

**From flat glass to float glass industry:
40 years of major changes in Europe**
**(History and description of current status
of float glass industry in Europe)**

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Flat glass: sheet and polished glass

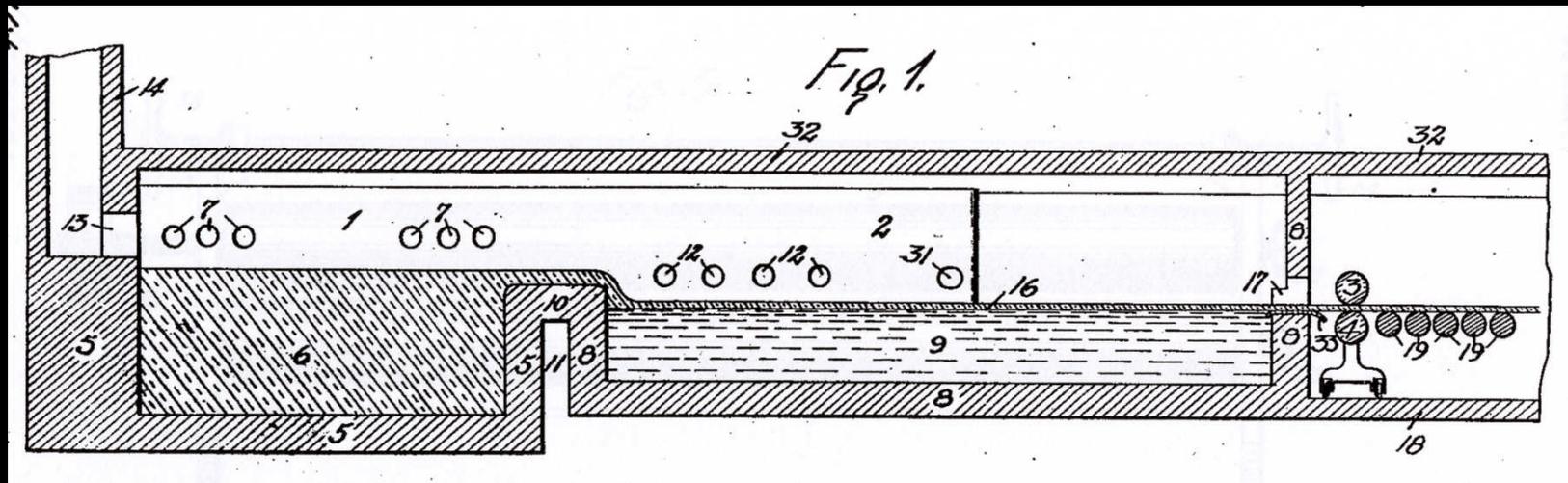
- For centuries flat glass has been produced by blowing or by casting.
- From 1920's, continuous ribbon of plate glass has been made by drawing (Fourcault, Pittsburgh, Colburn / Libbey-Owens)
- Flat glass was mainly produced, early 1960's, by many small companies
- Segmentation was huge between window glass and mirror glass.

Float Legend

- Legends about glass are numerous, starting with Pliny the Elder describing how the Phoenicians made the first glass.
- A legend is also displayed about float glass.
One evening, in 1952, Alastair Pilkington was washing dishes in his home and he daydreamed as he watched a bar of soap float in the greasy water. He visualised glass floating like a bar of soap and suddenly conceived of an idea that revolutionised the glass industry.

Basic Float Patent

- The flat glass process patented in 1848 by Henry Bessemer, an English engineer was the first attempt to make a continuous ribbon of flat glass by forming the ribbon between rollers.
- Float glass has been first patented in the United States in 1902 by W. E. Heal and again in 1925 by Hitchcock.



Pilkington Patent

- Alastair Pilkington of Pilkington has been identified as the main contributor for the development of the float glass process. Extensive work has been developed inside Pilkington Brothers along 1950's.
- The first really good float glass was made in July 1958. Pilkington company spent millions pounds between 1952 & 1958 on that development
- British Patent 0769692 explained, in 21 pages, the process.

Float licensing by Pilkington

- Pilkington has been very successful in commercializing the float glass process, obtaining "Original License Patents", restricting its use through licenses and by defining it as "Confidential Information" in their confidentiality agreements.
- Pilkington Brothers began to sell its own float glass and Licensed the process to other glass manufacturers from 1962, with PPG being the first licensee.



