noise
- Greater than 95 percent reduction in UV entering the vehicle through the side glazings

Laminated sidelights have a similar construction to laminated windshields, namely a plastic interlayer sandwiched between two glass plies. In order to meet door slam tests, both plies need to be semi-toughened to give additional strength to the glazing. Currently most products are 2.1/0.76/2.1mm, 1.8/0.76/1.8 mm and 1.6/0.76/1.6 mm construction. The trend to lighter weight glazing means that an overall 4 mm make up is becoming critical as laminates are adopted on lower segment vehicles. Pilkington Automotive researchers have made it possible to supply high quality 4 mm laminated sidelights in simple and complex geometry to tight tolerances.

Besides its intrinsic benefits identified above, laminated glazing also offers an opportunity to create advanced glazings with additional features, such as coatings or wire heating for de-misting, or modified interlayers (e.g. solar control, colors, acoustic enhancement).

The additional cost of laminated side glazings is offset by the above opportunities which can enable the car manufacturer to customize the vehicle and make it more attractive and desirable to the car buyer. Today's vehicle designers expect the glazing to perform as more than merely a window. They want added functionality.

Integrated Antennas

With the ever-increasing demands of global communication systems, Pilkington Automotive can design and manufacture fully integrated antenna systems either on the glass surface, or inside the glazing construction. This approach allows the VM to move away from traditional rod-based antennas, which not only improves the styling and aesthetic appeal of the vehicle but also removes the threat of vandalism. The use of on-glass antennas is firmly established in Japan, a known pacesetter for electronic solutions, and is now increasing in Europe and North America. Considerable expertise exists inside Pilkington Automotive to take advantage of this growing trend.

Instrument Display

Head Up Display (HUD) systems have long been used in military aircraft to project information into the pilot's field of vision. Pilkington Automotive has successfully adapted this technology so that it can be used in road vehicles at a cost acceptable to the market. Interest in HUD technology is continually growing as people demand ever more functionality in their vehicles.

Pilkington Automotive's advanced press bend windshields offer absolute state of the art optical surfaces for the HUD systems to display the image on. The excellent full surface control properties of the press bend windshields are perfectly aligned to the tight tolerance requirements to ensure that 'ghost images' are not seen by the end users. Facilities to manufacture these types of windshields exist in Europe, North America and Asia.

Water Management

Pilkington Automotive's Hotscreen™ product incorporates fine wires that are capable of de-icing a frozen screen at -5°C inside two minutes. A recent innovation allows the full area of the screen to be de-iced within this timescale. Further customer benefits are achieved if this type of technology is employed where the wipers rest on the windshield.

Pilkington Automotive has also developed a full area coated heated windshield that provides both de-ice and anti-mist properties. As power levels increase in vehicles, this will provide an elegant way to electrically heat windshields that have an infrared reflective coating applied directly to the glass. This heating functionality is in addition to the benefits of optimized solar control and high shape complexity that are already achieved with Pilkington Automotive coating technology.

Pilkington Automotive has also developed a patented sensor that detects moisture on the windshield and automatically activates the windshield wipers. This rain sensor, attached to the interior of the windshield, detects moisture by using infrared light emitting diodes. This technology is licensed in the market place and is being increasingly adopted on new models.

Another technology that improves driver visibility is a 'hydrophobic' coating, which is applied to the outside glass surface and significantly improves water droplet flow from the vision area. Hydrophobic products are used extensively in Japan, with significant adoption in Europe and market interest in North America.

Full Service Supply

Driven by the industry's need for increased design efficiency and reduced time to market, Pilkington Automotive has developed a world class, full service supply capability. For the majority of its OE customers, Pilkington Automotive provides design expertise which then leads to product sequencing and 'just in time' delivery to the VM's assembly line.

AGR Market Offerings

Whilst all of the glazing products offered by Pilkington Automotive are initially seen in the OE market, the benefit of increasingly complex glazing installations is also felt in the aftermarket. In addition to supplying replacement glazings to the aftermarket, Pilkington Automotive also sells the tools and accessories used by windshield fitters, thereby supplying them with all the equipment required for a re-glazing job.

4. Sustainability

Glass has a unique role to play in promoting sustainability, reducing greenhouse gas emissions and mitigating the effects of climate change. The 'energy balance' between manufacture of high-performance glazing products and their use means that the energy used and CO₂ emitted in manufacture are quickly paid back through the lifetime of the products. The energy involved in glass-making should therefore be seen as an investment in future energy saving.

