BIM coaches training

Paris , January 9 & 10, 2018

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NZEB building specificities and regulations

Myriam Olivier, ASTUS-Construction

What is the meaning of « Sustainable construction » ?

Sustainable construction

- 1. answer the needs of “sustainable development”
  - Limit global warming
    - Less greenhouse gaz
  - Limit non-renewable material consumption
    - Energy : petroleum, charcoal, uranium …
    - Building material, water,
  - Biodiversity Preservation

Sustainable construction

- 2. … while answering citizens and users needs
  - Confort and quality of life
  - Construction and operating costs

- 3. … and comply with governmental regulations
  - Thermal efficiency
  - Air quality
  - Fire, seismic, acoustic, ….

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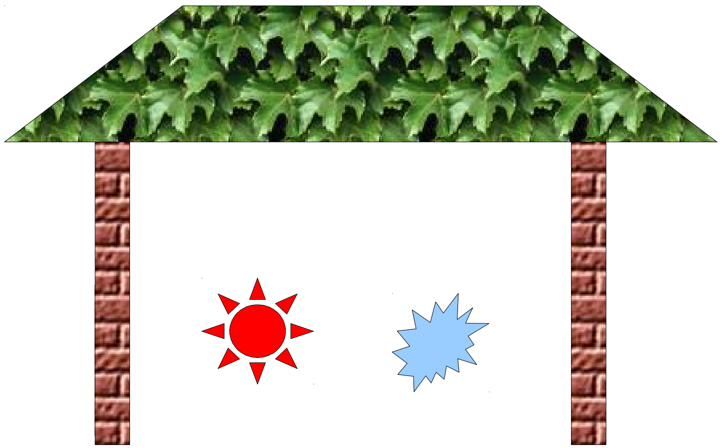
GLOBAL and SYSTEMIC approach

GLOBAL and SYSTEMIC approach

- A building is not just :



- A building is a COMPLEX system

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GLOBAL and SYSTEMIC approach

- A building is a <u>COMPLEX system</u>
  - Orientation
  - Openings
  - Structural & filling building materials
  - Insulation position
  - Heating / refreshing systems
  - Ventilation systems ...

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→ systemic approach

GLOBAL and SYSTEMIC approach

- A building needs many <u>stakeholders / actors</u>
  - contracting owner
  - Architect / project manager
  - Engineering departments / offices
  - Contractors
    - Many different building trades
  - Users / Inhabitants

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→ GLOBAL approach

Sustainable building design

… a few ***technical*** basis

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Sustainable building design

1 . SYSTEMIC design
… to be implemented
right from the beginning

SYSTEMIC design

- Bioclimatic design
  - At the Suburb's scale
    - Street and tenant orientations
    - Other buildings shadows
    - Energy management
  - At the Building's scale
    - Orientation
    - Size and area of openings

→ global design

SYSTEMIC design

- Building's behaviour
  - Structure
    - Heavy material → inertia
    - Light material → insulation
  - Wall filling → need inertia or insulation ???
  - Windows
    - Catch Solar energy
- Building envelop optimisation
  - Limit energy needs
  - → energetic calculation of the outer envelop

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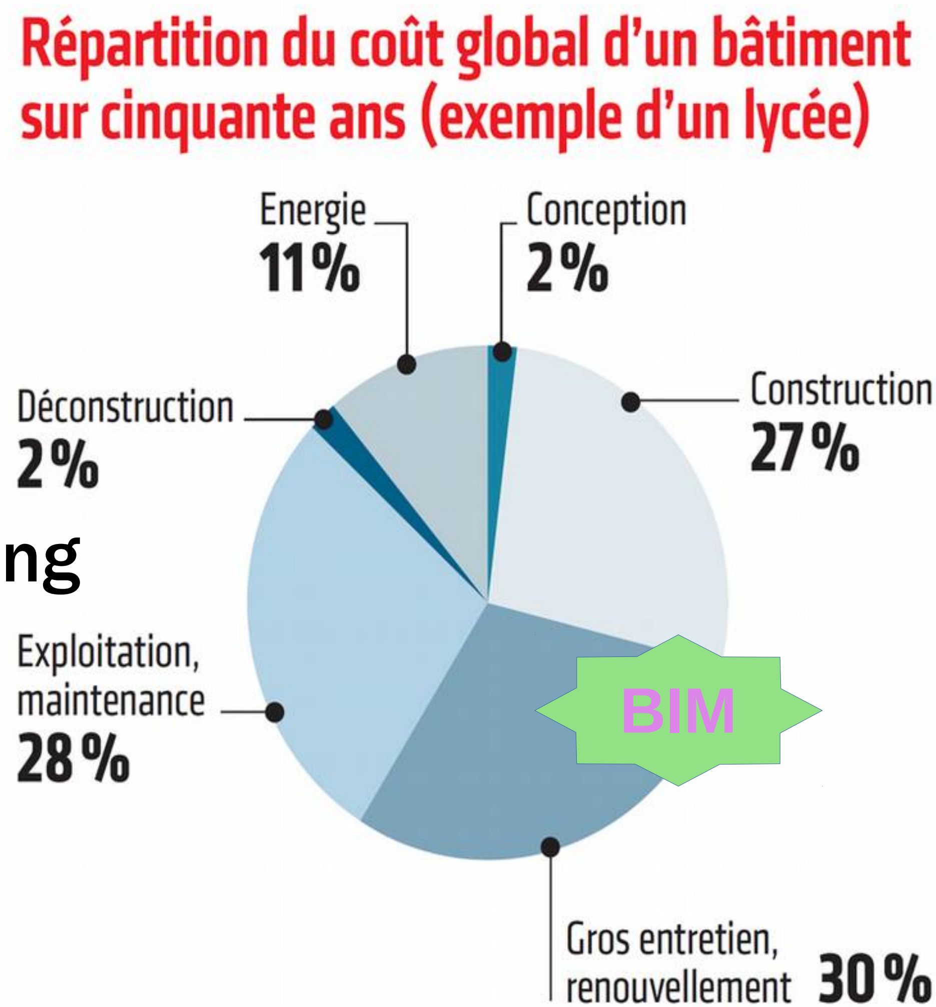
SYSTEMIC design

- System optimisation
  - Heating
  - Ventilation
  - Cooling
  - Hot water
  - Lighting
- + Specific energy (electricity use)
- Renewable energy
  - Scale of the building
  - Scale of the suburb

Expenses along a building life cycle

- Global cost
  - Design/ studies
  - Construction / investment
  - Building life / working
  - End of life / deconstruction



Sustainable building design

1 . SYSTEMIC design

2 . thermal comfort
2.1 global design

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Sustainable building design

- What is the weather like ?
  - Cold in Winter (and cool in summer) ? → North of Europe
  - Hot in Summer (and mild in winter) ? → Spain
  - Cold in Winter AND Hot in summer ? → France + Spain
- It will determine :

→ building orientation

- Individual housing or multi-residential buildings ?
- Public buildings or offices ?

→ openings and sun-protections

→ material : insulation vs inertia

Sustainable building design main parameter : WINTER

- Protection against cold weather
  → individual housing
  - Main rooms oriented to the SOUTH
    - Urbanism
    - Buffer spaces north side
  - Limit heat loss → INSULATION
    - «compact» architecture
    - Maximum ratio : volume/exterior surface
  - Main winds
    - Protection against cold winds, shutters

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Sustainable building design main parameter : WINTER

- Protection against cold weather
  → office & residential building
  - East-West building orientation
  - or South oriented through-building
    - Urbanism
  - Limit heat loss → INSULATION
    - compact architecture
    - Green-house effects
  - Protection against cold winds …
    - Buffer spaces north side, shutter

Sustainable building design main parameter : SUMMER

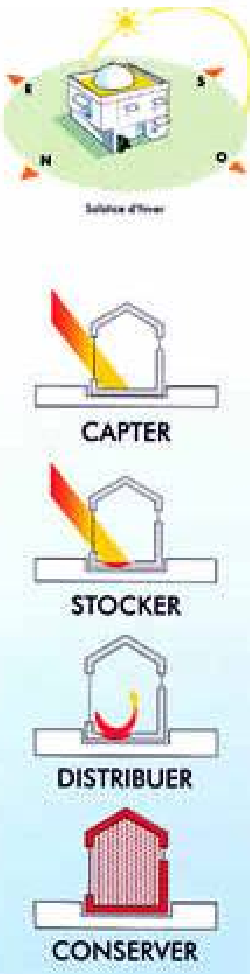
- Protection against hot weather
  - Main rooms protected from the sun
    - Sun shade and/or Sun protection / blinds
  - Increase heat loss→ «spread» architecture
    - If possible
  - Main winds
    - Natural ventilation ...
- Roof Insulation
- Inertia + night ventilation

Envelop bioclimatic design

hiver

In winter

→ “warm” strategy



Position
Orientation
Architecture

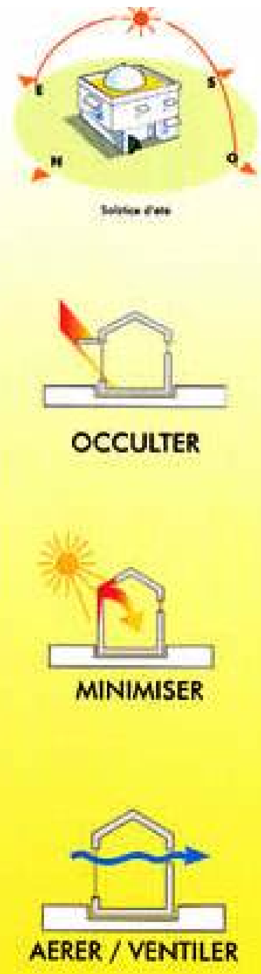
- *Attract solar calories*
- *Store calories within the walls*
- *Make the calories circulate in the building*
- *Keep the calories inside & limet their loss*

Mplement

En été

In summer

→ “cold” strategy



Position
Orientation
Architecture

- *Protection against direct solar energy*
- *Minimize solar calories entrance*
- *Get rid of over-heating and un-useful calories*
- *Cool the building with natural devices*

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Sustainable building design

2 . thermal comfort
2.2 building material

Insulation & Inertia : Envelop

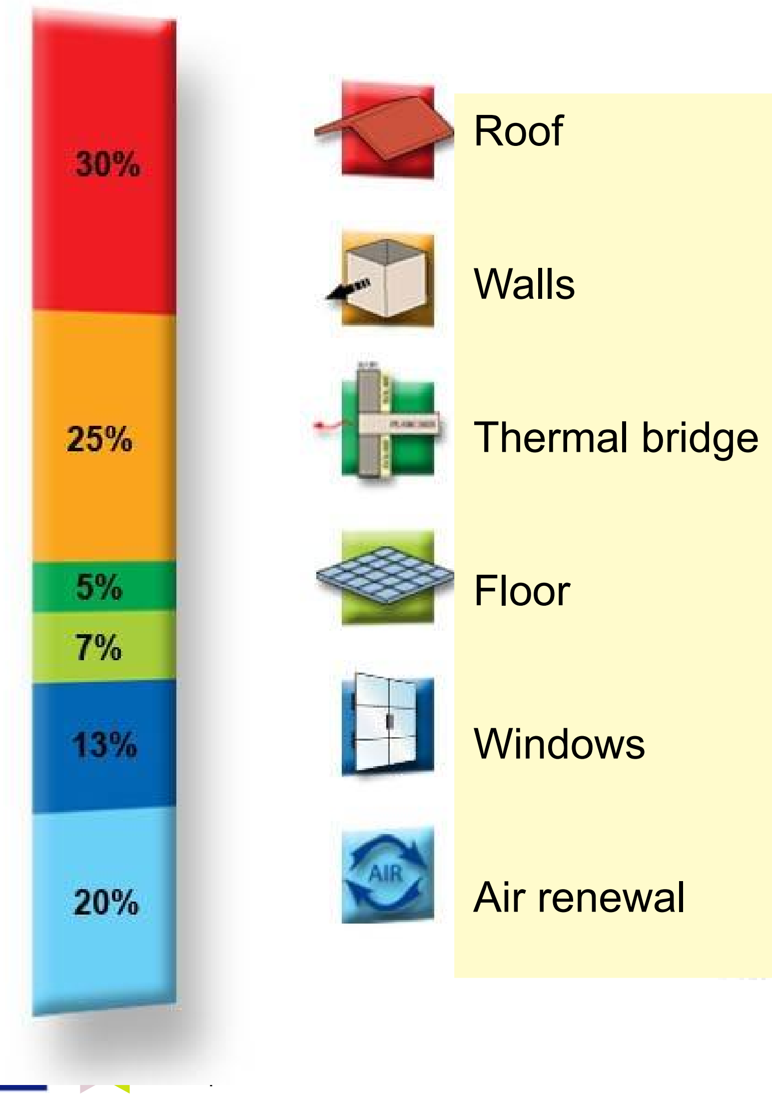
- Insulation
  - Protection against cold & warm weather
  - Limit / suppress heat transfers
  - Static behaviour : thermos bottle
- Inertia
  - Accumulation of warmth / cold
  - Variable speed of heat transfer
  - Dynamic behaviour (night/day)

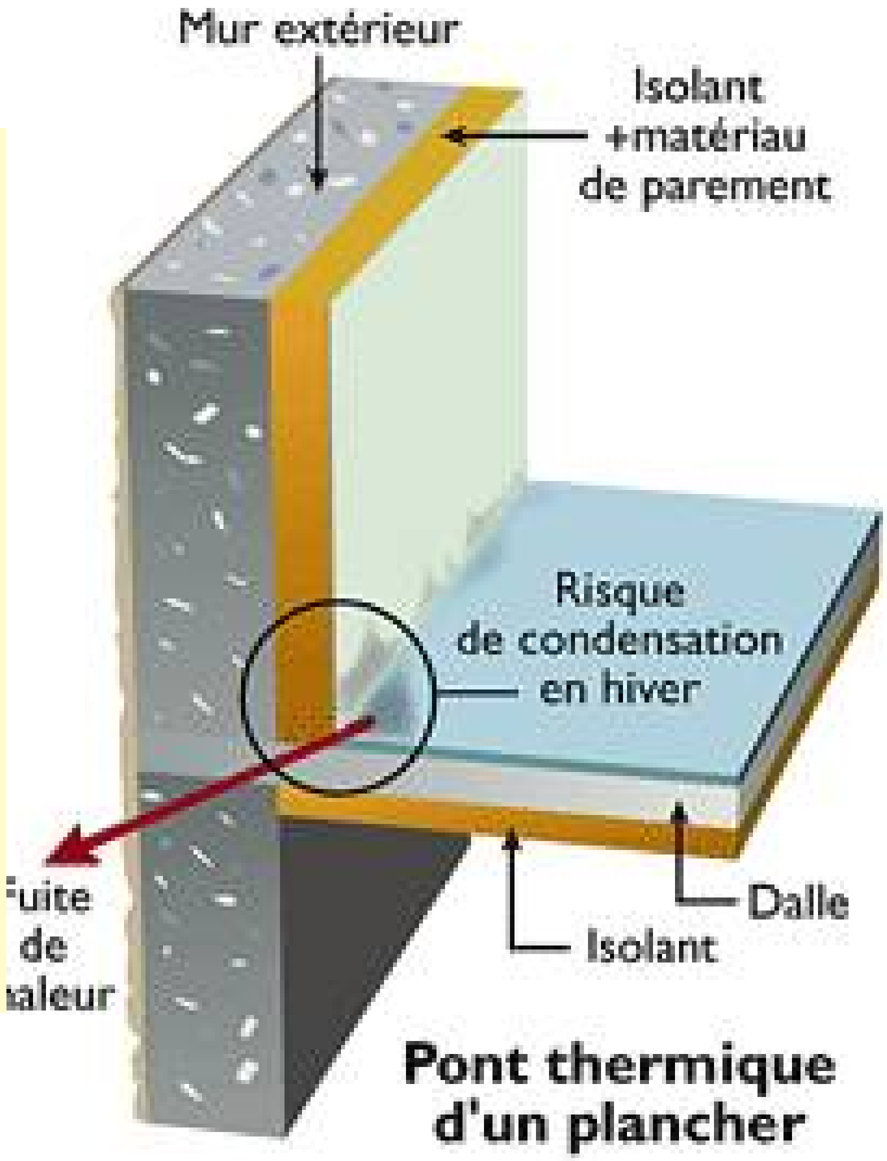
Insulation & Inertia : Material

- Load bearing materials
  - Inertia :
    - Concrete and concrete blocs
    - Earth, adobe, straw ...
    - Burnt blocks
  - Insulating material :
    - autoclaved aerated concrete
    - ~ perforated burnt bricks
    - ~ wood