**14 December 1962 at St Helens. Signature of licence contract
Boussois & Glaverbel**

Float Glass a key process

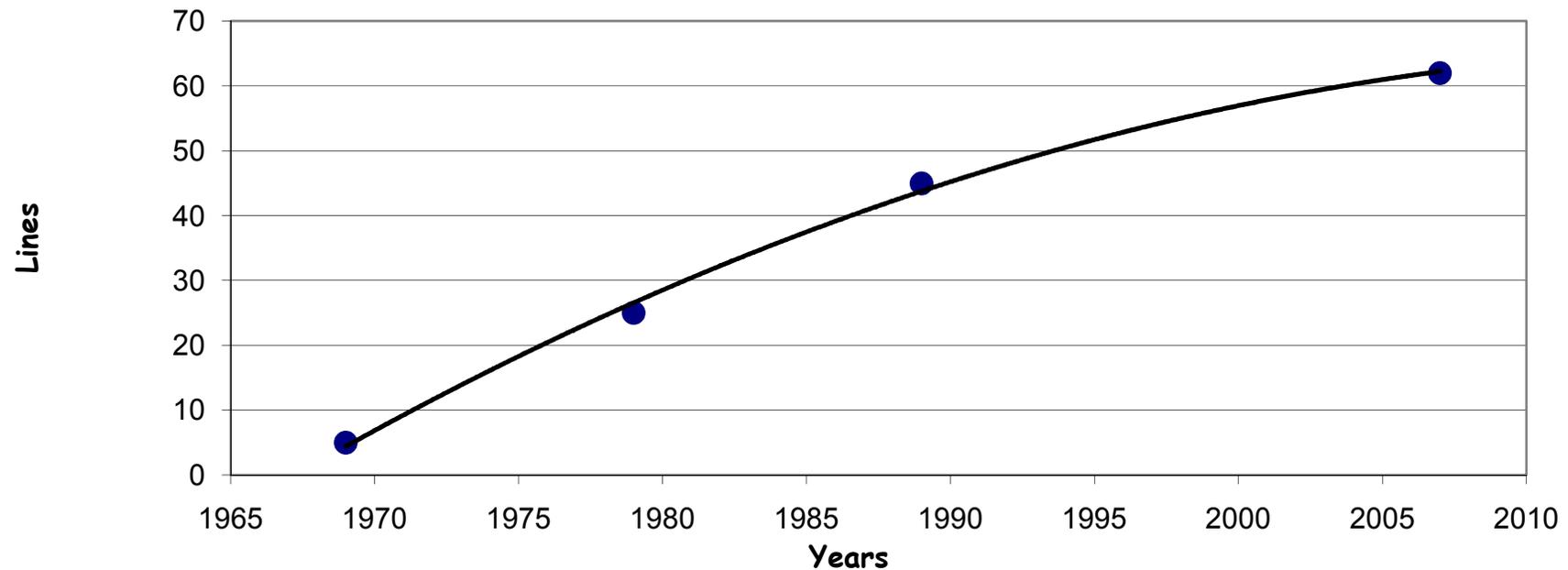
- Today, 90% of flat glass is made utilizing that float process.
- About 300 float lines in the world
- the American newspaper "Popular Mechanics" has made Float glass one of the top 50 inventions of the past 50 years.

Current Float manufacturing

- Float glass is made by melting raw materials into a furnace
- The molten glass is, then, fed into the float bath through a delivery canal. Amount of glass entering onto the tin bath is controlled by a gate (tweel).
- The tin bath is protected, from oxidation, by an appropriate atmosphere (mixture of nitrogen and hydrogen).
- The glass, onto the tin surface, is forming a floating ribbon (approximately 6 mm) with perfect smooth and glossy surface on both sides. Machines are used in the tin bath to control both the thickness and the width of the glass ribbon.
- As the glass flows down the tin bath, the temperature is reduced until the glass sheet can be lifted from the tin onto rollers.
- It, then, passes through the lehr where it is cooled gradually so that it anneals without strain
- Glass is cut mainly in **Jumbo sizes: 3.21 x 6.00 meters**, or split sizes: 3.21 x 2.5 meters)

