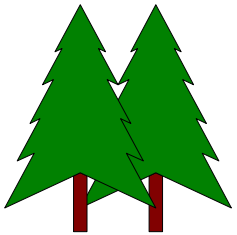
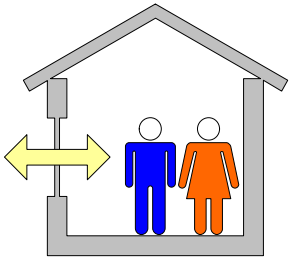
What do we want from windows?

The homeowner:



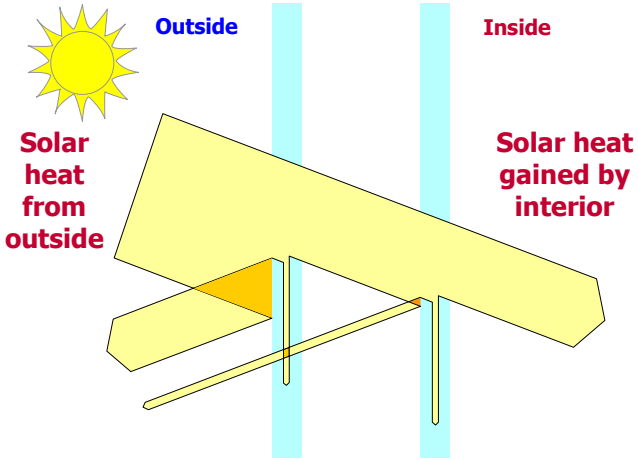


- ❑ Daylight
- ❑ Visual contact with the outside world
- ❑ **Energy efficiency**
- ❑ Rapid ventilation
- ❑ Escape in the event of fire

What affects the energy efficiency of windows?

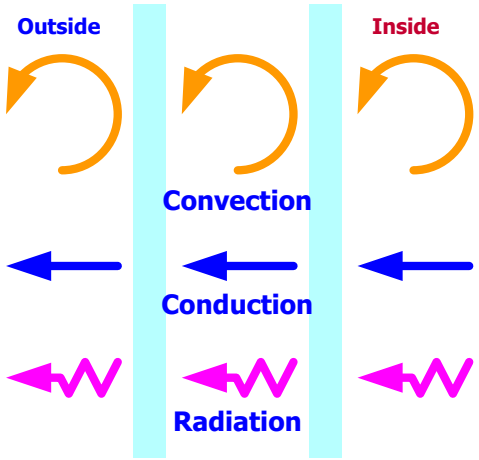
- ❑ **Solar heat gain adds heat though the window (Positive)**
- ❑ **Thermal losses lose heat through the window (Negative)**
- ❑ **Air losses lose heat through the window (Negative)**

Solar heat gain (Positive)



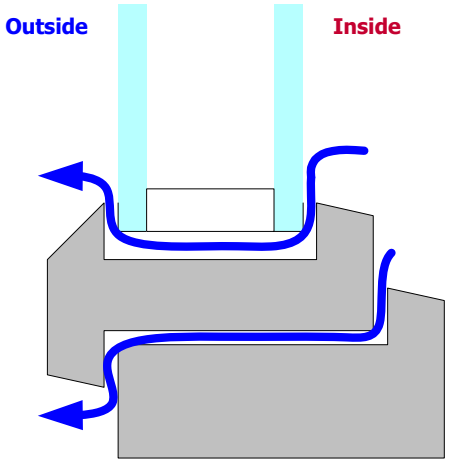
Solar heat is reflected, absorbed and transmitted

Thermal losses (Negative)



Thermal losses from convection, conduction and radiation

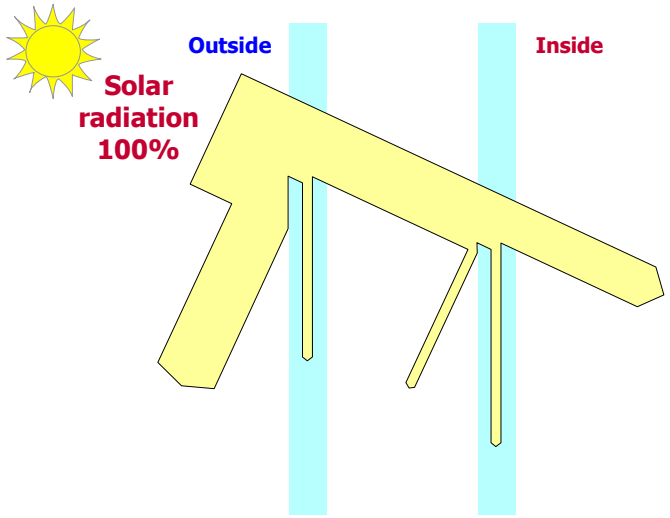
Air losses (Negative)