- Filling Materials
  - Inertia :
    - Burnt blocks
    - concrete blocs, earth
    - Hemp-, wood-, flax- lime blocks
  - Insulating material :
    - Mineral wool
    - Vegetal wool (wood, hemp, ...)
    - Polystyrene ...
    - straw

Main places where heat is dissipated





Insulation : a few data for walls

- Thermal Conductivity : **λ (W/m.K)**
  - λ low → good insulation
    - Fiber glass, straw … λ = 0,03 to 0,06W/m.K
  - λ high → poor insulation
    - Concrete, earth : λ = 0,7 to 1,1 W/m.K,
    - Wood : λ = 0,13 to 0,2 W/m.K
- Wall thermal resistance : R (m^2.K/W)
  - R = sum of (material thickness / λ = e / λ)
  - R high → well insulated wall
    - 20cm Concrete alone → R = 1 /0,2 = 0,2 m^2.K/W
    - 20 cm Concrete + 20cm insulation → R= 1/0,2 + 0,2/0,04 = 5,2m^2.K/W

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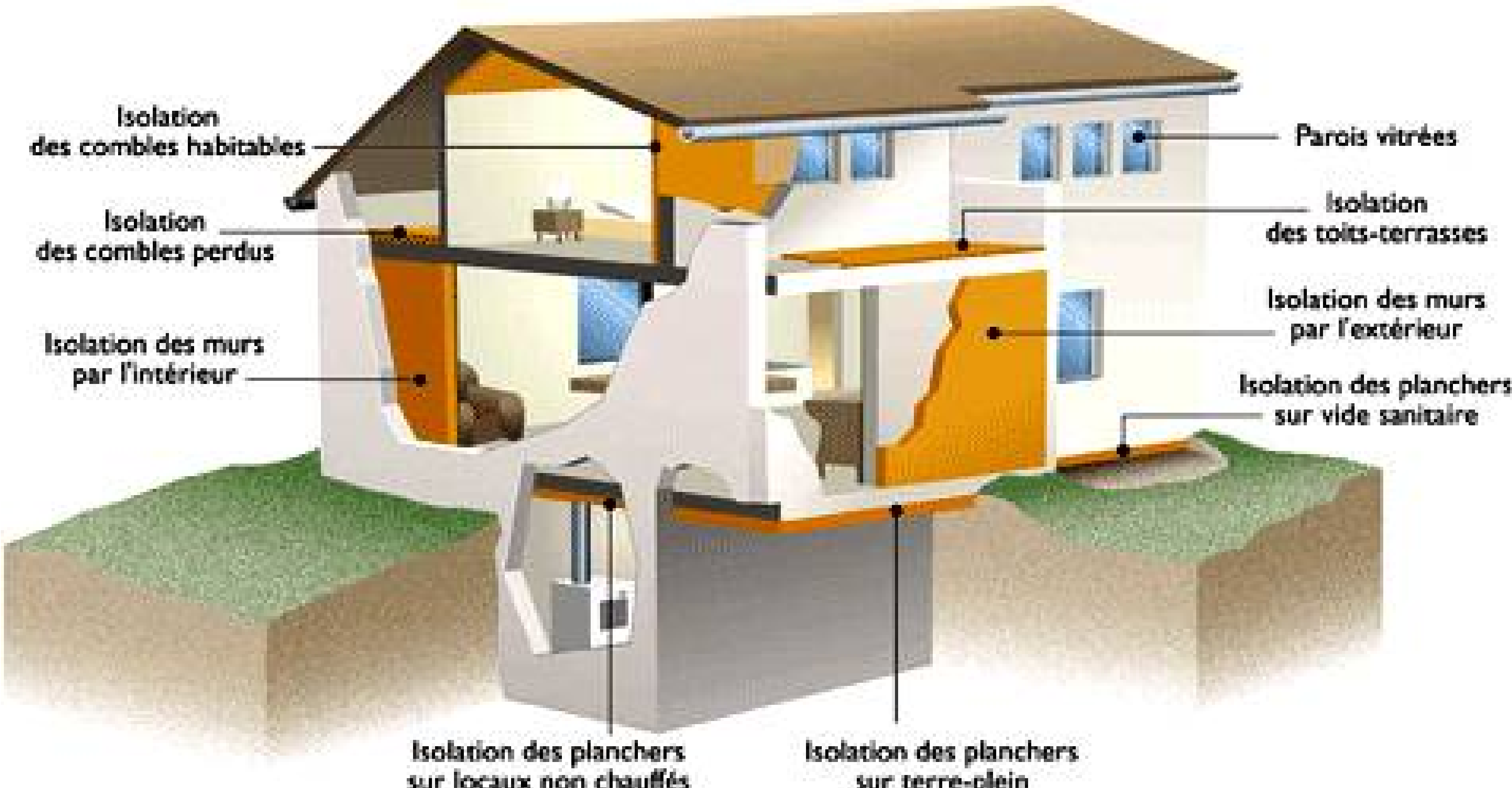
Insulation : blind walls



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Insulation : windows

- Thermal transmission coef. : $U = 1/R$
- U low → insulated glazing
  - Simple glazing : Ug = 6 W/m².°C
  - Triple glazing : Ug = 0,5 W/m².°C
  - *(20 cm fiber glass : U = 0,2 W/m².°C)*
- Solar transmission factor (en %)
  - Capacity to transfer energy & light
  - impact de la surface vitrée

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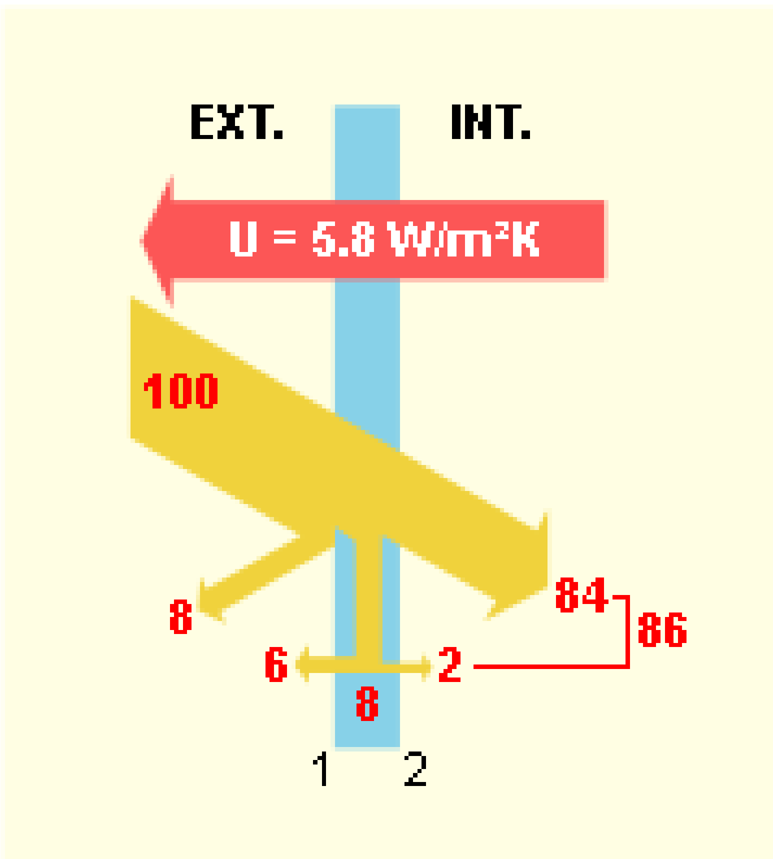
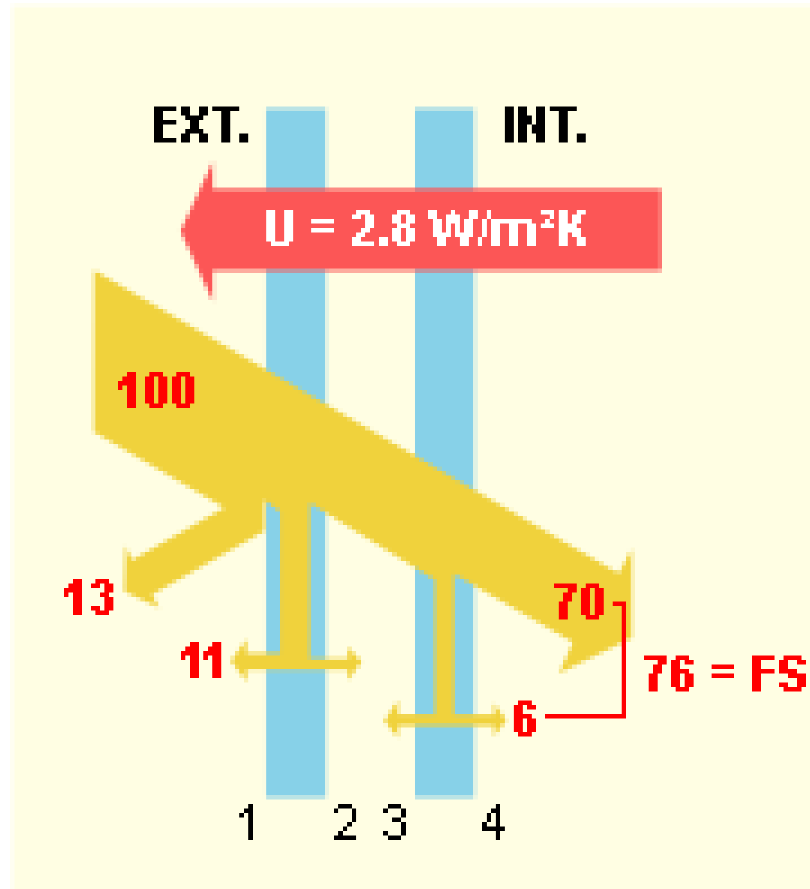
Energy transmission through windows



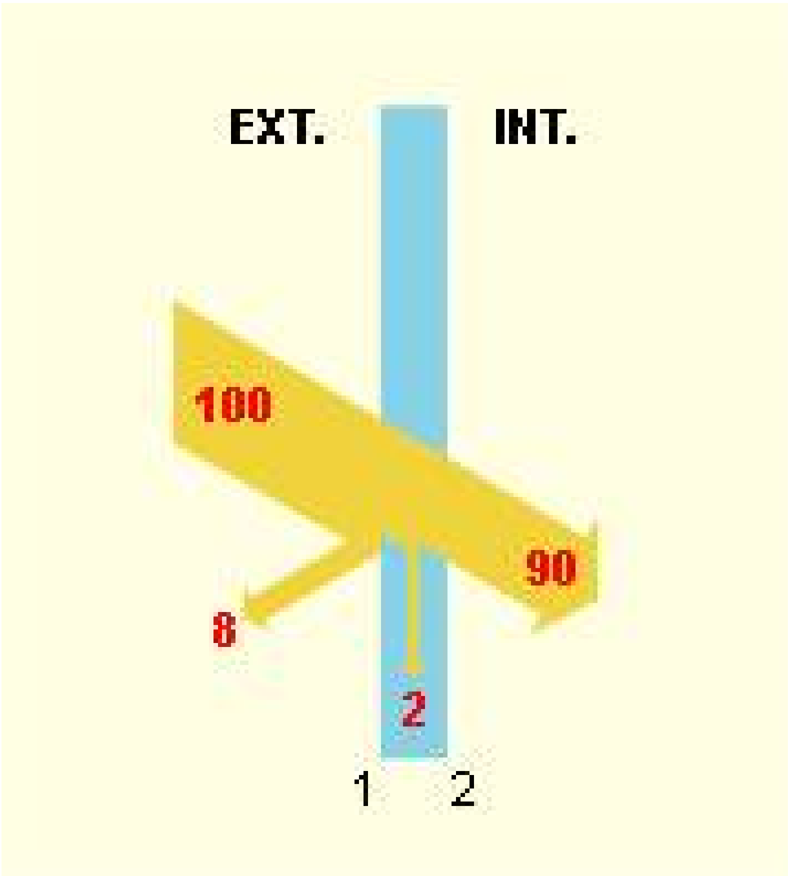
Simple glazing



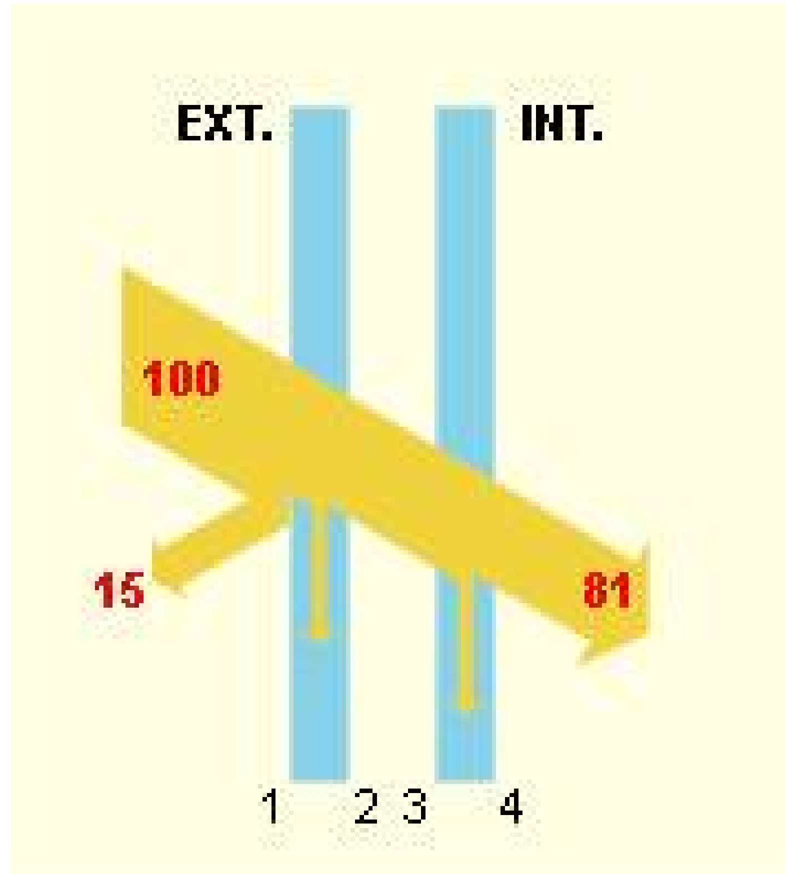
Double glazing

http://www.energieplus-lesite.be/index.php?id=10397

Light transmission through windows : TL



Simple glazing



Double glazing

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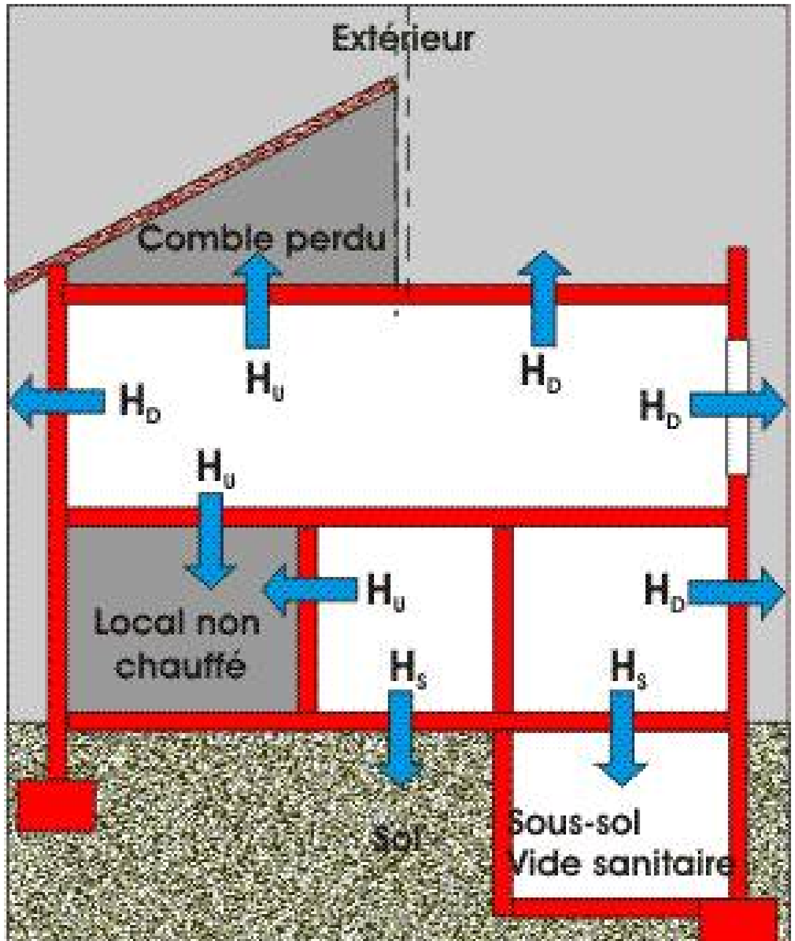
INSULATION : energy loss calculation



