



# Low-E Insulating Glass for **Energy Efficient Buildings**

How policy-makers could save energy and significantly  
reduce CO<sub>2</sub> emissions to meet EU targets for 2020

A brochure from



**GLASS FOR EUROPE**

Europe's Manufacturers of Building, Automotive and Transport Glass

## Key Facts about the EU's 2020 Targets

**Fact:** Up to 90 million tonnes of CO<sub>2</sub> emissions could be saved annually by 2020 if all Europe's buildings were fitted with double-glazed Low-E insulating glass units (i.e. all existing and new, residential and non-residential buildings).

**Fact:** Up to 97 million tonnes of CO<sub>2</sub> emissions could be cut if, in addition to retrofitting existing buildings with Low-E double-glazing, greater use were made of triple-glazed Low-E units for new buildings, where appropriate (i.e. in cooler northern regions).

**Fact:** This is good news because the EU has committed to cutting around 300 million tonnes of needless CO<sub>2</sub> emissions annually in the same time frame by saving energy wasted in residential and non-residential buildings. **Extensive use of Low-E insulating glass units could achieve as much as one third of the EU's emissions reduction targets for buildings.**

**Fact:** EU leaders want to save 20% of the EU's overall energy requirement by 2020, cutting CO<sub>2</sub> emissions in the process. If successful, the EU's overall energy saving would be 390 million tonnes of oil equivalent and a cut of 780 million tonnes<sup>1</sup> in CO<sub>2</sub> emissions.

**Fact:** The EU's overall inability to use energy efficiently across all activities will needlessly cost hundreds of billions of euros by 2020. So greater use of Low-E insulating glass units will also save money.

**Fact:** With modern materials and technologies, it is possible to design buildings which dramatically reduce heating requirements, or even eliminate the need for conventional heating systems (low energy buildings). Low-E insulating glass units – particularly triple-glazed – are a crucial component in reducing the need for heating in such buildings.

**Fact:** Low-E glazing technology exists today and is ready to use. Energy savings from the installation of Low-E insulating glazing far outweigh the energy consumed in manufacturing the glass. With architectural glass industry emissions in Europe estimated to be in the region of four to five million tonnes of CO<sub>2</sub> per year,<sup>2</sup> the potential savings from the increased use of Low-E insulating glass units exceed the manufacturing emissions considerably.

**Sources:** General facts from “**Action Plan for Energy Efficiency: Realising the Potential**” (Communication from the European Commission, COM(2006)545 final of 19.10.2006) and facts about Low-Emissivity glass are from “**Potential impact of Low-Emissivity Glazing on energy and CO<sub>2</sub> savings in Europe**” (TNO Report 2008-D-R1240/B by TNO Built Environment and Geosciences, Delft, The Netherlands).

<sup>1</sup> This figure refers to the target for the EU25.

<sup>2</sup> “Energy and Environmental Benefits from Advanced Double Glazing in EU Buildings”, March 2005, page 11, GEPVP

# Low-E Insulating Glass is an Energy Saver. Promoting its Use Will Cut CO<sub>2</sub> Emissions.

Many new and most existing buildings use unnecessary energy in order to keep people comfortably warm inside. This means more CO<sub>2</sub> emissions than needed.

Over 40% of all energy consumed in the EU is in buildings. Making new and existing buildings as energy efficient as possible will make significant strides towards meeting the EU's CO<sub>2</sub> reduction goals.

Policy-makers could achieve around one third of the energy saving targets for buildings identified in the European Commis-

sion's "Action Plan for Energy Efficiency: Realising the Potential" by promoting the use of double or triple-glazed Low-Emissivity (Low-E) insulating glass units in existing and new buildings in Europe. Low-E insulating glass units save energy because they reduce the heat loss from a building through the glass. At the same time they allow a significant amount of the sun's

heat to come in, thus reducing the need for artificial heating of the building.

The potential for Low-E insulating glazing to cut CO<sub>2</sub> emissions from buildings has been analysed in a study by the Dutch scientific institute TNO. This study is technically rigorous and conservative. The results are presented in this brochure. The study concludes

that as much as 97 million tonnes of CO<sub>2</sub> emissions could be avoided annually by the year 2020 if Low-E insulating glass was used optimally in new and old buildings throughout Europe (see Table 3).

