IEA SHC task 47:

Renovation of Non-Residential Buildings towards Sustainable Standards

# SUBTASK D:
# ENVIRONMENTAL AND HEALTH IMPACT ASSESSMENT

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# Sustainable building renovation, which issue?

**«A development that meets the needs of the present without compromising the ability of future generations to meet their own needs. »** Brundtland Report, 1987

**Building sector in Europe - 25 billion of m²**

- Non residential sector represents 25%
- 40% built before 1960

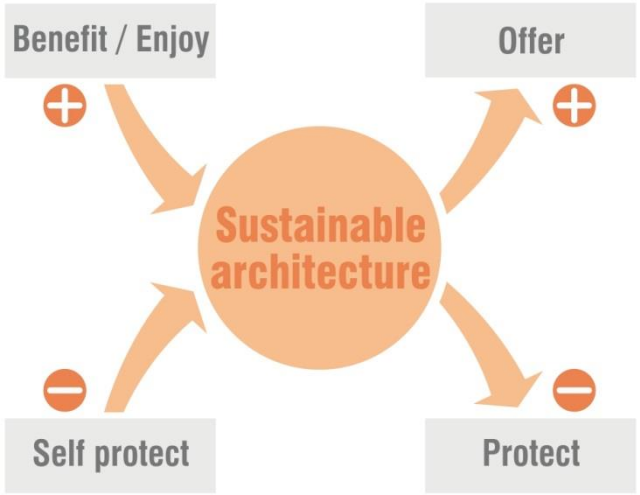
**Building sector in Europe - Environmental impacts**

- **40 %** of natural resources depletion
- **40 %** of total energy consumption
- **35 %** of waste production
- **40 %** of greenhouses gases emissions (GWP)
- **15 %** of water consumption

Source: European Conference On Sustainable Renovation Of Buildings (2012)

# Sustainable building renovation, which issue?

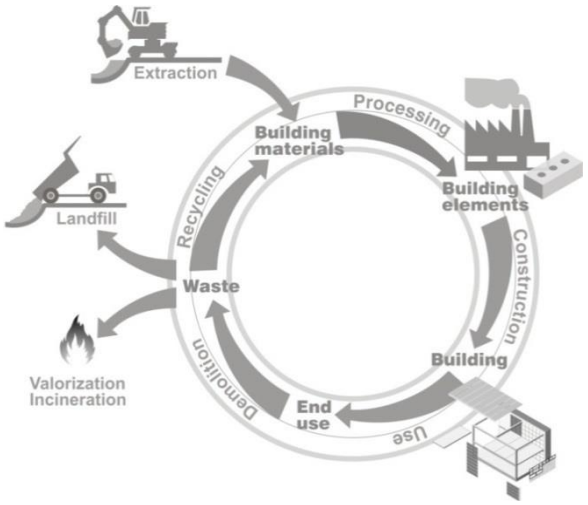
Definition of sustainable design for building renovation




**Improve comfort, well-being and quality of life by limiting or reducing environmental impact**

- ➔ Scale of time:
  From the design to the demolition, from the extraction to the end of life
- ➔ Spatial scale
  From the interior space of a room to the global scale of the Earth through the public space, the city blocks, the city, …

# Sustainable building renovation, which priorities?




## Reduce resources depletion :

water, raw materials, spaces…
Increase water resources, Increase biodiversity

## Reduce fossil energy consumption

Increase buildings and systems performances
Increase the use of renewable energy

## Reduce environmental risks

Reduce toxic emissions, Reduce atmospheric pollutants, Prevention : landscapes, biodiversity

## Human health and well-being

Increase comfort and quality of life
Favor social exchanges and social diversity

## Reduce waste production

Manage building and operation waste
Increase adaptability of building and recycling