Float lines in Europe from late 1960's to 2007

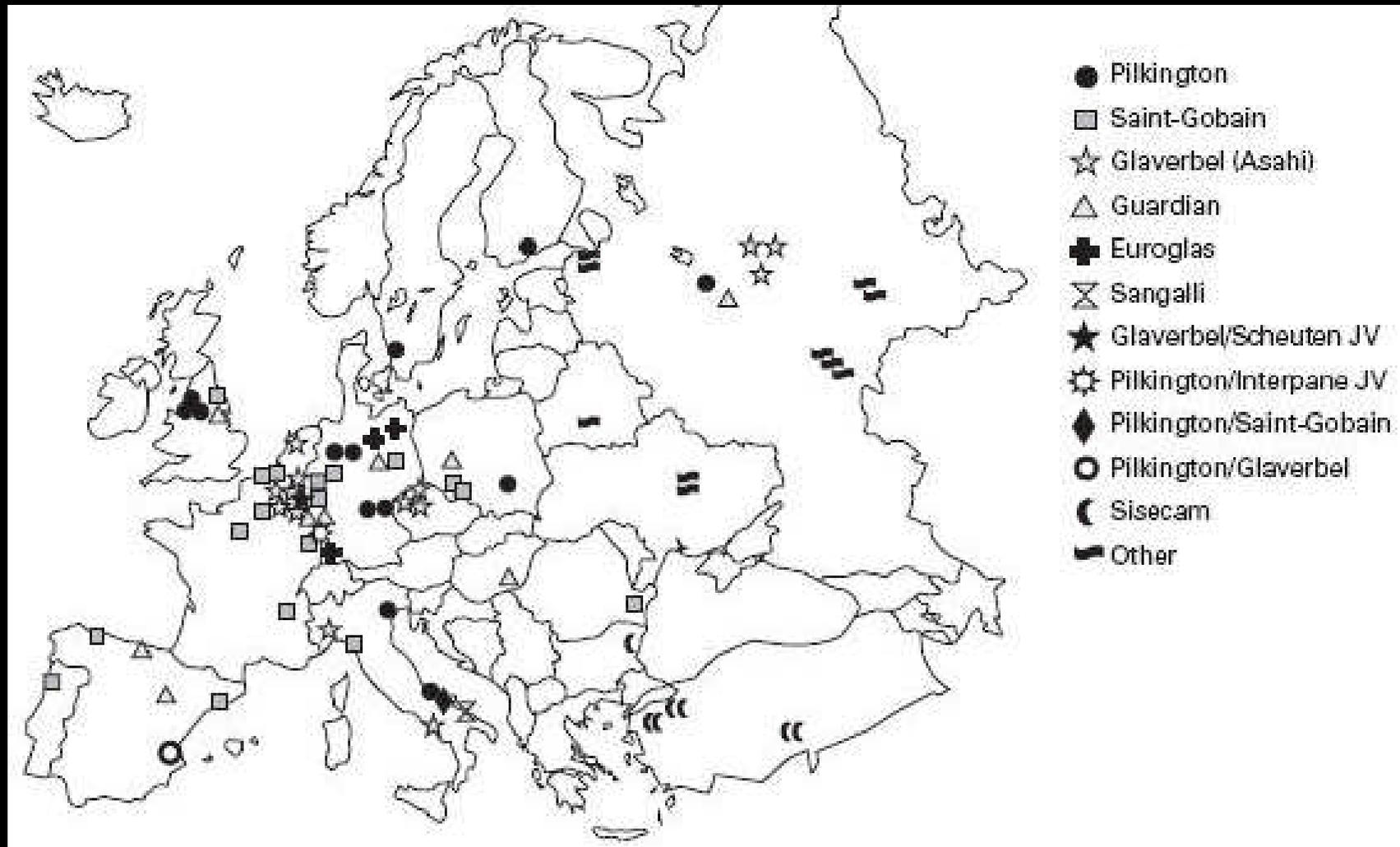
Number of float lines in Europe



62 Float lines in Europe

Source: BJS.Différences data bases

Float lines in Europe



Investment

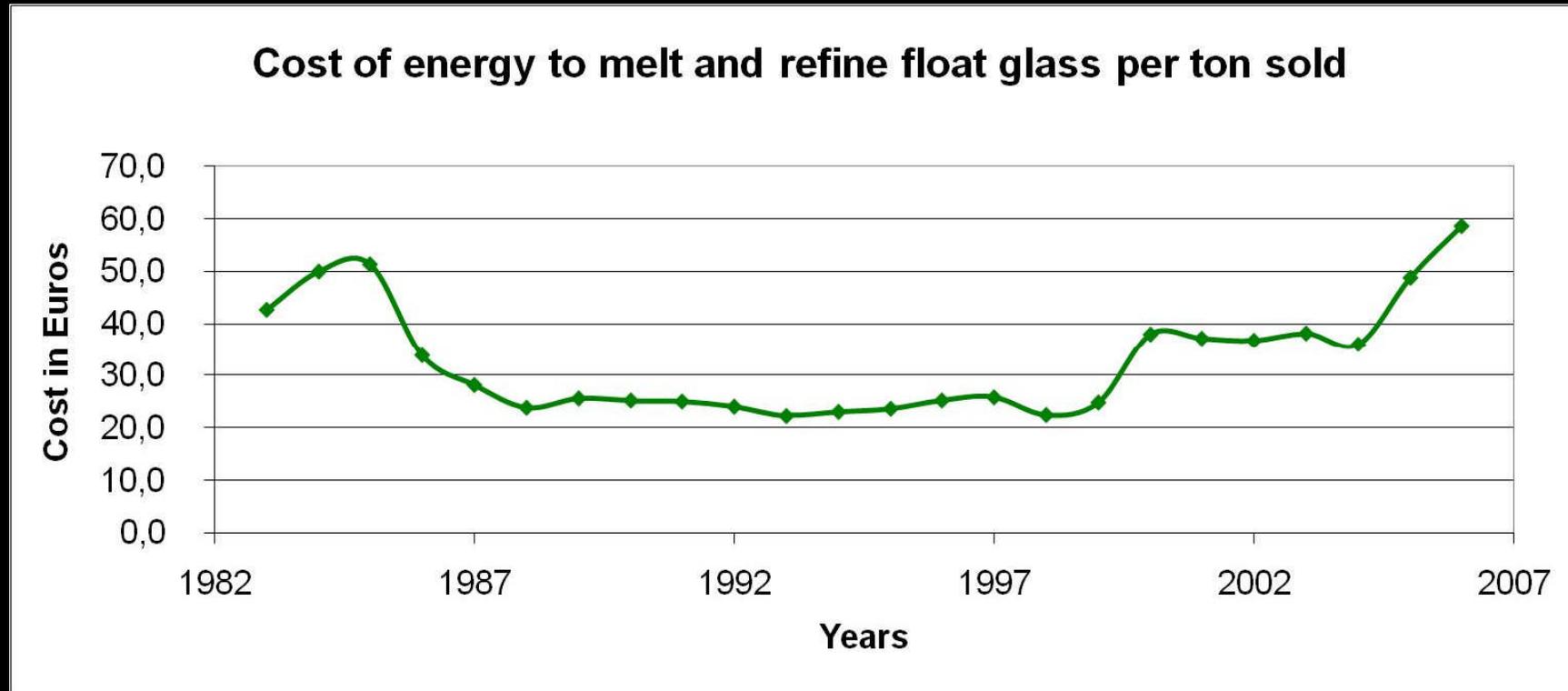
- Investment, for 600 tons/day float line, is 120 to 150 million Euros with European engineering.
- Investment of a 600 tons/day production line is about 1.8 to 2.5 times yearly turnover of the plant, when it was about 1.2 to 1.5 times that yearly turnover, late 70's.

Production costs

- **Typical nominal float glass production costs are:**
 - **raw materials (20%)**
 - **energy (20%)**
 - **overhead (17%)**
 - **labour (15%)**
 - **depreciation (13%)**
 - **transport (10%)**
 - **other (5%)**

Source: Pilkington and the flat glass industry (2006 issue), appendix 1, Manufacturing

