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Choosing 'High energy performance' glazing in windows

Informative paper on the benefits of high energy performance glazing in renovation, its technologies and key performance parameters compared to older and inefficient glazing

Glass and glazing have a unique feature: **transparency.**

It is thanks to this transparency that **glass lets daylight into buildings and offers building occupants views to the outside**. Glass is installed in buildings for these two main reasons, but also to ensure comfortable and healthy conditions for occupants, due to daylight's role in regulating the body clock.

The transparency of glazing also affects its energy performance as it allows to capture or repeal free heat gains provided by the sun. To increase performance and reduce heat transfers, many invisible innovations were incorporated into insulating glass units independently of the number of glass panes. Put in simple terms**, double or triple glazing are not relevant categories to assess the thermal performance of glazing. One needs to look at the specific performance parameters of glazing.**

This informative paper is meant **to shed light on high energy performance glazing,** their key performance parameters and how to choose glazing in building renovation and window replacement to maximise energy savings and comfort for building occupants. **It formulates recommendations to both end-consumers and policymakers.**

The information contained in this paper is generic and simplified to be accessible to all. It is non-commercial and refers to product types readily available across Europe.

The benefits of upgrading to high energy performance glazing

- ***Saves money on energy for heating and cooling**. At times of uncertainties around energy supply and high energy prices, saving energy from heating and cooling buildings is beneficial to consumers and a policy priority in Europe. Studies have shown that Europe could save nearly 30% of buildings' energy use thanks to high energy performance glazing (see annex 1).*
- ***Contributes to global efforts to reduce CO_2 emissions**. Thanks to energy savings realised in buildings, high energy performance glazing helps reduce CO_2 emissions in buildings. They can significantly contribute to the EU achieving its climate-neutrality objective.*
- ***Improves comfort and well-being inside buildings.** With the avoided heat transfers between the inside and outside of buildings, comfort is greatly improved for occupants. The sensations of cold air circulation indoors in winter and the risks of over-heating in summer are minimised.*
- ***Allows the integration of new comfort features and functionalities.** Glazing with high energy performance are available and they can fulfil additional functions. For instance, they can combine acoustic properties, safety or security functions. Options are countless to meet people' needs.*
- ***Increases building retail values.** Buyers, the real estate market and financial institutions value more properties with high energy performance due to high energy costs and regulatory constraints. Buyers often look at windows as an indication of energy performance.*

GLASS FOR EUROPE aisbl/ivzw | Rue Belliard 199, B - 1040 Brussels | T + 32 2 538 43 77 | F + 32 2 280 02 81
info@glassforeurope.com | VAT : BE 0418 828 479 | EU Transparency Register : 15997912445-80
WWW.GLASSFOREUROPE.COM

RECOMMENDATIONS FROM THE FLAT GLASS AND GLAZING INDUSTRY

FOR POLICY-MAKERS

- Put in place **effective measures to support the renovation of buildings**, alongside measures set in the EU Energy Performance of Buildings Directive and the Energy Efficiency Directive.
- Design and consolidate **financial incentives to window and glazing replacement.**
- Do not limit financial support to the replacement of single glazed windows. Many EU buildings are still equipped with uncoated double glazing, with very poor energy performance. **Uncoated double glazing need urgent upgrades** to realise massive energy savings.
- **Review minimum energy performance requirements for windows** alongside obligations and guidelines contained in the Energy Performance of Buildings Directive. In some European countries, these minimum performance standards are set at levels below standard product performance and therefore do not support energy savings efforts.
- When introducing minimum performance requirements, **consider setting requirements on both U value (thermal transmittance) and g value (solar heat gain or protection)**. The g value has become an important parameter in the performance of windows and is essential to adapt buildings to rising temperatures and heat waves. Alternatively, requirements can be based on 'energy balance' calculations.

FOR CONSUMERS

> First, **have a look at your windows and glazing**. If the window is single glazed or has been installed decades ago (please refer to page 5 for indicative dates), your window is most likely equipped with an old-generation and inefficient type of glazing that needs to be replaced.

> Check if a change of window or glazing entitles you **to financial support**.

> Should you consider changing glazing or window, **get in touch with several installers**. The choice of the most adequate glazing depends on the building, its location, its use and occupants' comfort expectations so be sure to discuss the glazing performance with an expert.