- Determine the heated volume
- Calculate the loss of energy going through walls, roof, floors and windows

H : Transfer of Energy = $1/R * A * \Delta t$ (W/m²)

Inertia

- Dynamic behaviour
  - ± rapid transfer of cold/heat from outside to inside
  - Storage of cold/heat in the inside wall
- Model
  - Day / Night
  - Complex mathematical model

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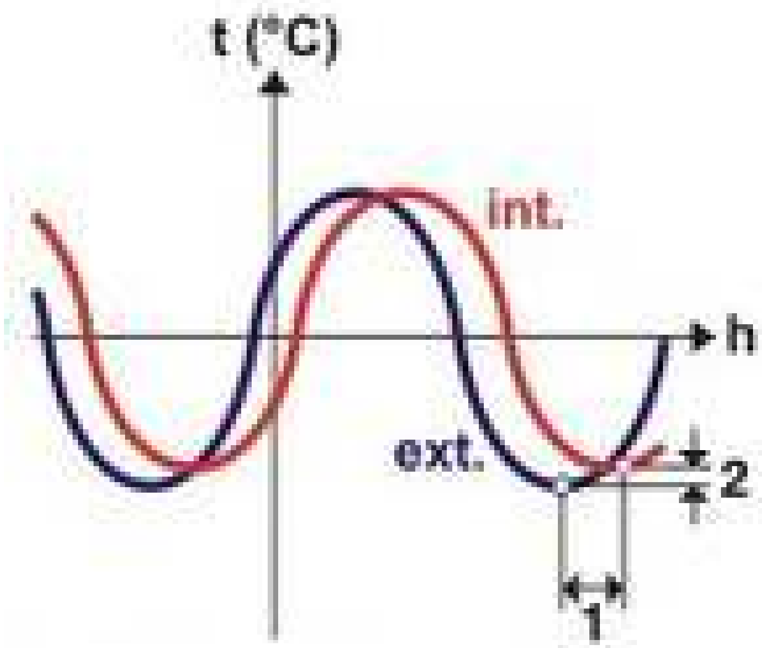
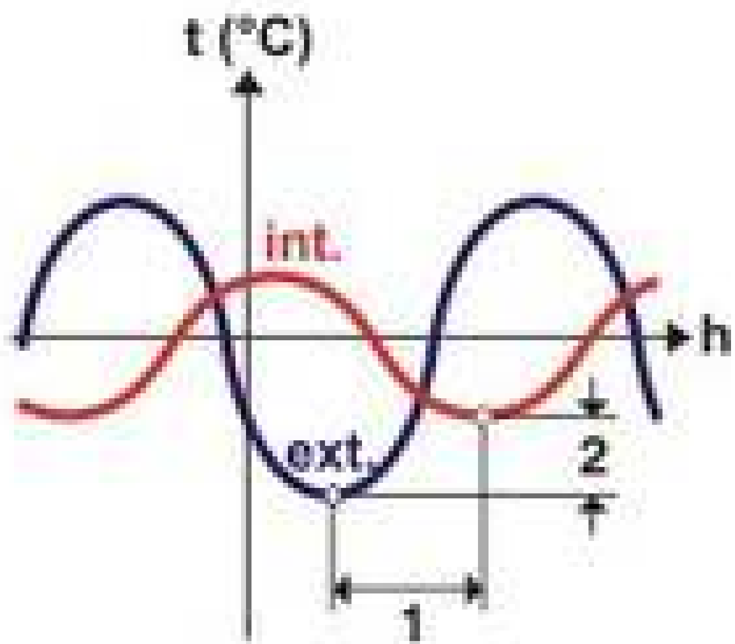
Inertia : thermal delay and damping

- Low inertia



- High inertia



1: Thermal delay
2: Damping

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Inertia : material specification

- Thermal capacity (ex specific heat) C : W/m.°C
  - Capacity to store heat
  - Copper : 380   concrete : 1.75   insulating material wool : 0.04
- Thermal diffusivity = (λ / ρ. C) en m²/s
  - Speed in transmitting heat → thermal delay
  - Concrete : 5 à 8 10^{-7} PSE : 4 à 8 10^{-7} wood: 2 10^{-7}
- Thermal effusivity = $(\lambda.\rho.C)^{1/2}$ en $W.h^{1/2}/m^2.°C$
  - Speed to absorb/ give back heat
  - steel 14 000 ; concrete: 2000 ; wood: 350 ; PSE : 40

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Insulation, Inertia & comfort

- In cold regions
  - Insulation keeps heat inside

    → thick insulation
- In warm region
  - Inertia delays heat peak (thermal delay)
  - Inertia lowers heat peak (damping)

    → inertia + roof insulation + sun protection on walls

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Insulation, Inertia & comfort

- In tempered climate
  - Cold in winter

    → insulation during winter
  - Hot in summer
  - → inertia for summer

- MORE COMPLEX OPTIMISATION

Sustainable building design

1 . SYSTEMIC design
2 . thermal comfort

3 . indoor air quality and comfort
3.1 ventilation

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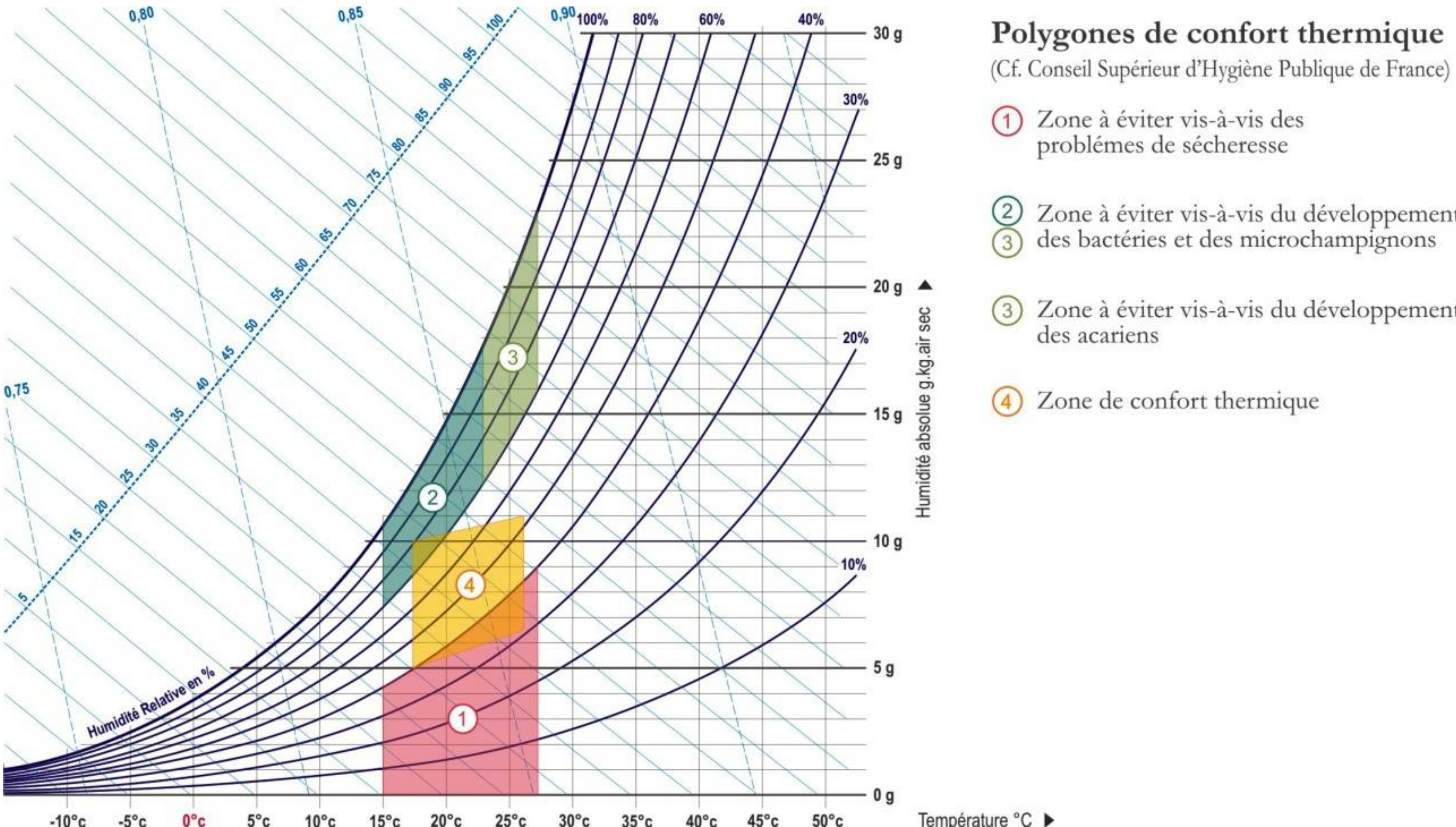
humidity + temperature = Comfort

- Origin of Humidity
  - Inhabitants
  - Cooking
  - Bathroom
  - Capillarity
  - Outside air
- Risks
  - Health
  - Condensation …
- Temperature
  - Inhabitants
  - Use (cooking, electric devices …)
  - Solar energy through windows
  - + Heater

humidity + temperature = Comfort



Indoor Air Quality & comfort

- Origin of bad “Indoor Air Quality”
  - people’s own pollution
    - Water vapour, CO^2, smoke, cleaning agent
  - Building and furniture materials pollution (VOC)
  - Outdoor air pollution
- Air renewal : Ventilation / Aeration
  - Natural : window opening , vertical air duct = chimney
  - Mechanical :
    - simple, humidity-controlled, balanced, decentral balanced,
    - with heat recuperation

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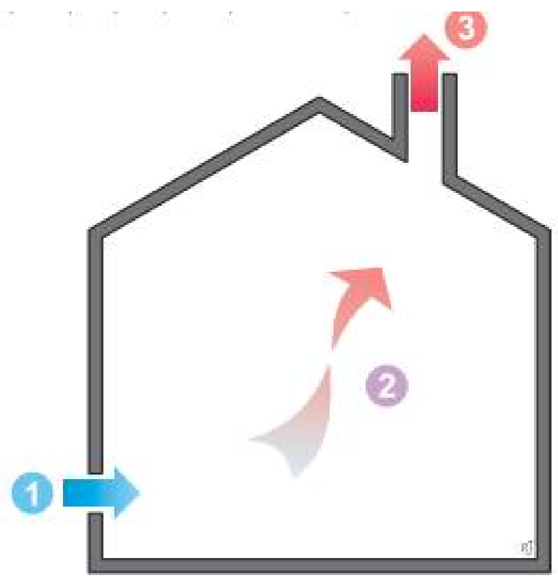
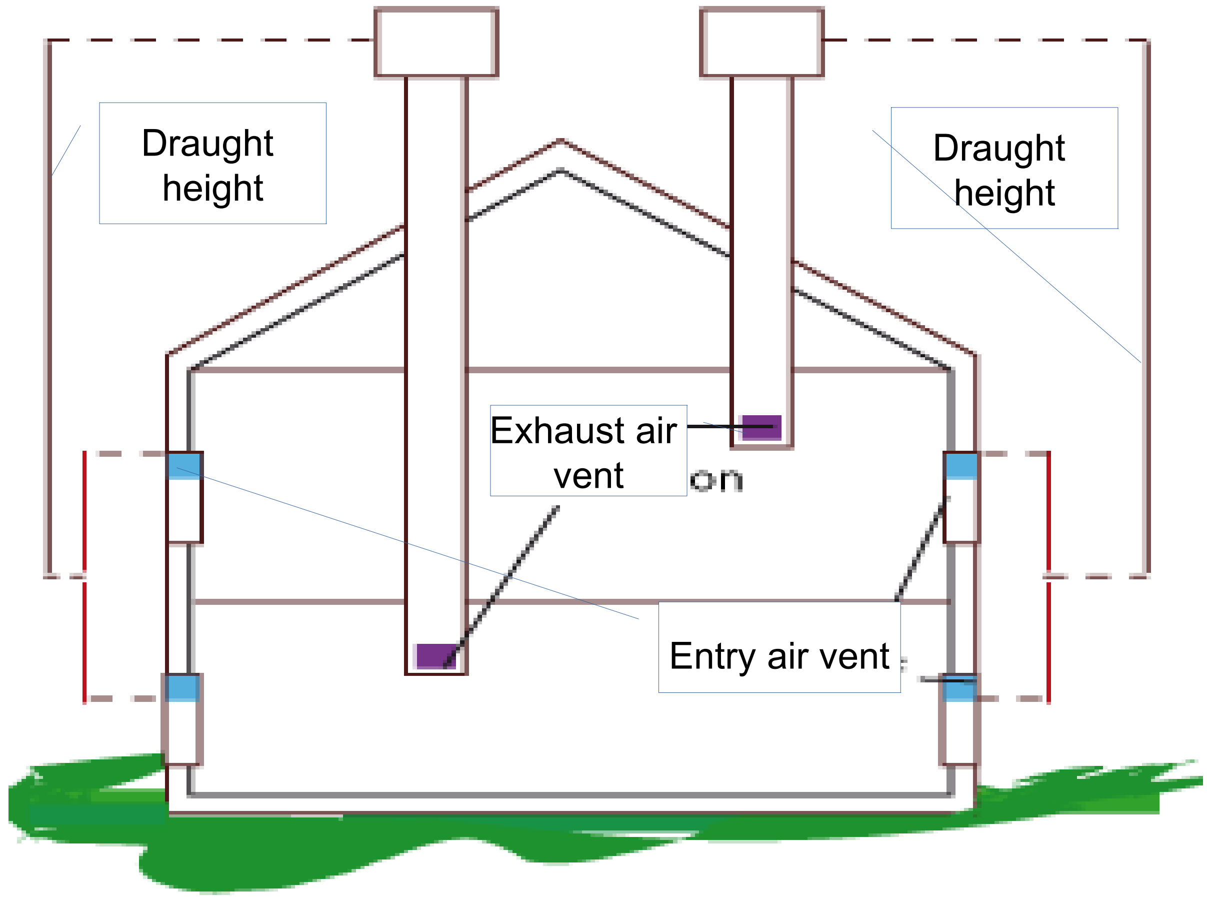
Ventilation

