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Training for Renovated Energy Efficient Social housing

Intelligent Energy -Europe programme, contract n° EIE/05/110/SI2.420021

Intelligent Energy Europe

Section 1 Techniques
1.2 Replacement of glazing

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ARMINES – CEP

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Introduction

- **Glazing is an essential component for energy efficiency, related to both thermal and lighting energy needs**
- **Due to a fast technical evolution in this field, glazing is generally obsolete in the existing building stock, and its replacement has to be studied**
- **Appropriate choice of glazing requires to balance heat gains and losses during the heating season, summer comfort as well as day-light issues**

Main issues and definitions

- **Improving the glazing quality (e.g. from single to advanced glazing) is among the most energy efficient measures**
- **Sometimes the glazing area can be modified : e.g. reduced in a north facade, increased in a south facade**
- **Attention should be also paid to solar protection, and possible ventilation air inlets placed in window frames**
- **The three important characteristics of windows / glazing are : the heat loss factor (U in $W/m^2/K$) , the light (τ) and solar (g) transmittance factors**
- **A glazing is chosen according to the climate, orientation and exposure, in order to maximize the heat gains - losses balance**

Main recommendations

- **Keep large glazing area in living rooms (daylighting)**
- **Keep large glazing % in south facade and integrate solar protection (e.g. overhangs, external blinds)**
- **Reduce glazing area in north facades**
- **Choose low emissivity argon filled glazing (but high g-value in south facades), well insulated window frames, possibly triple glazing according to the climate**
- **If possible, compare different types of glazing using calculation (see section 2.1 and 2.2)**

Example : Montreuil, France

Before renovation :
single glazing
50% of the facades are glazed

After renovation :
Low emissivity double
Glazing, argon filled,
Reduced glazing area
In the north facade,
Glazed balconies

Contents

- **Glazing area, energy and comfort**
- **evaluation of the solar exposure of a façade,**
- **Heat losses and solar transmittance factor of various glazing types,**
- **choice of a glazing according to the climate, orientation and exposure, heat gains and losses balance for different glazing types,**
- **influence of glazing replacement on the heating energy consumption + comfort of a building**

Improvement of glazing performance

- **Heat loss factor of advanced glazing 10 times lower compared to single glazing**
- **Changes the recommended glazing ratio in facades (around 50% in the 60's, reduced to 20% in the 80's, trend to increase now)**
- **Solar and light transmittance are also important**
- **Solar protection has to be associated according to the climatic conditions**

Modification of the glazing area ?

- **Cheaper to replace glazing by opaque wall, but :**
- **Opinion of the tenants ?**
- **Enough daylighting ?**
- **Useful solar gains in winter ?**
- **Improvement of summer comfort ?**
- **-> this decision requires consultation among tenants and energy assessment (see tools section 2.1 for heating load calculation, and 2.2 thermal simulation, + daylighting calculation e.g. next slides)**

Lighting requirements in dwelling

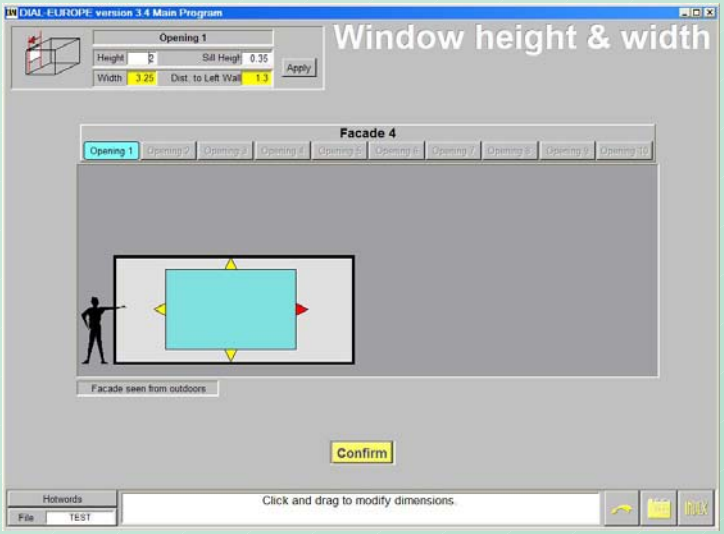
- **Luminous flux (lumen) related to energy flux (W) according to the eye sensitivity, depending on the wave length of the emitted radiation (0 for infra-red and UV, maximum for yellow and green)**
- **around 15-30 Lm/W for incandescent lamps, 60-100 for low consumption lamps, 100-160 for daylight**
- **Indicator of visual comfort (quantity of light) : Illuminance (lux = lumen/m2)**
- **300 to 500 lux needed for reading and writing**
- **100 to 200 lux for circulating, storing…**

