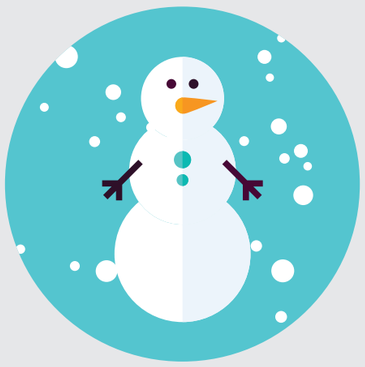
How to assess the thermal performance of windows?

European Aluminium

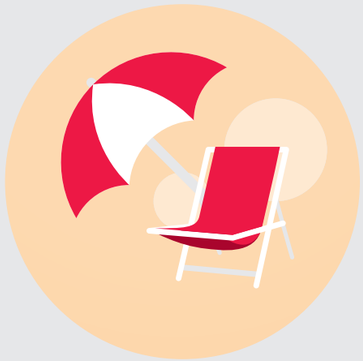
ENERGY BALANCE EQUATION

SOLAR GAINS - HEAT LOSSES

How to optimise energy balances across seasons?



SOLAR GAINS - HEAT LOSSES



SOLAR GAINS - HEAT LOSSES

HEATING SEASON

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ENERGY BALANCE

$$B \cdot g_w - A \cdot (U_w + H)$$

$B \cdot g_w$ — Solar gains to be maximised

$A \cdot (U_w + H)$ — Heat losses to be minimised

BUILDING TYPE

- Thermal mass
- Thermal loads
- Occupancy

LOCATION

- Local climate
- Window orientation

WINDOW PRODUCT

- Air permeability class → **L**
- Thermal transmittance → U_w or $U_{w,eff}$ if shutter used during night
- Solar energy transmittance → g_w

Base T°

Below which building needs heating

External T°

Solar irradiation

Wind

A

Heating degree hours

How much and how long external temperature is lower than building base T°

B

Usable solar radiation

H

Air infiltration

COOLING SEASON

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ENERGY BALANCE

$$Y \cdot g_w - X \cdot (U_w + H)$$

Solar gains to be minimised — **Heat losses**

BUILDING TYPE

- **Thermal mass**
- **Thermal loads**
- **Occupancy**

Base T°

Above which building needs cooling

External T°

X

Cooling degree hours

How much and how long external temperature is higher than building base T°

LOCATION

Local climate

Solar irradiation

Y

Solar radiation leading to overheating

Window orientation

Wind

WINDOW PRODUCT

- **Ventilative cooling**
- **Air permeability class** — **L**
- **Thermal transmittance** — U_w
- **Solar energy transmittance** — g_w or $g_{w,eff}$ if shading used during day

H

Air infiltration

THERMAL TRANSMITTANCE U

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COMPONENTS

GLASS PANES

U_g

GLASS SPACERS

Ψ_g

FRAME

U_f, Ψ_{gb}

SHUTTER

ΔR

EN ISO 10077-1

WINDOW

Window without shutter

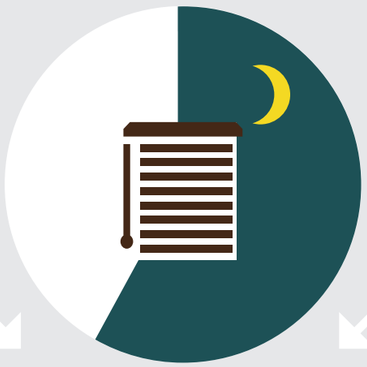
U_w

Window with shutter closed

$U_{w,s} = (1/U_w + \Delta R)^{-1}$

OPERATION

Time share with shutter closed



C

$U_{w,eff} = (1-C) \cdot U_w + C \cdot U_{w,s}$

SOLAR ENERGY TRANSMITTANCE

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COMPONENTS

GLAZING UNIT

g

FRAME

F_F

Frame to window ratio*

SHADING

F_c

Shading factor

OPERATION

Z

Time share with shutter closed during cooling season

$g_t^{**} = g \cdot F_c$

WINDOW

g_w = **$g \cdot (1-F_F)$**

for heating season and cooling season without shutter

if Z=0

$g_{w,eff}$ = **$[(1-Z) \cdot g + Z \cdot g_t] \cdot (1- F_F)$**

for cooling season

if Z=1

$g_{w,tot}$ = **$g_t \cdot (1-F_F)$**

*As complement to F_F, frame properties are also considered in France, based on NF P50-777.

**When calculated for a reference glazing instead of a specific glazing, g_t is replaced by g_{tot}.