> Make sure to **ask for the U values (U_w for the window and eventually the U_g for glazing) and the g value of glazing.** In many instances, you will be provided U_w values only, but you must obtain at least the g value of the glazing to make an informed decision. The U value of the glazing, i.e. U_g, can be asked or derived from the U value of the window, i. e. U_w (see Chart 1).

> Glazing types need to be part of the discussion with installers. Envisage with them the several options available and **the possibility to opt for different glazing types depending on orientations and window sizes**. Choosing a high energy performance window that repeals solar heat, i.e. a lower g value, is a 'summer comfort' choice that becomes increasingly important all over Europe because of more intense and prolonged heat waves in summer.

> In Europe, do not go for windows with **U_g values** above 1.1. This will be guaranteed if the U_w value is no more than 1.4. In the Northern and central / continental regions of Europe, lower U values are strongly recommended. *ATTENTION: The U_w value is the U value of the entire window. The U_w value of a window will always be higher than the U value of its glazing (U_g) (see Chart 1).*

> Choose glazing with higher **g values** to maximise solar heat gains or with lower g values to minimise solar heat gains and risks of overheating. All over Europe, large glazing facing south or west should better have low g value. Low g value glazing are also recommended for all windows in the hottest regions of Europe.

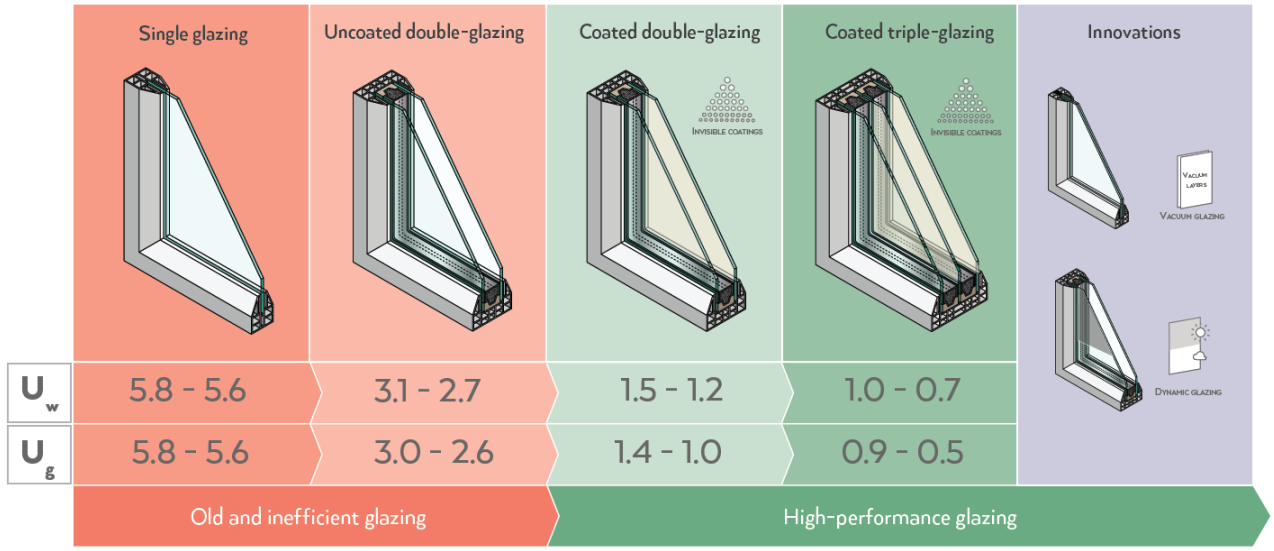
What are ‘high energy performance glazing’?

High energy performance glazing refers to an insulating glass unit (IGU) which is composed of two or three panes of glass, which have been processed and assembled to provide superior energy efficiency and performance characteristics compared to standard glazing.

A high energy performance glazing typically combines the following characteristics:

- **It is an IGU made of two or three panes of glass**. De facto, a single glazed window or façade is NOT high energy performance.
- **Some of the glass panes within the IGU have been applied a ‘coating’** to enhance the thermal and visual properties of glass. These coatings consist in nearly invisible layers of different metal oxides of extremely thin thickness applied uniformly on the glass surface. Double glazed windows without coated glass do NOT qualify as ‘high energy performance’ glazing.
- **The space between the several panes of glass can be filled with specific gas** to minimize heat transfers. These gasses are completely inert, invisible, and sealed in the IGU.
- **IGUs are assembled with energy-efficient spacers** between the glass panes and sealants to provide long-lasting high energy performance to the glazing unit.
- There are alternative innovative products on the market providing even higher performances such as vacuum glazing or dynamic glazing.