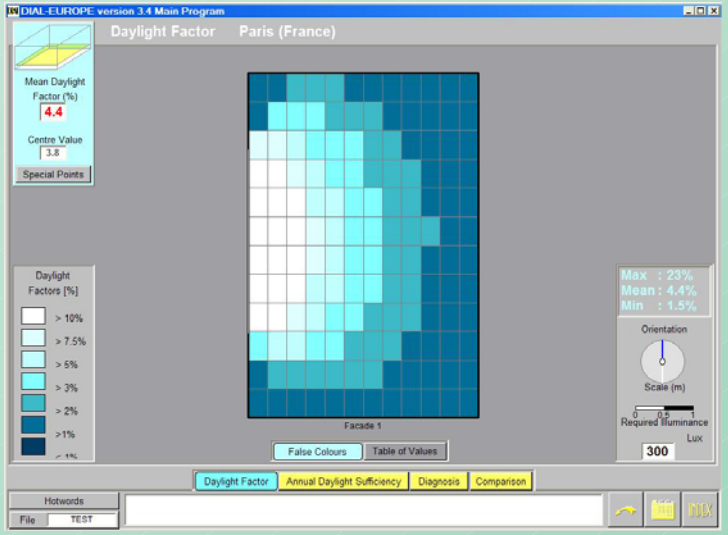
Daylighting

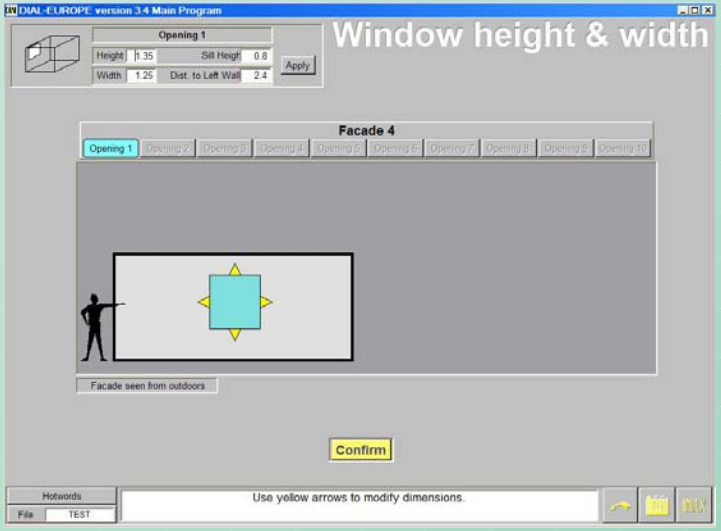
- **Improves visual comfort**
- **Saves energy**
- **Reduces overheating in summer by avoiding the use of artificial lighting and the induced heat**
- **Daylight factor : indoor illuminance / outdoor illuminance by overcast sky (%)**
- **Recommended values : 1% in a bedroom, 1.5% in a living room, 2% in a kitchen**

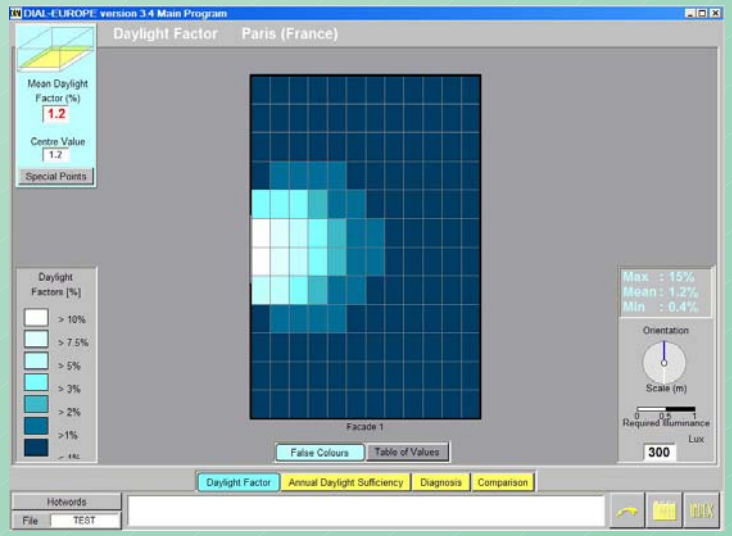
Enough daylight ?

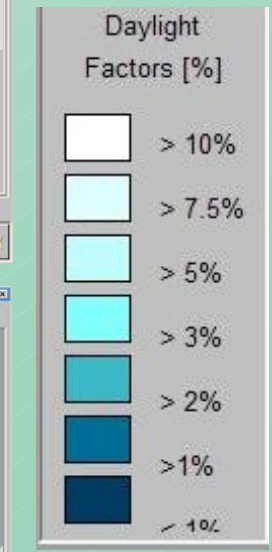
Example evaluation using DIAL











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See http://www.estia.ch/DIAL-EuropeE.html

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Glazing influences heating load

- heat balance including losses and solar gains.
- climate (temperature, solar radiation),
- solar exposure of the façade (orientation, shading),
- characteristics of the glazing (heat loss and solar transmittance factors),
- characteristics of the building (e.g. glazing area versus thermal mass),
- equipment (and its control),
- indoor conditions (temperature, internal heat gains).