The NSG Group is fully committed to sustainability. The Group's policies underline the unique contribution its products can make to addressing climate change and the challenges the Group faces in improving its own energy usage and resource management. The Group's product range and R&D efforts are geared to addressing the challenges of a low-carbon world.

Glass in buildings

CO₂ emissions from buildings, in the EU could be cut by 140 million tonnes if current glazing were replaced by low-e double glazing.

Energy issues are crucial to the building glass industry, as glass products can make an important contribution to combating climate change. Improving the energy efficiency of buildings brings other benefits too. Buildings are more comfortable and cheaper to run for the owner and occupier. And from a social point of view, national economies and energy security will improve when energy-importing countries become less dependent on increasingly expensive supplies from other parts of the world.

CO₂ emissions and low-e double glazing

The European glazing trade association, Glass for Europe, of which the NSG Group is a member, published in 2005 a study into the CO₂ savings potential of replacing ordinary single or double glazing with low-e glass. It showed that CO₂ emissions from buildings, which amount to 765 million tonnes of CO₂ per year in the EU, could be cut by 140 million tonnes if the current glazing were replaced by low-e double glazing.

Even taking into account the 4.6 million tonnes of CO₂ released per year by the building glass industry in its production processes to manufacture the additional glass required (NSG Group in Europe released 1.7 million tonnes in 2008), the replacement of obsolete glass in old buildings and specification of energy-efficient glass in all new buildings would result in a huge net benefit.

CO₂ emissions and solar control glazing

In regions where the ambient temperature is often uncomfortably hot, the increasing tendency is to install air conditioning and that, of course, brings with it an energy and carbon burden. Glass for Europe has recently published a report, 'Impact of Solar Control Glazing on Energy and CO₂ Savings in Europe', which quantifies the potential CO₂ savings in the year 2020 through the installation of solar control glass in air-conditioned buildings. The study shows that installing solar control glass versus air conditioning under the current growth scenario would produce annual savings of around 1.1 million tonnes of CO₂ by 2020. If air conditioning use in Europe were to approach the level of usage in North America, annual savings would be closer to 7 million tonnes.

Sustainability in buildings

Glass is used extensively in most buildings, both for exterior and interior use; as a construction material, for functionality, for decoration and for interior fittings. Around the world, policy-makers have begun to realize how important the quality of buildings is in relation to the quality of the environment and to the overall quality of people's lives.

Policy and legislative activity addressing the building sector, including the glass products that are used in buildings, is increasing worldwide. The Group's products play a vital role in improving energy efficiency and reducing CO₂ emissions. But they also offer other advanced functionality, protecting against fire, insulating against noise, offering safety and security, privacy, decoration and even self-cleaning properties

Energy efficiency in buildings

In every region of the world in which the Group operates, the need to save energy is a political priority. Buildings account for almost 50 percent of the energy consumed in developed countries. Governments are putting increased focus on legislation and policies to improve their energy efficiency.

Buildings account for almost 50 percent of the energy consumed in developed countries

In North America, initiatives such as the environmental building rating system (LEED) run by the US Green Building Council are helping to transform the market for added-value glazing, and this will continue.

Similar opportunities are anticipated in Europe, for example, through the development of an EU-wide Energy Labeling system for windows. In China, legislation is at an earlier stage, but the government has already introduced building regulations to improve the energy efficiency of new buildings.

Thermal insulation – keeping heat in buildings

In cold weather, low emissivity (low-e) products reflect heat back into the building. Pilkington thermal insulation products combine unrivalled thermal insulation with high light transmittance and lower reflectance for a more neutral appearance. The Group's Spacia™ product was developed in Japan and was the world's first vacuum glazing commercially available, offering the thermal performance of conventional double glazing in the same thickness as single glass. Sales for this product are developing worldwide, particularly for use in historic buildings.

For the residential market, we have developed products combining thermal insulation and passive solar gain, helping domestic window companies meet homeowner demand for more energy-efficient windows.

Pilkington **energiKare™** is a family of energy-efficient Insulating Glass Units innovatively using low iron float glass Pilkington **Optiwhite™** in combination with Pilkington **K Glass™**, to provide the best possible energy-efficient performance. The product is being used in both replacement windows for homes and in newly-built dwellings utilizing both double and advanced triple glazing technology.

In warm weather, Pilkington solar control products dramatically reduce or reflect the sun's heat transmitted through the glass, while transmitting the majority of the light, minimizing the need for air conditioning. Solar control is a key issue in terms of energy saving. In hot conditions or for buildings with high internal heat loads, solar control glass is used to minimize solar heat gain, by rejecting solar radiation and helping to control glare.