As shown in the chart below**, the energy performance of windows is considerably increased with high energy performance glazing readily available** compared to old generation glazing.



This chart shows the typical U values of different windows[1]. The U value is an indication of heat losses, therefore the lower the U value, the higher the insulating performance. The average U value of high energy performance double glazing is four times lower than that of single glazing and twice lower than that of old-generation double glazing. The improvement is even higher with high energy performance triple glazing.

The U value is not the only energy performance parameter to look for when new glazing are being chosen. As explained below, the g value of glazing is also essential as it relates to the ability of glazing to capture or repeal free heat gains from the sun.

[1] U_w is the window value. It is always higher than the U_g value, which is the U value of the glazing component.

Which are the old-generation and inefficient glazing in need of urgent replacement?

Any window or glazing unit, which is not equipped with coated glass pane(s) is outdated in terms of thermal performance.

Practically are in dire need of urgent replacement:

- **Any type of single glazing**
- **Double uncoated or old-generation glazing**

The best proxy to identify whether a double glazing is an old-generation uncoated glazing, is the time of installation. A marking showing the production date often exists in most recent windows.

The table below provides generic indications based on the market penetration of high energy performance glazing in different regions of Europe. If the glazing was installed before the period mentioned, it is most likely an old-generation inefficient glazing.

Countries	
UK	A change in building regulations in 2002 resulted in low emissivity glass effectively becoming mandatory from that point. The majority of insulating glass units installed prior to 2002 are likely to be inefficient.
Spain	In Spain, since the last update of the Energy Saving Standard (CTE HE) published in September 2020, the Use of Double Glazing with coating in windows or equivalent is mandatory for certain climatic zones for all new buildings and major interventions in existing buildings.
France	According to *données Nationales de batiment* (BDNB) in France more than 30% of existing building are equipped with old generation double glazing (uncoated) (UFME paper February 2023). The majority of insulating glass units installed prior to 2000 are likely to be inefficient.
Germany	1995 is the date of the 3rd thermal insulation regulation (Wärmeschutzverordnung) in Germany. The majority of insulating glass units installed prior to 1995 are likely to be inefficient.
Belgium	The majority of insulating glass units installed prior to 2000 are likely to be inefficient.
Netherlands	The majority of insulating glass units installed prior to 2000 are likely to be inefficient.
Poland	The majority of insulating glass units installed prior to 2005 are likely to be inefficient. Since 2021 new windows must meet very high energy performance standards. Because of climate conditions also some insulating glass units installed 2005 - 2020 are likely to be inefficient.
Scandinavia & Finland	The majority of insulating glass units installed prior to the 1990s are likely to be inefficient.

Is high energy performance glazing an available and affordable solution?

High energy performance glazing has been available on the European market for decades.

In most instances, it has become a ‘mainstream’ product while old-generation glazing are less and less proposed. This is partly due to building codes in most European countries, which raised performance standards for new construction and major renovations to the extent that old-generation glazing disappeared for component retrofitting like window replacement.

One nevertheless needs to look for the window and glazing performance parameters (see below), in particular in Europe's Southernmost regions, e.g. Spain, Malta, Greece, etc., where old-generation double glazing are still too often on offer.

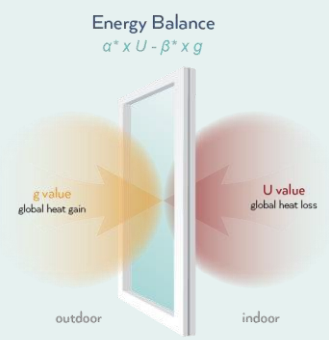
Because it has become mainstream, **choosing high energy performance glazing does come at a minimal increase in cost** compared to uncoated double glazing when these are still on offer. There are however different types of high energy performance glazing providing different thermal properties, performance levels or extra functions, which can have an impact on price.

What are the key parameters to look for when upgrading glazing or windows?

Choosing high energy performance glazing involves considering **two main factors: the insulation property, i.e. the U value, and the solar heat gain, i.e. the g value**.

These values need to be looked at depending on the type of climate the building is situated in and, eventually, the size of the window and the orientation of the façade where the glazing is installed.

Main values to be considered



U_g value: the thermal transmission

High energy performance glazing have low U values. The lower the U value, the less heat is lost from the inside and the more insulation the glazing provides. Across all climates, low U value glazing are recommended.

