



ENERGY EFFICIENT WINDOWS & DOORS

A GUIDE TO THERMAL PERFORMANCE

INTRODUCTION

IMPROVING THE ENERGY EFFICIENCY OF WINDOWS AND DOORS

Background

Environmental issues, reducing carbon dioxide emissions and saving energy are all important, influencing factors in many decisions made by a large number of industries and the building industry is no exception. Buildings, both domestic and commercial are major energy consumers, so reducing energy loss is of growing significance to architects, specifiers and homeowners.

Buildings lose energy through numerous areas and the lack of sufficient insulation and thermally efficient products results in a higher usage of energy for heating, in turn increasing the carbon dioxide emissions, the main gas responsible for global warming. The UK government has committed itself to huge reductions in CO₂ emissions within the Kyoto Agreement and has also set a target for all new homes to be “Zero Carbon” from 2016. This can only be achieved by significantly reducing the energy use of houses.

Government, consumers and specifiers are focusing more and more on the energy efficiency of building products. Windows are one of the prime components of interest. It is estimated that approximately 20% of energy lost from a building is through its windows and doors so improving their energy efficiency gives a large improvement to the energy efficiency of the building as a whole.

Windows are in place for a long time and efficiency gains achieved by fitting high performance windows are effective for the life of the product. This will significantly reduce fuel bills, improve comfort and reduce greenhouse gas emissions for the life of the window installation.



*Thermal image showing heat loss
through windows.*

Building Regulation

Energy efficiency is integral within the Building Regulation Part L (Conservation of Fuel and Power), with the current requirements of a building to have a target CO₂ emission rate - windows and doors need to meet certain thermal efficient criteria in order to comply.

There are currently three evaluating methods to determine the compliance with building regulations:

- U value of the whole window
- window energy rating (WER)
- The centre pane U value of the glazing unit (in certain circumstances)

Table 1 shows the current values required for new and replacement windows and doors.

Fittings	Standard for new fittings in extensions
Window, roof window and rooflight	$U_w = 1.6 \text{ W/m}^2\text{K}$ or WER Rating = Band C or centre pane $U_g = 1.2 \text{ W/m}^2\text{K}^*$
Doors with more than 50% of their internal face area glazed	$U = 1.8 \text{ W/m}^2\text{K}$

Table 1. (Values correct at time of print)

**exception - where the external appearance needs to be maintained*

In 2007 the Government set out in its Building a Greener Future Policy, its intention for new homes to be net zero carbon from 2016. As steps to achieving this target, carbon emission standards for new homes are to be improved by 25% in 2010 and 44% in 2013 when compared to the levels of 2006.

Government Target – CO₂ Saving

Almost half of the UK's carbon emissions come from the use of buildings (27% from homes and a further 17% from non-domestic buildings) – Source: Energy White Paper 2007. In order to meet the target of 80% reduction in carbon emissions by 2050 the energy efficiency of both the new build as well as existing homes need to be improved.

THERMAL EFFICIENCY

MAIN INFLUENCING FACTORS

When determining the energy efficiency of a window there are three main factors that have an influence on its performance.

The first and largest factor is the window's thermal transfer value, the U Value. The second factor and one which has a large influence in window energy rating (WER) calculations is the solar gain - G Value. The third, smallest factor, but an important one, is the performance of the window's gaskets and beads and its prevention of air loss through the seals - air leakage.

U Value

The U value is a measure of the amount of heat energy that is transmitted through the window by means of radiation, convection or conduction. The value is given as the rate at which heat energy is transferred through a square metre of material when there is a difference in temperature from one side to the other ($W/m^2 K$). As the U value decreases, so does the window's ability to transfer heat and as such improves the thermal performance. In short, for the purpose of thermal efficiency, the lower the U value, the better the window.

Each element of the window has a U value associated to it and these together will determine the U value of the window as a whole. (See Table 2 for typical U Values) For windows, the U value of PVC is a constant, with its size and shape defining its thermal transmittance value. For S706, REHAU Edge and REHAU Tritec systems, this value is $1.4W/m^2 K$ for the PVC window profile.