In temperate conditions, it can be used to balance solar control with high levels of natural light. The correct choice of glass can help to reduce the capital outlay, running costs and associated carbon emissions of a building throughout the year.

Glass and solar energy

Glass has a key role in attempts to find cheaper and more efficient ways of generating power from the sun. The Group's products support the three leading solar energy technologies: thin film and crystalline solar modules and concentrated solar power applications.

Glass is an integral and important element of solar modules, used to convert solar energy into electricity. Increasingly, electrically conductive glass is used in photovoltaic modules as the front contact of the solar cell, to form a system which generates a direct electrical current. Where the power feeds into a grid, it is first converted into alternating current.

The United States and the European Union in particular, are encouraging the production of renewable energy and in December 2008 the EU published the Renewable Energy Directive. Carbon-trading schemes encourage CO₂ reductions, adding further impetus to the development of renewable energy options. US government schemes designed to encourage 'green' industries are also expected to play an important part in establishing renewable technologies.

Government subsidies are increasingly playing a role in encouraging solar generation, with feed-in tariffs in countries such as Germany, Spain, Italy and Greece making it economic for solar generators to feed power into the national grid systems. The authorities in Japan have indicated likely support for homeowner solar installations and US tax incentives are adding further impetus to these technologies.

Even without such subsidies, many systems already make economic sense and costs are anticipated to fall further as the technology matures with grid parity expected to be achieved over the next few years.

The NSG Group is well placed to supply all three of the leading solar energy technologies.

Thin film photovoltaic solar modules

Technology characteristics: Produces power at low cost per watt, ideal for solar farms. Benefits from generating consistent power, not only at elevated temperatures, but also on cloudy, overcast days and at low sun angles.

Glass type required: Transparent Conductive Oxide Coating on float glass. The glass both lets light through and helps conduct the electricity produced.

NSG Group Products: NSG TEC™ glass is a high-performance, highly durable, electrically conductive glass used in a wide range of markets including photovoltaics, where it is used to construct thin film PV modules. With the Group's advanced technology, the coating properties can be 'tuned' to a wide variety of Thin Film PV technologies, including silicon and cadmium telluride based.

Crystalline photovoltaic solar modules

Technology characteristics: Highly efficient, but crystalline modules have a higher manufacturing cost per watt than thin film. Ideal for applications where space is at a premium, but can also be installed effectively in solar farms with reasonably high solar radiation.

Glass type required: Low iron rolled glass plus anti-reflective coating, to ensure that the maximum amount of solar radiation hits the PV cells.

NSG Group Products: Pilkington **Sunplus™** is a high-performance, low iron glass designed to maximize solar energy collection through very high light and solar

transmission. The high solar energy transmission of Pilkington **Sunplus™** makes it an ideal choice for crystalline PV photovoltaic solar cells.

Concentrated solar power applications

Technology characteristics: Typically large area mirror arrays. Requires a large area and lots of sunshine. Particularly effective in sunny deserts.

Glass type required: Low iron float glass.

NSG Group products: Pilkington **Optiwhite™** is an ultra-clear float glass with very low iron content and its high solar energy transmittance makes it ideal as a base substrate for mirrors used in concentrated solar power applications.

Glass in Vehicles

The global automotive industry is increasingly addressing the sustainability agenda. The shift to electric vehicles and plug-in hybrids marks a new era, with CO₂ reduction a major focus. This requires glazing advances in solar energy control, weight reduction and energy saving.

As a world leader in automotive glazing, the NSG Group is meeting these challenges. It is developing automotive coating technology and glass compositions to produce advanced infra-red absorbing and high-performance infra-red reflecting technology. The Group aims to provide further opportunities for vehicle manufacturers to reduce CO₂ output.

Lightweight glazing

There can be over 13 individual pieces of glazing on a vehicle, all of which contribute to the overall vehicle mass and contribute significantly to the overall weight of the vehicle and to fuel consumption.

The NSG Group's developments have been heavily focused on the introduction of lightweight glass and glazing technology, with the launch of reduced thickness laminated and toughened sidelights, backlights and rooflights. Through continuous developments in the Group's glass-shaping capability to enable asymmetric windshield constructions, Pilkington Automotive is contributing to the future of automotive glazing products.

With the Group's developing glass-shaping technology, it is now possible for vehicle manufacturers to reduce the mass of glass components by up to 25 percent. Glass in vehicles offers more properties than simple transparency, so when designing vehicles for reduced mass in the components, consideration needs to be given to acoustics, stiffness, sealing and guiding systems and solar control.