Site analysis, evaluation of solar exposure

Is this building suitable for solar retrofit ?

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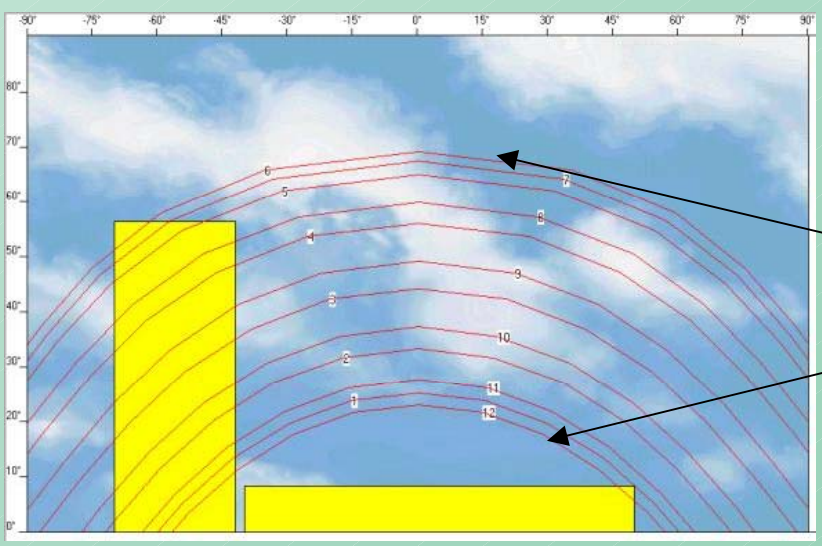
Site analysis, evaluation of solar exposure

Height
0° = horiz.
90° = vert.



azimuth, 0° = south
90° = west

June

December

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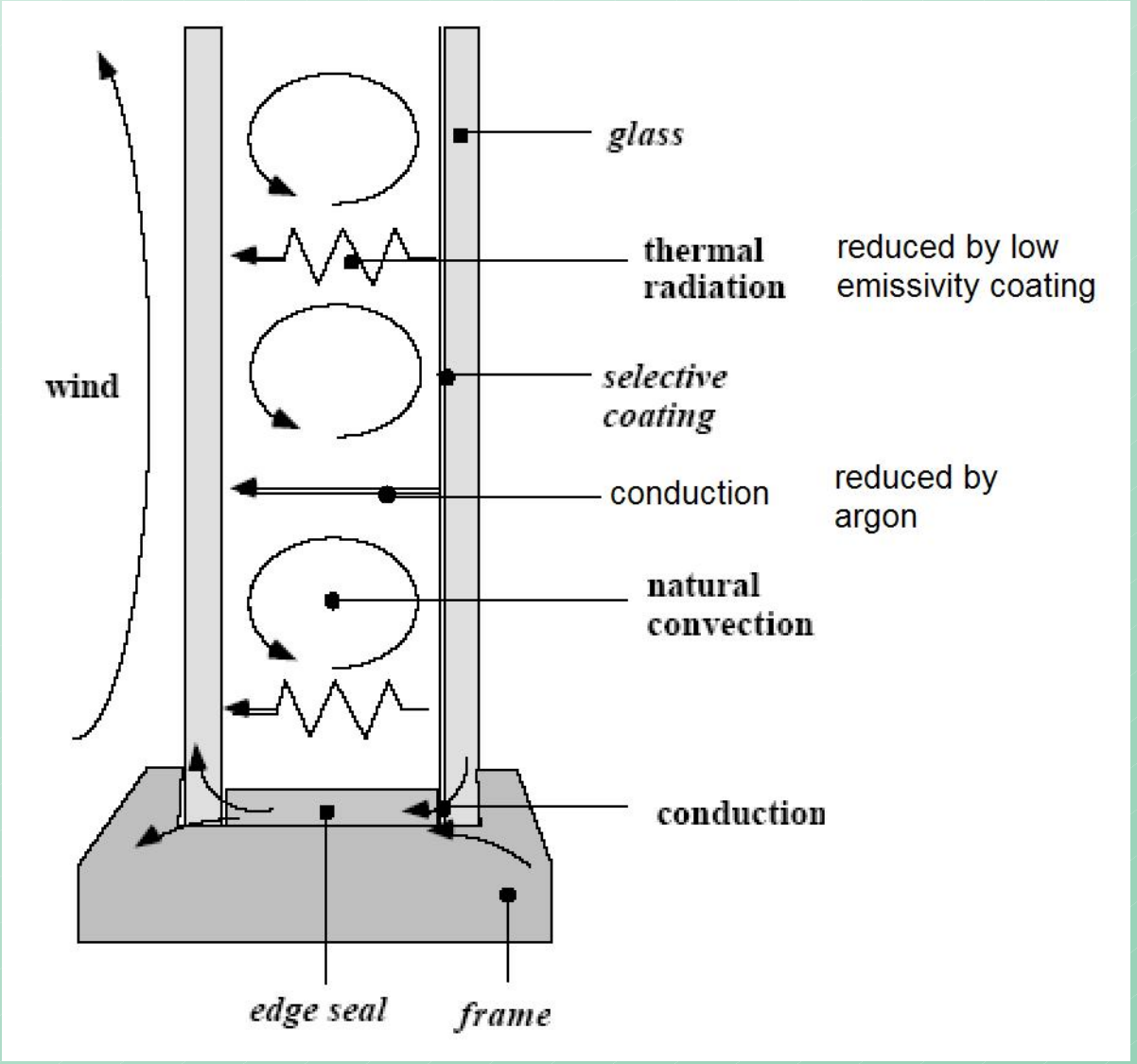
Heat transfer in glazing