If a reinforcement material is added to the profile this will change its thermal properties. As steel and aluminium are good conductors of heat and have a high U value, this will increase the profiles' ability to transfer heat and thus make it less thermally efficient.

In contrast, adding material with a lower U value, such as REHAU Thermal Sleeves, will reduce the amount of heat transmitted and therefore improve the frame's thermal efficiency. (See Table 3).

Thermal Conductivity - U Values ($W/m^2 K$)	
Material	U Value
Air	0.02
Argon	0.015
PVC	0.19
Steel	45
Aluminium	250

Table 2.

Thermal Conductivity - U Values ($W/m^2 K$)	
System Configuration	U Value
S706 Profile	1.4
REHAU Tritec Profile	1.4
with full reinforcement	1.7
with Std reinforcement	1.5
with Thermal Sleeve	1.3

Table 3.

The largest area of the window is the glazing. This will have the greatest effect on the windows' thermal performance (*figure 1*) and comes in a number of options from standard single pane to more commonly used double glazing, to enhanced coated multi-pane glazing units with highly insulating gas filled cavity and thermally efficient warm edge spacer bars. The large array of options means that U values for glass units can range from approximately 6 W/m² K to 0.5 W/m²K and when combined with the window frame, can enable the architect, specifier etc to choose a wider range of thermally efficient windows that are fit for purpose, not only in terms of thermal values but also in terms of allowable budget.

G Value

The Solar Gain factor is a value that represents the amount of heat that is absorbed from solar energy and is the ability of the window to re-radiate this heat into the room. The solar gain factor is mostly affected by the glazing unit and values should be obtained from the supplier/manufacturer.

Air Leakage

The air leakage value is the value taken from test reports carried out by UKAS approved test laboratories, commonly part of the BSI weather test. The L₅₀ value is the amount of air leakage lost through the window at a pressure of 50Pa.

REHAU Windows have achieved a zero air leakage test result at this pressure.

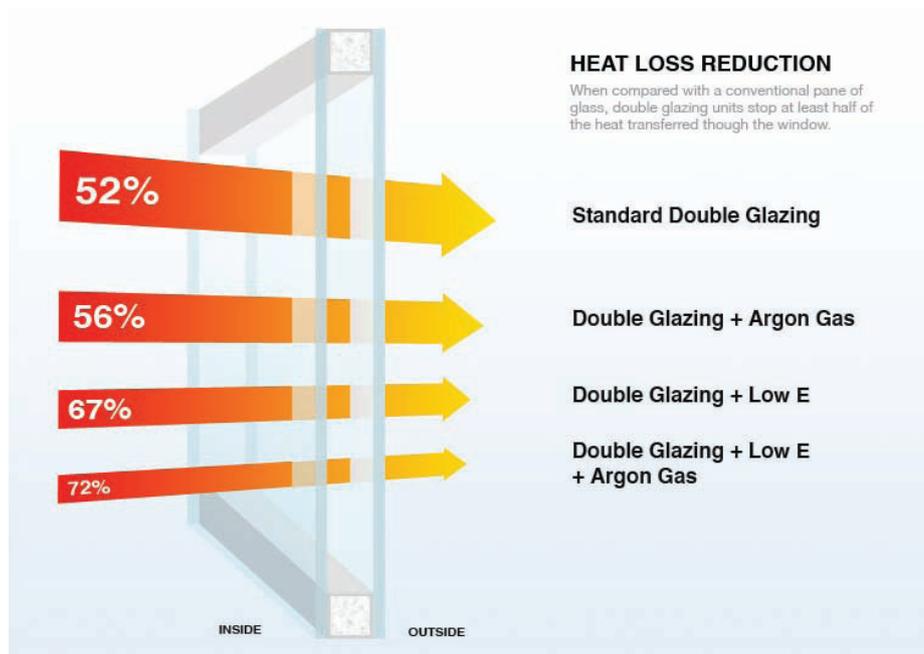


Figure 1.
Percentage increase in performance versus a single pane

WER'S

ENERGY RATINGS FOR WINDOWS

A window energy rating (WER) is a calculation which takes into account the thermal properties of the window and produces a value known as the Energy Index. This value is then translated into an A – G rating based on a sliding scale.

