Sustainable modification of buildings.

How to save energy and money in YOUR house.

SUSTAINABLE MODIFICATION OF BUILDINGS.

INDEX

3 Chapters:

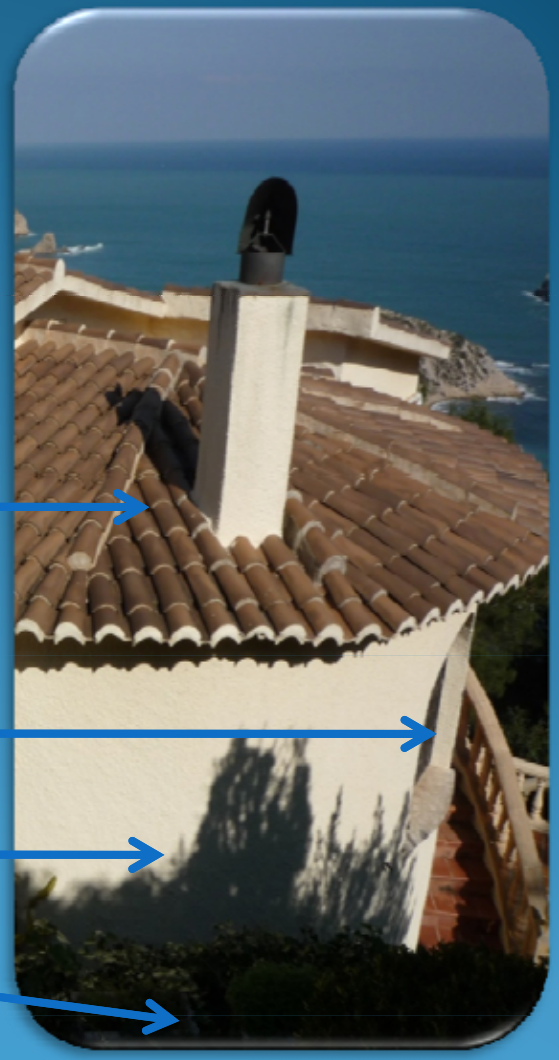
1. Why is a modification of a building worth to do?
2. Technical solutions
3. Practical example

ACTUAL SITUATION

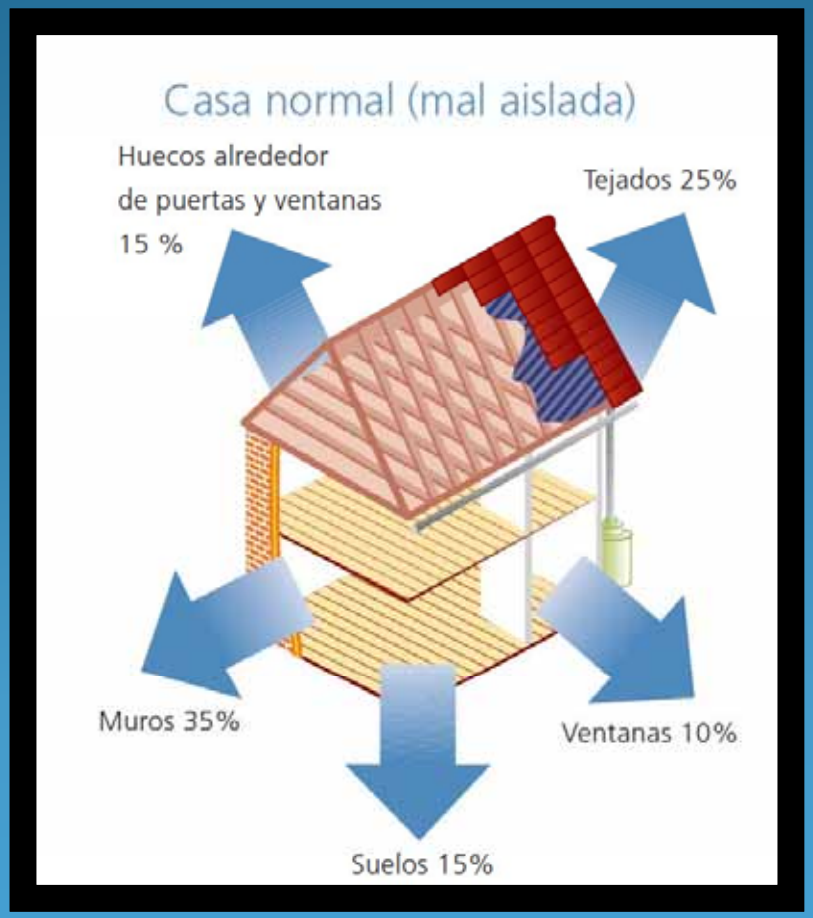
Single family houses

= badly insulated

(constructed before2006)



Single family house - badly insulated



SYMPTOMS AND CONSEQUENCES

- Health and good health missing.

- Superior use of energy
  to heat or cool the house

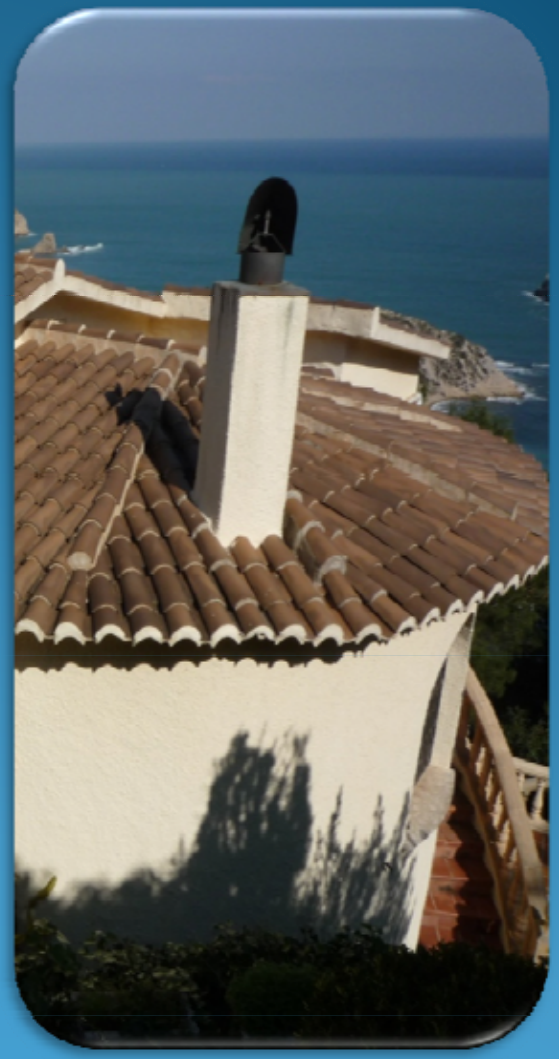
>> High energy bills

>> High emission of CO_2.