# Sustainable building renovation, BREEAM assessment

Table 21-1: BREEAM assessment issues by building type and their percentage contribution to BREEAM performance

| | | Office | Retail | Industrial | Healthcare | Primary School | Secondary school | Further Education | Higher Education | Prisons | Courts | Multi-residential | Other buildings |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Management** | | | | | | | | | | | | | |
| **Man 01** | Sustainable procurement | 4.4% | 4.4% | 4.4% | 4.4% | 4.4% | 4.4% | 4.4% | 4.4% | 4.4% | 4.4% | 4.4% | 4.4% |
| **Man 02** | Responsible construction practices | 1.1% | 1.1% | 1.1% | 1.1% | 1.1% | 1.1% | 1.1% | 1.1% | 1.1% | 1.1% | 1.1% | 1.1% |
| **Man 03** | Construction site impacts | 2.7% | 2.7% | 2.7% | 2.7% | 2.7% | 2.7% | 2.7% | 2.7% | 2.7% | 2.7% | 2.7% | 2.7% |
| **Man 04** | Stakeholder participation | 2.2% | 2.2% | 2.2% | 2.2% | 2.2% | 2.2% | 2.2% | 2.2% | 2.2% | 2.2% | 2.2% | 2.2% |
| **Man 05** | Service life planning and costing | 1.6% | 1.6% | 1.6% | 1.6% | 1.6% | 1.6% | 1.6% | 1.6% | 1.6% | 1.6% | 1.6% | 1.6% |
| **Health & Wellbeing** | | | | | | | | | | | | | |
| **Hea 01** | Visual comfort | 2.8% | 3.5% | 2.8% | 4.2% | 2.6% | 2.6% | 2.8% | 2.8% | 2.8% | 2.8% | 2.5% | 2.8% |
| **Hea 02** | Indoor air quality | 5.6% | 5.3% | 5.6% | 5.0% | 5.3% | 5.3% | 5.6% | 5.6% | 5.6% | 5.6% | 5.0% | 5.6% |
| **Hea 03** | Thermal comfort | 1.9% | 1.8% | 1.9% | 1.7% | 1.8% | 1.8% | 1.9% | 1.9% | 1.9% | 1.9% | 1.7% | 1.9% |
| **Hea 04** | Water quality | 0.9% | 0.9% | 0.9% | 0.8% | 0.9% | 0.9% | 0.9% | 0.9% | 0.9% | 0.9% | 0.8% | 0.9% |
| **Hea 05** | Acoustic performance | 1.9% | 1.8% | 1.9% | 1.7% | 2.6% | 2.6% | 1.9% | 1.9% | 1.9% | 1.9% | 3.3% | 1.9% |
| **Hea 06** | Safety and security | 1.9% | 1.8% | 1.9% | 1.7% | 1.8% | 1.8% | 1.9% | 1.9% | 1.9% | 1.9% | 1.7% | 1.9% |
| **Energy** | | | | | | | | | | | | | |
| **Ene 01** | Reduction of $CO_2$ emissions | 8.1% | 9.5% | 8.1% | 8.1% | 8.4% | 8.4% | 8.1% | 8.1% | 8.1% | 9.8% | 9.8% | 9.5% |
| **Ene 02** | Energy monitoring | 1.1% | 1.3% | 1.1% | 1.1% | 0.6% | 0.6% | 1.1% | 1.1% | 1.1% | 0.7% | 0.7% | 0.6% |
| **Ene 03** | Energy efficient external | 0.5% | 0.6% | 0.5% | 0.5% | 0.6% | 0.6% | 0.5% | 0.5% | 0.5% | 0.7% | 0.7% | 0.6% |