The idea of a WER is to give the customer a clear indication of what he/she is buying with regards to its performance in the energy efficiency stakes and uses a labelling system that has been established throughout Europe and is one which is commonly known to the public – mainly in the sales of white goods and household appliances by which the label shows the product to have been graded on its performance.

The calculation is based on a standard window by which all manufacturers should use as common ground – so that all are working to the same specifications. It is a 1480mm high by 1230mm wide casement window, split equally with a mullion, with one half fixed. The opening half can then be a side hung, top hung, tilt & turn, fully reversible or pivot.

The Window Energy Rating not only compares like for like windows but can also be used to demonstrate the performance in order to comply with Part L of the Building Regulations.

In-house Preparation

Decide which profiles and glazing combinations you would like to use

In order to be able to offer energy rated windows the fabricator or installer needs to apply for approval from an associated WER Scheme.

WER Simulation & Quality Management System

Simulate the theoretical performance of the window by an accredited simulator

Have a system that chooses the correct components

By independent audit, approval requires certification of the suppliers' in-house quality management system to ensure that only the correct window is manufactured in order to meet the performance measured by the official WER simulation report or calculation.

Audit By Independent Agency

Validation of simulation & Quality Management System

Once approval has been granted, a label will be issued by the subscribed WER scheme to distinguish the particular Energy rating that has been achieved.

Approval & Label Issue

Windows that achieve a C rating or above can also be included in the Energy Saving Trust Scheme and can display the "Energy Saving Recommended" certification mark.



For more information visit:
www.energysavingtrust.org.uk

Achievable WER Ratings

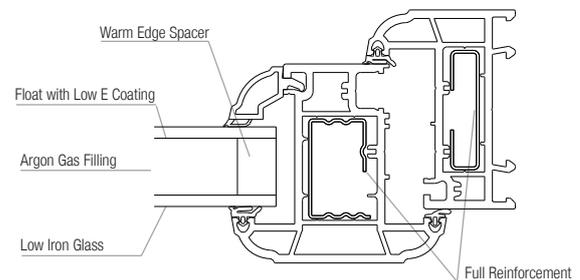
The Solar Gain, the Thermal Transmittance and the Air Leakage influence the Window Energy Rating and because of this each profile and glazing unit combination needs to be simulated unless the particular WER scheme allows substitution of like for like products.

Below, you can find general guidance on how to achieve an A, B and C rating with the REHAU Tritec, REHAU S706 and REHAU Edge Systems. It is to be noted that even an A Rating can be achieved using the standard profile and reinforcement range.

Energy Window	
	A
Energy Index (UgW/m²/year)	2
The climate zone is:	UK
Thermal Transmittance (U-value)	1.41 W/m².K
Solar Factor (g-value)	0.40 W/m².K
Effective Air Leakage (l/m².a)	0.00 W/m³.K

A rating can be achieved with REHAU Tritec, REHAU S706 and REHAU Edge systems by using:

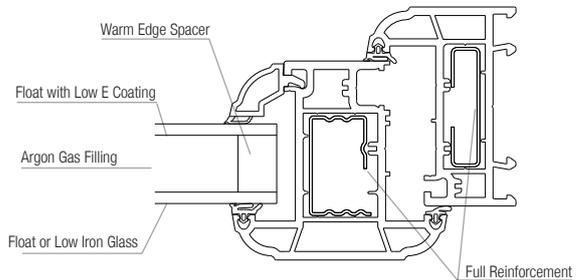
- Slim sightline profiles
- Standard or Full Reinforcement
- Double glazing with Argon gas filling, Low E coating and Low Iron glass
- Warm Edge Spacer



Energy Window	
	B
Energy Index (UgW/m²/year)	-3
The climate zone is:	UK
Thermal Transmittance (U-value)	1.41 W/m².K
Solar Factor (g-value)	0.40 W/m².K
Effective Air Leakage (l/m².a)	0.00 W/m³.K

B rating can be achieved with REHAU Tritec, REHAU S706 and REHAU Edge systems. Achievable as both standard and full reinforcement.