- natural ventilation





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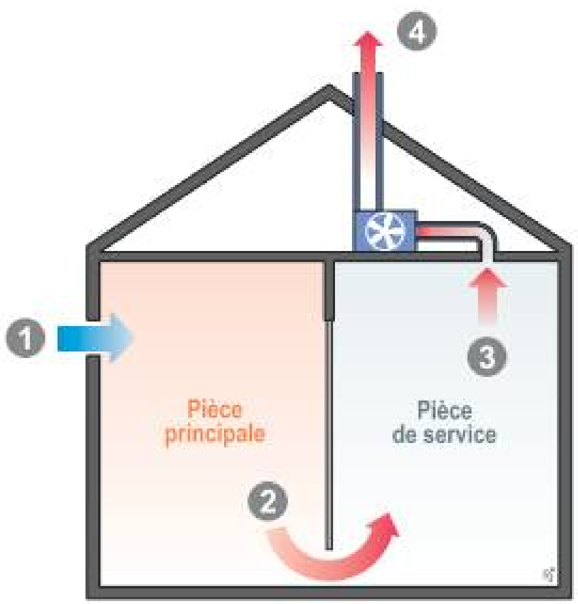
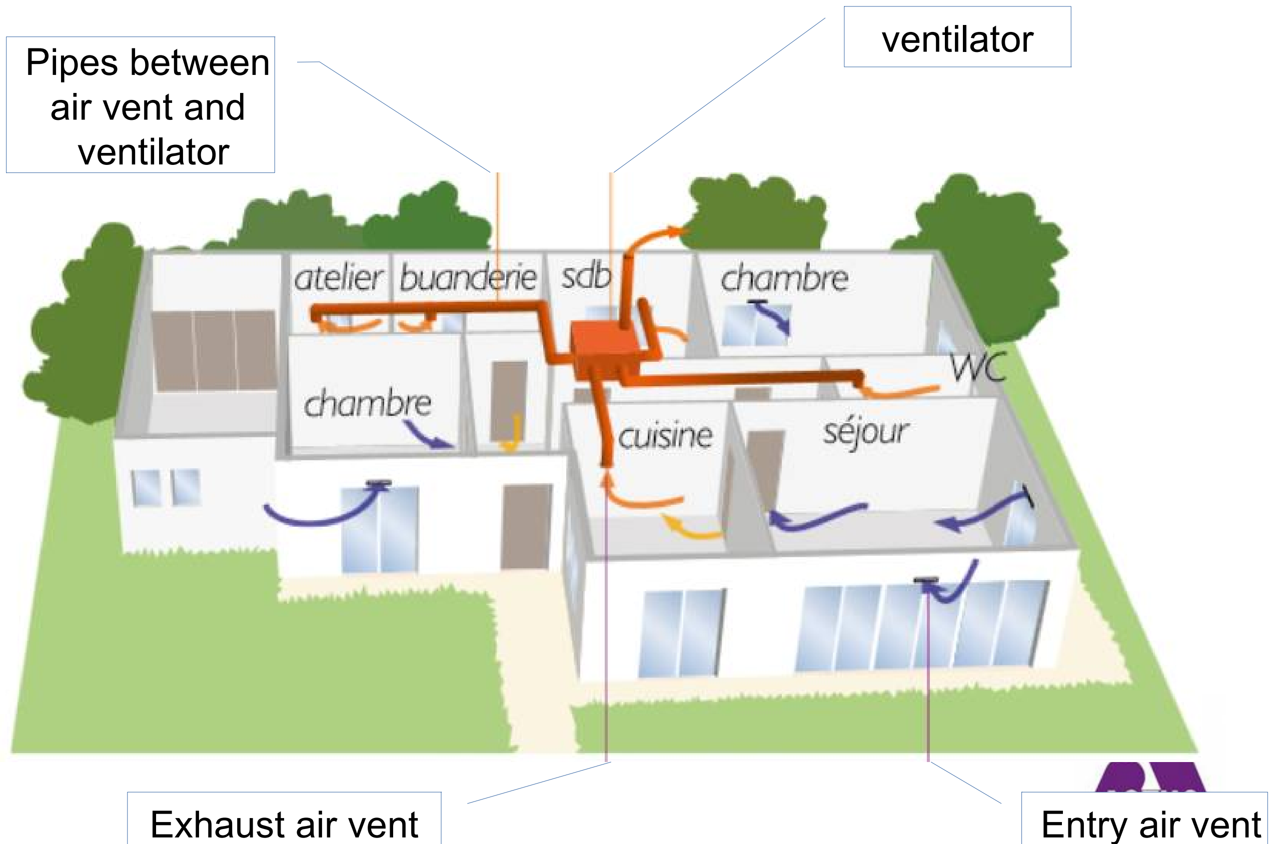
Ventilation

- **Mechanical ventilation**





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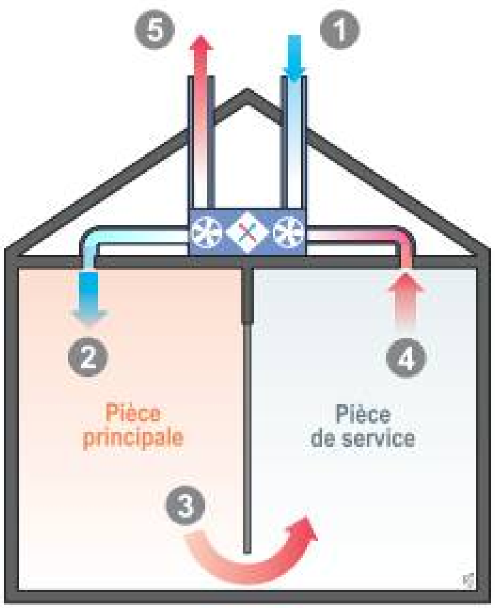
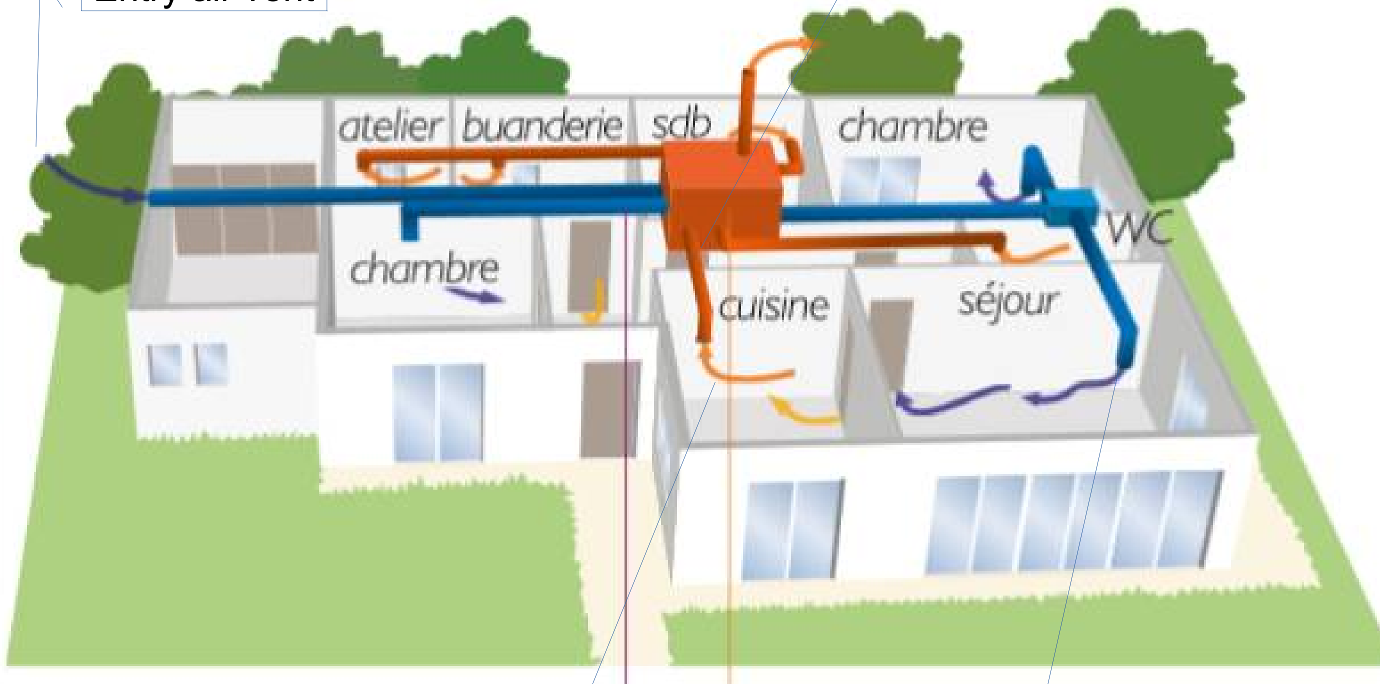
Ventilation

- **Global balanced ventilation**



Entry air vent

Ventilator
with temperature
exchange



Exhaust air vent

INSUFFLATION
Pipes

Ventilation

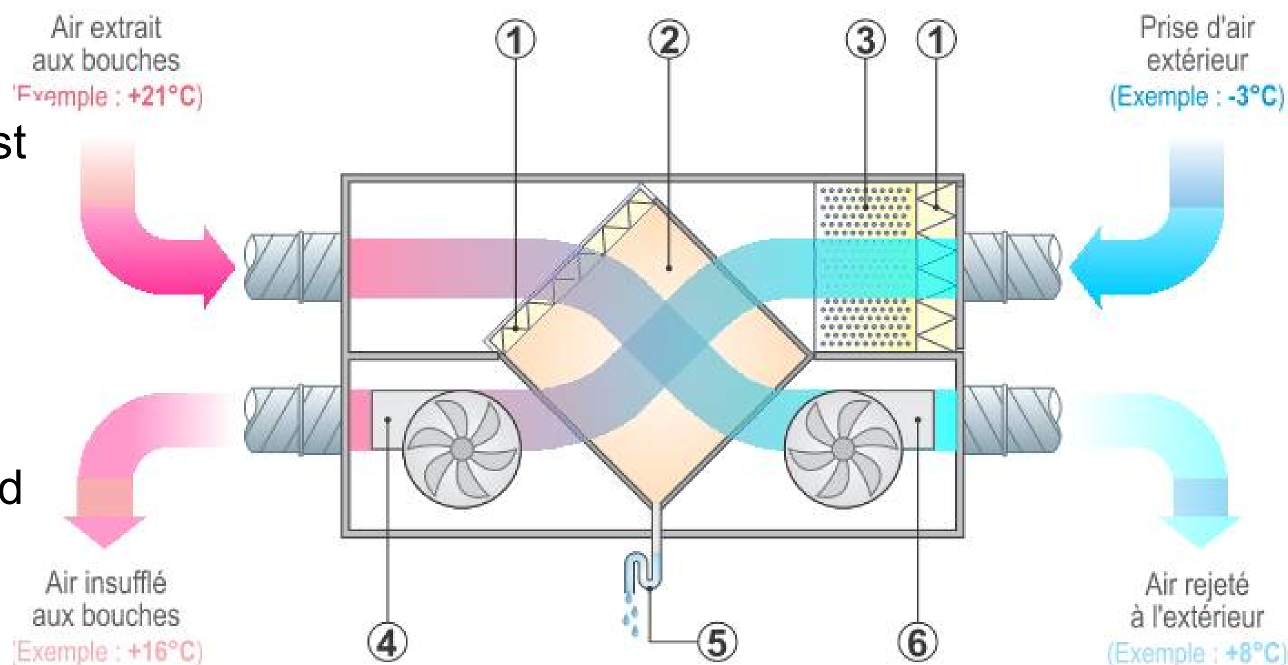
- **Global balanced ventilation : heat exchanger**

Air exhaust

Fresh Air Entry

INSIDE

OUTSIDE



Pre-heated clean air

released air

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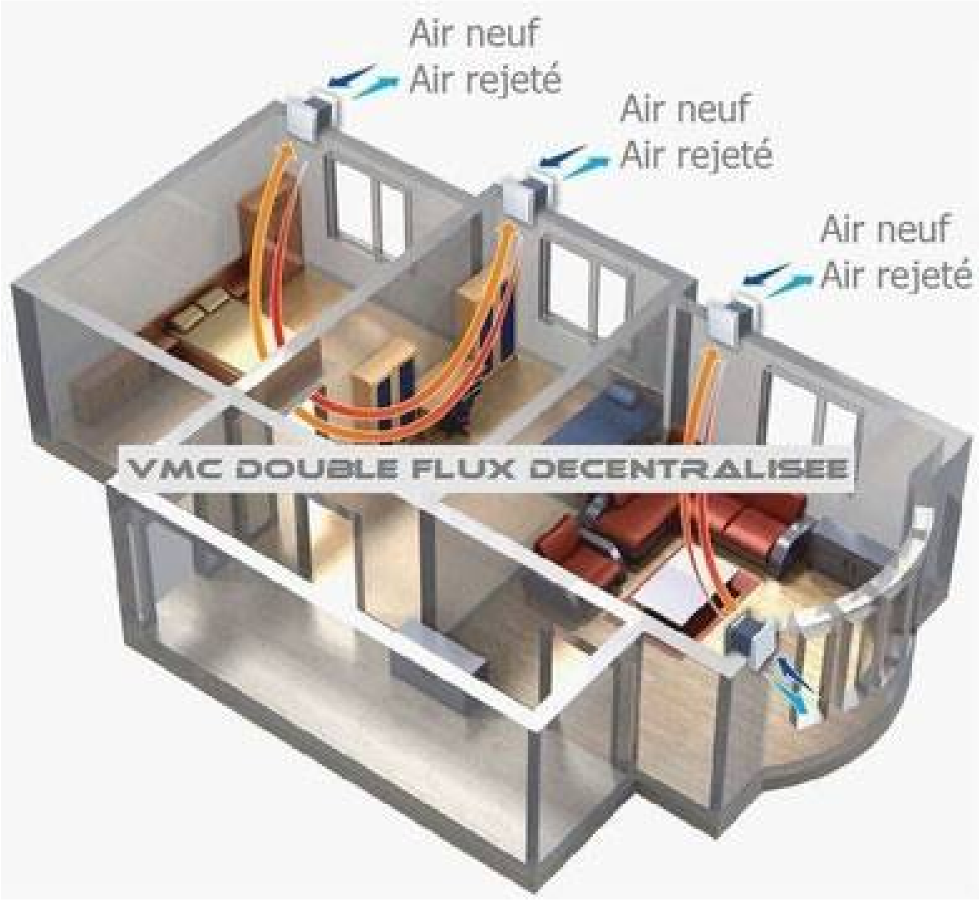
Ventilation

- **Decentral balanced ventilation**



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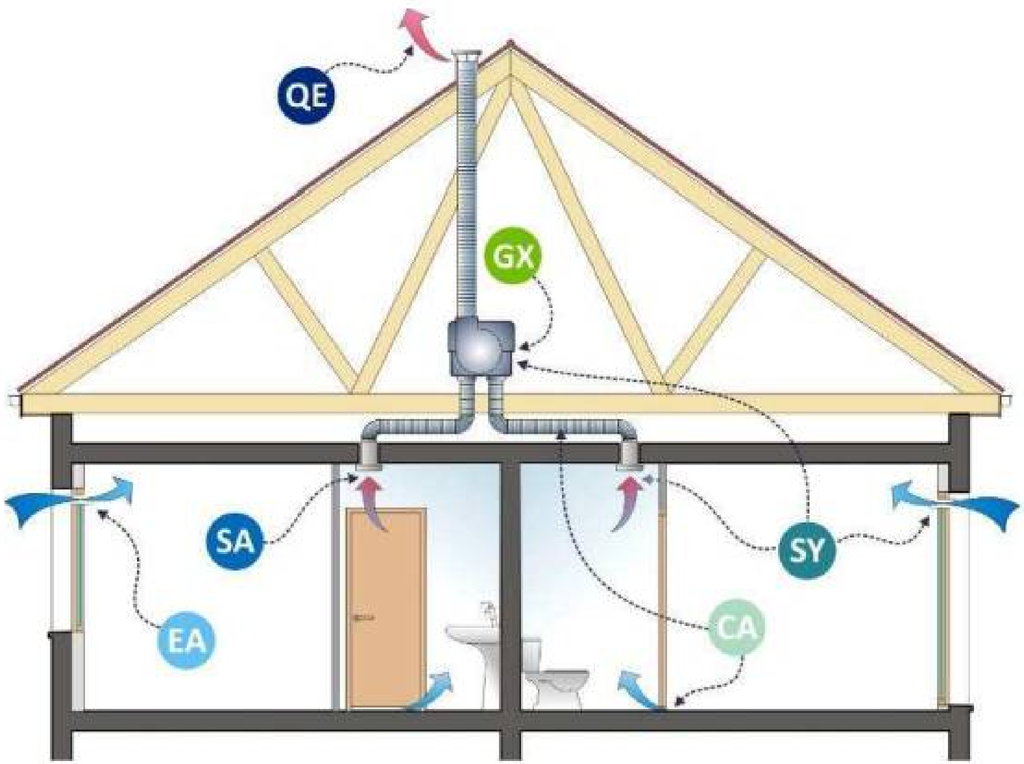
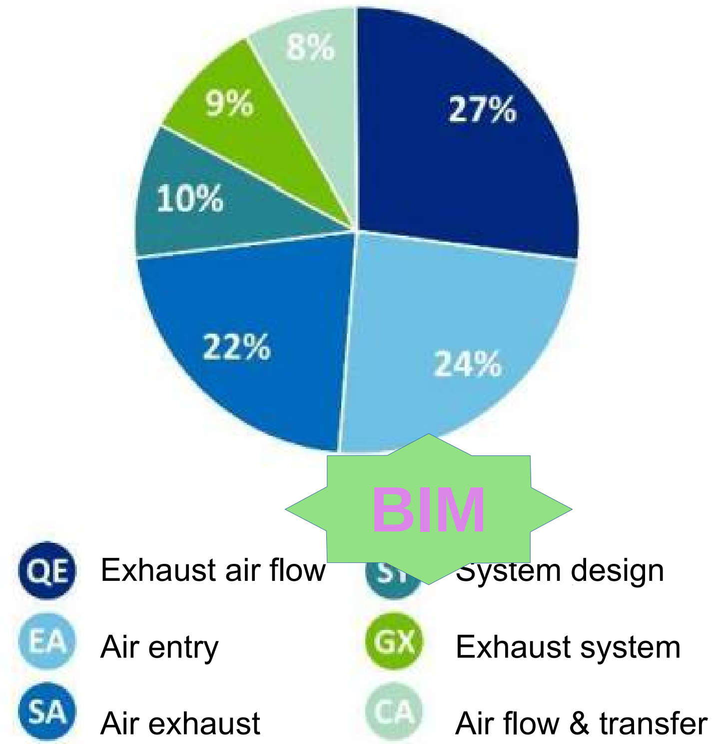
Ventilation