12%

15%

19%

**Subtask D focuses on school renovation**

# Sustainable building renovation, BREEAM assessment

| | | Office | Retail | Industrial | Healthcare | Primary School | Secondary school | Further Education | Higher Education | Prisons | Courts | Multi-residential | Other buildings |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | lighting | | | | | | | | | | | | |
| **Ene 04** | Low or zero carbon technologies | 2.7% | 3.2% | 2.7% | 2.7% | 2.8% | 2.8% | 2.7% | 2.7% | 2.7% | 3.3% | 3.3% | 3.2% |
| **Ene 05** | Energy efficient cold storage | 1.6% | 1.9% | 1.6% | 1.6% | 1.7% | 1.7% | 1.6% | 1.6% | 1.6% | 2.0% | 2.0% | 1.9% |
| **Ene 06** | Energy efficient transportation systems | 1.1% | 1.3% | 1.1% | 1.1% | 1.1% | 1.1% | 1.1% | 1.1% | 1.1% | 1.3% | 1.3% | 1.3% |
| **Ene 07** | Energy efficient laboratory systems | 2.7% | 0.0% | 2.7% | 2.7% | 2.8% | 2.8% | 2.7% | 2.7% | 2.7% | 0.0% | 0.0% | 0.0% |
| **Ene 08** | Energy efficient equipment (process) | 1.1% | 1.3% | 1.1% | 1.1% | 1.1% | 1.1% | 1.1% | 1.1% | 1.1% | 1.3% | 1.3% | 1.3% |
| **Ene 09** | Drying space | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.6% |
| **Transport** | | | | | | | | | | | | | |
| **Tra 01** | Public transport accessibility | 2.7% | 4.4% | 2.7% | 4.0% | 3.4% | 3.4% | 3.6% | 3.6% | 4.0% | 4.4% | 2.7% | 3.6% |
| **Tra 02** | Proximity to amenities | 0.9% | 0.9% | 0.9% | 0.8% | 1.1% | 1.1% | 0.7% | 0.7% | 0.0% | 0.9% | 1.8% | 0.7% |
| **Tra 03** | Cyclist facilities | 1.8% | 1.8% | 1.8% | 1.6% | 2.3% | 2.3% | 1.5% | 1.5% | 2.0% | 1.8% | 0.9% | 1.5% |
| **Tra 04** | Maximum car parking capacity | 1.8% | 0.0% | 1.8% | 0.8% | 0.0% | 0.0% | 1.5% | 1.5% | 0.0% | 0.0% | 1.8% | 1.5% |
| **Tra 05** | Travel plan | 0.9% | 0.9% | 0.9% | 0.8% | 1.1% | 1.1% | 0.7% | 0.7% | 2.0% | 0.9% | 0.9% | 0.7% |
| **Water** | | | | | | | | | | | | | |
| **Wat 01** | Water consumption | 3.3% | 3.3% | 3.3% | 3.3% | 3.3% | 3.3% | 3.3% | 3.3% | 3.3% | 3.3% | 3.3% | 3.3% |
| **Wat 02** | Water monitoring | 0.7% | 0.7% | 0.7% | 0.7% | 0.7% | 0.7% | 0.7% | 0.7% | 0.7% | 0.7% | 0.7% | 0.7% |
| **Wat 03** | Water leak detection | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% |

