WINDOW ENERGY RATINGS

It used to be standard practice for house builders to build in window frames as the walls were built, and to glaze the windows later. But it is becoming increasingly common for the walls to be built with openings for the windows, and for factory glazed windows to be fitted later. So pre-glazed windows are becoming much more common – especially as Continental windows, which are invariably pre-glazed, become more popular.

Many ranges of pre-glazed windows have been given a Window Energy Rating. Note that this rating applies to the range of windows, and not to any particular window within the range. The intention is that Window Energy Ratings enable a comparison to be made of the energy performance of different ranges of pre-glazed windows.

A Window Energy Rating for the UK

In assessing the energy performance of a window, three factors need to be taken into account:

- Heat gained by solar radiation through the glass.
- Heat lost by thermal transmittance through the glass and frame.
- Heat lost by air infiltration past the weather seals.

In 2003, a European Window Energy Rating System was proposed. The following year, the British Fenestration Registration Council introduced the BFRC Rating based on these proposals. The rating for a particular range of windows gives a theoretical figure for the amount of heat lost (or gained) over a year, through a window of a standard size and configuration (1.23 x 1.48 metre, with a fixed light next to an opening casement or sash). The calculations are generally made using figures obtained from software analysis of the window design, rather than from laboratory measurements.

The rating is derived from the three factors mentioned above, using the following formula:

$$\text{Energy Index} = 218.6 \times g_{window} - 68.5 \times (U_{window} + \text{Air Leakage Factor})$$

where:

- g_{window} is the Solar Factor for the window.
  This is a measure of solar gain – hence the letter 'g'. (Another term used is 'g-value'.) It is an index of the heat gained in the heating season due to solar energy transmitted through the glass relative to the amount of solar energy incident on the whole window.
  (By the way, when you see plain 'g' being used elsewhere, you need to understand whether it is g_{window} or g_{glass} that is being referred to. The value of both g's is theoretically between 0 and 1.)
  The value of gwindow depends on the relative area that is glazed, as well as the nature of the glazing. Assuming the glazing of a typical window accounts for 70% of its area, if the glazing were perfectly transparent to all solar radiation gwindow would have the value 0.7. So don't expect g_{window} to be close to 1 – a value above 0.4 is good.

- To obtain the Air Leakage Factor, the Air Leakage Rate at a pressure difference of 50 Pascal is converted into an equivalent heat loss rate that has the same units as U_{window} (by using the volumetric specific heat of air). Air leakage is the least significant of the three factors.

- The figures in the formula, 218.6 and 68.5, apply to the UK climate.

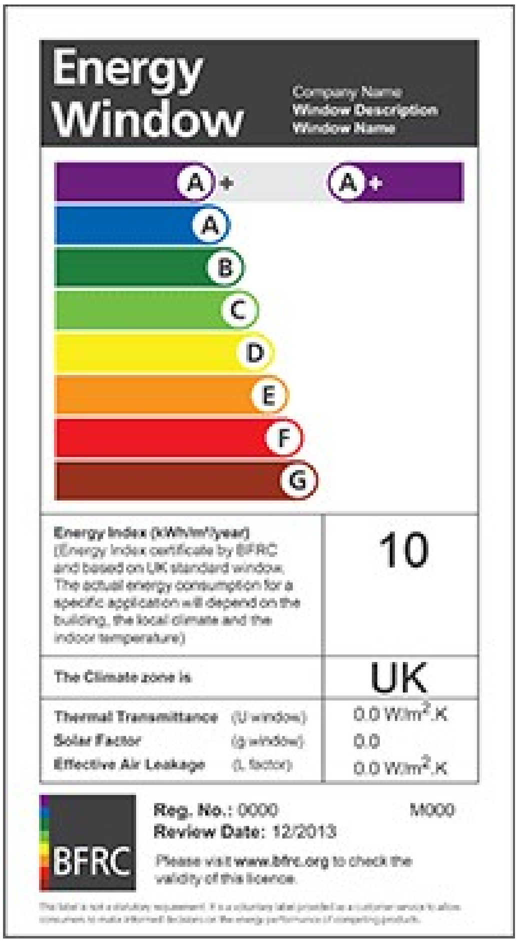
The Energy Index determines the BFRC Rating. Originally, the top Rating was 'A', but the thermal performance of windows has greatly improved over the last decade, so a new rating 'A+' was introduced at the top of the table in August 2013.

BFRC Rating	Minimum Energy Index
A+	10
A	0
B	-10
C	-20
D	-30
E	-50
F	-70
G	–

There are three companies that certify the BFRC ratings:

BFRC itself,
BSI,
and Certass.

Rather confusingly, their labels are a little different. Here's an example of a top-rated window range according to BFRC:



Example WER certificate for a top rated window range

In addition to the rating (from A+ to G), many certificates give:

- Energy Index (kWh/m^2.Year).
- Thermal transmittance, Uwindow (W/m^2.°C).
- Solar Factor, gwindow (in the range 0 – 1).
- Effective Air Leakage (W/m^2.°C).

(In the certificate above, from the BFRC website, all these quantities have been given the value 0.0, which is unrealistic. For a window range that has received a Simplified Energy Licence – rather than a Detailed one – the above four figures cannot be given. The Simplified Energy Licence is available to window manufacturers using registered profiles, usually of uPVC or aluminium. There will be more about 'profiles' in a later article.)

Energy Index, and Solar Factor – the higher the better.
Thermal Transmittance and Effective Air Leakage – the lower the better.