- **Main problems with ventilation system**





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Ventilation

- Many solutions for correct ventilation system
- For example : ventilation pipes
  - "real and formal" design of the whole system
    - Calculation
    - Position of pipes
    - Conflict check with structure
  - Use of rigid pipes
    - Instead of flexible pipe

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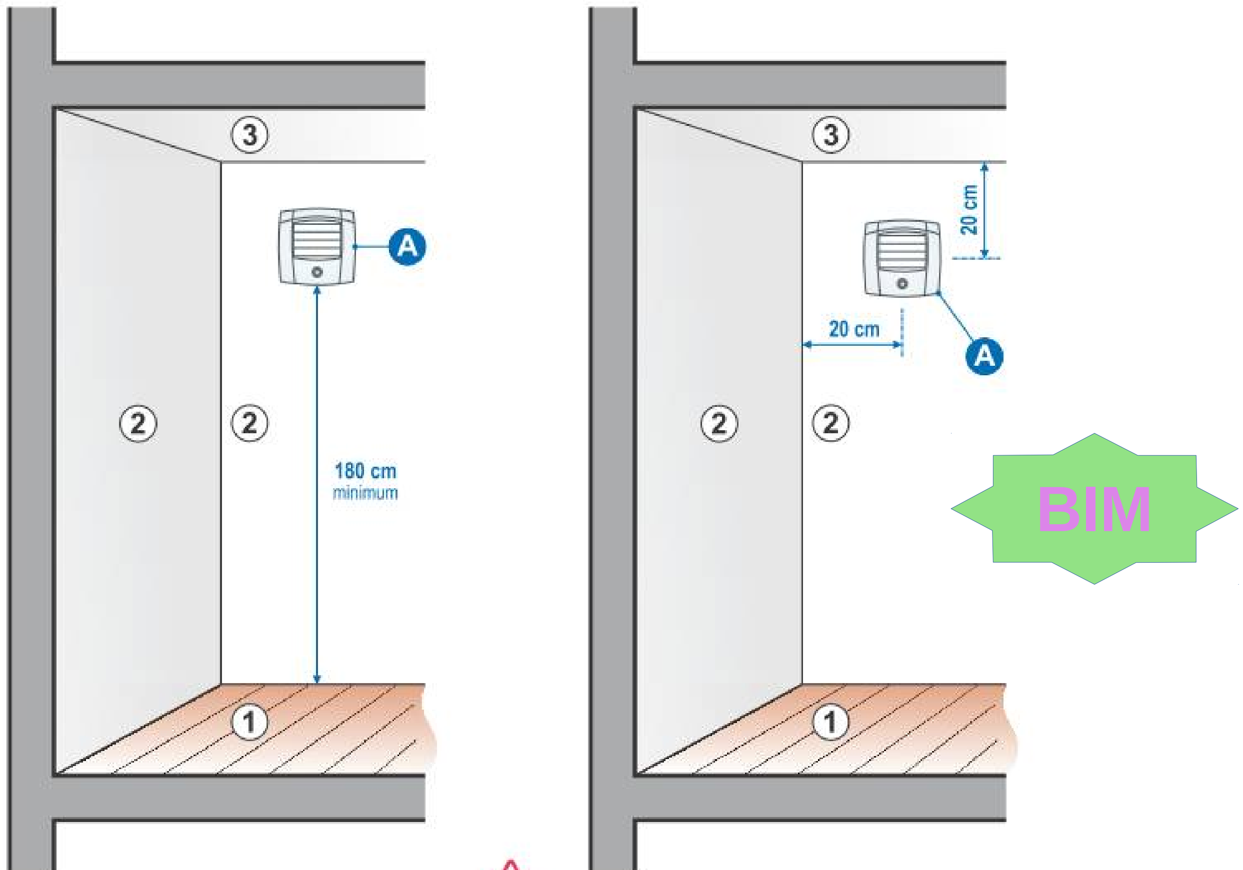
Ventilation

- Exemple : exhaust air vents position



Ventilation

- Quality control of ventilation : principal points
  - Design of the whole system
  - Implementation of the whole system
  - Measurement of the exhaust air flow
    - Flow or pressure
- European norms
  - Transferred in each countries
  - Made explicite

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Ventilation

- European norms
  - EN 14134, only for residential housing
    - Ventilation for buildings : Performance testing and installation checks of residential ventilation systems
    - Released : 01/08/2004, under revision for 01/08/2019
  - EN 16211
    - Ventilation for buildings - Measurement of air flows on site – Methods
    - Released date : sept. 2015
  - EN 15299, idem 14134 , for service and tertiary sector
  - EN 16798-17, only for residential housing
    - Energy performance of buildings - Ventilation for buildings -directive EPBD. Released : 12/08/2017
    - Application of Directive 2010/31/EU on the energy performance of buildings, mainly on “engine”
    - Released : July, 2017

Sustainable building design

1 . SYSTEMIC design

2 . thermal comfort

3 . indoor air quality and comfort

3.2 airtightness

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Airtightness : What ?

- Objective :
  - limit all un- controlled air flow through the heated envelop
- Means :
  - Determine the limit of the heated volume
  - Analyse all components along & across the limit
  - Treat all specific points to keep the envelope airtight

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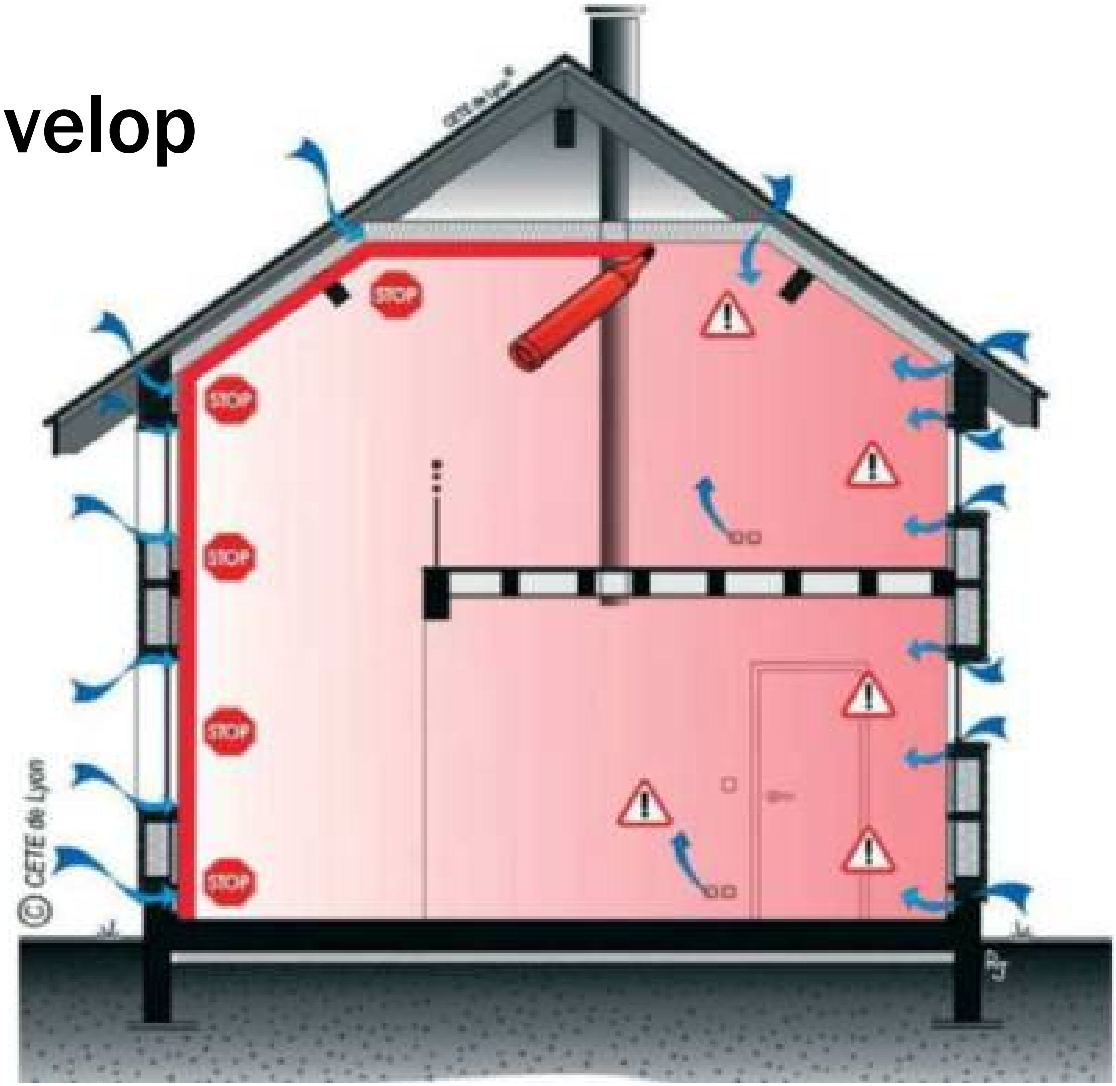
Airtightness : What ?

- **Airtight envelop**



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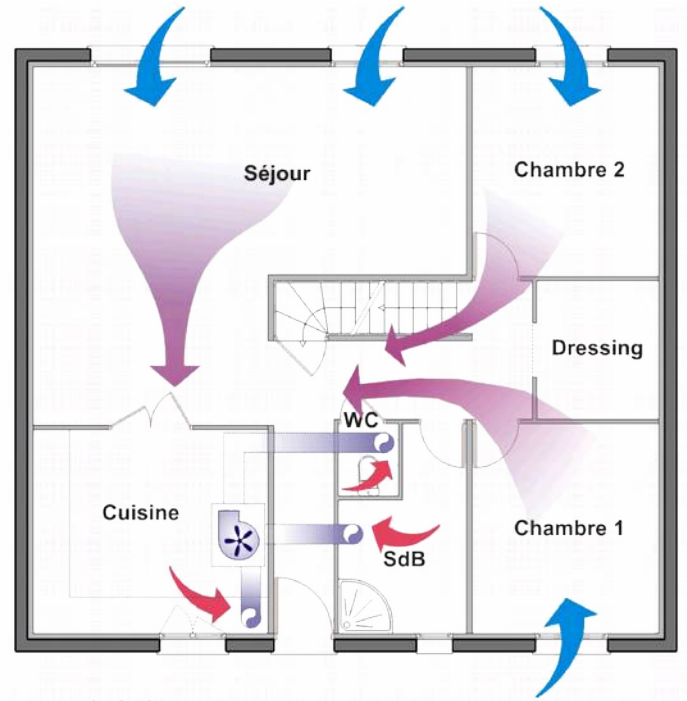
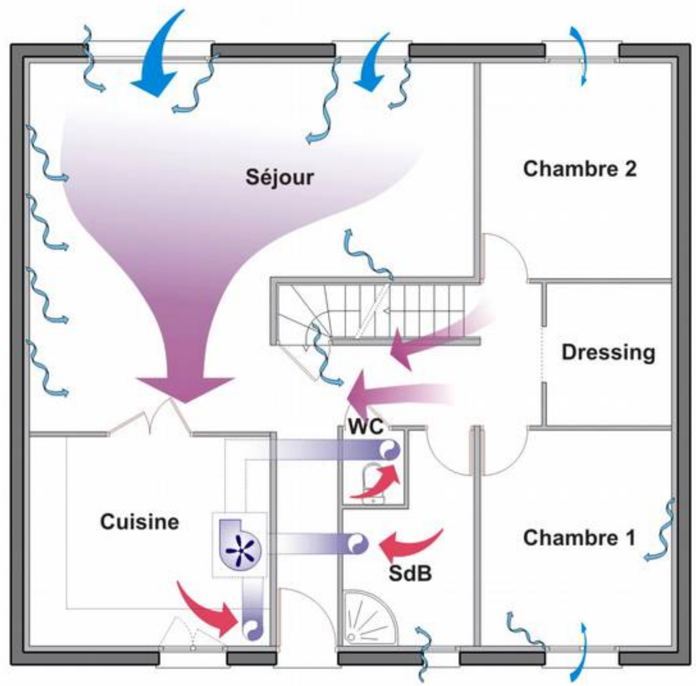
Airtightness : Why ?

- More efficient ventilation





GOOD airtightness

➡ Optimized ventilation

BAD airtightness

➡ Higher airflow in the main room
Low airflow in bedrooms

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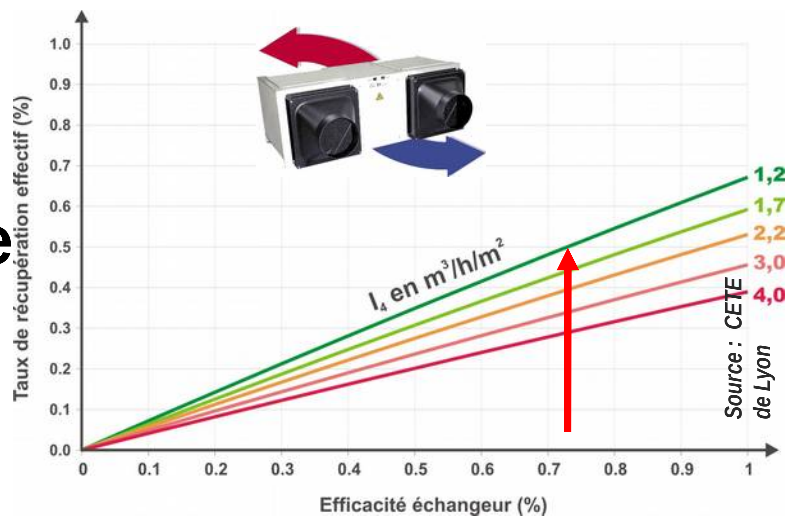
Airtightness : Why ?

- Better energy efficiency
  - The envelop default entails a higher energy consumption

    → 10 à 20 kWh/yr/m²

    = ¼ of NZEB energy consumption !

  - Low airtightness entails a lower energy recovery in balanced heat exchange



Airtightness : Why ?

- Better thermal comfort
  - When cold air enters through cracks
    - Cold draught
    - Sensation of cold wall
    - Change in temperature

Airtightness : Why ?

- Better acoustic comfort
  - If cold air enters through cracks
  - Then .. exterior sounds enter also

Airtightness : Why ?