Solar control technology

The relationship between high-performance solar control glazing and vehicle CO₂ emissions reduction has long been recognized. It has been established that control of the heat energy entering the vehicle will have a direct impact on mobile air conditioning usage and will lead to reduced fuel consumption and CO₂ output.

The Group's advanced solar control glass can make a significant contribution to the reduction of air conditioning usage by reducing solar heat gain. Approximately 30 percent of the heat loading on a car's interior comes through the windshield.

Pilkington Automotive's vehicle glazing products provide advanced solar control by absorbing or reflecting the infra-red energy from the sun. The Group's range of optimized green and privacy solar absorbing glasses can reduce the heat entering a vehicle by up to 65 percent.

Ensuring passenger comfort and safety

The Group develops and supplies not only glass but also glazing systems that are used to mount and seal the products in vehicle apertures. Pilkington Automotive is working constantly to decrease the component content, with a view to reduced cost and weight. New technology areas, for example, integral seals, significantly reduce processing steps and the amount of hardware needed to transform glass products to glazing products. Issues such as driver visibility and pedestrian safety overlay the Group's work in the development of the next generation of automotive glazing.

Glass and end-of-life vehicles

Glass typically constitutes around 3 percent of the composition of an average car. The automotive glass industry has not been directly involved in the setting of end-of-life Vehicle legislation, but we are actively involved in work on the elimination of harmful materials in glass, ink, solder and other components used for automotive glass products.

Appendix 1 – Glass Manufacture

FLAT GLASS MANUFACTURE

Glass is obtained by the fusion of several inorganic substances. The fused mass is cooled to ambient temperature at a rate fast enough to prevent crystallization, i.e., the molecules cannot arrange themselves into a crystalline pattern. The fast rate of cooling to prevent crystallization applies to transparent glasses.

1. Raw Materials and Costs of Flat Glass

- The mix of raw materials used in the production of flat glass is known as the batch, which is mainly composed of three components: silica sand, soda ash and dolomite/limestone.
- Recycled glass (cullet) is used in the fabrication of flat glass and represents on average 15 percent of the materials used. Its addition helps reduce the energy required in the process.
- Silica sand, soda ash, dolomite and dolomite/limestone represent together 99 percent of all raw materials used in the production of glass, excluding recycled glass.

The remaining ingredients aid the melting and refining (bubble removal) reactions and impart color and there is water addition during batch mixing to prevent subsequent segregation.

Silica sand is the main component of the batch, as it constitutes about 62 percent of the batch weight excluding recycled glass. Soda ash is one of the most expensive raw materials used in glass manufacturing and represents about 16 percent of the batch weight but about 60 percent of the batch cost. In terms of costs, raw materials and energy are the single largest elements, followed by overheads and prime labor.

2. Basic Manufacture

There are three main flat glass manufacturing methods for producing the basic glass from which all processed glass products are made.

■ Float

Over 90 percent of the world's flat glass is made by the float process (see below). This is the way all of the world's high quality, optically clear glass is made.

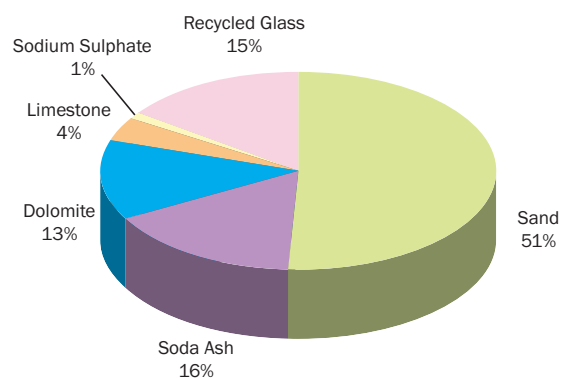
■ Sheet

Approximately 6 percent of the world's flat glass is made by the sheet process. This process predates, competes with and is gradually being replaced by float. The majority of the world's sheet production is in China with the remaining pockets in the less developed markets of Africa, Eastern Europe and Asia.