Cost of energy

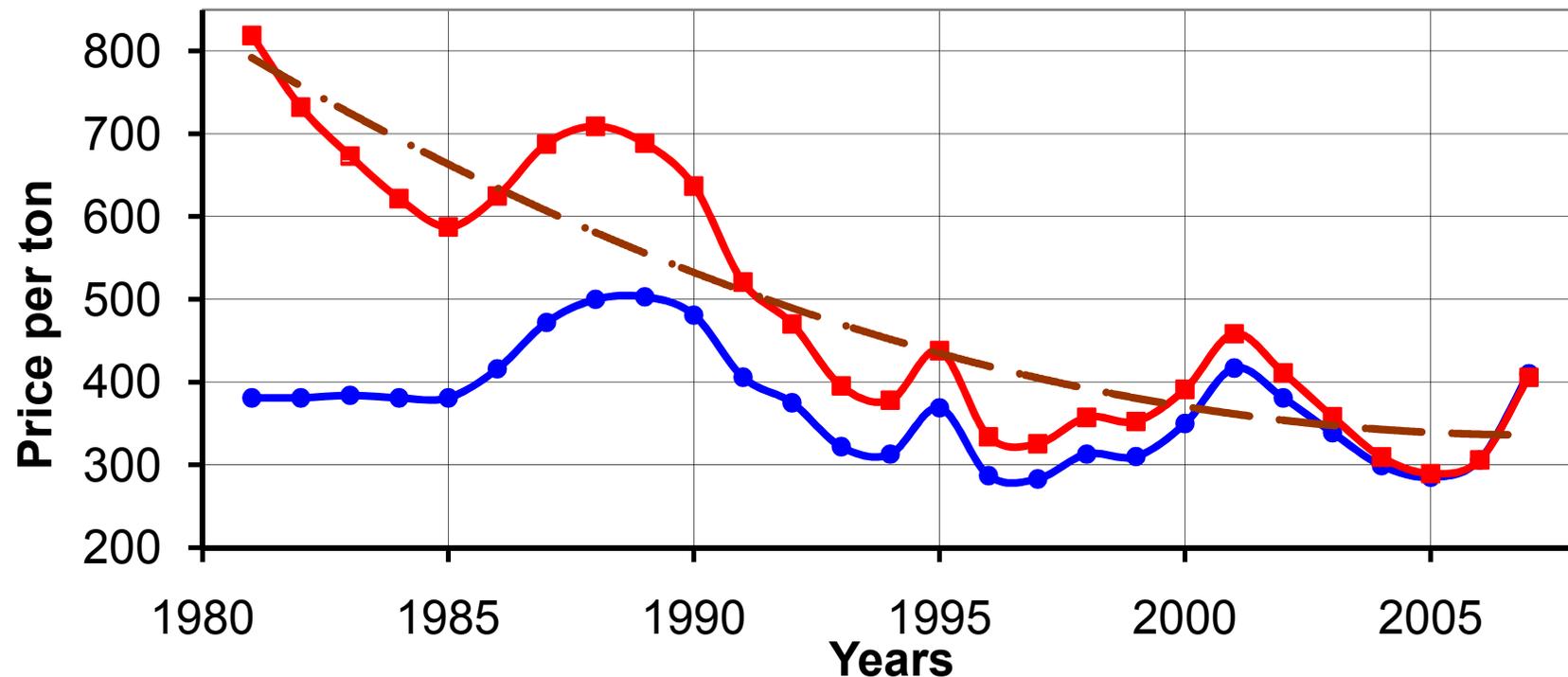


(Source: BJS.Différences data bases,
calculation based on 2200 kWh/ton sold and average yearly price of energy utilized in melters)