8%

6%

# Sustainable building renovation, BREEAM assessment

| | | Office | Retail | Industrial | Healthcare | Primary School | Secondary school | Further Education | Higher Education | Prisons | Courts | Multi-residential | Other buildings |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | and prevention | | | | | | | | | | | | |
| **Wat 04** | Water efficient equipment (process) | 0.7% | 0.7% | 0.7% | 0.7% | 0.7% | 0.7% | 0.7% | 0.7% | 0.7% | 0.7% | 0.7% | 0.7% |
| **Materials** | | | | | | | | | | | | | |
| **Mat 01** | Life cycle impacts | 4.8% | 5.2% | 2.8% | 5.8% | 5.8% | 5.8% | 5.8% | 5.8% | 4.5% | 5.8% | 5.8% | 5.8% |
| **Mat 02** | Hard landscaping/boundary protection | 1.9% | 1.0% | 1.4% | 1.0% | 1.0% | 1.0% | 1.0% | 1.0% | 1.1% | 1.0% | 1.0% | 1.0% |
| **Mat 03** | Responsible sourcing of materials | 2.9% | 3.1% | 4.2% | 2.9% | 2.9% | 2.9% | 2.9% | 2.9% | 3.4% | 2.9% | 2.9% | 2.9% |
| **Mat 04** | Insulation | 1.9% | 2.1% | 2.8% | 1.9% | 1.9% | 1.9% | 1.9% | 1.9% | 2.3% | 1.9% | 1.9% | 1.9% |
| **Mat 05** | Designing for robustness | 1.0% | 1.0% | 1.4% | 1.0% | 1.0% | 1.0% | 1.0% | 1.0% | 1.1% | 1.0% | 1.0% | 1.0% |
| **Waste** | | | | | | | | | | | | | |
| **Wst 01** | Construction waste management | 4.3% | 5.0% | 5.0% | 5.0% | 5.0% | 5.0% | 5.0% | 5.0% | 5.0% | 5.0% | 5.0% | 5.0% |
| **Wst 02** | Recycled aggregates | 1.1% | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% |
| **Wst 03** | Operational waste | 1.1% | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% |
| **Wst 04** | Speculative floor and ceiling finishes | 1.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| **Land Use and Ecology** | | | | | | | | | | | | | |
| **LE 01** | Site selection | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% |
| **LE 02** | Ecological value / Protection | 1.0% | 1.0% | 1.0% | 1.0% | 1.0% | 1.0% | 1.0% | 1.0% | 1.0% | 1.0% | 1.0% | 1.0% |


12,6%


7,6%


10 %

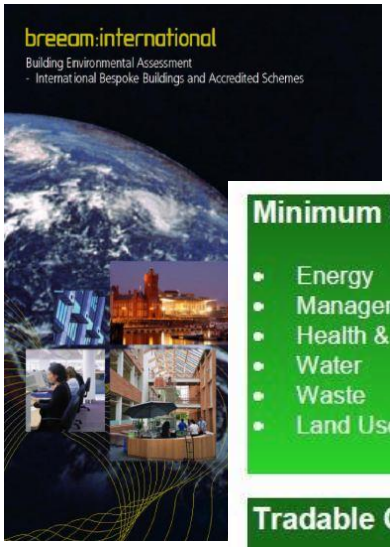
# Sustainable building renovation, BREEAM assessment

| | | Office | Retail | Industrial | Healthcare | Primary School | Secondary school | Further Education | Higher Education | Prisons | Courts | Multi-residential | Other buildings |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LE 03 | Mitigating ecological impact | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% |
| LE 04 | Enhancing site ecology | 3.0% | 3.0% | 3.0% | 3.0% | 3.0% | 3.0% | 3.0% | 3.0% | 2.0% | 3.0% | 3.0% | 3.0% |
| LE 05 | Long term impact on biodiversity | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% | 3.0% | 2.0% | 2.0% | 2.0% |
| **Pollution** | | | | | | | | | | | | | |
| Pol 01 | Impact of refrigerants | 2.3% | 2.3% | 2.5% | 2.3% | 2.3% | 2.3% | 2.3% | 2.3% | 2.3% | 2.3% | 2.3% | 2.3% |
| Pol 02 | $NO_x$ emissions from heating/cooling | 2.3% | 2.3% | 1.7% | 2.3% | 2.3% | 2.3% | 2.3% | 2.3% | 2.3% | 2.3% | 2.3% | 2.3% |
| Pol 03 | Surface water run-off | 3.8% | 3.8% | 4.2% | 3.8% | 3.8% | 3.8% | 3.8% | 3.8% | 3.8% | 3.8% | 3.8% | 3.8% |
| Pol 04 | Reduction of night time light pollution | 0.8% | 0.8% | 0.8% | 0.8% | 0.8% | 0.8% | 0.8% | 0.8% | 0.8% | 0.8% | 0.8% | 0.8% |
| Pol 05 | Noise attenuation | 0.8% | 0.8% | 0.8% | 0.8% | 0.8% | 0.8% | 0.8% | 0.8% | 0.8% | 0.8% | 0.8% | 0.8% |
| **Innovation** | | | | | | | | | | | | | |
| Inn 01 | Innovation | 10.0% | 10.0% | 10.0% | 10.0% | 10.0% | 10.0% | 10.0% | 10.0% | 10.0% | 10.0% | 10.0% | 10.0% |