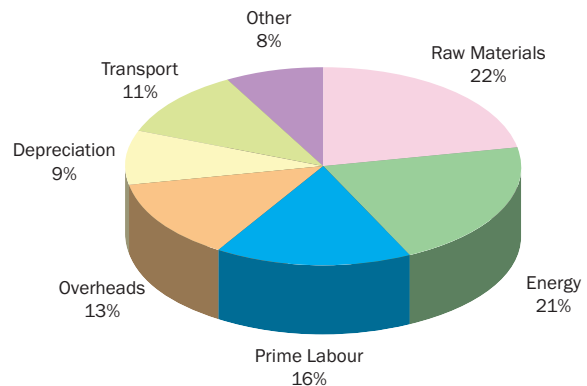
■ Rolled

The rolling process makes patterned, figured and wired glass products. Semi-molten glass is squeezed between metal rollers to produce a ribbon with controlled thickness and surface pattern.

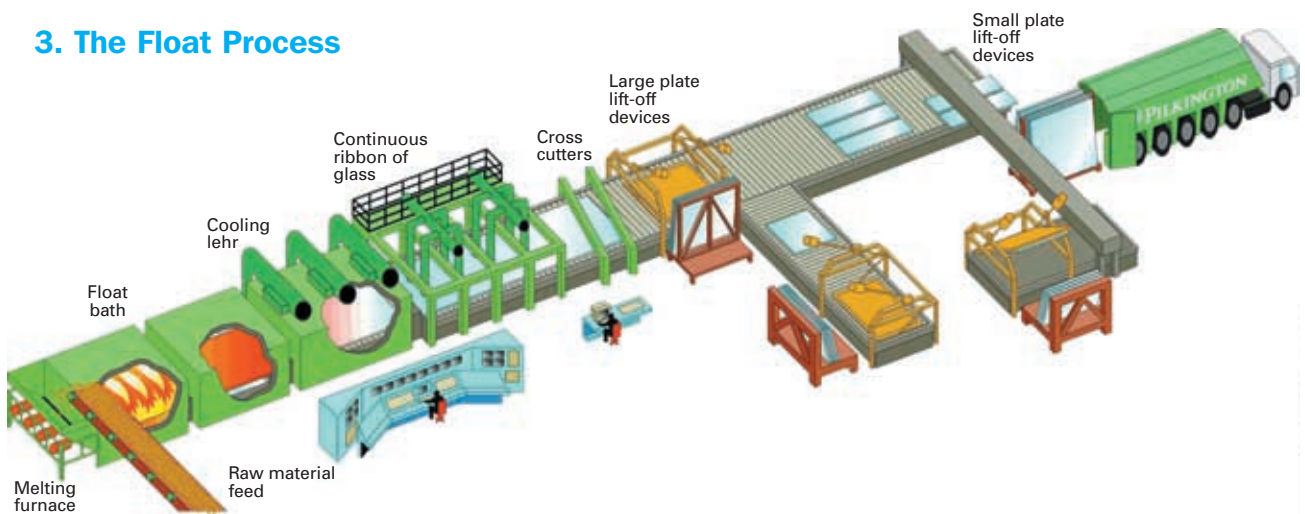
Float Glass Raw Materials



Float Glass Nominal Costs



3. The Float Process



At the heart of the world's glass industry is the float glass process - invented by Sir Alastair Pilkington in 1952 - which manufactures clear, tinted and coated glass for buildings, and clear and tinted glass for vehicles. The process, originally able to make only 6mm thick glass, now makes it as thin as 0.4 mm and as thick as 25 mm.

Molten glass, at approximately 1000°C, is poured continuously from a furnace onto a shallow bath of molten tin.

It floats on the tin, spreads out and forms a level surface. Thickness is controlled by the speed at which solidifying glass ribbon is drawn off from the bath.

After annealing (controlled cooling) the glass emerges as a 'fire' polished product with virtually parallel surfaces.

A float plant, which operates non-stop for between 10-15 years, makes around 6,000 kilometers of glass a year in thicknesses of 0.4 mm to 25 mm and in widths up to 3 meters.

The float process has been licensed to more than 40 manufacturers in 30 countries.

Over 380 float lines are in operation, under construction or planned worldwide with a combined output of about 1,000,000 tonnes of glass a week.

The NSG Group operates or has interests in 49 float lines worldwide.

3.1 Modified Basic Manufacture

There are three main forms of modification to the basic manufacturing processes.

Tinted

Extra ingredients are added to the raw materials of glass at the melting stage to produce tinted products. Cobalt and nickel tint glass grey; ferrous oxide tints glass blue, while ferric iron generates a yellow tint - both together tint glass green.

Tinted glass is used in buildings and vehicles to control heat and light transmission.

Coated (On-line)

Modified properties are produced from the basic glass by means of surface coatings. Glass can be coated on-line in the float process as the ribbon of glass is being formed in the float glass bath.