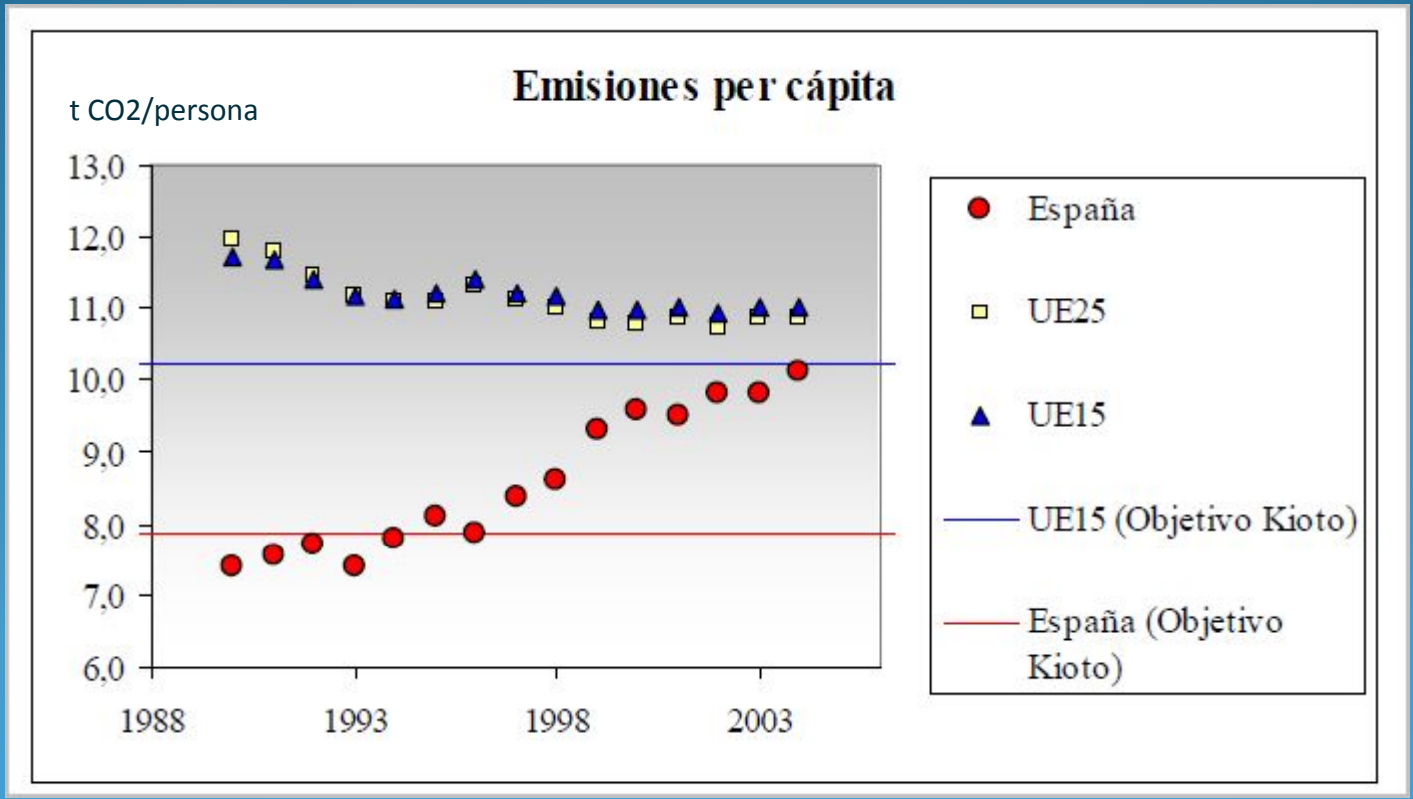
MODIFY…..WHY?

3 Reasons:

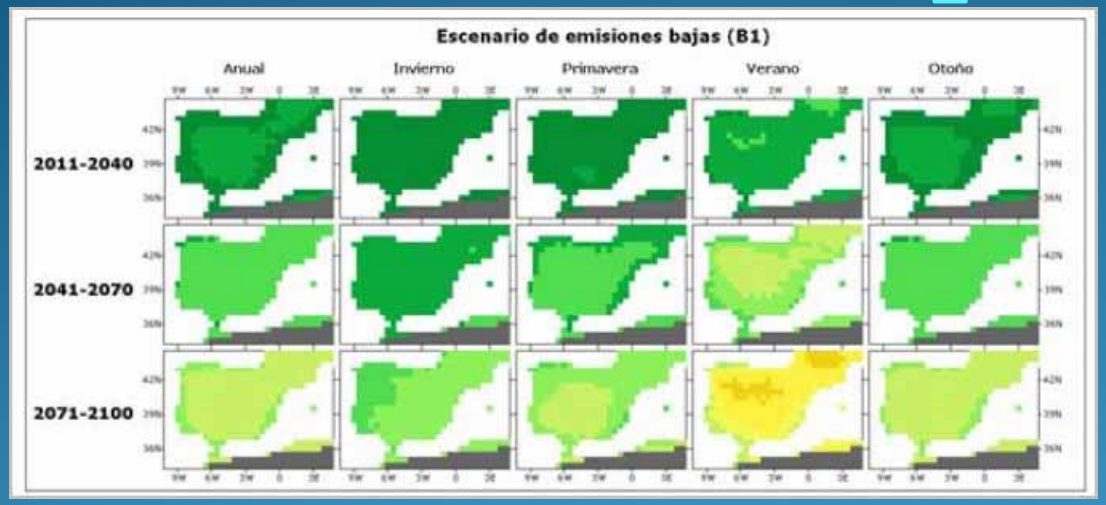
1) Emissions CO_2
2) Legislation
3) Advantages for the owner / user

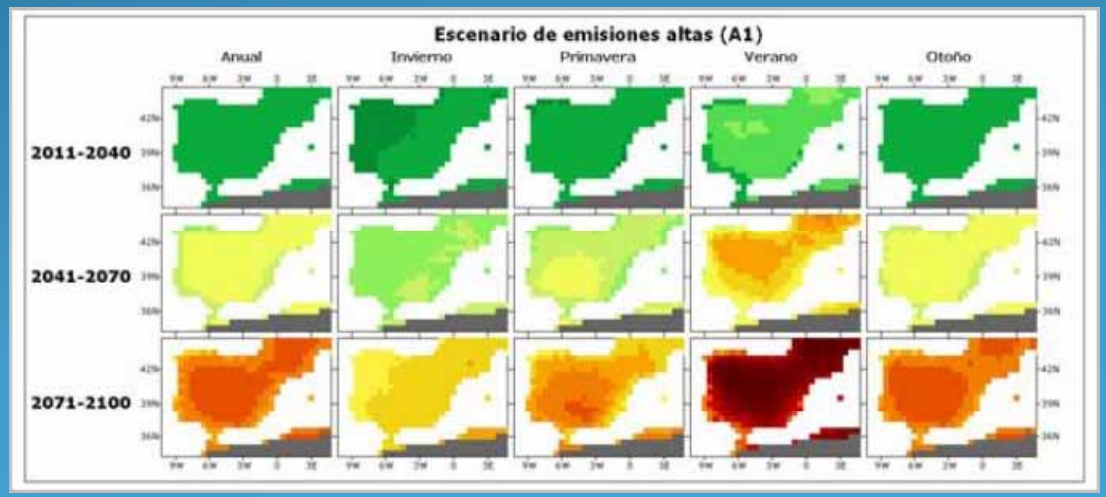


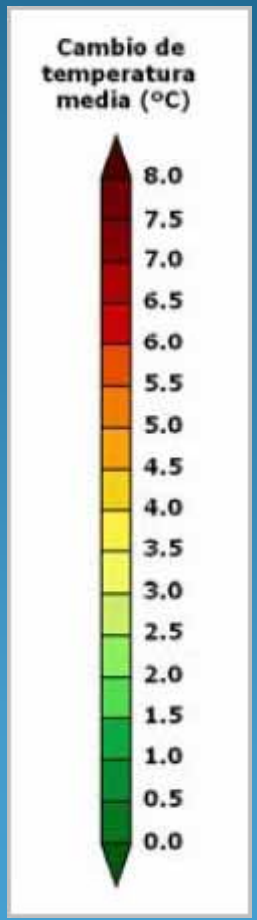
1 | EMISSION CO_2
Comparison of emissions CO_2



1 | EMISSION CO_2 | PROGRESS







1 | EMISSION CO_2
Change of the climate

1 | EMISSION CO_2
"It's in our hands"

Responsability of the total energy use in Spain

1) Using the car:

12 % of the total energy use

2) Energy consumption of the buildings:

7 % services sector

10 % domestic sector

2 |LEGISLATION

Directiva 2002/91/CE of the european parlament

Aim

To bring forward the energy efficiency of buildings

CTE
Código Técnico de la Edificación

RITE
Reglamento de Instalaciones Térmicas en los edificios

Certificación Energética de Edificios

2 | LEGISLATION |CTE

CTE
Código Técnico de la Edificación

Basic requirements of quality

Security
- Structure
- Fire protection
- Use

Habitability
- Health
- Noise protection
- Energy saving

Accessibility

2 |LEGISLATION |CTE | DB-HE

CTE | DB HE | Energy savi

HE 1: Limitation of the demand of energy*

HE 2: Effort of the thermal instalations (> R

HE 3: Energy effiency of lightening systems

HE 4: Solar contribution of drinkable water**

HE 5: Photovoltaics contribution for electricity

* a) new constructed buildings

b) modifications with an area of > 1000 m2 floor space and 25% of his exterior walls.