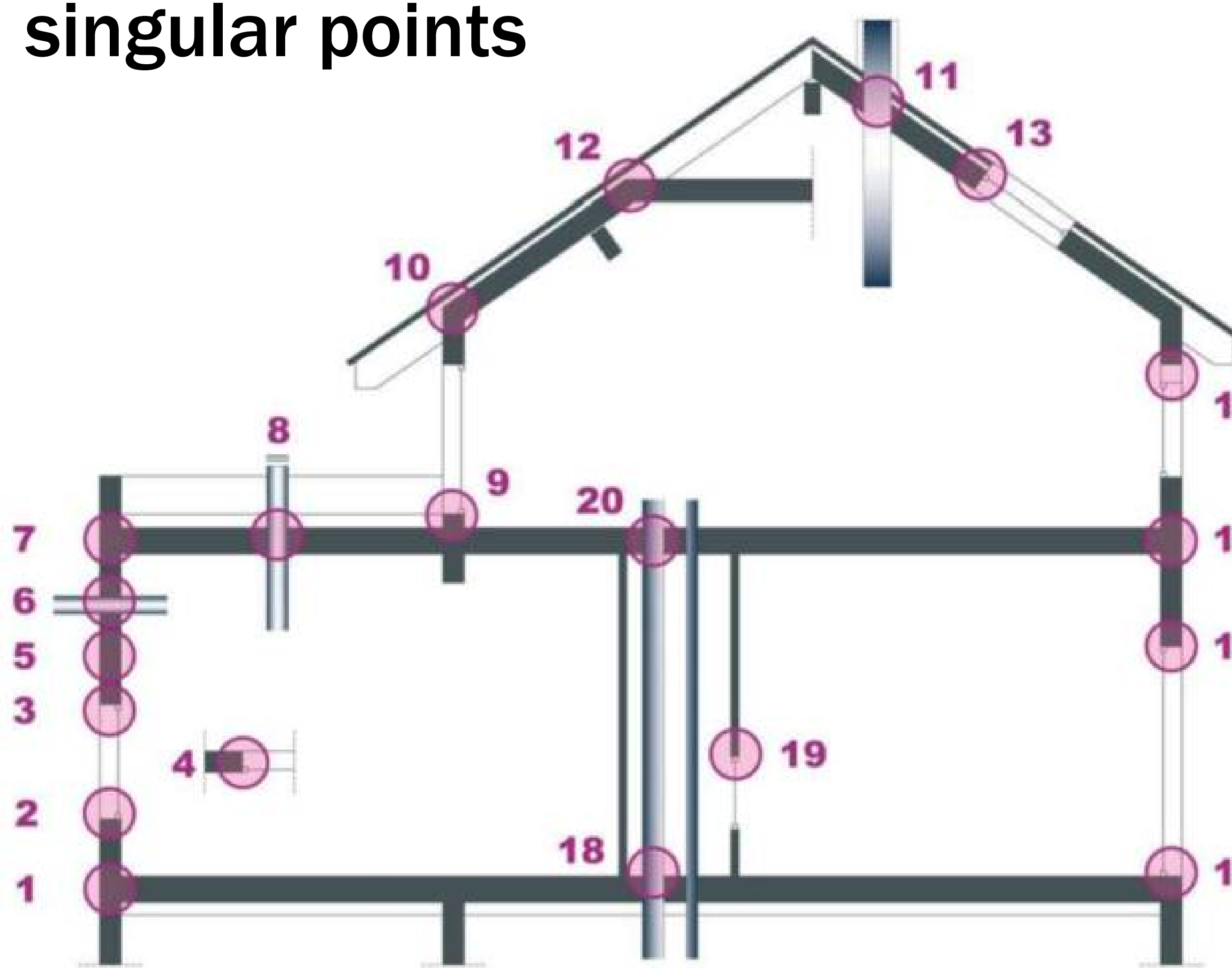
- Better building conservation
  - If interior air gets outside through cracks
    - Air gets colder when crossing the insulating material
    - Usually, interior air is loaded with humidity
  - Then RISK of CONDENSATION that entails :
    - Wet insulating material
    - Loss of thermal characteristics
    - Mould development
    - Black stains
    - Steel corrosion

Airtightness : Why ?

- Confinement in case of chemical hazard
  - Seveso like industrial plants
  - Confinement + close all entry vents
    = no polluted/dangerous exterior air infiltration in the building

Airtightness : how ?

- Check all singular points



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Airtightness : how ?

- Main singular points : design and documentation
  - Concrete (or similar) block wall
    - Plaster rendering
  - Wooden structure + insulating material
    - Airtightness membrane
  - Joining (windows and door)
    - Lasting, adapted and non-shrinkable seal

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  - Pipe sheath (electricity, water, air, ...)
    - Adapted treatment

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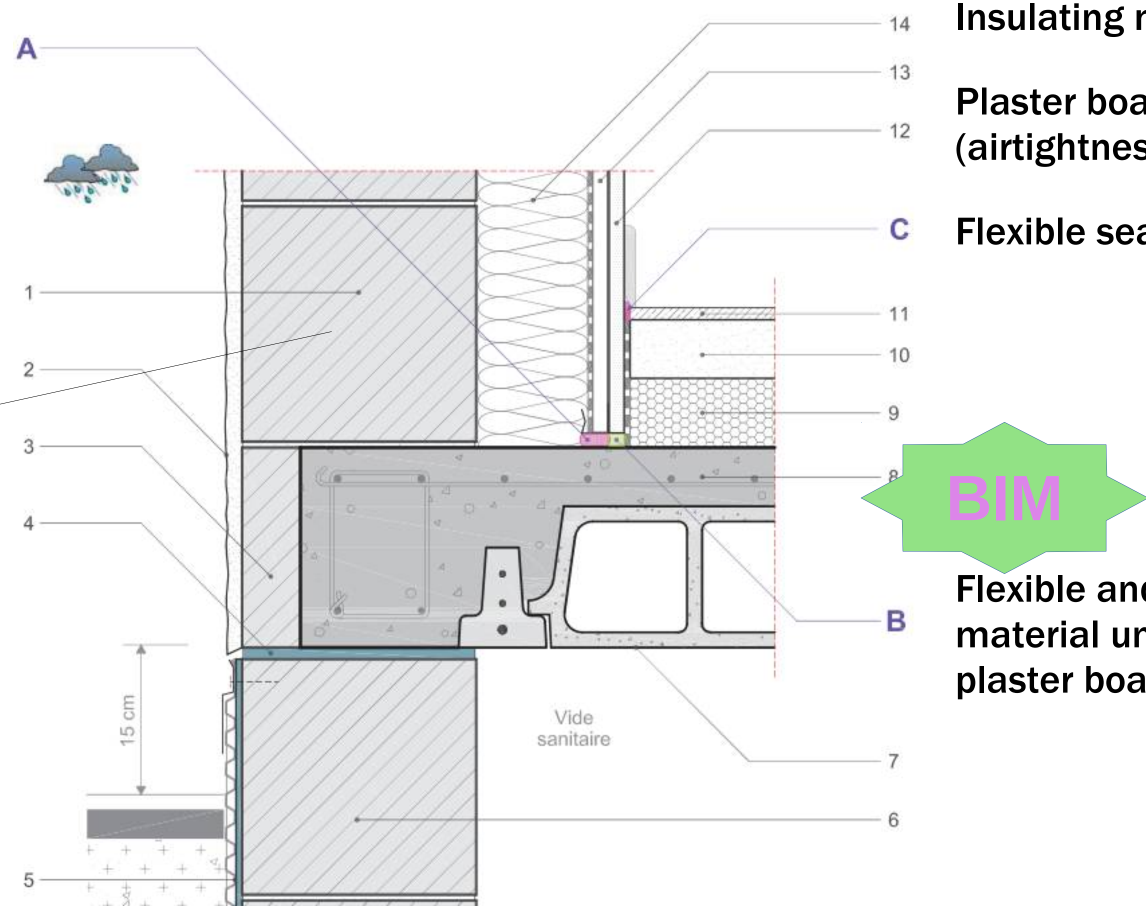
Airtightness : how ?

- ex. 1 : concrete block and interior insulation

Airtightness is mainly fixed with a double layer of foam rubber placed under the lower metal ribband of the plaster board support

Masonry block



Insulating material

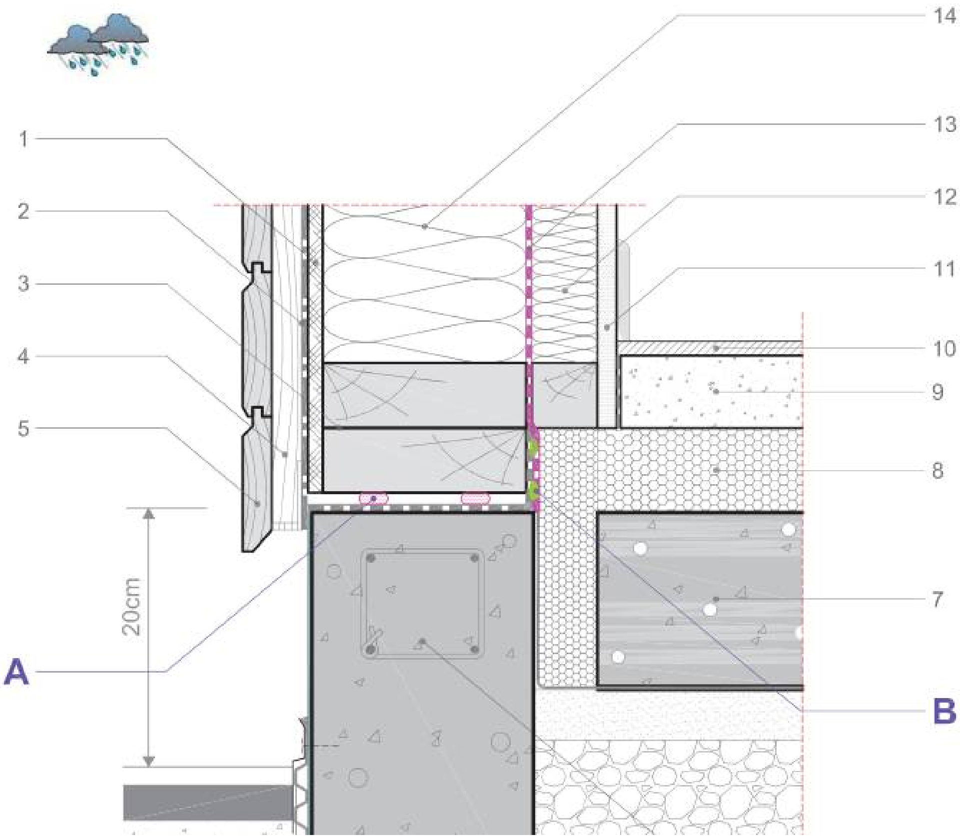
Plaster board (airtightness)

Flexible seal

Flexible and insulating material under the plaster board

Airtightness : how ?

- ex. 2 : wooden structure



Insulating material

Continuous airtight and vapour-barrier membrane

Rain barrier

Airtightness is fixed with a double layer of foam rubber placed under the lower wooden ribband of the structure

Perfect gluing of the vapour barrier on the insulating material or on the slab

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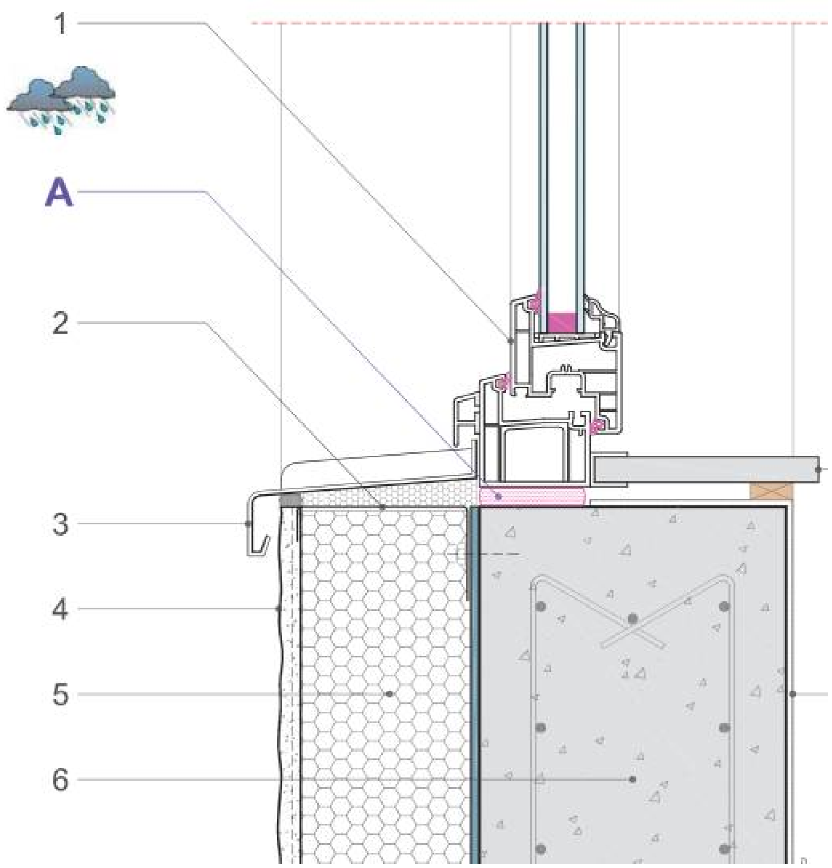
Airtightness : how ?

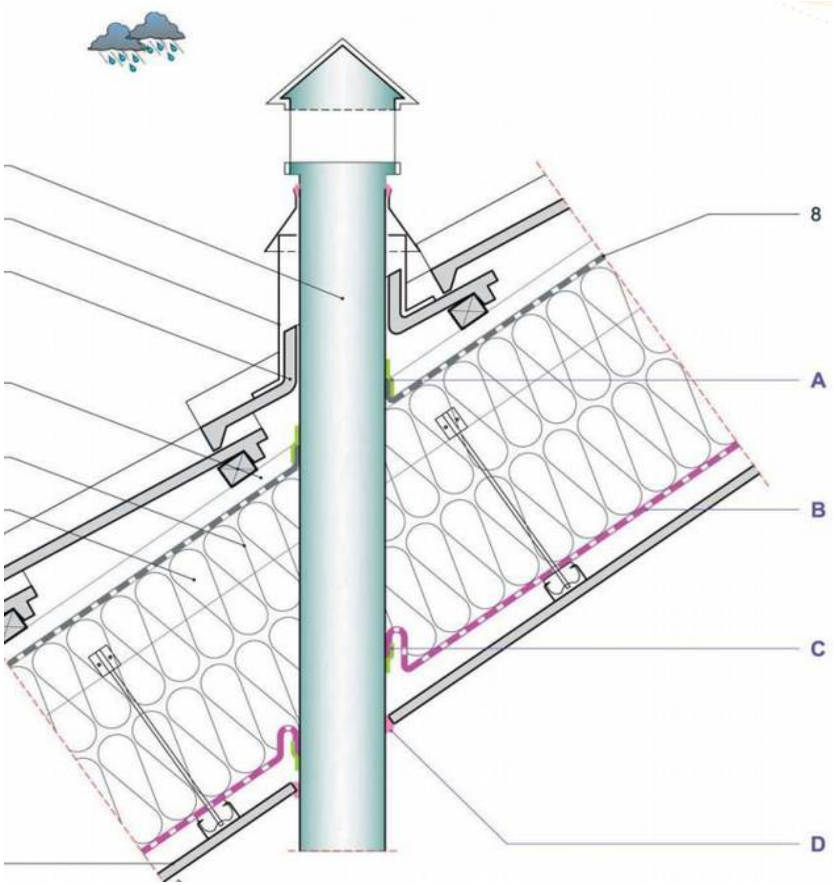
- ex. 3 : windows

Airtightness is fixed with a double layer of pre-compressed foam rubber, placed around the window structure



Airtightness : how ?