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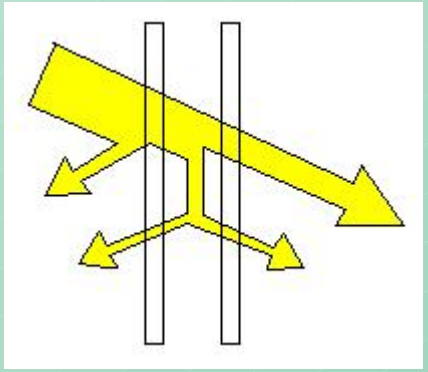
Thermal properties of glazing

- **Insulation : U-value (W/m2/K)**
- **Argon filling reduces the heat losses, xenon and krypton even more but expensive**
- **Solar factor g = proportion of solar radiation transmitted + absorbed and emitted inwards**



} g

- **Higher g value for low iron glass but expensive**

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Thermal properties of glazing

Glazing type	U value in W/m2/K	Solar factor g in %
double glazing	3	78
Hard coating low e with 12 mm air gap	1,9	72
Hard coating low e with 16 mm argon gap	1,5	72
soft coating low e with 12 mm air gap	1,7	58
soft coating low e with 16 mm argon gap	1,1	58
Low iron + soft coating + 16 mm argon gap	1,1	75
3-pane window with low -e coating and argon filling	0.9	42
3-pane window with low -e coating and krypton filling	0.6	42
3-pane window with low iron glass, low -e coating and krypton filling	0.6	62

Choose also insulated window frames !