** ACS : Xàbia = Climate zone IV

> 70% Solar contribution (one familily house) with electric support and > 60% with petroleum, gas support.

3 | ADVANTAGES FOR THE OWNER

- Save money (energy bills)

- Achieve more health and comfort
  - Comfortable temperature
  - No more condensations and mildew
  - Enhance the acustics insulation

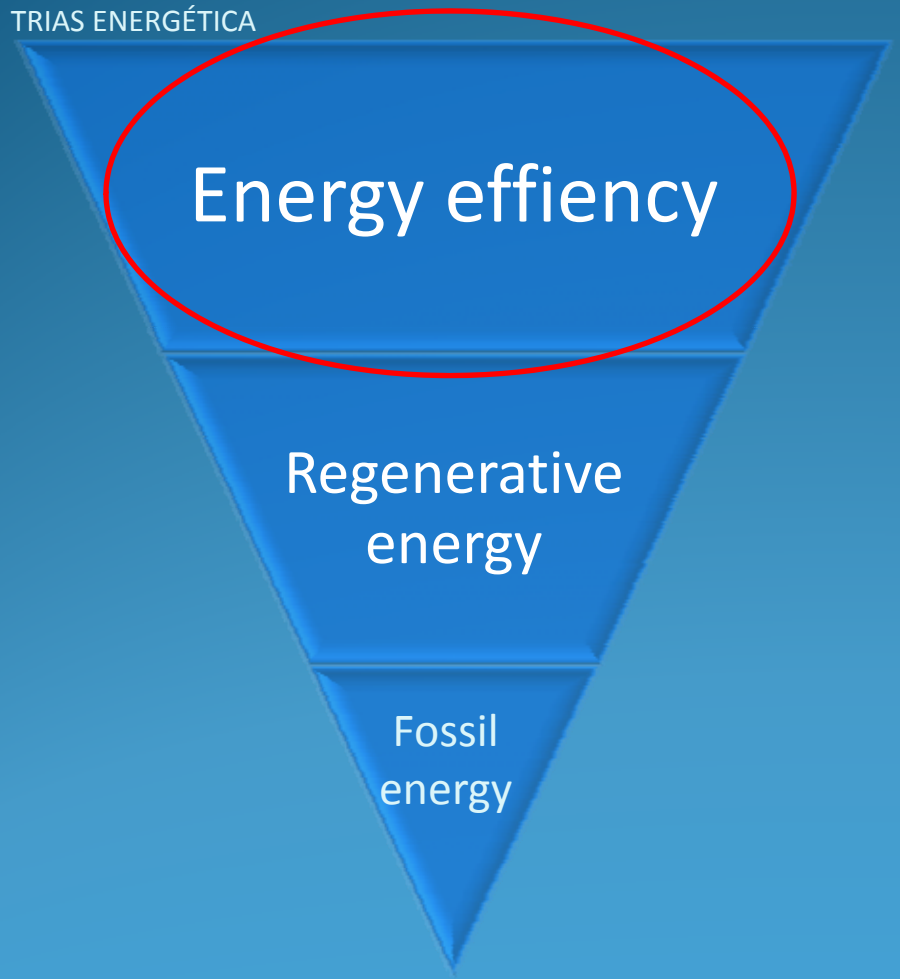
- Enhance the selling possibilities
  - Unique selling point

Which is the way to……

- Save energy?
- Reduce the energy dependency?
- Reduce the CO_2 emission?
- More comfort for the user?

The importance of the Building shell

TRIAS ENERGÉTICA



Good insulation=
Most important step to save energy!

Reduce the demand of energy
- Avoid energy loss
- Preview energy saving measures

Use sources of regenerative energy

Produce and use fossil energy in a more efficient way.

“The most ecological energy is the energy which isn’t used.”

Modification Building shell

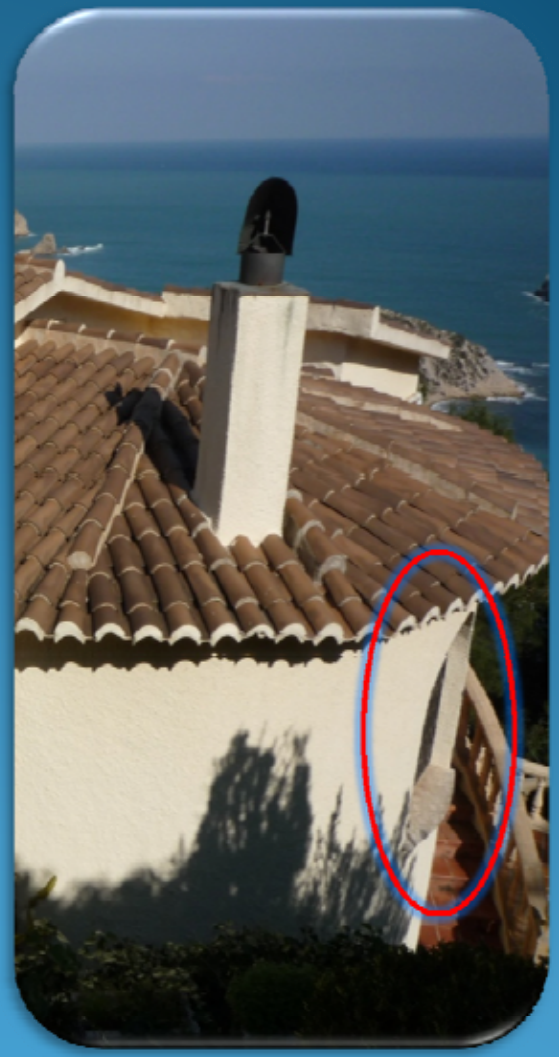
4) Roofs

1) Windows

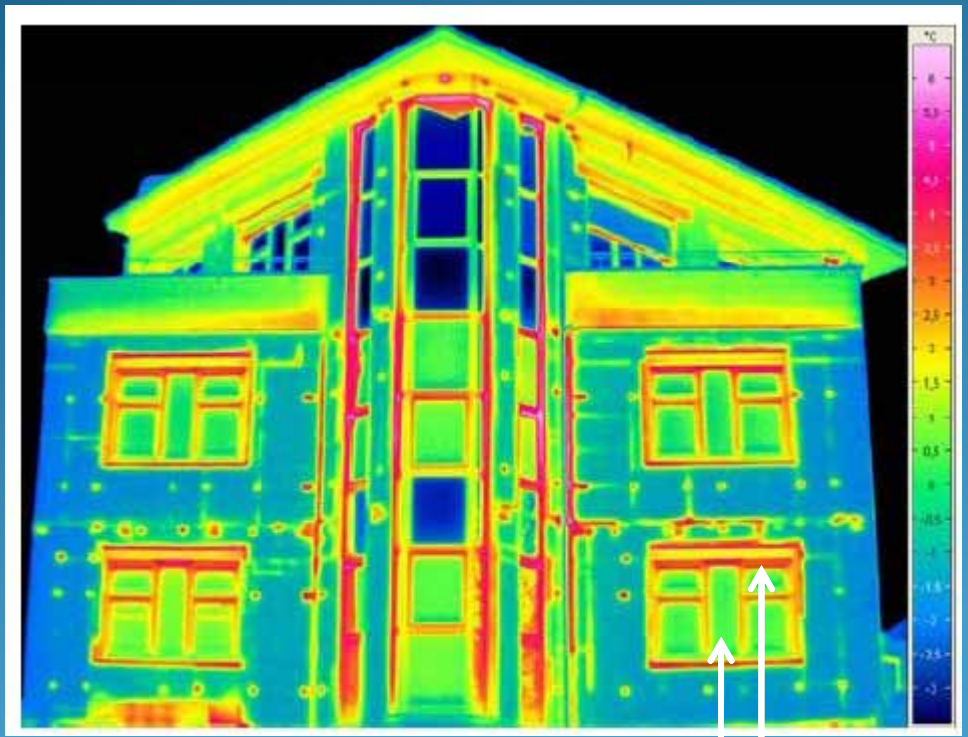
2) Facades

3) Floors

1 | Modification of windows



1 | Modification of windows



Glass

Frame

Change of windows
= easiest intervention

1 | Modification of windows

Frame

25 – 35% of the window area

A) Metalic frame, U* = 5,7 W/m²K

B) Metalic frame with a break of the thermal bridge (RPT), U = 3,20-4W/m²K

C) Wooden frame, U = 2,0-2,2 W/m²K

D) PVC frame, U = 1,8 - 2,2 W/m²K

* U = Thermal conductivity. Small "U" = good insulation.