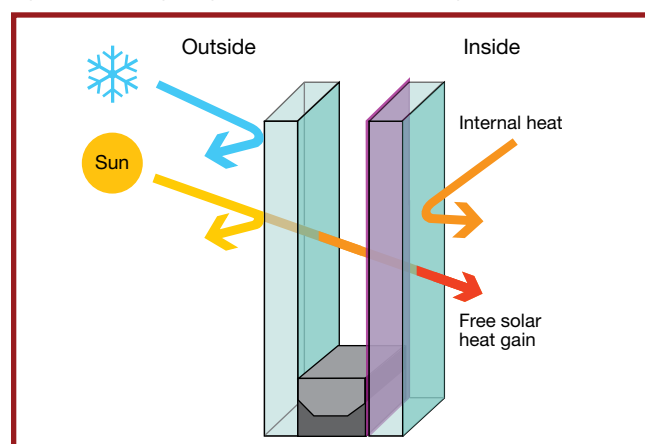
This technology exists today. The EU and its Member States can use it to help achieve their own targets, by acting to ensure that it is more widely used.

## Low-Emissivity glass

"Emissivity" refers to the ability of the glass surface to reflect heat. Low-E glass is specially treated with a microscopically thin, virtually invisible transparent coating on one surface. The coating reflects heat back into the building, thereby reducing the heat loss through the window. It also reduces the heat transfer from the warm (inner) pane of glass to the cooler (outer) pane, thus further lowering the amount of heat that escapes from the window. The coating allows large amounts of solar energy to enter the building, thereby heating it. This coating is used on glass in both double and triple-glazed units.

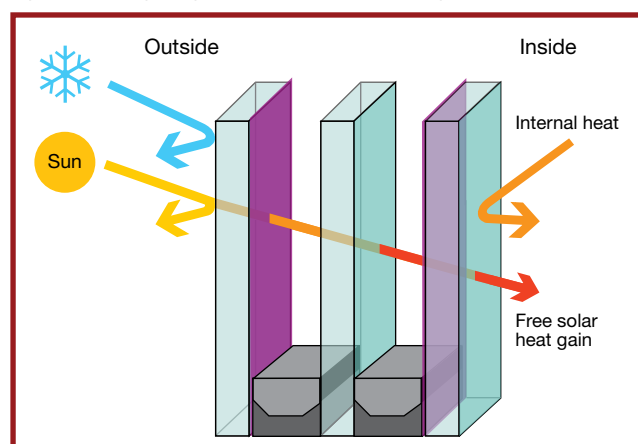
The properties of Low-E insulating glazing enable it to be a net contributor of energy in buildings.

Figure 1: Double glazing unit with one Low-E coating



■ Low-E coating applied to one side of the glass

Figure 2: Triple glazing unit with two Low-E coatings







# Stay warm. Save energy. Cut emissions.

With so much human activity taking place indoors, achieving and maintaining a comfortable temperature is paramount. However, this must be managed in the most energy-efficient and sustainable way.

Most buildings we occupy today were constructed at a time when energy efficiency was not a big feature of architectural design. Building products to conserve heat were not optimised. As a result, a huge amount of heat is lost from existing buildings through out-of-date windows. A top priority should be the replacement of inefficient glass in these buildings so that the central heating can be turned down.

The investment in new windows will be paid back in a matter of years in reduced heating costs.

CO<sub>2</sub> emissions will also fall. There is no time to lose – the targets set under the UN Kyoto Agreement are due to be delivered very, very soon. There is, however, financial resistance to replacing inefficient windows in existing buildings because of the significant up-front cost. Governments can and should provide financial or fiscal incentives to owners of homes and other buildings to install state-of-the-art windows.

All new buildings should be obliged by law to use energy-saving windows. It is also vital that

the revision of the Energy Performance of Buildings Directive (which requires all EU member states to improve their building regulations every five years) is extended to cover smaller buildings. National governments need not wait for a new Directive to encourage greater use of Low-E insulating glass. They should show an example by retrofitting public buildings and provide economic stimulus that will reduce the financial burden of replacing outdated windows with the best on offer today.

## What can policy-makers do to give Europe new windows and cut CO<sub>2</sub> emissions?

- Encourage and, where necessary, require the use of double and triple-glazed Low-E insulating glass units in national building regulations for new construction.
- Encourage or require retrofitting of existing buildings with Low-E insulating glass units by fiscal or legislative means.
- Provide economic and fiscal incentives to both users and manufacturers of Low-E insulating glazing to promote better market uptake of these energy-saving products.
- Ensure that all relevant public buildings are fitted with appropriate Low-E insulating glass units.
- Organise information and communication campaigns on the benefits of using Low-E insulating glazing.
- Ensure that Energy Performance Certificates for buildings explain and quantify the potential energy and CO<sub>2</sub> savings achievable through using double and triple-glazed Low-E insulating glass units.