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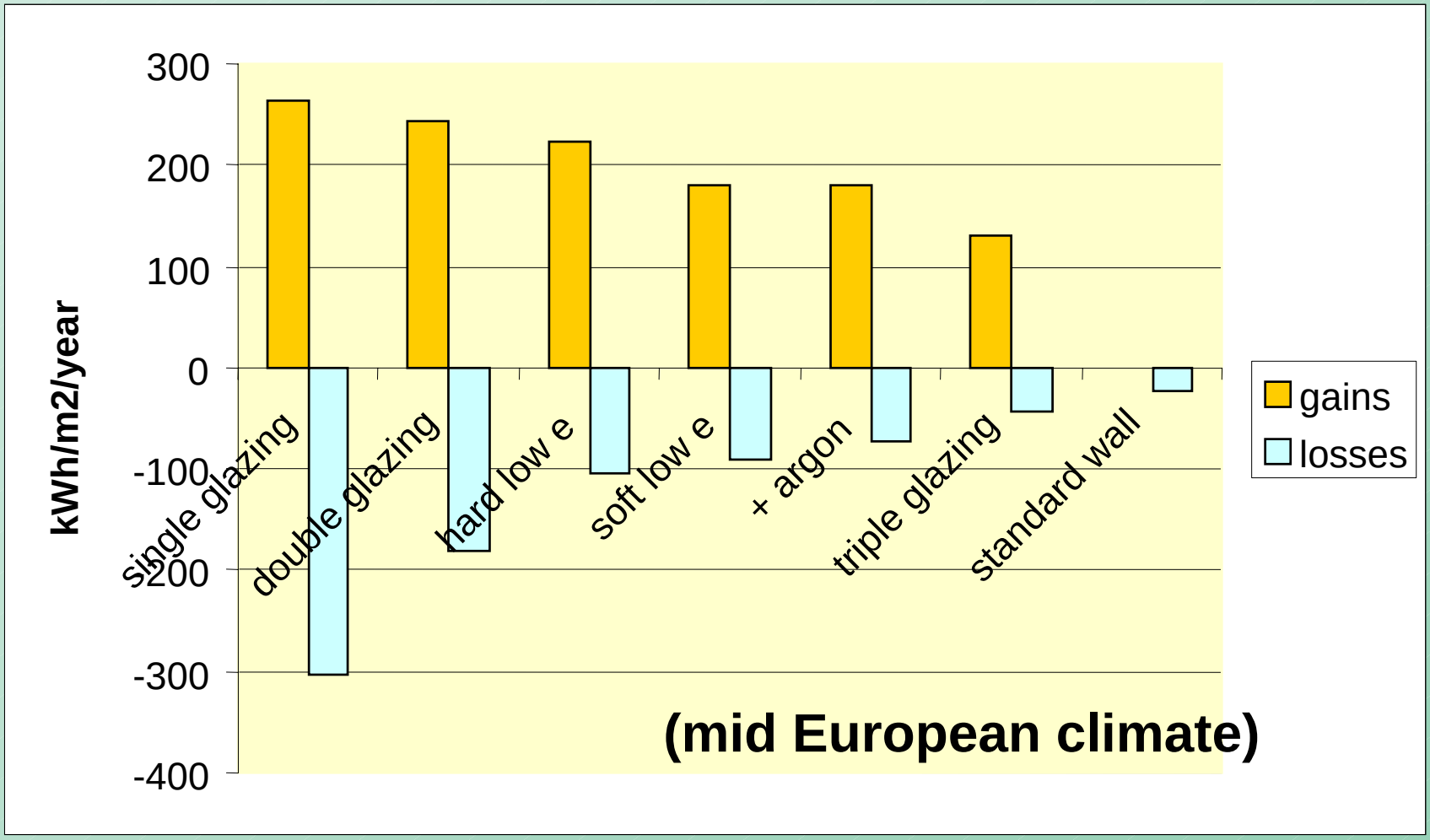
Heat balance of 1 m2 south oriented glazing



Choose hard coating on south facades, soft coating on other orientations

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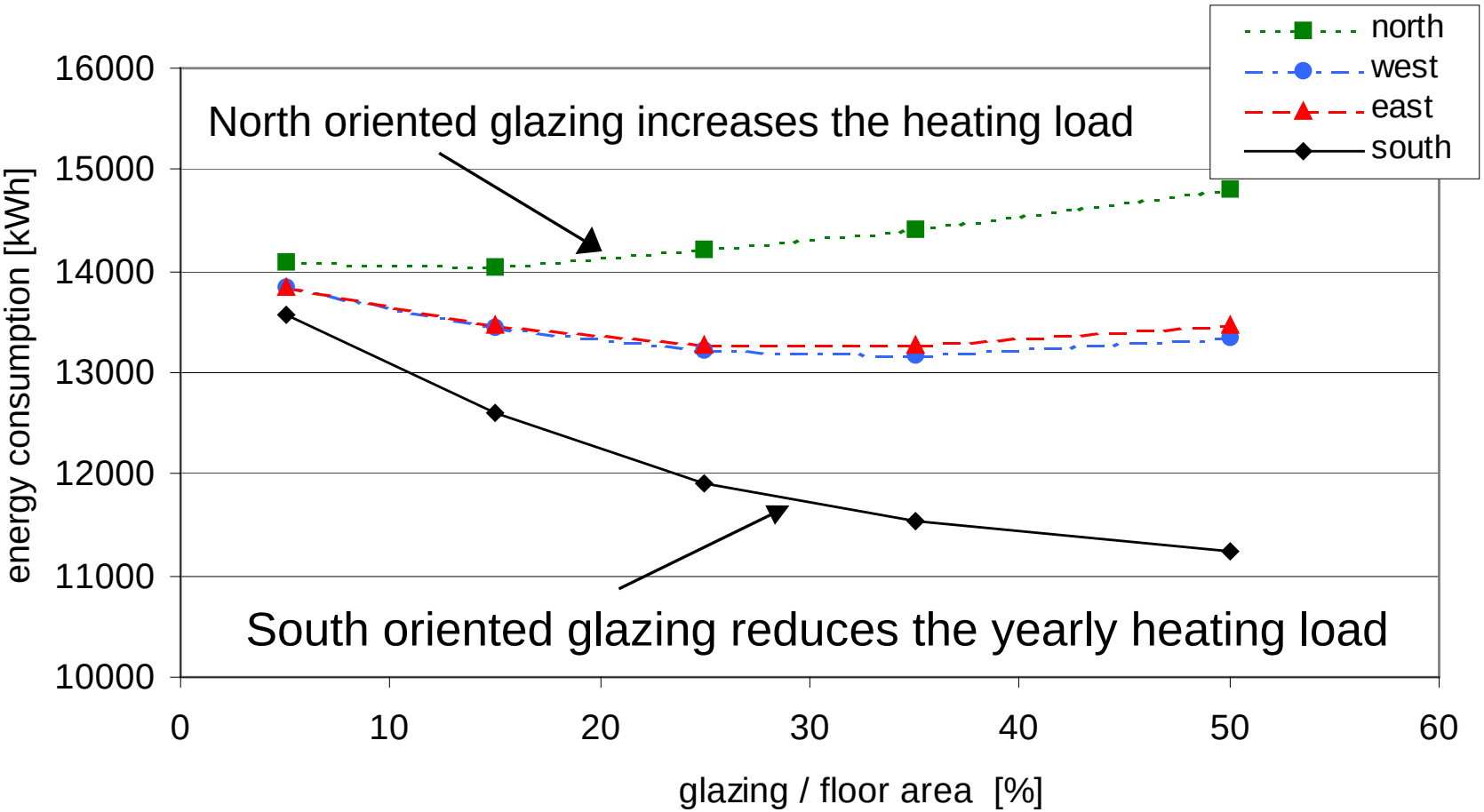
Useful solar gains in winter, example in Paris