1 | Modification of windows

Glass = 70% of the window area

A) One glass panel, U = 5,7 W/m²K

B) Double glazing

Composición²	4-6-4	4-8-4	4-10-4	4-12-6
U (W/m²K)	3,3	3,1	3,0	2,9

C) Glazing with low conductivity

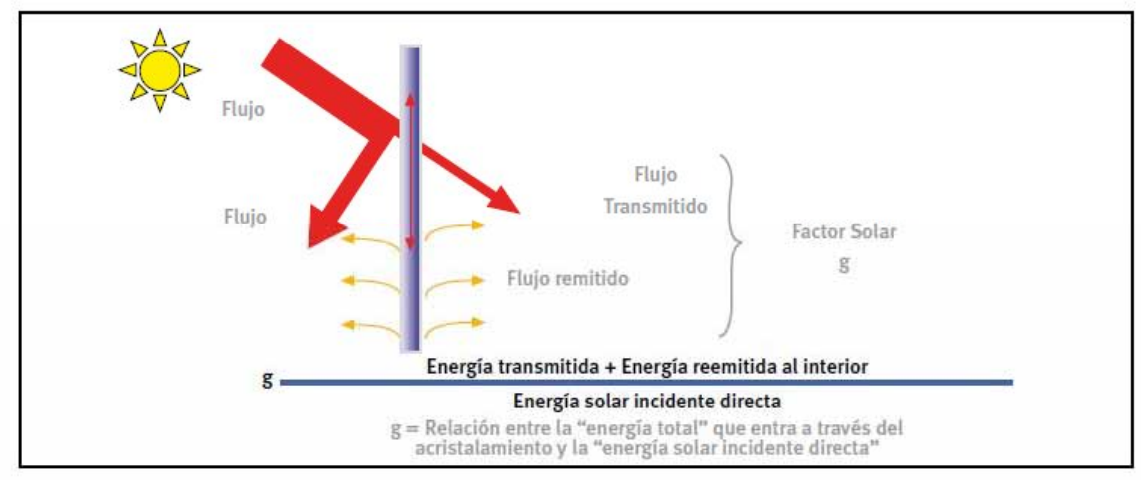
(layer of oxid on of the glass panels)

Composición⁴ con un vidrio normal y un vidrio de baja emisividad (ε ≤ 0,03)	4-6-4	4-8-4	4-10-4	4-12-6
U (W/m²K)	2,5	2,1	1,8	1,7

1 | Modification of windows

Glass

1. Thermal conductivity (W/m²K)
2. Solar factor (g)



a) Simple one glass:
g = 0,83
b) Double glazing
g = 0,75
Modification:
Glass with solar control

1 | Modification of windows

Situación	Acristalamiento	Espesor cámara	Carpintería	Pérdidas (*) (%)	Ahorro (**) (%)
Inicial	Doble	6	Metálica	100	0
1	Doble	12	Metálica	93	8
2	Doble	6	Metálica RPT	88	13
2	Doble bajo emisivo	6	Metálica	88	13
3	Doble	12	Metálica RPT	80	20
4	Doble bajo emisivo	6	Metálica RPT	75	25
4	Doble	6	Madera	75	25
5	Doble bajo emisivo	12	Metálica	73	28
6	Doble	6	PVC	70	30
7	Doble	12	Madera	68	33
8	Doble	12	PVC	63	38
8	Doble bajo emisivo	6	Madera	63	38
9	Doble bajo emisivo	12	Metálico RPT	60	40
10	Doble bajo emisivo	6	PVC	58	43
11	Doble bajo emisivo	12	Madera	48	53
12	Doble bajo emisivo	12	PVC	43	58

(*) % de pérdidas energéticas a través del cerramiento tomando como referencia (100%) la situación inicial
(**) % de ahorros (reducción de pérdidas energéticas) logrados a través del cerramiento respecto a la situación inicial
Cálculos realizados para participación de 30% marco y 70% acristalamiento

1 | Modification of windows

Advantage

- Easy and economical (e.g. just the change of the glass)
- Less loss of energy =
  less expense on energy bills and less CO_2
- Upgrade: Acoustics, security, solar control and maintenance in one step
- Improvement of comfort (no drafts)

1 | Modification of windows

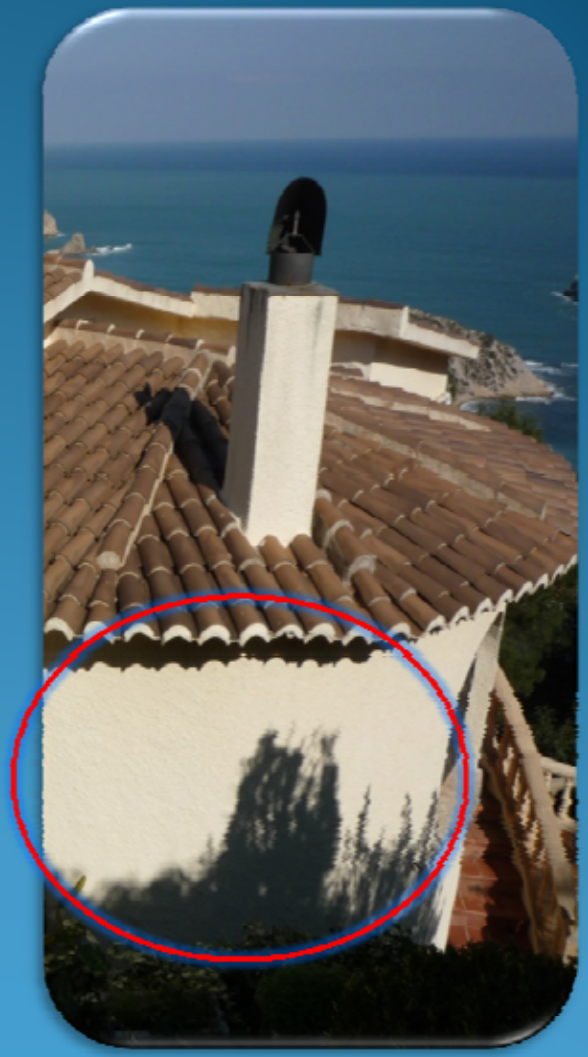
Please note:

Instalation of the windows in

the same line of the insulation

avoids thermal bridges and mildew.

2 | Modification of facades



2 | Modification of facades

Systems

A. Exterior thermal insulation

B. Interior thermal insulation

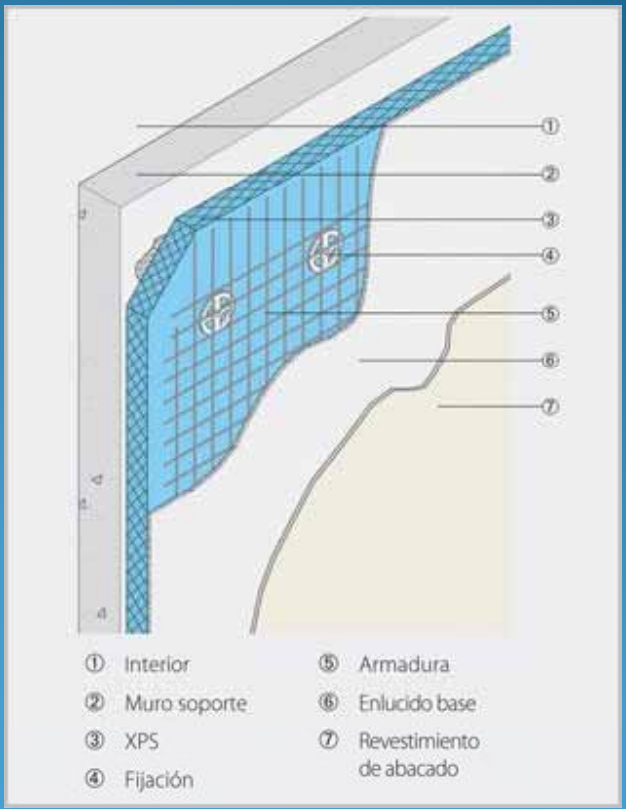
C. Thermal insulation by injection in the hollow space