The technology uses chemical vapor deposition to apply a microscopically thin coating on the glass at a temperature of about 600°C.

Pilkington **K Glass™**, Pilkington **Energy Advantage™** and Pilkington **Activ™** are produced by this process.

4. Building Products Processing

4.1 Semi-Finished Processing

The following types of processing are high volume and predominantly performed by glass manufacturers.

Coating (Off-line)

Off-line processes use a vacuum coating technology called sputtering. A 'target' material is bombarded to produce atoms which are deposited on the glass.

This process is used to make products such as Pilkington **Optitherm™ S3** and Pilkington **Suncool™**.

Laminating

Plies of glass are bonded or laminated together with a layer of polymer film in between. By using heat and pressure, air bubbles are eliminated from the laminate so that it appears optically as a single sheet of glass.

Mechanically, however, it is more robust: if the laminate is fractured, the broken glass fragments are held together and are less likely to cause injury. Laminated glass is used in safety and security applications.

Silvering

Float glass is made into mirrors in a process which deposits a thin film of high purity silver on one surface of the glass. A further thin film is then deposited to protect the silver from oxidation. Finally, a ceramic paint is applied.

This is the process by which Pilkington **Optimirror™ Plus** is made.

4.2 Downstream Processing

The following types of processing are performed by glass manufacturers and also by other companies.

Multiple Glazed Units

Multiple glazed units incorporate two (or more) panes, separated by spacers to create a hermetically sealed gap between each successive pane in the unit, e.g. Pilkington **Insulight™**. This gap can be filled with air, which is subsequently desiccant dried, low conductivity gases such as argon can be used instead of air in the cavities or, in the case of the Group's Spacia™ product, the layer of dry air is replaced by a vacuum to achieve higher performance.

Heat Treatment

Toughened glass, or tempered glass as it also known, is produced when float glass is heated to around 650°C, then quenched with air jets so that the surfaces are cooled quickly, and the inside core more slowly. At room temperature, the core continues to cool. The surfaces go into compression and the core goes into tension. When the glass breaks, the core releases tensile energy resulting in the formation of small, safer glass particles. Toughened glass is used in safety glazing in buildings.

Shaping

Glass can be bent into shape for some building applications. Between 500°C and 600°C the viscosity - or syrupy nature - of glass falls by a factor of 10,000 as it transforms from a brittle solid to a plastic substance. The science of glass bending is to use this plastic phase to produce shapes that are free from wrinkles and other optical defects.

Sag-bending is the most widely used process. The glass is heated to the plastic phase and allowed to sag under its own weight to the required shape.

Surface Working

Fine surface textures can be applied using sand blasting and acid etching.

5. Automotive Products Processing

Because glazing is an integral part of any vehicle's styling, each piece of automotive glass is unique to a specific opening within any individual vehicle. Hence three-dimensional shaping of the glass, together with imparting

its increased strength and safety properties are at the heart of automotive glass processing. However, ahead of this, certain pre-process operations must be undertaken.

5.1 Pre-Processing

Pre-processing involves a number of preparatory activities, ahead of submitting the glass to heat treatment.

They include:

- cutting out the flat glass template from standard, rectangular 'block sizes' of automotive float
- edge-working the shaped, but still flat, piece of glass to provide a smoothed glass edge
- drilling any required holes within the glass

- washing the glass, before clean-room printing is undertaken
- printing of obscuration bands, logos etc. on the glass in a single pass process for simple features but a two or three pass process for demisting circuits, antennas and alarms.

On completion of these pre-process activities, the glass proceeds to be shaped and to receive its safety properties.

5.2 Automotive Glass Shaping and Strengthening

There are two basic forms of glass shaping and strengthening for automotive applications, though hybrid processes have more recently been developed.

Automotive Toughening

Toughened glass, or tempered glass as it is sometimes called, is most frequently used in the rear and side windows of vehicles. It is designed to be much stronger than non-safety glass. However, in the case of a breakage, it shatters into very small pieces rather than sharp shards of glass, thereby significantly reducing the risk of injury.

This is made possible by the toughening process which introduces internal stresses into the glass through a combination of controlled heating to very high temperatures, (>640°C) and differential cooling.

The heating cycle is also used to shape or curve the glass, either by allowing the heated glass to 'sag' to a pre-defined mold shape under gravity, or for more complex shapes, by being pressed to shape by male and female molds.