Air losses from warm air leakage

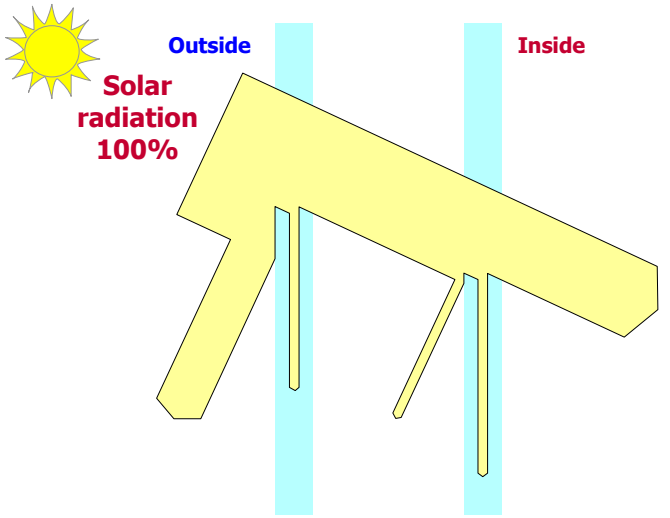
Improving solar heat gain

Increasing the g-value increases the solar heat gain



g = 0.40

40% of solar radiation is gained by the interior

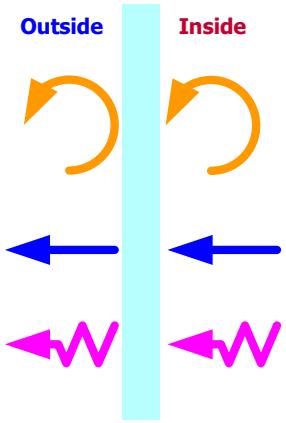


g = 0.50

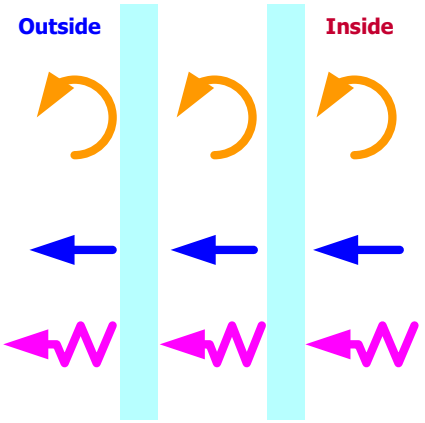
50% of solar radiation is gained by the interior

Improving thermal transmittance

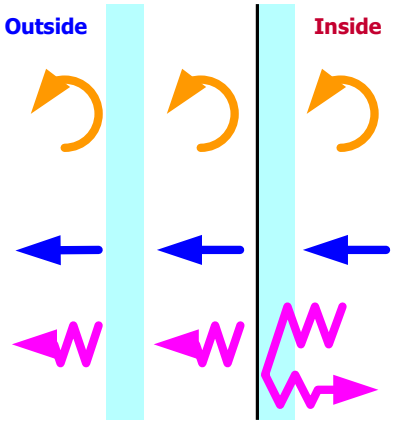
Decreasing the U-value decreases thermal transmittance losses



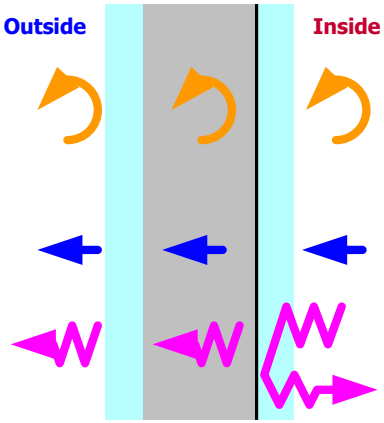
Single glazing
(U_{glass} ≈ 6 W/m²K)



Standard double glazing
(U_{glass} ≈ 3.0 W/m²K)



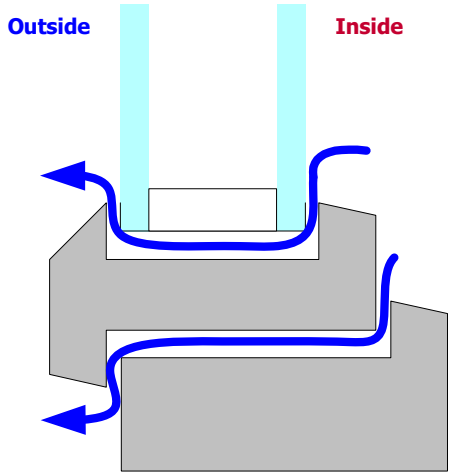
Double glazing with low-e coating
(U_{glass} ≈ 1.7 W/m²K)