2A|Facades | Exterior

System 1:

ETICS = External Thermal Insulation Composite System

- XPS (High density polystyrene)
- EPS (Expanded polystyrene)



2A|Facades | Exterior

Thermal conductivity, U (W/m²K)

Example:

- Cavity wall

  (Thermal resistance R = 0,17m²K/W)

Fachada de dos hojas con cámara (R= 0,17 m²K/W)

Tipo de fábrica exterior	Sin rehabilitar	Rehabilitada con XPS en espesor de: 3 cm	4 cm	5 cm	6 cm	8 cm	10 cm
½ asta L.P.	1.561	0,748	0,616	0,524	0,456	0,362	0,307
1 asta L.P.	1.242	0,666	0,559	0,482	0,424	0,341	0,292

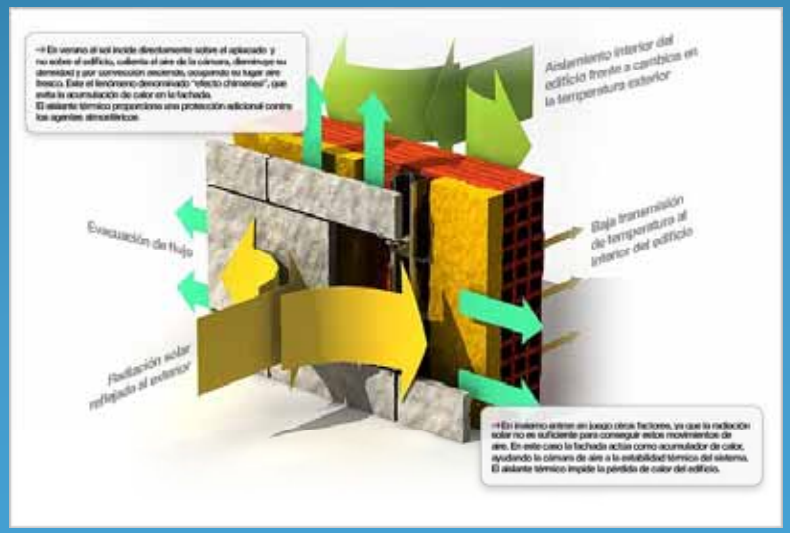
Requirement CTE: 0,82 W/m²K

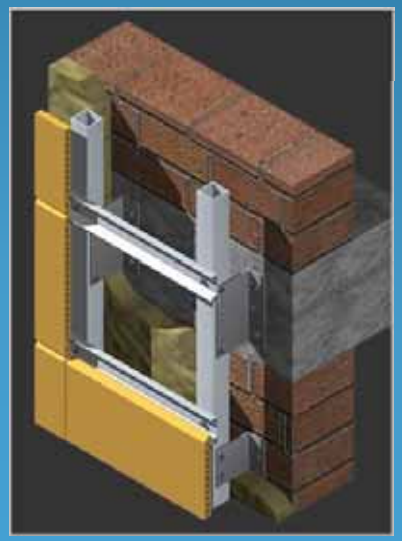
½ asta ("pie"): 11,5 cm
1 asta ("pie"): 24 cm

2A|Facades | Exterior

System 2:

- Ventilated facade
  - Mineral rock wool
  - PUR (sprayed polyurethan)





2A|Facades | Exterior

2A|Facades | Exterior

Advantages:

- Erase thermal bridges
  >> avoid condensation and mildew.
- No moving out necessary
- No reduction of the floor space
- Use the inertia of the concrete ceiling
  (like a heat accumulator)
  >> stabilize the temperature of the living space
  >> less use of energy for heating and cooling
  >> less expense.

2A|Facades | Exterior

Please note:

- Use specialized companies
- Systems DITE

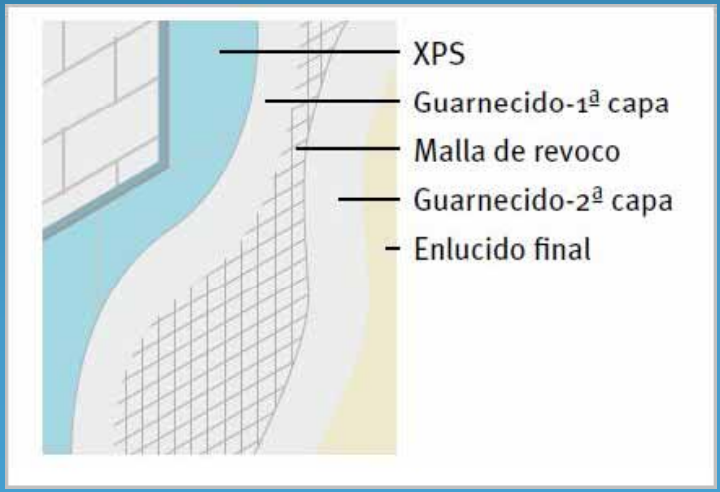
  (Documentos de Idoneidad Técnica Europea)

2B|Facades | Interior

Two systems for interior modification of facades

1. XPS (High density polystyrene)

   > to plaster on it



2B|Facades | Interior

2. XPS (High density polystyrene) or mineral rock wool

> finished with gypsum plaster board

2B|Facades | Interior

Advantages:

- Easy modification, the owner could realize it
- Buildings with monument protection

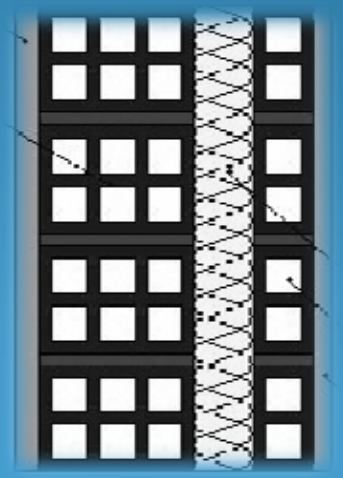
Disadvantages:

- User has to move out
- Reduction of the floor space
- Danger of condensation and mildew!
- Living space will be heated quite fast, but there is no mass to maintain the energy.

2C | Modification of facades Injection in hollow space

Foam of PUR (sprayed polyurethan) of low density

- 12 kg/m³ in the beginning
- 18 – 25 kg/m³ finished
- Thickness at least 40 mm
- Drill drifts:
  - Distance < 50 cm
  - Without being in the same line



2C | Modification of facades Injection in hollow space

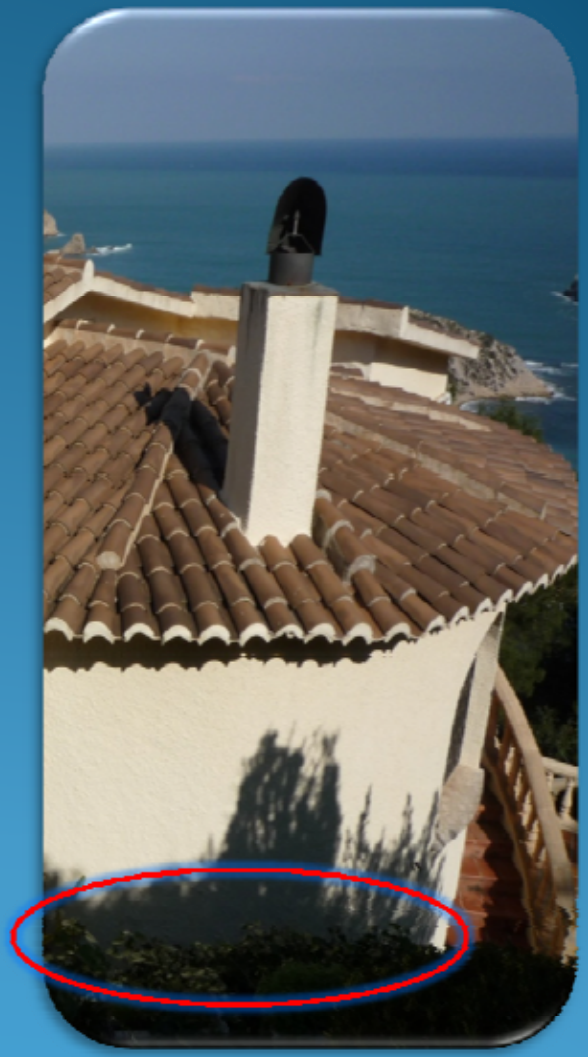
Advantage:

- Maintain the floor space

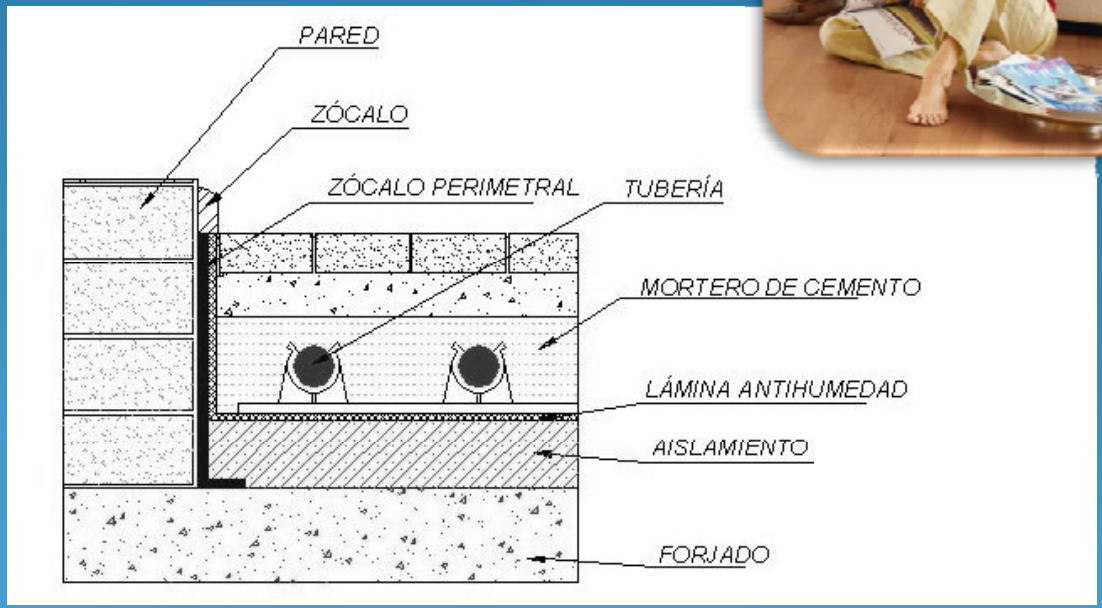
Disadvantage:

- Danger of fissures if the product is not injected with low density!