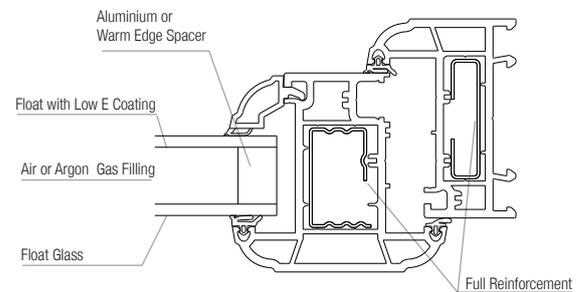
- Slim sightline profiles
- Standard or Full Reinforcement
- Double glazing with Argon gas filling, Low E coating
- Warm Edge Spacer



Energy Window	
	C
Energy Index (UgW/m²/year)	-12
The climate zone is:	UK
Thermal Transmittance (U-value)	1.41 W/m².K
Solar Factor (g-value)	0.40 W/m².K
Effective Air Leakage (l/m².a)	0.00 W/m³.K

C rating can be achieved with REHAU Tritec, REHAU S706, REHAU Heritage and REHAU Edge systems. Large number of combinations available in terms of profile choice, reinforcement and glazing options.

- Achievable with larger frames
- Achievable with Aluminium spacer bar
- Achievable with Air filled glazing units



CODE FOR SUSTAINABLE HOMES

BRE ENVIRONMENTAL ASSESSMENT METHOD

CODE LEVELS

The Building Regulations Part L sets out minimum requirements for energy efficiency for new buildings and for work to existing buildings including alterations and extensions.

In parallel to the mandatory Building Regulations, a voluntary scheme called “Code for Sustainable Homes” has been introduced to the private residential market. The Code Assessment comprises of nine key areas with Energy Efficiency being the most important one, with nearly 40% of all points related to this section.

For the Social Housing Market the achievement of Code Level 3 has been mandatory since 2008. It is envisaged that this requirement will increase to Code Level 4 for 2011/2012.

There is also an increasing number of Pilot Schemes which aim to achieve even higher Code Levels up to Code Level 6.

The table below illustrates how the various Code Levels are linked to the energy performance required by Building Regulations.

Date	2010	2013	2016
Energy efficiency improvement of the dwelling compared to 2006 (Part L Building Regulations)	25%	44%	Zero carbon
Equivalent standard within the Code	Code level 3 	Code level 4 	Code level 6 

These reductions of CO₂ emissions are to be met via the overall performance of the building. In this respect energy losses through windows play an important part.

In order to achieve a CO₂ reduction of 25% and gain a Code Level 3, windows for new build projects will need to achieve a Uw-Value of 1.2 – 1.5 W/m²K. From October 2010 this has been a mandatory requirement within the Building Regulations.

To reduce CO₂ emissions by 44% and achieve Code Level 4, windows for new build projects will need to achieve a Uw-Value of 0.8 – 1.2 W/m²K.

For Buildings to achieve Code Level 6 or Passive House Standard, windows will need to achieve a Uw-Value of 0.8 W/m²K. At this level of performance it becomes more important to design the building with the correct glazed area depending on direction and size to balance solar gain during winter with overheating during the summer.

REHAU Window and Door Systems can provide you with solutions from meeting current building regulation up to Code Level 6, A Zero Carbon Home.

The Green Guide

The Code for Sustainable Homes assesses key areas, the Energy Section being the most important one, requiring solutions for energy efficient windows. Combined with this, REHAU window systems can provide you with additional points for your Code Rating under the section, "Material". Within this section points are allocated according to the BRE Green Guide Rating of the product. The Green Guide contains more than 1200 specifications used in various types of buildings. It examines the relative environmental impacts of construction materials commonly used in six generic types of building including:

- Commercial buildings, such as offices
- Educational
- Healthcare
- Retail
- Residential
- Industrial

This data is set out as an A+ to E ranking system, where A+ represents the best environmental performance / least environmental impact, and E the worst environmental performance / most environmental impact.

REHAU window systems are in the highest category, achieving an A Rating for residential developments and A+ Rating for commercial developments.

For more information visit:

www.breeam.org
www.communities.gov.uk/planningandbuilding
www.energysavingtrust.org.uk

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