# European Buildings... need New Windows!

Double glazing is a well-established product but it is not standard everywhere in Europe. Indeed, huge segments of the building stock in Europe are still single-glazed, wasting vast amounts of energy every minute.

Far too often windows are only replaced with double glazing when they become decrepit. Replacing inefficient windows at the current rate will take de-

cades to complete. But “end-of-life” should not be the criterion for replacement of inefficient windows – energy savings should be the driver. Waiting until window replacement is unavoidable misses the opportunity to save huge amounts of energy, CO<sub>2</sub> emissions and money.

Much of the older installed double glazing performs inadequately too. A strong argument also exists

for replacing this outdated double glazing with today’s super efficient double and triple glazing, which performs much better.

Not all glazing is the same quality and not all double glazing makes use of high performance Low-E insulating glass units. Quality of components and manufacture make a difference. This is why a dynamic EU-wide energy labelling scheme for windows would

help consumers identify the most efficient products. It would also provide a reference structure for government incentive programmes to encourage sales of the best-performing windows and promote ongoing product improvement.

## If securing supply is a top priority, why waste energy needlessly?

The cost of energy is crucial to any economy - national or international, business or home. Soaring oil and gas prices at different moments over the past thirty five years have triggered successive economic downturns across the globe. Natural reserves are dwindling and sustainable alternatives are often more costly. Yet global energy demand continues to grow.

Oil and gas reserves are concentrated in the hands of a few. This makes the rest of the world dependent on market policies and decisions it cannot easily influence. Manipulation of energy supplies influences economic well-being and political stability. Every country now worries about security of energy supplies because lack of energy has the potential to disrupt their way of life on a massive scale.

Fears about the vulnerability of energy supply infrastructures have also grown as a result of the rise in international terrorism. And accidents, natural disasters and freak weather conditions also have the potential to cut off supplies unexpectedly. Again, this puts security of supply in the spotlight. Governments the world over are actively looking at how to reduce dependence on any one source of energy.

In the meantime, the single most important thing policy-makers can and should do is make sure we use no more energy than is strictly necessary. Heating homes, workplaces and public spaces consumes - and wastes - vast amounts of energy. It is obvious that many of our buildings in Europe need priority attention. Low-E insulating glass in double and triple glazing is an existing technology for keeping warmth inside buildings. Installing it more widely would mean that heating systems could be turned down or off, saving lots of scarce energy and reducing reliance on others – thereby enhancing our security.

The most secure energy is saved energy.



# A Rigorous Study

## A scientific determination of the potential benefits of Low-Emissivity glass

Glass for Europe commissioned Dutch technical research institute TNO to perform a study of the potential energy and CO<sub>2</sub> savings in Europe from an increased use of Low-E insulating glazing. The report of the study is available on request from Glass for Europe or can be downloaded at: [www.glassforeurope.com](http://www.glassforeurope.com).

The study is exceptionally rigorous in its methodology and controls, conservative and cautious in its approach to the assumptions built into the models. This has produced results that are serious, solid and credible.

TNO was asked to carry out an analysis of the potential energy and CO<sub>2</sub> emissions savings to be made by greater use of high performance double-glazed units using Low-E glass in all new and existing buildings across the EU27. The potential energy saving per year could be as much as 912,000 terajoules (TJ)<sup>3</sup> by the year 2020 leading to an EU-wide reduction in CO<sub>2</sub> emissions of up to 90 million tonnes annually. *The results country-by-country can be found in Table 2.*

In addition, TNO was asked to look at the savings potential if high performance triple-glazed

units using Low-E glass were fitted in all new buildings, except in the warmer southern regions of Europe where high performance double glazing would be used. The potential energy saving per year of this measure alone could be as much as 113,000 TJ by the year 2020 yielding an EU-wide reduction in CO<sub>2</sub> emissions in excess of 11 million tonnes annually. *The results country-by-country can be found in Table 3.*

The EU has committed to cutting by the year 2020 around 300 million tonnes of CO<sub>2</sub> emissions annually by saving energy in resi-

dential and non-residential buildings. Glass for Europe has concluded from this study that consistent and appropriate use of both double and triple-glazed Low-E units across the EU27 in all existing and new buildings has the potential to save as much 97 million tonnes of CO<sub>2</sub> per year by 2020 – that is 30% of the annual target the EU has set for itself.