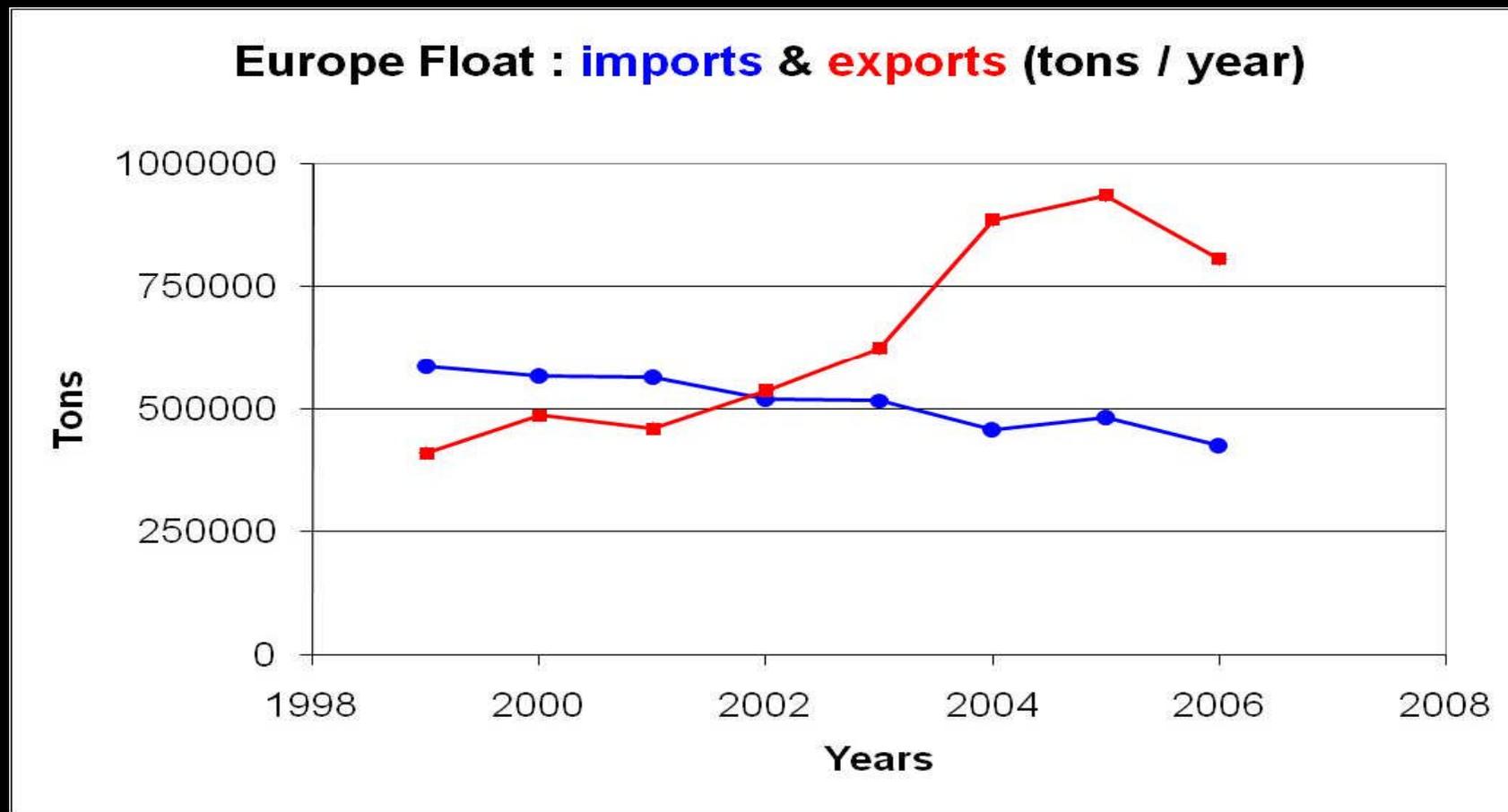
25 years of clear float prices from 1981 to 2007 in Western Europe

Clear Float price per ton - yearly average

(current € - constant 2006 €)



Float glass in Europe: imports & exports



40 years in Europe

Since early 60's European flat glass industry has mainly moved through 5 stages, which have modified strongly that industry and its structure:

- Early Stage (60's)
- Industry restructuring (70's)
- First wave of new comers (80's)
- European Consolidation (90's) and arrival of second new comers wave
- Global consolidation (2000's)

Early stages (60's)

- Most of the window glass was produced by sheet process. Polished glass was mainly utilised for special usage (mirrors, ...).
- Float had to face a pretty strong pushback from fans of polished glass who did not believe in late 60's and early 70's that float would replace polished glass...
- BSN attempted, late 1968, early 1969, to takeover Saint Gobain. The hostile bid has not been successful but has strongly influenced the glass history in Europe, in the last 30 years of 20th century.

Industry restructuring (70's)

- In Europe, several float lines have been implemented inside plants which were producing previously sheet glass or polished glass.
- Along years 1970's flat glass industry had to close a lot of sheet plants assuming the production transfer from sheet glass to float glass. Gilly plant closure, in Belgium, in 1975 has been a key event of that period.
- Price increase of oil (with two major crises) along the 1970's period influenced industry restructuring and new strategy definition.
- First big move has been sales and dismantlement of BSN flat glass branch (late 1970's, early 1980's) sales of Flachglas to Pilkington, Glaverbel to Asahi and Boussois to PPG.
- Developments of tinted glass and coated glass (mainly on line coatings) have been major improvements for the flat glass industry.
- Low-e coatings are appearing on the market

First wave of new comers (80's)

- Two new float glass companies are entering onto the European market: Guardian in Luxembourg & Sisecam in Turkey.
- These two companies strongly influenced the market by implementing new business practices. Low production costs, low structure costs influenced selling prices and forced other glass companies to review their own practices. Structure costs (research and marketing) were reduced and productivity has been noticeably improved.
- Off-line coatings and laminated glass developments have been major improvements, along the decade.
- All developments performed along these years on melting and refining did not let any major change in the production processes. Only noticeable changes have been energy consumption reduction.