- ex. 4 : ventilation exhaust air pipe



Protection screen over Insulating material

Protection screen must be carefully scotch taped around the pipe

Continuous airtight and vapour-barrier membrane

Vapour barrier must be perfectly scotch taped on the pipe

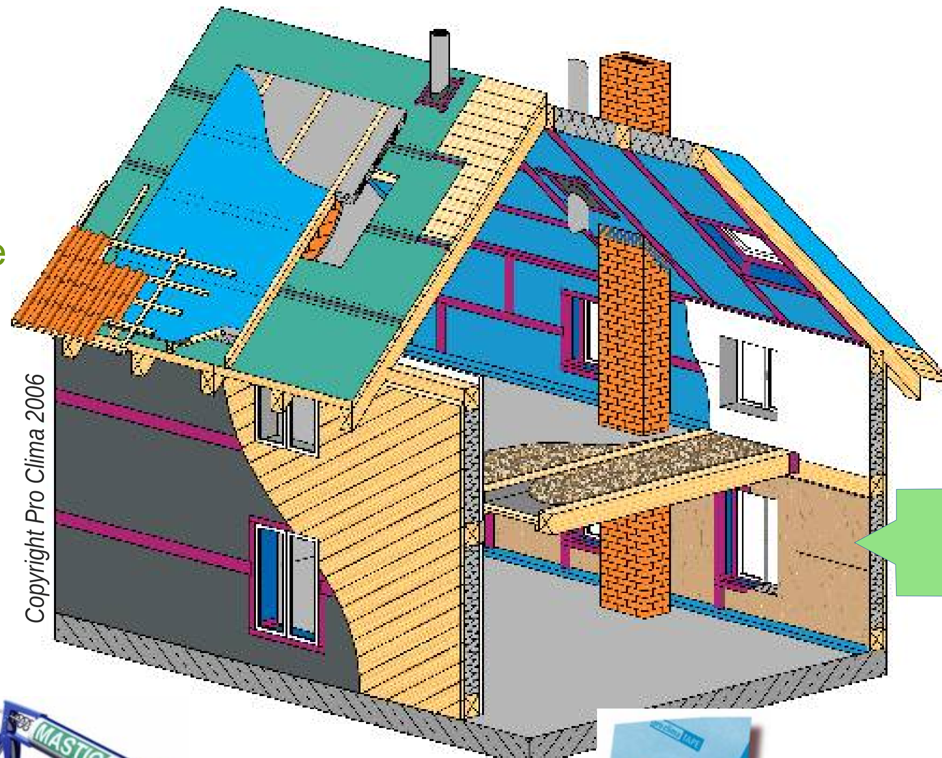
Plastic flexible seal

Airtightness : how ?

- **Airtightness materials**

connecting sleeve

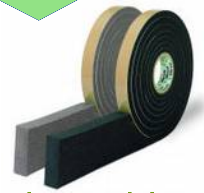
membrane



Airtightness tape

Expandable foam

BIM



Joining rubber foam

Mastics & Glue

Cable tapering sleeve

BIMplement

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Airtightness measurement

- **blower door (**individual housing & multi-residential
  b

(1 ventilator)
Volume < 2000 m^3

(2 ou 3 ventilators)
Volume < 4000 ou 6000 m^3

BIMplement

ASTUS CONSTRUCTION

Airtightness measurement

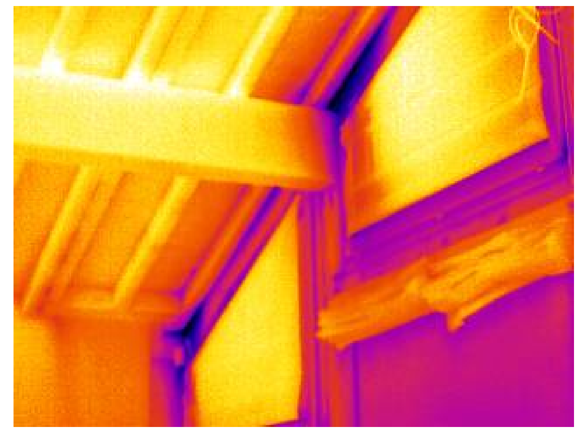
- **blower door (large buildings)**

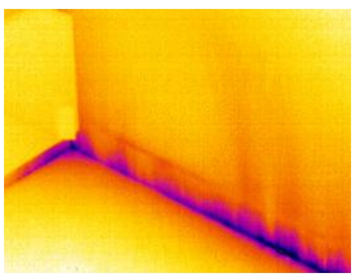
Volume < 18 000 m³

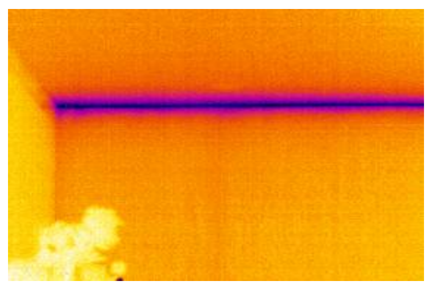
Volume < 75 000 m³

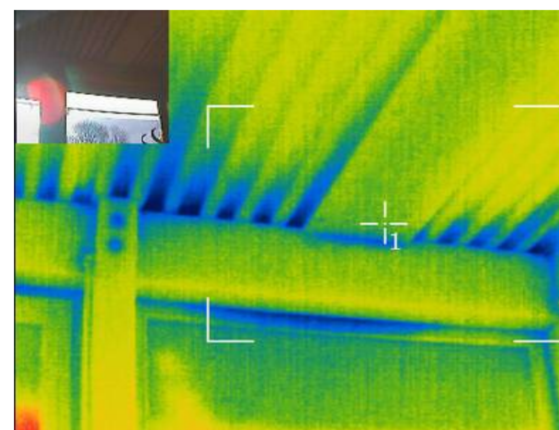
Airtightness measurement

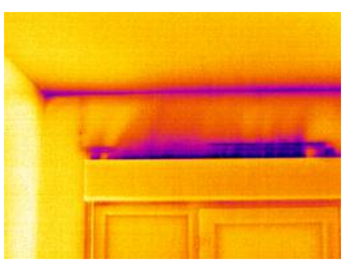
- Leak position (smoke or thermal video)
  - Interface wall-floor-roof

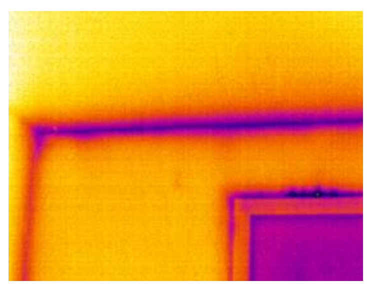








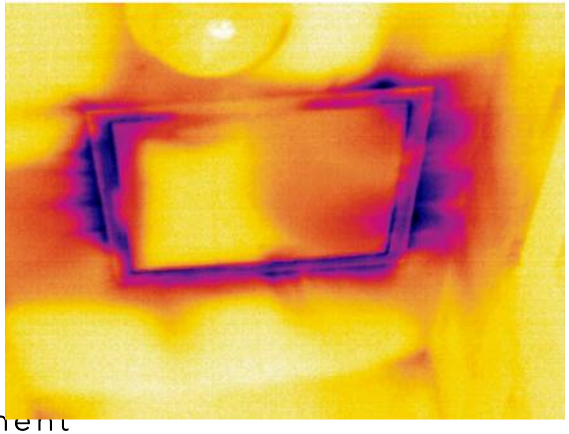
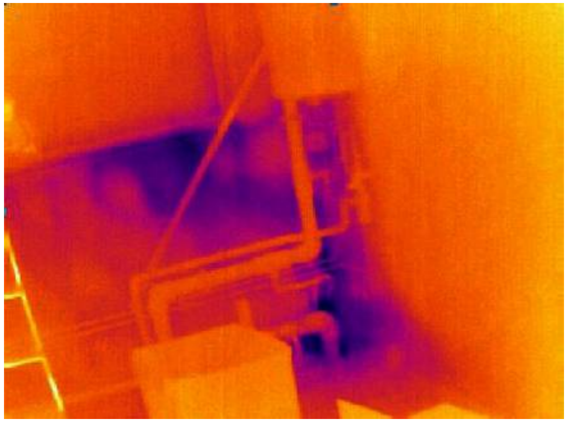




Airtightness measurement

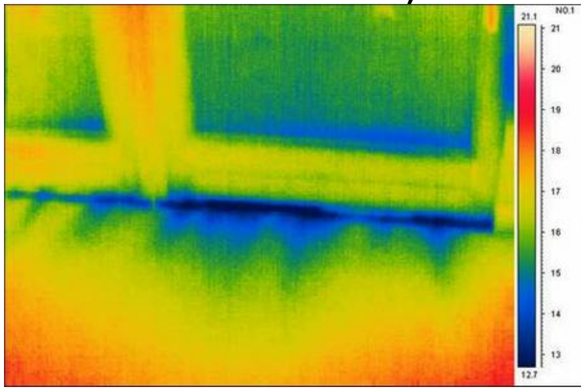
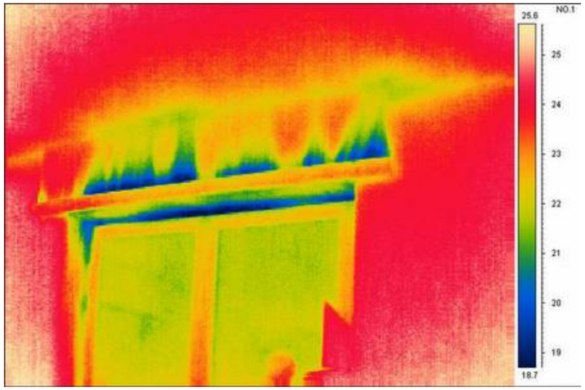
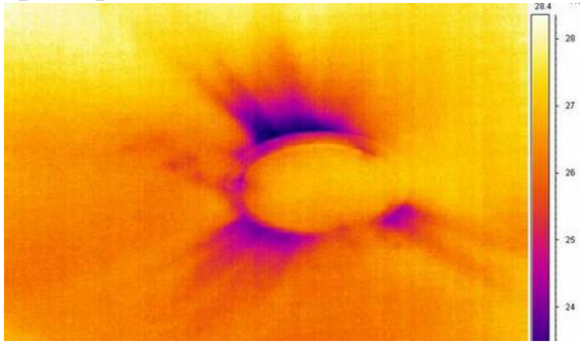
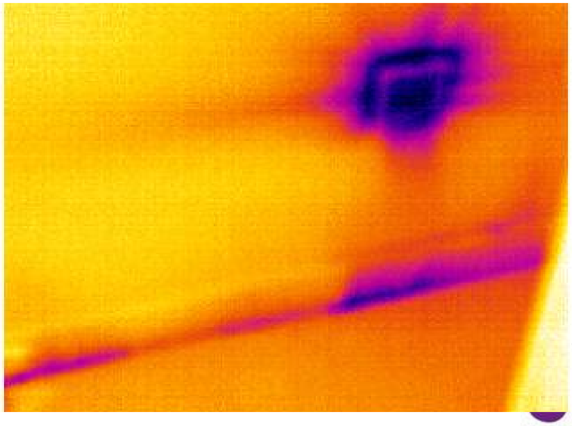
- Leak position (smoke or thermal video)
  - Pipes, electric network …



Airtightness measurement

- Leak position (smoke or thermal video)
  - Window frame,   electrical equipment …

Source photo: SARL Alsatech

Airtightness measurement

- Results of the test
  - Locate the leaks positions
  - Measure air leakage under a Pressure of 50pa
  - n_{50}, volume (heated volume of the building) /hour
    - Bad airtightness : n_{50}, 6 à 8 volume/hour
    - Good airtightness : n_{50}, 2 à 3 volume/hour
    - Passive Haus label : n_{50}, < 0,6 volume/hour

BIMplement

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Airtightness measurement

- Results of the test … in France
  - Measure air leakage under a Pressure of 4pa
  - Q_{4pa}Surf, leakage per m² (area of the heated vol.)
    - Bad airtightness : $Q_{4pa}S = 2$ (m³/hr/m²)
      - n_{50}, 6 à 8 volume/hour
    - Good airtightness : $Q_{4pa}S = 0{,}6$ (m³/hr/m²)
      - n_{50}, 2 à 3 volume/hour
    - Passive Haus label : $Q_{4pa}S = 0{,}2$ (m³/hr/m²)
      - n_{50}, < 0,6 volume/hour

    (value for housing → 300m²)

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Airtightness measurement

- **Comparison for a 100m² house**

RT 2012

Passiv-Haus

Exigence RT 2012
211 cm²

$Q_{4Pa\ surf}$ = 0,60 m3/h/m²

n_{50} = 2,5 vol/hr

$Q_{4Pa\ surf}$ = 0,16 m3/h/m²

N_{50} = 1,2 vol/hr

Valeur réglementaire :
200 000 constructions/an

label : 1 000 constructions/an

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Airtightness : norms

- European norms
  - EN ISO 9972, released in 2015
  - for the measurement of the air permeability of buildings or parts of buildings in the field.
  - describes the measurement of the resulting air flow rates over a range of indoor-outdoor static pressure differences.

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Airtightness : Conclusion

- Airtightness : a very good indicator of building quality
  - Construction durability
  - user's comfort
  - Impact on IAQ and health
- Client's responsibility
  - Project specification
  - On-site follow-up
  - Maintenance
- User' information

BIM

Sustainable building design

4. stakeholders and *global* approach

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Numerous Stakeholders and Global approach

- Urbanist
- Architect
- Engineer
  - Load bearing
  - Energy-Environment
  - Air quality - Health
- Contractors/Trades
- Industrials
- Inhabitants

→ Urban planning

→ General design

→ Calculation

→Structure

→Heating, Cooling,

→Ventilation

→ Building skills

→ Products

→ End Users & Maintenance

BIMplement

Numerous Stakeholders and Global approach : **from design to realisation**

- Sketch level
  - Owner → specify needs and quality control
  - Architect + structure and energy engineers
- Detailed or Preliminary design
  - Idem + industrials and general contractors
- Construction step → Different trades ?
  - Idem + Project manager and (lots of type) builders
    - opposition or collaboration ?
    - Quality control ? skills improvement ?

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Numerous Stakeholders and Global approach : **Use and operating**

- Inhabitants
  - Understand the building management
  - Manage use and system optimisation
- Facility manager/ Real estate
  - Maintenance & Building automation
  - Energy efficiency follow-up
- Retrofitting and energy improvement
  - ... that entails changes in building behaviour
  - Among which : vapour transfers

BIM

– BIM element

As a FIRST conclusion sustainable construction requires :

- Systemic design : optimisation
  - A building is complex system
  - Maximise one parameter entails lowering another one !
- Global realisation : Cooperation between
  - Owner, architects, engineers
  - Project manager & construction companies
- Take users/inhabitants into account

Sustainable building design

5. … and NZEB buildings

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nZEB / NZEB definition

net-Zero Energy Building (nZEB – EU definition)

→ zero net energy consumption :

the <u>total amount</u> of energy
used by the building on an annual basis

≈ amount of renewable energy
<u>created on the site</u>

NZEB definition

Nearly Zero Energy Building

→ the very low amount of PRIMARY energy required should,
to a very significant extent,
be covered by energy from renewable sources, including
renewable energy produced on-site or nearby

NZEB construction

NZEB Energy ?