## Key factors considered

The calculation of the potential benefit of greater use of Low-E insulating glass units in the 27 EU Member States took various key factors into account. Direct or extrapolated data were used for local climatic conditions; the mix of energy sources in use (CO<sub>2</sub> output per TJ varies depending on whether, for example, electricity is gener-

ated from coal, gas or nuclear); and the nature of the building stock (categorised by, for example, age, construction materials, whether residential or not, centrally-heated or not). Eight distinct groupings were identified on this basis.

The following performance values for the glass were used: triple

glazing – g value: 0.6; U value: 0.7; double glazing – g value: 0.6; U value: 1.1.

For the purposes of the calculations made in this study, it is assumed that glass units with these performance specifications are installed between 2008 and 2020 for existing and new buildings.

<sup>3</sup> A terajoule is 10<sup>12</sup> joules. A joule is the amount of energy needed to produce power of one watt continuously for one second, or heat one gramme of dry, cool air by 1 degree Celsius. An average French city of one million inhabitants consumes about 50,000 terajoules of energy a year.



# Significant Savings Potential

Up to 30% of the EU's CO<sub>2</sub> reduction targets for buildings could be achieved with Low-E glazing.

Table 1: Annual energy and CO<sub>2</sub> savings potential in the EU27 by the year 2020 from optimal use of Low-E insulating glass units.

Usage of Low-E insulating glazing	Energy savings [TJ]	Energy savings Millions of tonnes of oil equivalent	CO <sub>2</sub> reduction [kt]
Double glazing in all new buildings	50,213	1.2	4,767
Triple glazing in all new buildings, except in the South where double glazing is used	112,955	2.7	11,303
Double glazing in all buildings (existing & new)	912,493	21.7	90,077
Double glazing in all existing buildings	862,280	20.5	85,310
Max potential: double & triple glazing (as appropriate) in all existing & new buildings	975,235	23.2	96,613

It is already the case that Low-E glazing is being used in both new and existing buildings. Table 1 shows the additional saving that could be made over and above current trends.

## What does this mean for policy-makers?

### Message No. 1:

By adapting building regulations to require the use of high performance Low-E double or triple glazing (as appropriate) in the construction of **all new buildings**, the EU27 could save between 50,000 and 113,000 terajoules of energy annually by 2020 and cut CO<sub>2</sub> emissions by between 4.7 and 11.3 million tonnes per year. *This would be cost-free for government.*

### Message No. 2:

By using a mixture of legislation and market-based incentives to promote the retrofitting of existing buildings with high performance Low-E double glazing, the EU27 could save up to 860,000 terajoules of energy annually by 2020 and cut CO<sub>2</sub> emissions by as much as 85 million tonnes per year. Government costs associated with these measures (tax credits or subsidies, for example) would most likely be offset, at least in part, by increased VAT receipts from sales of new windows, reduced unemployment costs and healthier income tax revenues (although this has not been studied).

### Message No. 3:

By acting on both fronts – promoting use of high performance Low-E double or triple glazing (as appropriate) in all new and existing buildings – the EU27 could save up to 975,000 terajoules of energy annually by 2020 and cut CO<sub>2</sub> emissions by as much as 97 million tonnes per year, nearly one third of the EU's announced goal for buildings.

# Low-E double glazing in all Existing and New Buildings

Many buildings in Europe are still not fitted with standard double glazing, let alone Low-E insulating glass units. Table 2, below, offers us a look at the impact use of Low-E insulating glass units would have on CO<sub>2</sub> emission levels if all buildings all over Europe, both existing and new, were fitted with double-glazed Low-E insulating glass units. Millions of tonnes of CO<sub>2</sub> could be saved annually towards the EU's 2020 targets.

Table 2: Annual energy and CO<sub>2</sub> savings potential in 2020 - Use of high performance Low-E double glazing only