Automotive Laminating

Lamination is a form of safety glazing where normally two thin glass plies create a sandwich around a polyvinylbutyral (PVB) interlayer. Normally used for a vehicle's windshield, in the case of breakage, the glass is held in place by the interlayer, retaining emergency visibility for the driver.

Laminated glazing is also increasingly being specified for car side windows.

Usually the glass plies are shaped (curved) as matched pairs through heating to a temperature of around 620°C. As with tempering, the shape can be achieved through gravity 'sagging' or through press-bending for the more complex shapes.

Differential heating to control temperature across the surface of the glass, and hence the resultant degree of bending, is also used for more complex shapes. The shaped glass pairs are then gradually cooled to room temperature before the PVB laminate is sandwiched between them.

At this point the PVB is opaque and only becomes transparent at completion of the lamination process.

This involves the removal of any air trapped in the glass sandwich through a mechanical or vacuum squeezing process, followed by heating of the windshield to 140°C within an autoclave, under a pressure of 10 to 15 kg/cm², to complete the bonding of the two glass plies.

Increasingly, glazing systems rather than a simple piece of glass are being supplied to the vehicle manufacturers. Much of this value-added activity is undertaken once the glass has been laminated or tempered.

5.3 Glazing Systems Processes

Glazing systems help to simplify the vehicle assembly process. Modular systems such as encapsulation and extrusion are designed to facilitate adhesive bonding of the glazing to the vehicle.

Encapsulation

Encapsulation involves the injection molding of a polymer trim, shaped precisely to fit the vehicle body, to the periphery of the glazing. It also provides the opportunity to incorporate within the molding additional styling features, fixing mechanisms and even hinges for opening windows in minivans and estate cars.

Extrusion

An alternative glazing system is provided by the robotic extrusion of a polymer profile to the periphery of the glazing, with the extruded profile or seal being precisely shaped to the vehicle.

Assembly

Fixing of certain glazings within a vehicle can also be achieved through the application of locator clips to the glass. The attachment of such clips, together with other hardware, is most commonly referred to as assembly.