Regional Consolidation & Europe Consolidation (1990's)

- GEPVP was a group of 17 members in late 1970's. (BSN - De Maas - Fabbrica Lastre di vetro - Fabbricana Pisana - Flachglas - Gerresheimer Glas - Glas und Spiegel Manufactur - Glasfabrik Lamberts - Glaverbel - Pilkington - Saint Gobain - Saint Roch - Scanglas - SIV - Vegla - Vernante Pennitalia - Verreries de Blanc-Misseron)
- Today GEPVP is a group of 4 members (Glaverbel, Guardian, Pilkington & Saint Gobain).
- Pilkington bought part of SIV in 1993 and fully in 1995 (after the Flachglas acquisition from BSN, late 1970's)
- Glaverbel bought, in 1990, Czech flat glass industry, then Russian Borr and in 1998 PPG Europe (Boussois & Vernante Pennitalia)
- Saint Gobain integrates all its European affiliates from Belgium (Saint Roch), from Germany (Vegla), from Spain (Cristalleria Espagnola) and from Italy.
- Guardian integrates Spanish operations.
- Beside that consolidation, a second flow of new-comers are entering into the business (Euroglas, Sangalli, and recently Interpane)
- European Standardization (products standardization and product evaluation)

Global Consolidations (years 2000's)

- Main facts are: Pilkington is bought by Japanese NSG (2006). Glaverbel is becoming AGC, former Splintex (European automobile Glaverbel branch) is becoming AGC Automobile.
- Guardian is expanding their operations in all countries around the world.
- Saint Gobain is increasing number of their operations in all countries around the world and intensifying activities widely outside the glass business (Glass business counts for about 13 % of current Saint Gobain sales).
- Very large coater installed by Guardian has sculptured the European low-e coated glass market place and strongly influenced its price structure.
- Development of off line temperable coatings has been the major improvement. Low-e, with low solar factor is becoming high demanding products, for commercial buildings.
- Beside European or American companies, Chinese engineering companies are now providing knowledge to build float plants. New production lines, made with Chinese design are implemented in several regions around Europe.

Tomorrow ?

- Cost of energy and cost of manpower are likely going to influence location of production sites.
- For a while, Europe being very mature on flat glass production and flat glass fabrication was exporting developed products. Nowadays fabrication has made tremendous progresses outside Europe. Fabrication made outside Europe is now able to meet European standards.
- Flat glass will arrive, more often, in Europe in a way of fabricated products.

To conclude (1)

- Float glass history has started in Europe with the traditional flat glass industry, which all started glass business more than a century ago (Glaverbel, Saint Gobain and Pilkington).
- European float industry has been strongly modified by a first wave of new comers (Guardian & Sisecam - were originally from outside Europe) and by second wave of new comers (glass fabricators moving upstream their business).
- The "jumbo strategy", implemented by European float glass producers, has protected the European market from large imports because of difficulties to transport glass of such a size.
- Increase of float glass products imports in Europe (basic and fabricated products) will affect local float glass production.
- We believe in a quasi-pause in the expansion, in Western Europe, of the population of producers and in restructuration which will affect that business under pressure coming from producers located outside the European region.

To conclude (2)

- We trust that clear float glass price being currently above 400 Euros per ton, in Europe, is over the average trend curve and therefore we expect a selling price being, again, well below 350 Euros per ton, within 2 to 3 years.

To conclude (3)

- The float has made the forming stage of the flat glass production a benchmark.
- That industry needs, now, a revolution for the first stage of its production process: the glass melting. After many dreams and attempts which have not yet shaped a new success story we hope that a new melting technology will come and profile the flat glass future...

**Thank you
for your attendance**

If you want to get more information on the subject:

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