	Existing buildings (a)		New buildings (b)		Existing & new buildings (a)+(b)	
	Energy savings [TJ]	CO <sub>2</sub> reduction [kt]	Energy savings [TJ]	CO <sub>2</sub> reduction [kt]	Energy savings [TJ]	CO <sub>2</sub> reduction [kt]
<b>North</b>	<b>14,734</b>	<b>1,589</b>	<b>-2,621<sup>4</sup></b>	<b>-285</b>	<b>12,113</b>	<b>1,304</b>
Finland	5,409	584	-962	-105	4,447	479
Sweden	9,324	1,005	-1,658	-180	7,666	825
<b>Central maritime</b>	<b>232,306</b>	<b>24,074</b>	<b>7,469</b>	<b>841</b>	<b>239,775</b>	<b>24,916</b>
Belgium	15,227	1,577	490	56	15,717	1,633
Denmark	7,997	830	257	28	8,254	859
Ireland	5,959	621	192	20	6,151	641
Luxembourg	695	72	22	2	718	75
The Netherlands	24,194	2,517	778	84	24,972	2,601
United Kingdom	88,920	9,235	2,859	314	91,779	9,549
France	89,312	9,221	2,871	338	92,184	9,559
<b>Central Continental</b>	<b>202,049</b>	<b>21,026</b>	<b>7,458</b>	<b>794</b>	<b>209,507</b>	<b>21,820</b>
Austria	18,268	1,896	674	73	18,943	1,970
Germany	183,781	19,130	6,783	720	190,564	19,850
<b>South</b>	<b>174,774</b>	<b>15,958</b>	<b>28,332</b>	<b>2,499</b>	<b>203,106</b>	<b>18,456</b>
Cyprus	1,155	117	187	20	1,343	136
Greece	15,435	1,557	2,502	265	17,937	1,822
Italy	83,951	7,620	13,609	1,187	97,561	8,807
Malta	578	55	94	9	671	64
Portugal	15,316	1,398	2,483	219	17,799	1,617
Spain	58,339	5,211	9,457	799	67,796	6,010
<b>Baltic republics<sup>5</sup></b>	<b>17,736</b>	<b>1,773</b>	<b>494</b>	<b>50</b>	<b>18,230</b>	<b>1,822</b>
<b>Poland</b>	<b>64,246</b>	<b>6,435</b>	<b>4,216</b>	<b>413</b>	<b>68,462</b>	<b>6,848</b>
<b>Central<sup>6</sup></b>	<b>75,575</b>	<b>7,554</b>	<b>2,350</b>	<b>238</b>	<b>77,925</b>	<b>7,791</b>
<b>Romania &amp; Bulgaria</b>	<b>80,860</b>	<b>6,902</b>	<b>2,514</b>	<b>217</b>	<b>83,375</b>	<b>7,119</b>
<b>EU27</b>	<b>862,280</b>	<b>85,310</b>	<b>50,213</b>	<b>4,767</b>	<b>912,493</b>	<b>90,077</b>

<sup>4</sup> The negative values here are due to the fact that these countries already use triple glazing extensively in new buildings, whereas this table deals with the savings associated with the use of double glazing.

<sup>5</sup> Estonia, Lithuania, Latvia

<sup>6</sup> Czech Republic, Hungary, Slovakia, Slovenia



# Low-E triple glazing brings Added Benefits in Cooler Zones

Fitting triple glazing made with Low-E glass can further enhance energy efficiency gains in most parts of Europe. But it doesn't make much sense to do this where the climate is hot in summer, warm in winter. Double-glazed units are the best choice for these regions. Table 3, below, shows the potential of fitting Low-E triple glazing in all future new buildings all over Europe except in milder southerly regions where double glazing suffices. It also shows the impressive potential of combining the use of triple glazing in most new buildings with Low-E double glazing in all existing buildings.

Table 3: Annual energy and CO<sub>2</sub> savings potential in 2020 - Use of high performance Low-E double and/or triple glazing

	New buildings (triple glazing everywhere, with double glazing in the South)		Existing buildings (double glazing) New buildings (triple glazing everywhere, with double glazing in the South)	
	Energy savings [TJ]	CO <sub>2</sub> reduction [kt]	Energy savings [TJ]	CO <sub>2</sub> reduction [kt]
<b>North</b>	<b>2,790</b>	<b>313</b>	<b>17,523</b>	<b>1,902</b>
Finland	1,024	114	6,433	698
Sweden	1,765	199	11,090	1,204
<b>Central maritime</b>	<b>29,964</b>	<b>3,250</b>	<b>262,270</b>	<b>27,324</b>
Belgium	1,964	214	17,191	1,791
Denmark	1,032	111	9,029	941
Ireland	769	81	6,728	702
Luxembourg	90	10	785	82
The Netherlands	3,121	331	27,315	2,848
United Kingdom	11,469	1,227	100,390	10,463
France	11,520	1,278	100,832	10,499
<b>Central Continental</b>	<b>28,304</b>	<b>2,982</b>	<b>230,353</b>	<b>24,009</b>
Austria	2,559	273	20,827	2,169
Germany	25,745	2,709	209,526	21,839
<b>South</b>	<b>28,332</b>	<b>2,499</b>	<b>203,106</b>	<b>18,456</b>
Cyprus	187	20	1,343	136
Greece	2,502	265	17,937	1,822
Italy	13,609	1,187	97,561	8,807
Malta	94	9	671	64
Portugal	2,483	219	17,799	1,617
Spain	9,457	799	67,796	6,010
<b>Baltic republics<sup>7</sup></b>	<b>2,052</b>	<b>206</b>	<b>19,788</b>	<b>1,978</b>
<b>Poland</b>	<b>9,007</b>	<b>889</b>	<b>73,254</b>	<b>7,324</b>
<b>Central<sup>8</sup></b>	<b>6,042</b>	<b>609</b>	<b>81,617</b>	<b>8,162</b>
<b>Romania &amp; Bulgaria</b>	<b>6,464</b>	<b>556</b>	<b>87,325</b>	<b>7,458</b>
<b>EU27</b>	<b>112,955</b>	<b>11,303</b>	<b>975,235</b>	<b>96,613</b>