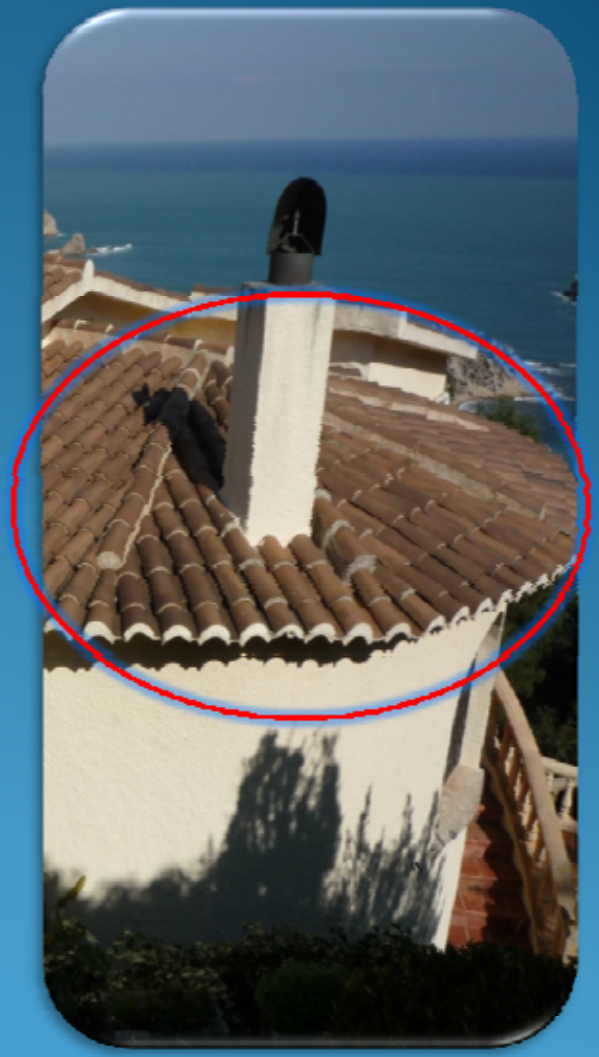
3 | Modification floors



3 | Modification floors



4 | Modification Roofs

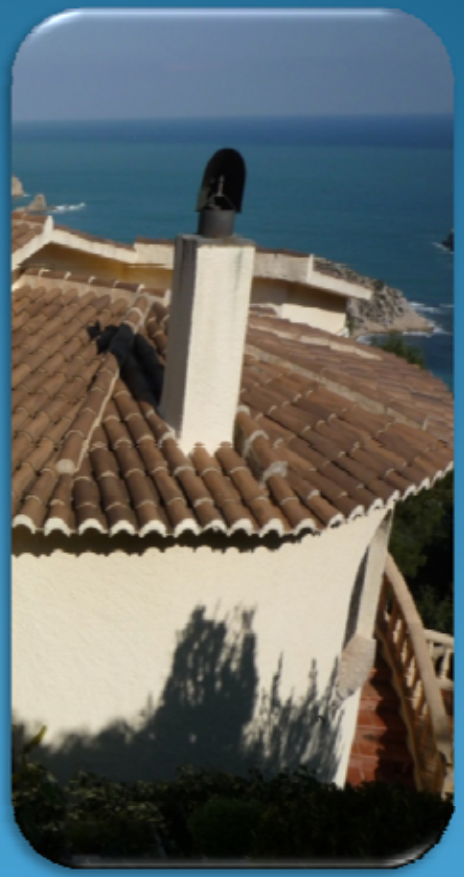


4 | Modification roofs

Systems of modification

A. Exterior modification

B. Interior modification

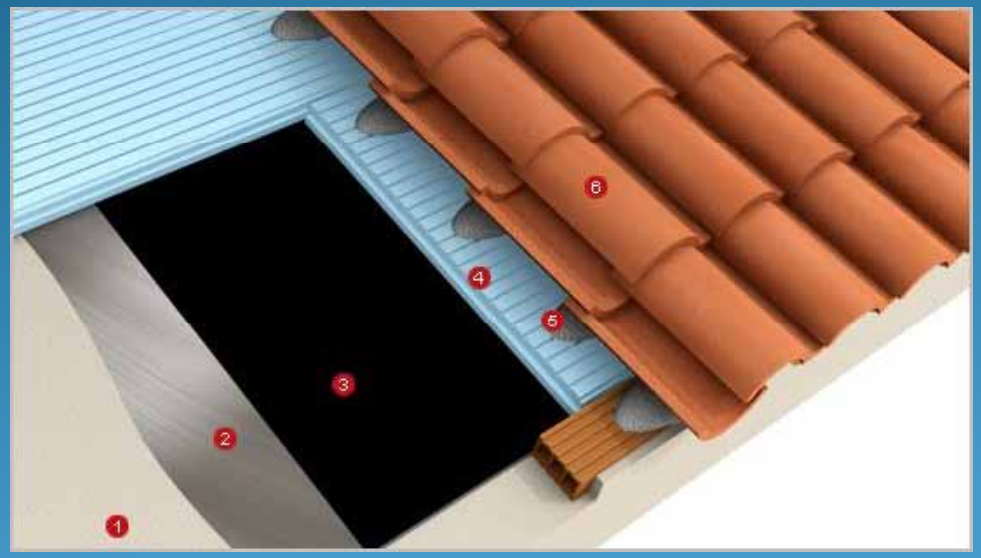


Roofsystems

- Inclined roof with roofing tiles
- Flat roof

4A | Roofs | Exterior

Inclined roof with roofing tiles



1. Ceiling
2. Priming coat
3. Waterproofing
4. Thermal insulation
5. Adhesive
6. Roofing tiles

4A | Roofs | Exterior

Integration of solar collectors

Foto: Velux

4 | Roofs | Exterior

Flat roof

1.1 Flat roof walkable

1.2 Flat roof not walkable

1.3 Green roof

2.1 “Warm roof” > cold and rainy climate

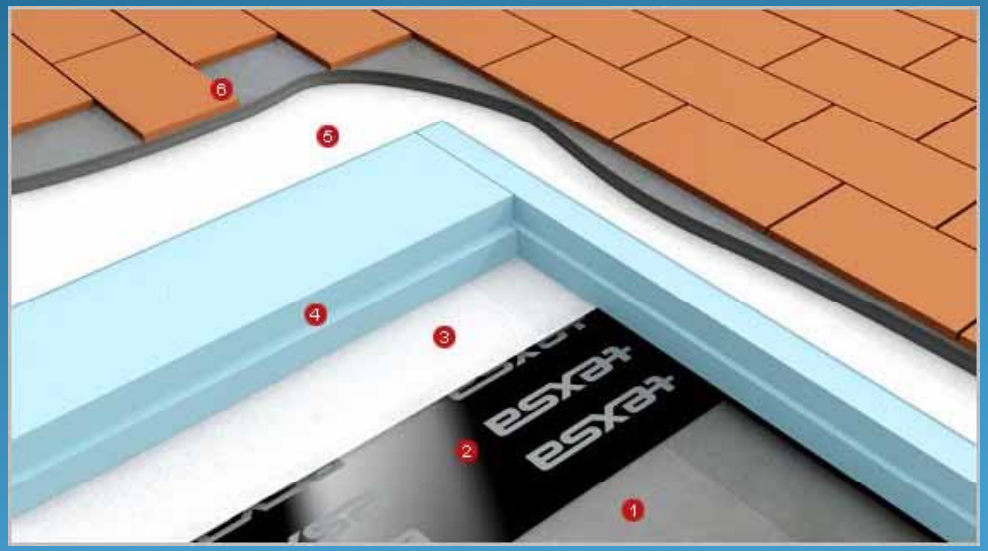
Waterproofing above the thermal insulation

2.2 “Cold roof” > hot and dry climate

Waterproofing below the thermal insulation

4A | Roofs | Exterior

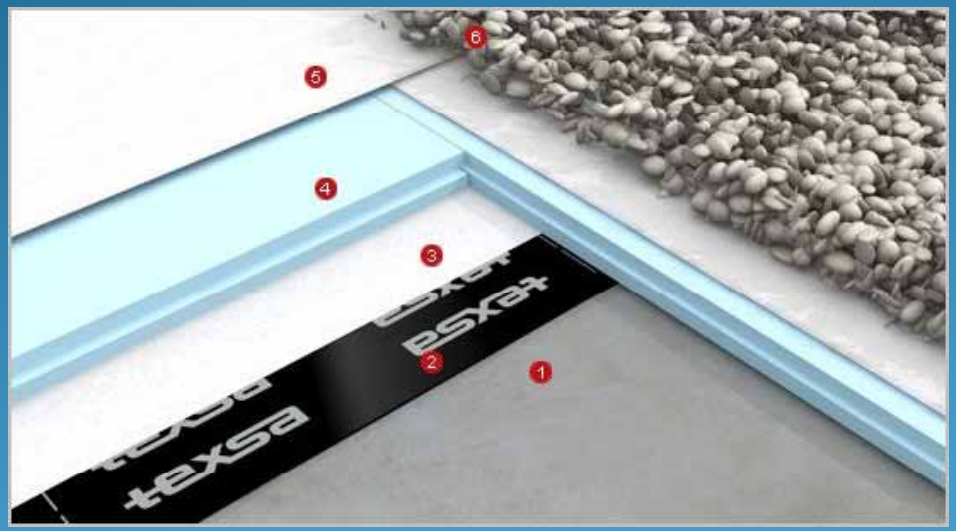
Flat roof | walkable | “Cold roof”



1. Ceiling
2. Waterproofing
3. Seperating layer
4. Thermal insulation
5. Seperating layer
6. Tiles

4A | Roofs | Exterior

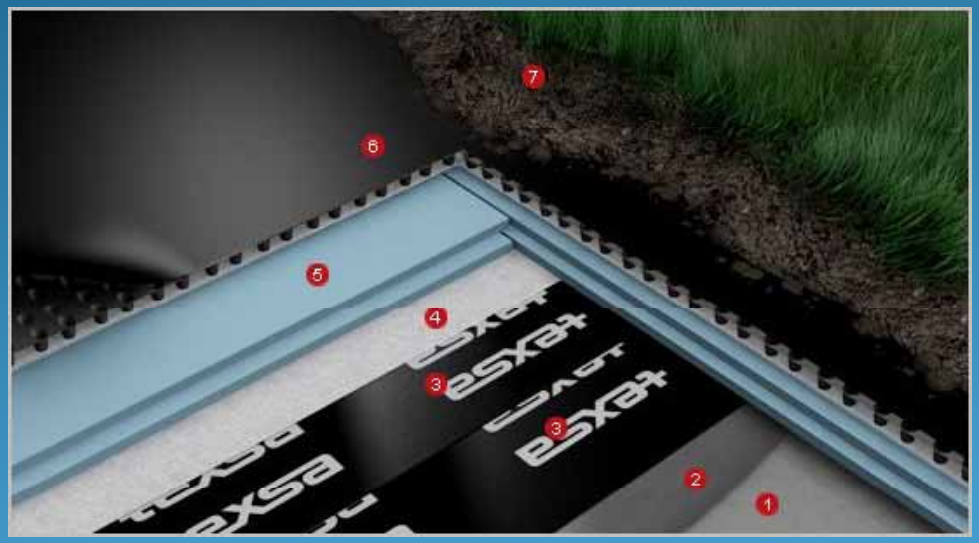
Flat roof| walkable| “Cold roof”



1. Ceiling
2. Waterproofing
3. Seperating layer
4. Thermal insulation
5. Seperating layer
6. Gravel

4A | Roofs | Exterior

Flat roof | Green roof | “Cold roof”



1. Ceiling
2. Priming coat
3. Waterproofing
4. Seperating layer
5. Thermal insulation
6. Drainage
7. Substrate and plants

4A | Roofs | Exterior

Thermal conductivity, U (W/m²K)

Example:

Modification of a walkable roof by adding thermal insulation XPS (High density polystyrene)

R del forjado (m²K/W)	Sin rehabilitar	Rehabilitada con XPS en espesor de: 3 cm	4 cm	5 cm	6 cm	8 cm	10 cm
0,23	1.376	0,631	0,535	0,464	0,410	0,332	0,285
0,30	1.255	0,605	0,516	0,449	0,398	0,324	0,280

Requirement CTE: 0,45 W/m²K

R = resistencia térmica

4A | Roofs | Exterior

Advantages

- Avoid condensations

  (whole ceiling is protected by the thermal insulation)
- Use the inertia of the ceiling to stabilize the interior temperatures
- Maintain the clear height of the living space
- Less disturbance for the inhabitant

4B | Roofs | Interior

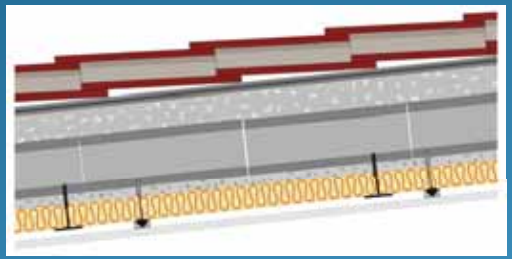
Systems

1.1 Gypsum plaster board and mineral rock wool insulation or polyurethane foam.

1.2 XPS (High density polystyrene) > to plaster on it (with a raspy surface)

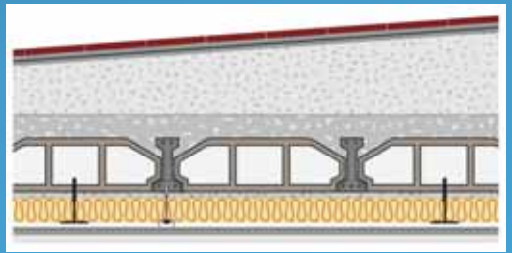
4B | Roofs | Interior

Thermal conductivity, U (W/m²K)