If the Energy Index is 10, as in the exceptionally good example shown in the certificate above, and if the house has, say, 40 square metres of such windows, then it could be expected that over a heating season the windows would result in a net energy gain of about 400 kWh. (400 = 10 x 40.) However, this figure is only an approximate expectation – see the next section. (Most windows, of course, have lower ratings, and yield an overall energy loss, not a gain – the Energy Index is negative.)

Note that within a particular range of windows, actual window size has an influence on actual performance:

- The ratio of glass to frame varies with window size, and heat losses depend on the values of Uglass and Uframe. Either might be the larger.

- Likewise, solar gains are relatively greater if glazing has a relatively larger area.

Limitations of WER's

The BFRC used to warn against attaching too much importance to the precise value of the Energy Index. But now their website states, misleadingly, that the Energy Index shows how much energy the window will save or lose.

The Energy Index figure is useful for making comparisons between window ranges, but it should be treated with plenty of caution if you want to use it in an energy calculation. The Energy Index and the Rating are only an approximate, comparative guide to how windows of a particular range will perform.

North facing windows

For windows facing north, solar radiation is much diminished, and so, too, is the potential for solar gain. The window U-value becomes of greater practical importance than the Energy Index in choosing such a window.

You may wish to have triple glazing on northwards windows, and good double glazing elsewhere – see my article on Glazing in the previous issue.

The origins of window ratings

As mentioned previously, the BFRC Rating is based on the European Window Energy Rating System (EWERS). Work was begun on developing this in 2001, when representatives from eight European countries, mostly from Northern Europe but also including Italy, came together for this purpose. At that time, window buyers were basing purchasing decisions on the value of Uglass. A better criterion of the overall energy performance of a window was needed.

Although there is a wide variety of climates and window styles across Europe, within a couple of years a suitable methodology had been developed, and this has been used as a basis for window rating in various countries, including the UK.

The BFRC rating

In 2004, the BFRC published details of their Window Energy Rating system based on the EWERS methodology. The heat balance is found for the window over a heating season – any cooling requirements in summertime are ignored. Residential occupation is assumed. And the calculation is based on the window being vertical in an 'average orientation' (over the cardinal directions, NESW).

The calculation of the Energy Index has the form:

$$\text{Energy Index} = A \times g - B \times (U + L)$$

Where: g: Solar Factor of window
U: U-value of window
L: Air Leakage Factor

The reference building was taken to be a Dutch terrace house with windows north and south – the area of windows in the south being twice that in the north. A Dutch occupancy pattern was assumed. The climate, though, is British. Complex calculations enable values to be found for A and B.

In fact, values of A and B were found for three different locations, Aberdeen in the north, Plymouth in the south, and Manchester in the middle. Their averages have been used in the rating equation quoted at the start of the article.

	kWh	
	A	**B**
Plymouth	198.4	54.7
Manchester	215.7	68.5
Aberdeen	241.8	82.1
UK average	218.6	68.5

A and B for EWERS heat balance

(EWERS: European Energy Rating System.)

Note the fairly wide variation in the values for A and B – another reason for regarding the ratings as good for making comparisons, while refraining from using the Energy Index as an absolute measure.

The future of Window Energy Ratings

The BFRC ratings apply only in the UK. For several years there has been work done on producing an EU rating system. Of course, there is a big variation of climates within the EU, and such a rating system would have to give ratings for several different types of climate. The introduction in 2013 of obligatory CE markings for building products across Europe has emphasised the need for EU window ratings.

(As daylighting is the prime function of windows, it would be useful if a new rating system also included a statement of the light transmittance value of the window. More about daylighting next month.)

SAP and Window Energy Ratings

WER's are recognised in Part L of the Building Regulations for existing dwellings, but not for new build. Instead, the three factors which determine a WER, namely U_{window}, gwindow, and Air Leakage, are incorporated into the SAP calculation itself. (U_{window} is used directly in SAP. Air Leakage due to windows is included in the in-situ measurement of the air leakage of the whole house, q50. The Solar Factor, g_{window}, from the BFRC certificate can be used instead of SAP's default, which is likely to be inferior.)

Passive House Criteria

To have a positive energy balance over the heating season, a window in a Passive House requires:

$$U_{glass} \leq 1.6 \text{ x } g_{glass}$$

where g_{glass} is the Solar Heat Gain Coefficient for the glazing.

If this condition is met, the solar energy harvested by the window is greater than the heat losses it incurs – provided it faces roughly southwards and is not excessively shaded.

However, there is a more stringent requirement for Passive House windows:

$$U_{window} \leq 0.8.$$

With a Uwindow value of 0.8, even when the temperature outside is -10°C, the temperature inside close to the window is a comfortable 17°C. (General room temperature: 20 °C.)

This criterion in effect requires triple glazing. (Currently the best double glazing has a U_{glass} of 0.9.) However, the criterion applies to a Central European climate, and I am not convinced that it is relevant to our Maritime climate.

FURTHER INFO:

BFRC
The British Fenestration Registration Council was absorbed into the Glass and Glazing Federation in 2005, but they still have their own website. (At the time of writing, the website has not been updated to display A+ ratings – they are still shown as A ratings. A new website is being developed.)
www.bfrc.org.
For info on BFRC Ratings Calculations, see:
www.bfrc.org/pdf/GGF calculations leaflet.pdf.

BSI Kitemarked WER
www.bsigroup.com.

Certas Thermal Rating Register
www.thermalratingregister.org.

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