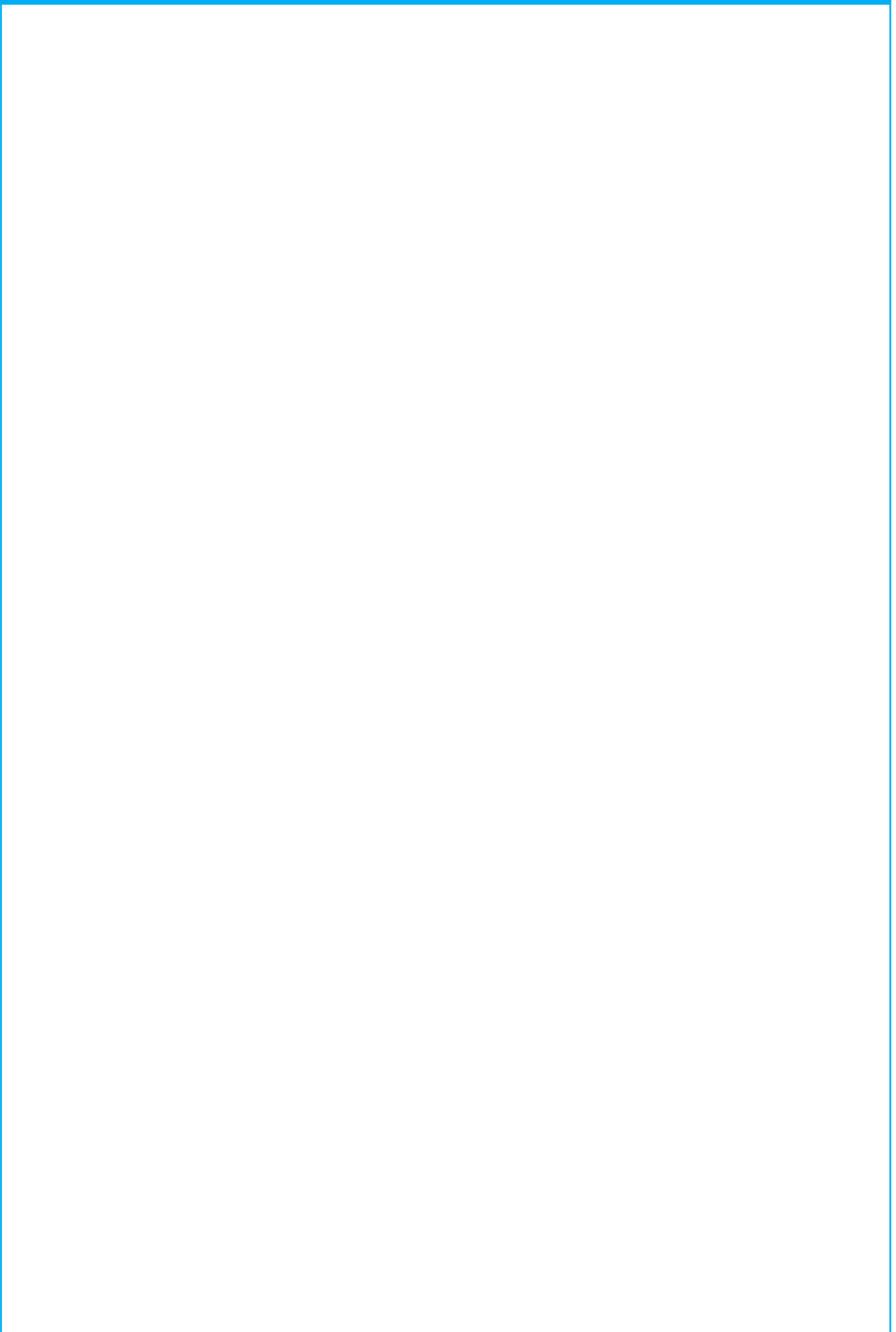
Appendix 2 – Float Operations

NSG Group and Associates' Global Float Operations

Location	Line	Completed	Comment
United Kingdom			
Cowley Hill	CH2	1972	
Greengate	UK5	1981	Currently on extended cold repair
	UK6	1992	
Germany			
Gladbeck	GL1	1974	
	GL2	1976	
Weierhammer	WH1	1979	
	WH2	1991	
Italy			
San Salvo	SS1	1974	
Flovetro	FV1	1979	Flovetro (50%) - Managed by Saint-Gobain
Venice	VE1	1987	
Sweden			
Halmstad	SK1	1976	
Finland			
Lahti	L1	1987	Closed in 2009
Poland			
Sandomierz	PS1	1995	
Russia			
Moscow	RM1	2006	JV Managed by NSG Group
Japan			
Maizuru	M5F	1965	
Maizuru	M1F	1998	
Chiba	V3F	1971	
Chiba	V1F	1986	
Malaysia			
Johor Baharu	JB1F	1993	
Johor Baharu	JB2F	1997	
Vietnam			
Hanoi	VFG	1999	
Vietnam	VGI	2008	Production currently suspended
USA			
Rosford	6F1	1970	
	6F3	1966	
Lathrop	10F1	1964	
Ottawa, Illinois	5F1	1970	
Laurinburg	75F1	1973	
	75F2	1980	
Argentina			
Lavallol	VV3	1989	VASA (51%) - Managed by NSG Group

NSG Group and Associates' Global Float Operations - Continued

Location	Line	Completed	Comment
Brazil			
Jacarei	C1	1982	Cebrace (50%) - Managed by Saint-Gobain
	C3	1996	Cebrace (50%) - Managed by Saint-Gobain
Caçapava	C2	1989	Cebrace (50%) - Managed by NSG Group
Barra Velha	C4	2004	Cebrace (50%) - Managed by NSG Group
Chile			
Concepción	LQ1	1996	Vidrios Lirquen (26%) - Managed by NSG Group
China			
Changshu	CS1	2006	SYP-Pilkington 50:50 JV - Managed by NSG Group
	CS3	2009	HSYP (19.6%) via SYP - Managed by SYP
Tianjin	T-SYP	1997	Tianjin-SYP (19.6%) via SYP - Managed by SYP
Suqian	CGH	1994	China Glass Holdings (26.9%)
	CGH	2002	China Glass Holdings (26.9%). Currently on extended cold repair
	CGH	2005	China Glass Holdings (26.9%)
Weihai	WE1	1995	China Glass Holdings (26.9%)
	WE2	2000	China Glass Holdings (26.9%)
	WE3	2003	China Glass Holdings (26.9%)
	WE4	2004	China Glass Holdings (26.9%)
Wuhai	WU1	1988	China Glass Holdings (26.9%)
	WU2	2001	China Glass Holdings (26.9%)
Xian	XI1	2005	China Glass Holdings (26.9%)
	XI2	2007	China Glass Holdings (26.9%)
Dongtai	DG1	2009	China Glass Holdings (13.7%)
Beijing	CG2	1995	China Glass Holdings (26.9%). Currently on extended cold repair





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