Reduce north facing glazing but not south facing glazing !

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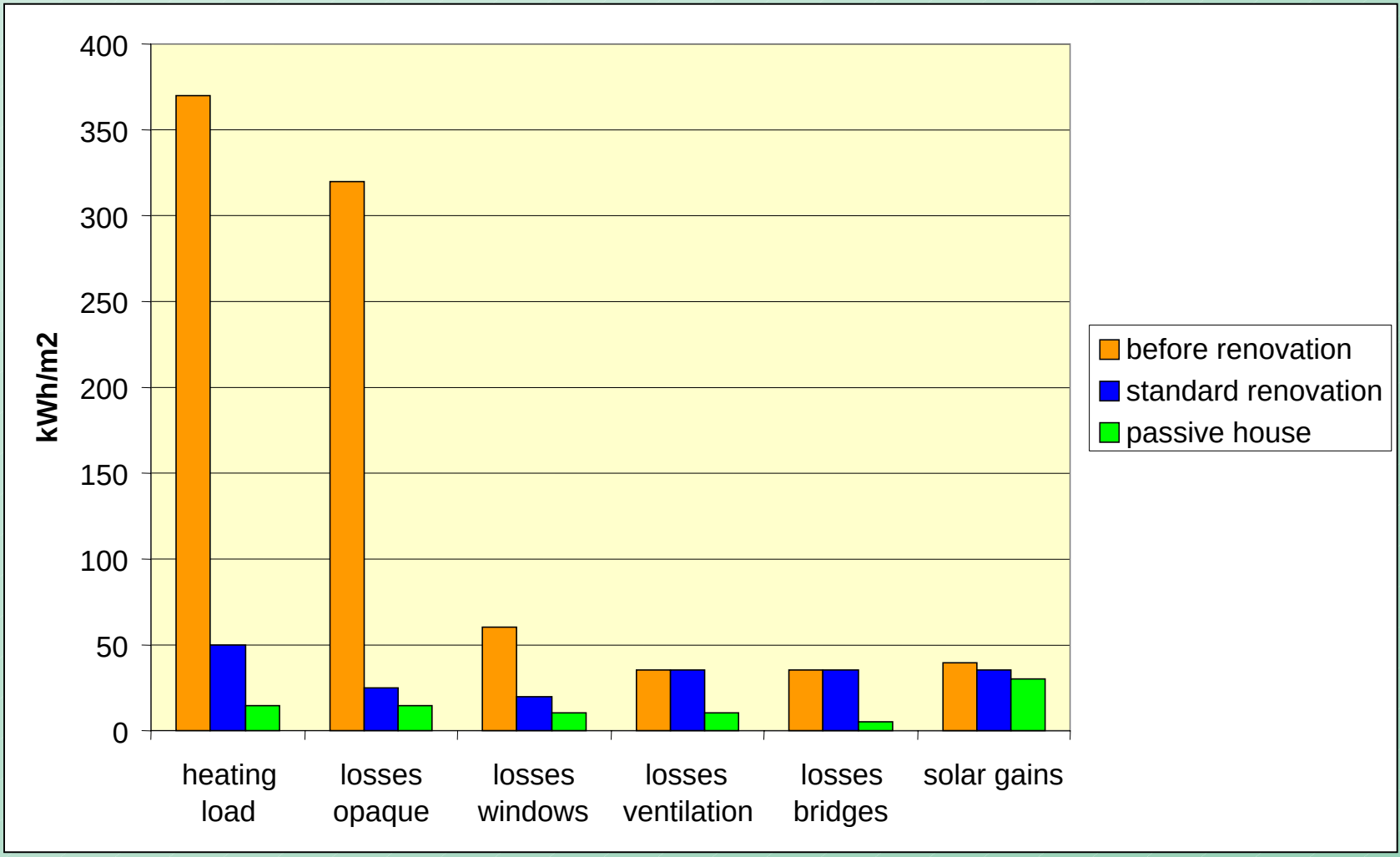
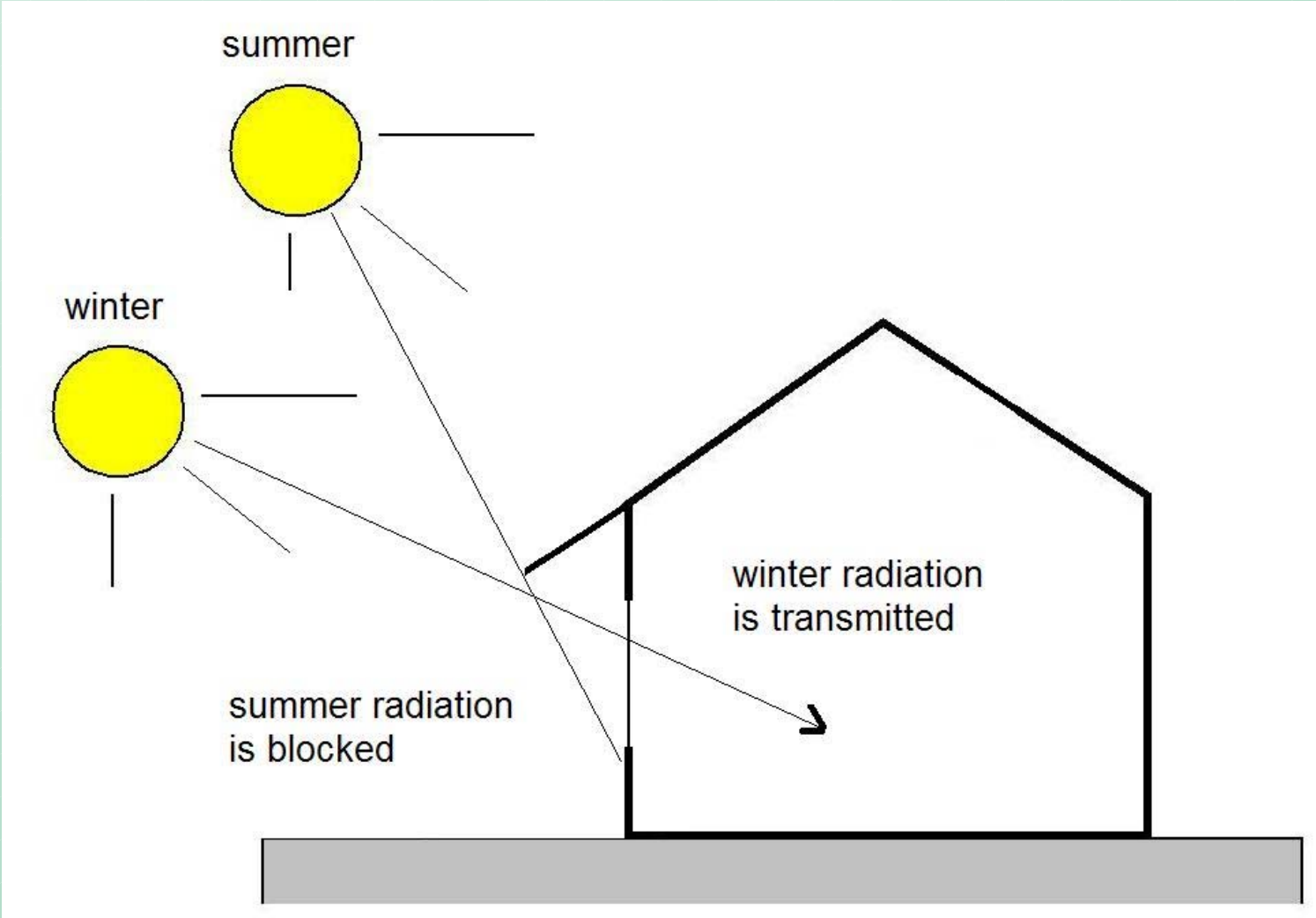
Heat balance of a dwelling with south oriented windows



Relevant energy performance indicator : kWh/m2
Passive house standard : heating load < 15 kWh/m2

Glazing and thermal comfort



At noon, the sun is higher in summer than in winter
-> possibility to use overhangs on a south facade