<sup>7</sup> Estonia, Lithuania, Latvia

<sup>8</sup> Czech Republic, Hungary, Slovakia, Slovenia





# Sustainable Development in Action

All across Europe, Low-E insulating glass units can help save energy and cut CO<sub>2</sub> emissions.

Some of the case studies in the research commissioned by Glass for Europe show very ambitious scenarios. It is unrealistic to think that all the energy inefficient glazing systems in all the existing buildings in Europe will be replaced in the short term. But a serious start could and should be made.

On the other hand, it is a simple matter of adapting national building regulations to require all new buildings to be fitted with state-of-the-art glazing appropriate for the local climatic conditions. If action were taken on new build-

ings, about 11 million tonnes of CO<sub>2</sub> could be saved for virtually no effort.

In the most ambitious scenarios, as much as a third of the EU's targeted reductions in CO<sub>2</sub> emissions due to buildings could be saved by maximum use of Low-E insulating glass units in new and existing buildings (to moderate use of central heating).

A separate study commissioned by Glass for Europe, shows as much as a quarter of the EU's targeted reductions in CO<sub>2</sub>

emissions could be saved by appropriate use of another high performance glass product, Solar Control Glass, in new and existing buildings (to reduce use of air-conditioning).<sup>9</sup>

More widespread use of these state-of-the-art glass products in buildings provides one of the easiest routes to major cutbacks in CO<sub>2</sub> emissions available today. As well as reducing the impact on the environment, this would also be good for the economy and good for people. The essence of sustainable development, in fact.

## What can policy-makers do?

There is no instant solution. Energy savings must be found across all sectors and activities; modest incremental savings add up to the overall goals we wish to achieve.

Many energy-efficient technologies exist already but are not adequately exploited. Low-E insulating glazing is a perfect example of a proven way to increase efficiency that can and should play a greater role. Use of Low-E insulating glass units provides a “win-win-win scenario”: keeping buildings warm inside and occupants comfortable and productive; reducing unnecessary CO<sub>2</sub> emissions and helping keep the planet cool; and, reducing energy needs and cutting costs.

Policy-makers should actively examine ways to promote greater use of Low-E insulating glass units in building projects. This could be achieved by legislative means. For example, national building regulations could require the use of Low-E insulating glazing, especially in cooler climates, or use economic and fiscal instruments to favour energy efficient choices, or a mix of both.

<sup>9</sup> The report “Impact of Solar Control Glazing on energy and CO<sub>2</sub> savings in Europe” (2008) is available on request from Glass for Europe or at [www.glassforeurope.com](http://www.glassforeurope.com).

## Europe's leading glass manufacturers have a Vision...

- To be forward-looking, innovative providers of state-of-the art products and technologies.
- To provide solutions to the major needs and challenges of our times, now and in the future.
- To be admired and valued for our products, which enhance people's lives and environment.
- To be a valued partner in promoting safety, security, comfort, and sustainability - recognised as responsible and responsive.
- To be an industrial manufacturing sector in which our employees will always be proud to work.

## Glass for Europe is the trade association representing these companies...

- AGC Flat Glass Europe.
- Pilkington.
- Saint-Gobain Glass.

## Glass for Europe has a clear Mission...

- To explain and promote the Vision of the glass industry.
- To explain and promote the value and contribution of the glass industry and its products.
- To represent the interests of our members in the policy-making process.
- To contribute to worldwide initiatives on product policy.



## Low-E Insulating Glass for **Energy Efficient Buildings**



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