- Calculation includes
  - heating, domestic hot water, cooling,
  - ventilation and ≈ lighting
- TOTAL Energy
  - Consumption evaluated in <u>primary energy</u>
  - Limited to <u>in-use activity</u>
  - <u>No embedded energy</u>

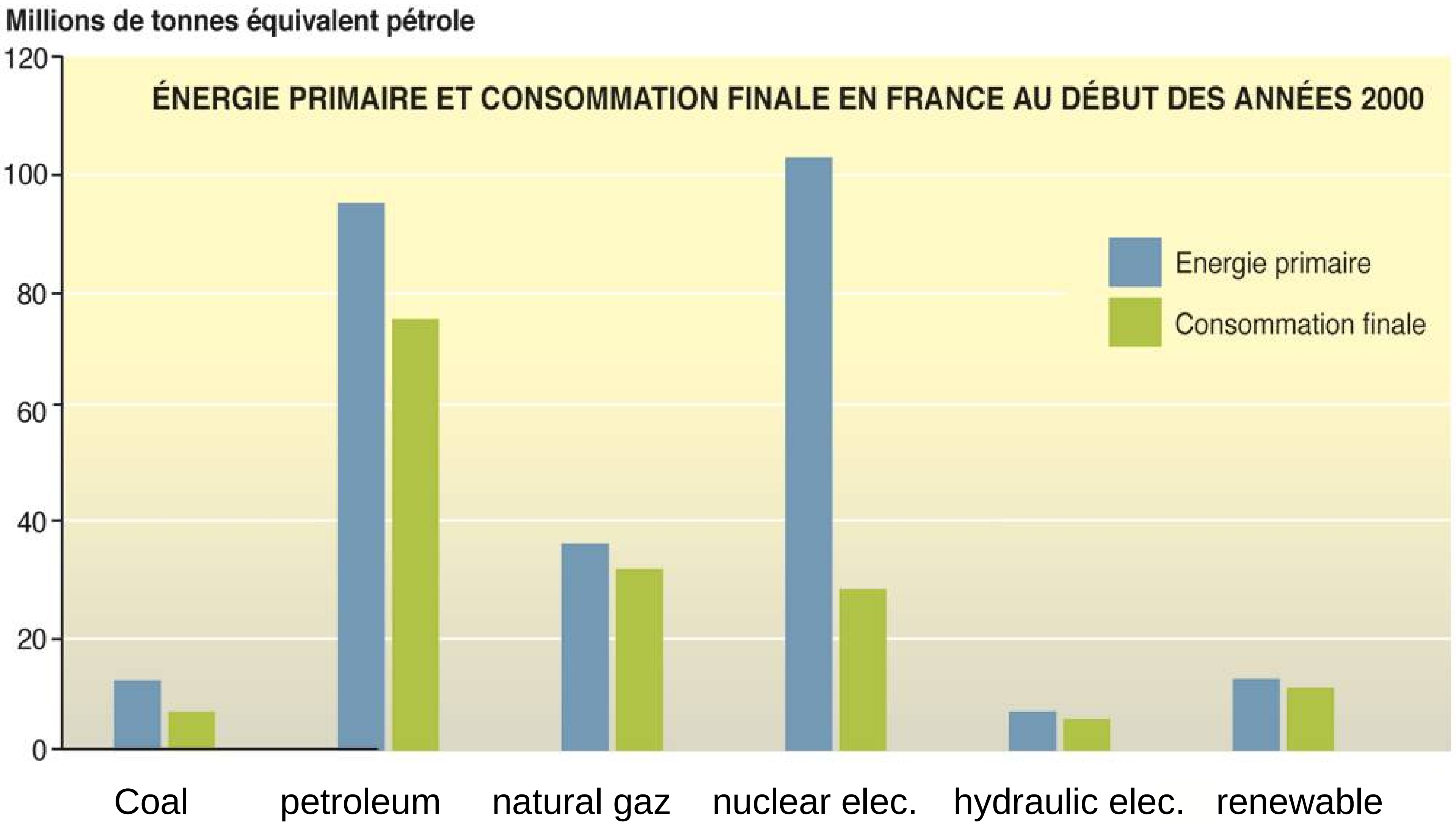
NZEB construction

Energy definitions :

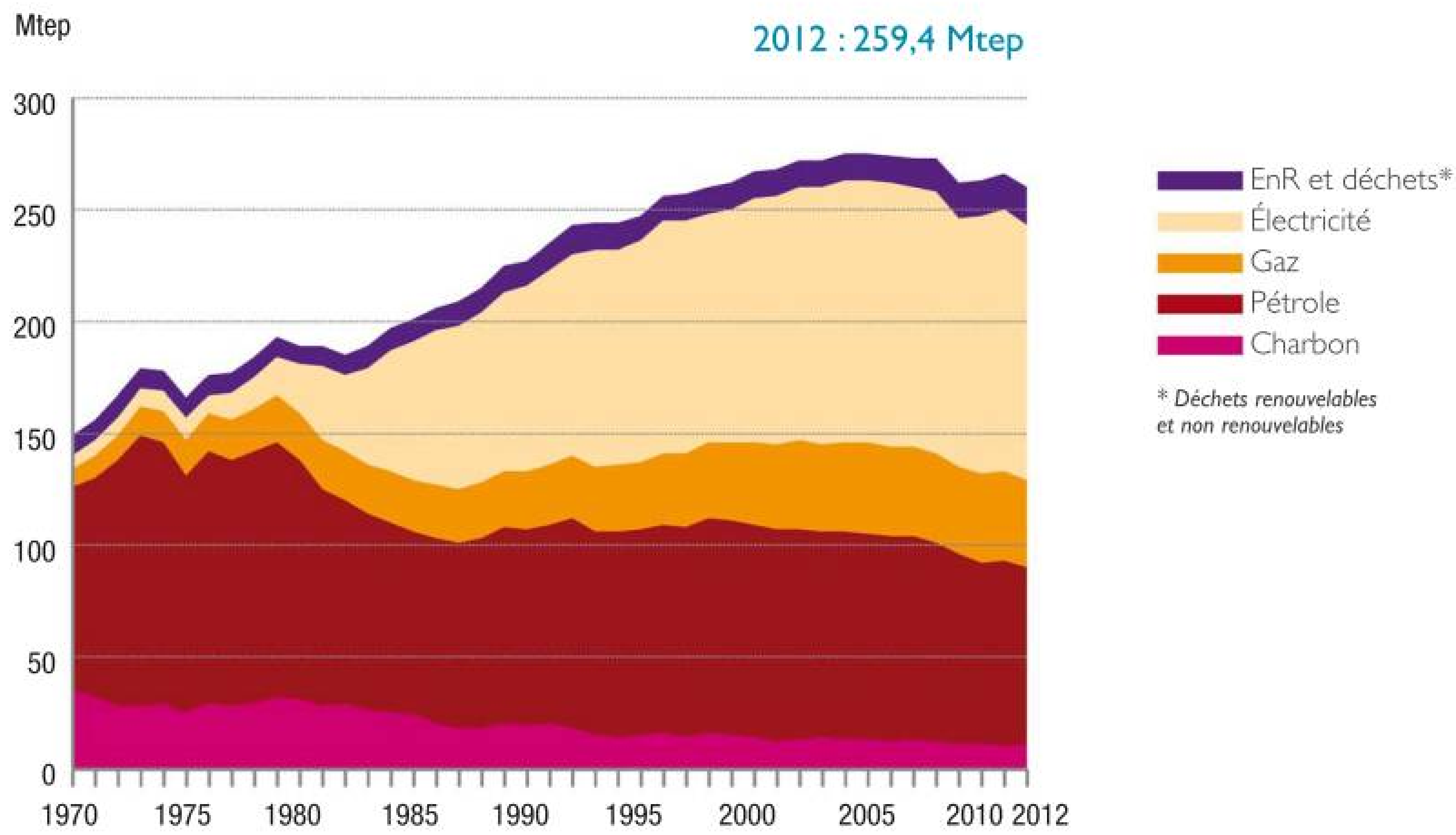
- PRIMARY energy : includes
  - Energy industrial manufacture
  - Energy transportation loss
  - Minimum loss with fuel and gaz
- FINAL energy : paid by the user (→ energy efficiency of gaz- or electrical devices)

In France, 1kWh final energy = 2,53 electric primary energy

Primary and final energy



Primary energy consumption in FRANCE



Source : MEDDE/SOeS - « Bilan énergétique de la France 2012 » - Juillet 2013
Données corrigées du climat

NZEB construction

Energy definitions :

- EFFICIENT energy : envelop energy loss (heat, ventilation, ...)
- EMBEDDED energy : total energy needed for
  - Production, manufacture of building material and devices during construction
  - Energy used during functionning of the building
  - Energy needed to deconstruct and recycle all materials and devices (end-of life)

NZEB definition

Right now, european countries regulation are based on **Nearly** Zero Energy Building

→ the very low amount of PRIMARY energy required should,
to a <u>very significant extent</u>,
be covered by energy from renewable sources, including
<u>renewable energy produced on-site or nearby</u>

NZEB definition

Nearly Zero Energy Building

→ **the NZEB concept :**
very flexible definition
no single, harmonised, NZEB definition throughout the EU

→ **Member States are responsible to define it in their national plans**

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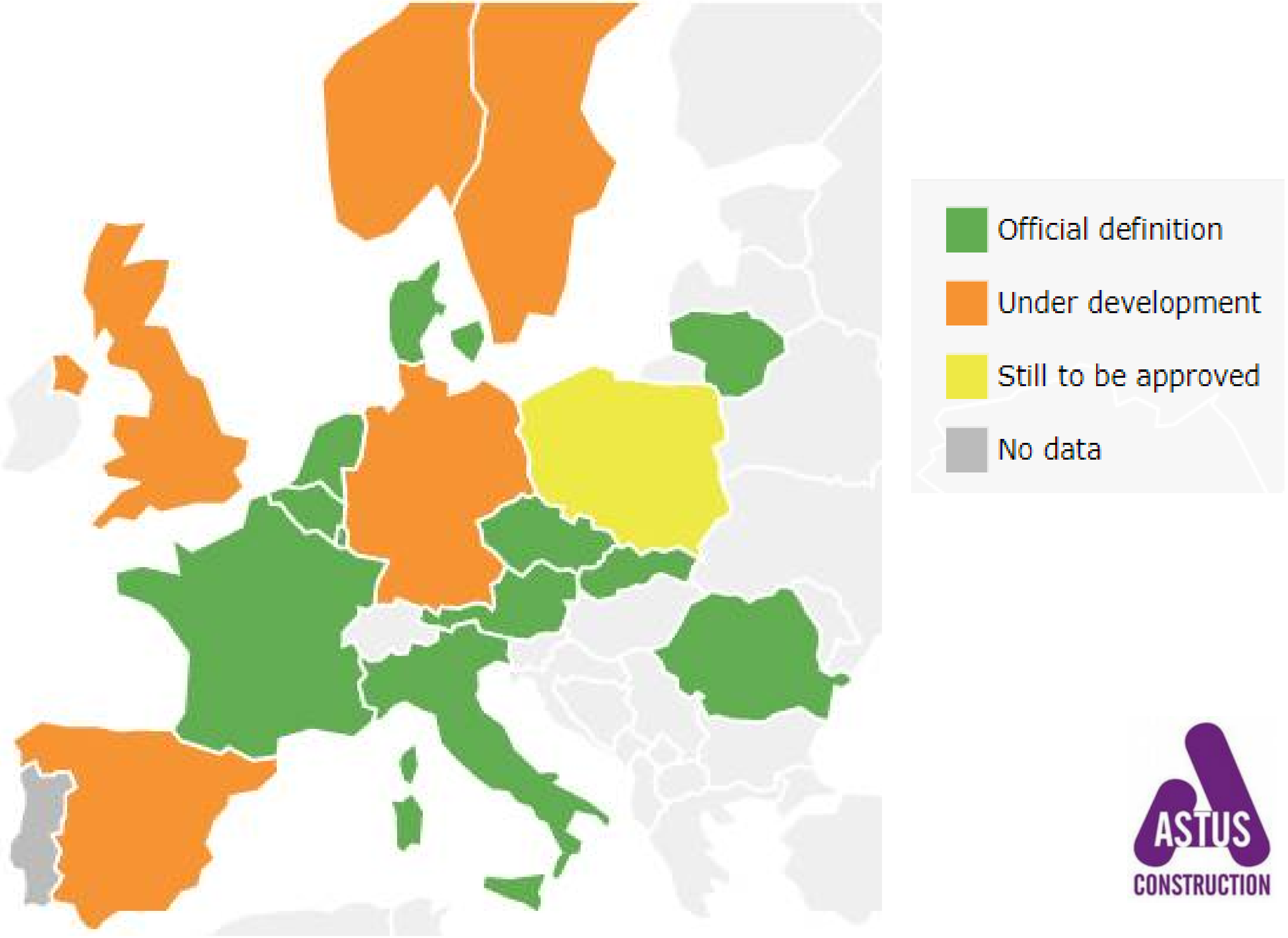
NZEB definition

- **EU member states with NZEB official definition**



NZEB construction - France

The French government considers that its NZEB definition matches the present regulation RT2012.

- In effect for ALL new buildings (since 1/1/2013)
- "Bbio" index defines the impact of bio-climatic design on building energy performance
  - Bbio = 2 x E_{heat} + 2 x$E_{cooling}$ + **5** x $E_{lighting}$
  - Bbio < Bbio $_{max}$ (RT 2012) : 42 (south) à 72 (North)

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NZEB construction - France

RT2012

- Energy efficiency : 40 to 60kWh/yr/m²
  - Depends on altitude, latitude, type of building…
- Summer comfort : $Tic \leq Tic_{ref}$ during 5 hot days
- Compulsory airtightness test
  - $Q_{4pa}Surf$ = 0,6 m³/hr/m² (individual housing)
  - $Q_{4pa}Surf$ = 1 m³/hr/m² (multi-residential buildings)

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NZEB construction - France

RT2012

- Minimum means to be implemented
  - Treat all thermal bridges
  - Compulsory renewable energy : hot water, micro energy production, …
  - Windows area = minimum 1/6 of wall areas
- Official calculation mathematical model
  - To verify the design compliance with RT2012

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NZEB construction - Europe

- Short review of BIMPLEMENT countries partners regulation *http://www.gbpn.org/databases-tools/*
- Lithuania, Netherlands, Poland, Spain
- In terms of
  - Primary Energy consumption in new buildings/ renovation

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NZEB construction - Europe

	Lithuania	Netherlands	Poland	Spain	France
Regulation	Regulation STR 2.01.09 : 201	National nZEB Plan	Consolidated report to EC	Decree 235/2013	Thermal Regulation 2012, Nat. nZEB Plan
Max. primary	energy				
Residential buildings	*building needs to comply with class A++*	*building needs to comply with energy performance coefficient =0*		*buildings will need to comply with class A*	*40-65* *80*
Non residential buildings	*building needs to comply with class A++*	*building needs to comply with energy performance coefficient =0*		*buildings will need to comply with class A*	*70-110* *60%PE*

BIMplement

France

- Energy efficiency
  - 40 – 60 kWh/yr/m²
- U-Value (W/m²K)
  - Overall U-Value 0.36
- Airtightness : Q_{4pa}Surf (under 4Pa) of building envelope
  - < 0.6 m³/hr.m² for individual housing
  - <1 m³/hr.m² for other residential buildings, hotels educational and health care buildings
  - < 2.5 m³/hr.m² for other buildings.

BIMplement

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Lithuania

- Energy efficiency
  - 80 $kWh/yr/m^2$
- U-Value (W/m^2K)
  - Roof 0.16
  - Wall 0.2
  - Floor 0.25
  - Window 1.6
- Airthightness
  - For naturally ventilated buildings, maximum n_{50}=3vol/hr,
  - for mechanically ventilated buildings, maximum n_{50}=1.5vol/hr

BIMplement

Netherlands

- Energy efficiency
  - 100 kWh/yr/m²
- U-Value (W/m²K)
  - Roof 0.4
  - Wall 0.4
  - Floor 0.4
  - Window 1.4
- Airtightness
  - For residential buildings, 200 dm3/s @10 Pa
  - for non-residential buildings 200 dm3/s per 500 m3 @10 Pa

Poland

- Energy efficiency
  -

- airtightness
  - buildings with gravity or hybrid ventilation $n_{50} < 3{,}0$
  - buildings with mechanical ventilation or air conditioning $n_{50} < 1{,}5$
  - passive buildings, $n_{50} \leq 0{,}6$ h

Spain

- Energy efficiency
- U-Value (W/m^2K)
  - Roof 0.38
  - Wall 0.66
  - Floor 0.49
  - Window 3.5
- Airtightness
  - 27 m3/(h.m2) at 100 Pa ("Not tested")

ventilation

- In the same way, each partner should find out the ventilation requirements in his country
- For instance, in France
  - Ventilation system is compulsory since 1982
  - Control is done <u>only on a volontary base</u>
  - The PROMEVENT protocol
    - is strongly recommended
    - is used as a base for the under revision EU norm

BIMplement

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Conclusion : How to implement

BIMplement

In terms of

- Energy efficiency
- Ventilation
- Airtightness

\+ BIM

BIMplement implementation Role of BIM coaches ??

- Design
  - Propose to specify objectives in terms of
    - BIM & building quality
    - Energy efficiency, Ventilation & airtightness
  - BIM project by the architect and design office
    - BIM Quality of the plans
    - Have a special concern about
      - Ventilation
      - Airtightness

BIMplement implementation Role of BIM coaches ??

- On-site Construction
  - Training implementation of blue and white collars
    - On site
    - Ventilation + air-tightness
  - Capacity to use the project BIM plans and data
    - Access to tablets or computers
    - Give the means to blue collars to report and display any problems / changes during implementation

BIMplement implementation Role of BIM coaches ??

- End of Construction
  - Quality control
    (as requested in the client's specifications)
    - Energy efficiency
    - Ventilation
      - PROMEVENT protocol ?
    - Airtightness
      - Blowerdoor test during construction & at the end

BIMplement

Thanks for your attention

This project has received funding from the European Union's h2020 framework programme for research and innovation under grant agreement no 745510