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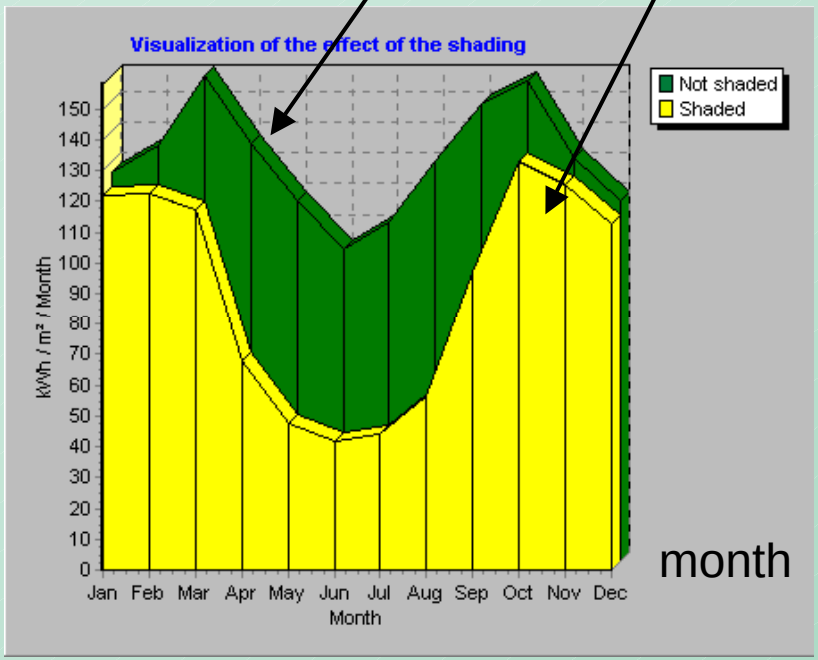
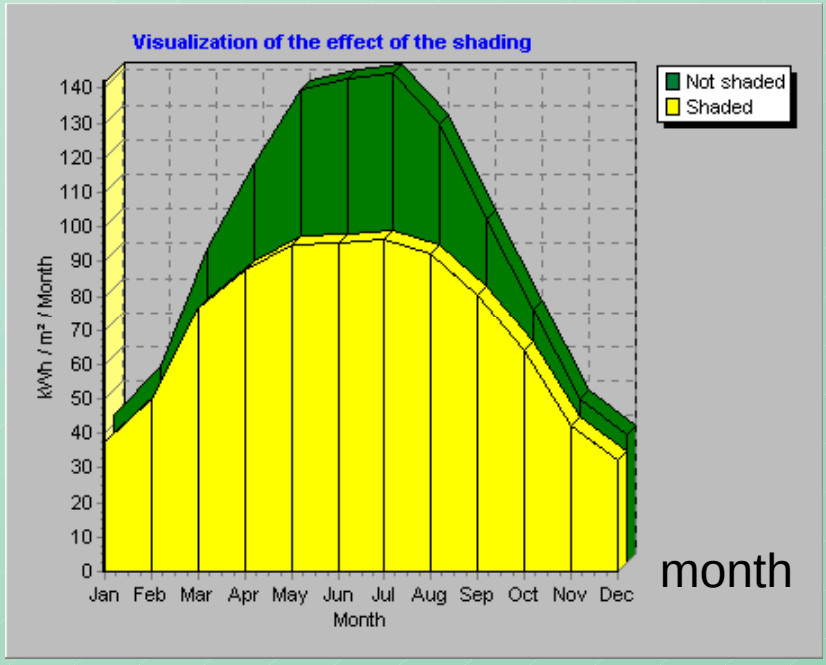
Glazing and comfort

Solar radiation, incident and shaded by 1m wide overhang

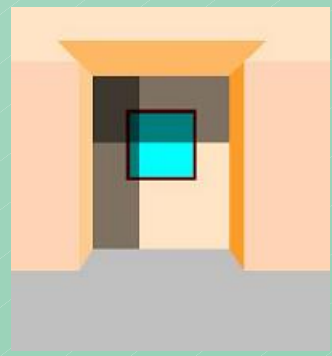


South facade



West facade

In summer, the solar radiation is higher on a west facade than on a south facade, where it is easier to reduce it using an overhang



Reduce glazing facing west but not south facing glazing !

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Solar protection

Horizontal shading
south facades
Zephyr system

Vertical shading
east / west facades
Arch. A. TOMBAZIS

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Movable shading devices

Wooden shutters : 9-10%

Internal Venetian Blinds : 45-65%

External Roller Blinds : 7-19%

External Venetian Blinds : 11-13%

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% transmission lower for external devices

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Main conclusions and recommendations

- **Keep large glazing area in living rooms (daylighting)**
- **Keep large glazing % in south facade and integrate solar protection (overhangs)**
- **Reduce glazing area in north facades**
- **Choose low-e (but high g-value in south facades), argon filled glazing, well insulated window frames, possibly triple glazing according to the climate**
- **Integrate adapted solar protection (external roller blind, horizontal or vertical shading…)**