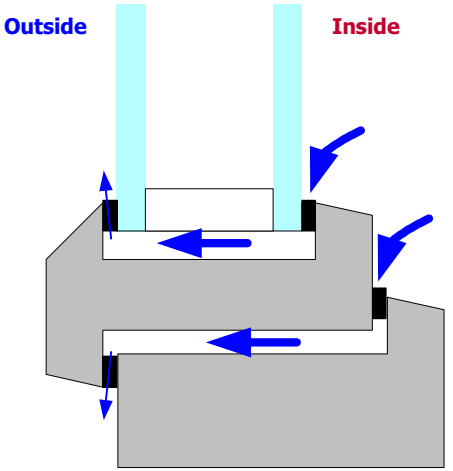


Double glazing with low-e coating and gas fill (U_{glass} ≈ 1.2 W/m²K)

Improving air leakage

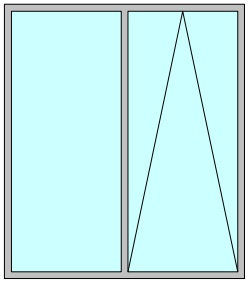
Decreasing the L-factor decreases the air leakage





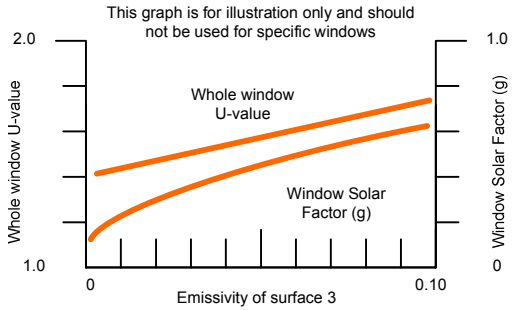
Assess the window and NOT the components

- **Always assess the system and NOT the components**
- **g_{window} is NOT the same as g_{glass} (g_{window} is almost always worse than g_{glass})**
- **U_{window} is NOT the same as U_{glass} (U_{window} is almost always worse than U_{glass})**
- **The L-factor should be assessed using the components of the real window**



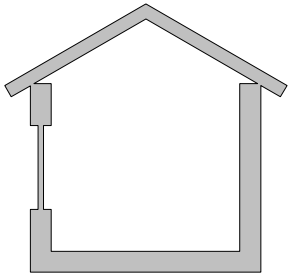
The problem

- **Decreasing the U-value excessively can decrease the g-value and decrease the overall energy efficiency of the window**
- **The solution is to assess the overall energy efficiency of the window using Window Energy Rating**

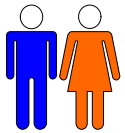


How do we get the formula for Window Energy Rating?

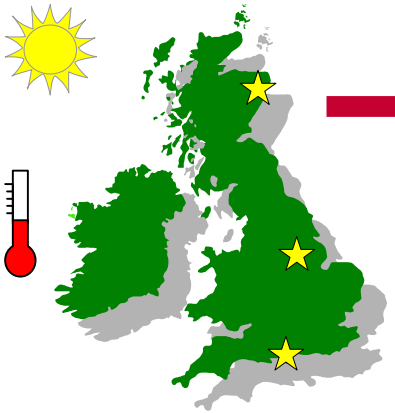
Standard house



Standard domestic occupancy



UK climate data for selected locations



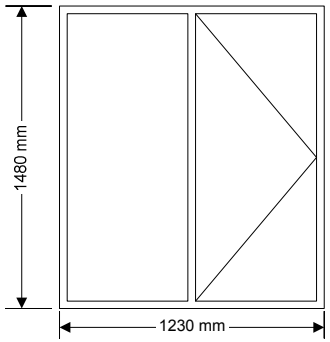
$$A^*g_{window} - B^*(U_{window} + L_{factor})$$

The BFRC Rating Formula, where:

A = 218.6

B = 68.5

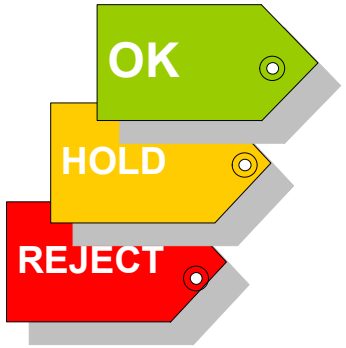
How do we get the Window Energy Rating for a specific window?

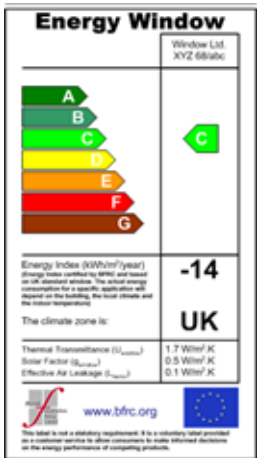


BFRC Rating =

$$A^*g_{window} - B^*(U_{window} + L_{factor})$$

BFRC Rating Scale	BFRC Rating (kWh/m²/year)
A	Greater than 0
B	-10 to < 0
C	-20 to < -10
D	-30 to < -20
E	-50 to < -30
F	-70 to < -50
G	Less than -70





Assess standard window style

Use formula

Assess bands

Check Quality Management

Issue label