1

2



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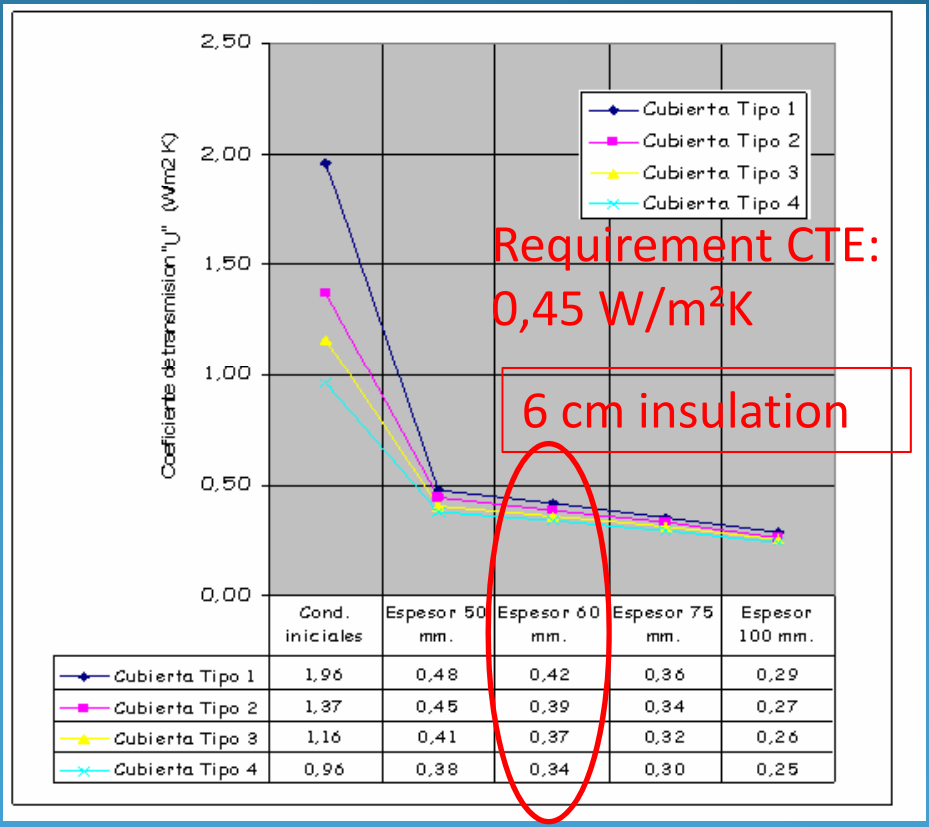


	Cond. iniciales	Espesor 50 mm.	Espesor 60 mm.	Espesor 75 mm.	Espesor 100 mm.
Cubierta Tipo 1	1,96	0,48	0,42	0,36	0,29
Cubierta Tipo 2	1,37	0,45	0,39	0,34	0,27
Cubierta Tipo 3	1,16	0,41	0,37	0,32	0,26
Cubierta Tipo 4	0,96	0,38	0,34	0,30	0,25

4B | Roofs | Interior

Advantages

- Only intervention from the interior without taking off the roof tiling
- Maintain the exterior aesthetics (especially buildings with monument protection)
- Easy to install in the case of gypsum plaster board

Disadvantage:

- Living space will be heated quite fast, but there is no mass to maintain the energy.

Please note:

- Condensations! >> Vapour trap necessary
- Construction height: aprox. 10 cm > reduction of clear height

4 | Roofs | Examples

- Modification of flat roof = Improvement of aesthetic

Modification | Example

Building with 6 apartments

Actual facade:

Rendered bricking	11,5 cm
Floating	1,0 cm
Air space	2,0 cm
Bricking	4,0 cm
Rendering	1,5 cm

Thermal conductivity U of the facade = 1,83 W/m²K

Modificated facade:

Stone panelling	1,0 cm
Thermal insulation	6,0 cm
Rendered bricking	11,5 cm
Floating	1,0 cm
Air space	2,0 cm
Bricking	4,0 cm
Rendering	1,5 cm

U of the facade = 0,55 W/m²K

Modification | Example

Building with 6 apartments

Existing windows, good condition
Existing roof without insulation

+ Change of the windows
+ Modification of the roof

Cost estimate:
3.800 €/apartment

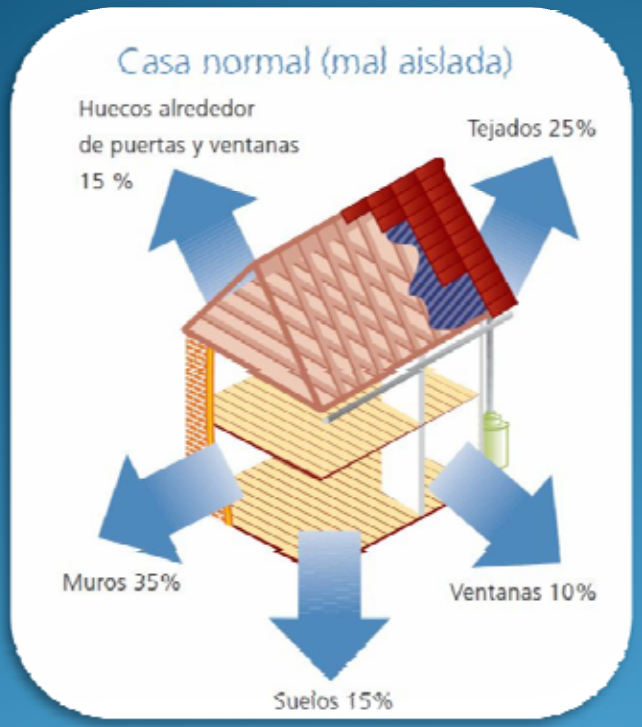
Heating costs/ apartment / year:
895 €

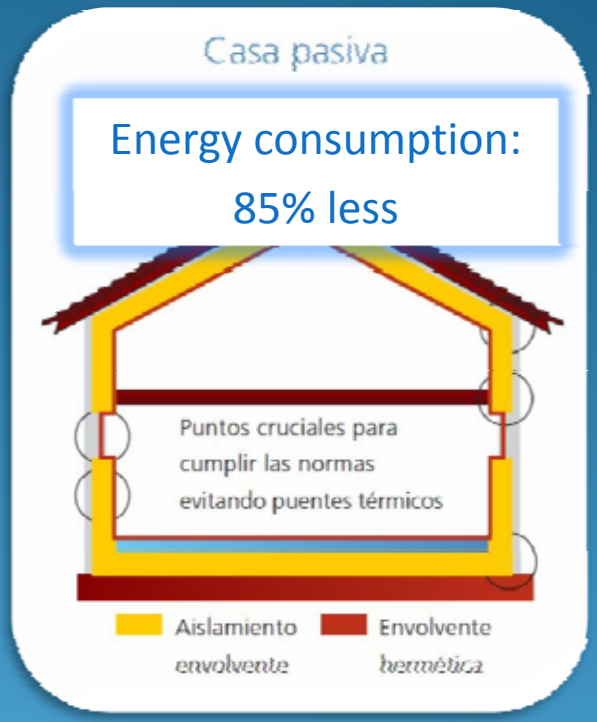
Heating costs / apartment / year
415 €

Saving
480€/year

Amortization
in 8 years

Perspective | Passive house





Normal house (bad insulated)

Energy demand:

aprox. 250 kWh/m²a

Passive house

Energy demand:

< 15 kWh/m²a

LIST OF REFERENCES

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- **IDEA** (Instituto para la Diversificación y Ahorro de Energía): Guía practica de la energía de edificios
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- **Productos**: Ursa, Knauf, Dow, Texsa, Velux

THANK YOU FOR YOUR ATTENTION

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