U_g values of high energy performance glazing typically range between 1.4 and 0.5, corresponding to window U_w values between 1.5 and 0.7.

g value: the heat gains

The g value expresses the amount of solar heat that passes through the glazing.

Depending on the climate, the window size and the glazing exposition, choosing the most appropriate g value will ensure comfort and energy savings depending on needs.

A high g value means the glazing will capture more free solar heat gains, while a lower g value indicates most solar heat gains will be repealed to avoid over-heating.

The alternative method: the energy balance

As an alternative to looking at the U and g values separately, a method exists to combine all the properties in a single equation that factors in climatic conditions. This is known as the energy balance.

While the energy balance is the most accurate method to assess the energy performance of glazing, calculations are not thoroughly conducted and made available to consumers, except in the United Kingdom and Denmark.

When available, the closer the energy balance value is to zero the better.

The choice of the most adequate glazing depends on the building, its location, its use and its occupants' comfort expectations. Advises from (window) experts should be sought but they need to be substantiated with clear information and glazing's key performance parameters.

Without the U value of the window, i.e. U_w, and, ideally, that of the glazing, i.e. U_g, plus the g value of glazing, an informed choice cannot be made. The installation of different glazing types in different windows, which depends on the orientation or the size of the window, cannot be envisaged without the basic U and g values of windows and glazing. **Glazing performance must be part of the discussion on windows.**

ANNEX 1

Energy savings and CO_2 emission reduction from high energy performance glazing

The data below is extracted from a study realised in 2019 by the Dutch independent scientific institute TNO:

Potential impact of high-performance glazing on energy and CO_2 savings in Europe – TNO – 2019.

Savings calculated at EU27 level plus the United Kingdom

SCENARIO	TOTAL ANNUAL ENERGY SAVINGS	TOTAL ANNUAL CO_2 EMISSION SAVINGS
ALL WINDOWS ARE CHANGED IN 2030 WITH READILY AVAILABLE HIGH-PERFORMANCE GLAZING	**75.5** Mtoe (-29%)	**94.3** MtCO2 (-28%)
ALL WINDOWS ARE CHANGED IN 2050 WITH IMPROVED HIGH-PERFORMANCE GLAZING	**67.3** Mtoe (-37%)	**68.5** MtCO2 (-37%)

Breakdown of savings per country

Scenario	2030			2050		
** One kilotonne of oil equivalent (ktoe) is equal to 11.6 GWh.* *** Percentage of energy consumption for heating and cooling buildings.*	TOTAL ANNUAL ENERGY SAVINGS		TOTAL ANNUAL CO_2 EMISSION SAVINGS	TOTAL ANNUAL ENERGY SAVINGS		TOTAL ANNUAL CO_2 EMISSION SAVINGS
	Ktoe*	%**	$KtCO_2$	Ktoe	%	$KtCO_2$
Austria	1789	-29%	1439	1579	-37%	1116
Belgium	1664	-32%	2868	1518	-42%	2397
Bulgaria	1180	-27%	411	1066	-35%	237
Croatia	655	-34%	690	534	-40%	536
Cyprus	57	-19%	88	54	-26%	82
Czech rep	1622	-34%	1870	1323	-40%	1190
Denmark	874	-32%	486	797	-42%	404
Estonia	390	-39%	156	316	-45%	106
Finland	1363	-34%	420	1197	-43%	268
France	9758	-32%	9594	8901	-42%	7580
Germany	17998	-29%	26240	15888	-37%	20175
Greece	760	-19%	1655	725	-26%	546
Hungary	1608	-34%	2145	1312	-40%	1573
Ireland	651	-32%	1193	594	-42%	829
Italy	4134	-19%	8234	3946	-26%	4929
Latvia	675	-39%	340	547	-45%	267
Lithuania	1026	-39%	498	832	-45%	314
Luxembourg	76	-32%	126	69	-42%	102
Malta	28	-19%	51	27	-26%	60
Netherlands	2643	-32%	4019	2411	-42%	3279
Poland	6073	-34%	8525	4953	-40%	5045
Portugal	754	-19%	413	720	-26%	265
Romania	3630	-27%	3652	3280	-35%	2946
Slovakia	852	-34%	1015	695	-40%	754
Slovenia	317	-34%	230	259	-40%	153
Spain	2873	-19%	3274	2742	-26%	1739
Sweden	2350	-34%	222	2063	-43%	159
United Kingdom	9715	-32%	14376	8862	-42%	11462
EU28	75514	-29%	94230	67210	-37%	68512