10 %

10 %

# Sustainable building renovation, BREEAM assessment




**Minimum Standards**

- Energy
- Management
- Health & Well-being
- Water
- Waste
- Land Use & Ecology

**Tradable Credits**

- Energy
- Water
- Materials
- Transport
- Waste
- Pollution
- Health & Well-being
- Management
- Land Use & Ecology

**Innovation Credits**

- Exemplary Performance Requirements
- Approved Innovation Credits

Category Scores → Environmental Weighting → Final Score →

| | |
|---|---|
| Pass | ≥ 30 |
| Good | ≥ 45 |
| Very Good | ≥ 55 |
| Excellent | ≥ 70 |
| Outstanding | ≥ 85 |

breeam rating

# Sustainable renovation of non residential buildings

## Innovative, replicable or successfull concepts

## When very low energy renovation rhymes with heritage value

Renovation of a public building in Brussels, Belgium

Architect: Sebastian Moreno-Vacca (A2M office - www.a2m.be)

# Sustainable renovation of non residential buildings

## Innovative, replicable or successfull concepts

*Source : A2M office*

Building built in 1934, in Art Deco style

Renovated in 2011/2012

Exemplary project in Brussels

Heating demand

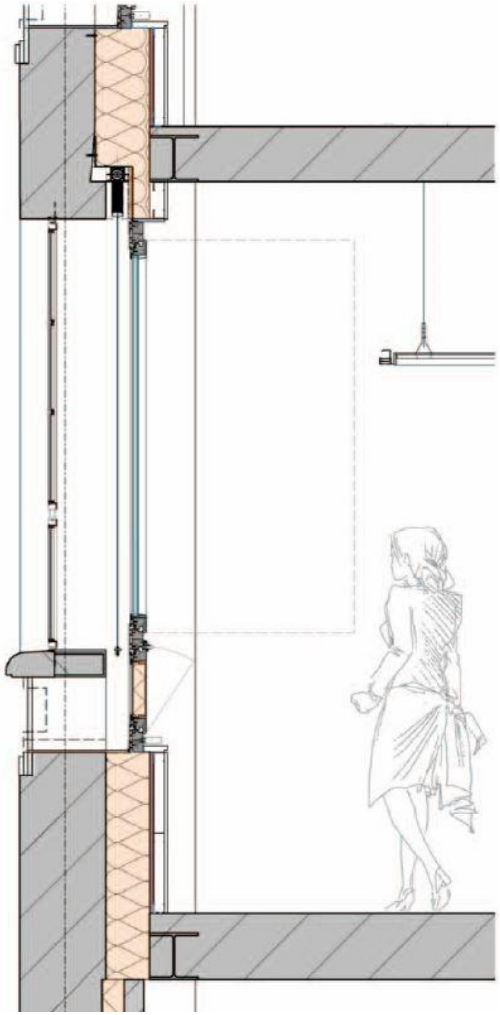
- before: **263 kWh/m²year**
- after: **19 kWh /m² year**

### Summary of U-values [W/m²K]

| | Before | After |
|---|---|---|
| Roof/attic | 3,47 W/m²K | 0,12 W/m²K |
| Floor/slab | 3,39 W/m²K | 0,32 W/m²K |
| Walls | 2,05 W/m²K | 0,23 W/m²K |
| Frame | 5,86 W/m²K | 1,58 W/m²K |
| Glazing | 4 W/m²K | 0,81 W/m²K |

# Sustainable renovation of non residential buildings

## Innovative, replicable or successfull concepts



- Inside insulation : cellulose in bulk
- Preservation of large existing windows,
- Doubling window by inside
- Solar shadings between the two windows

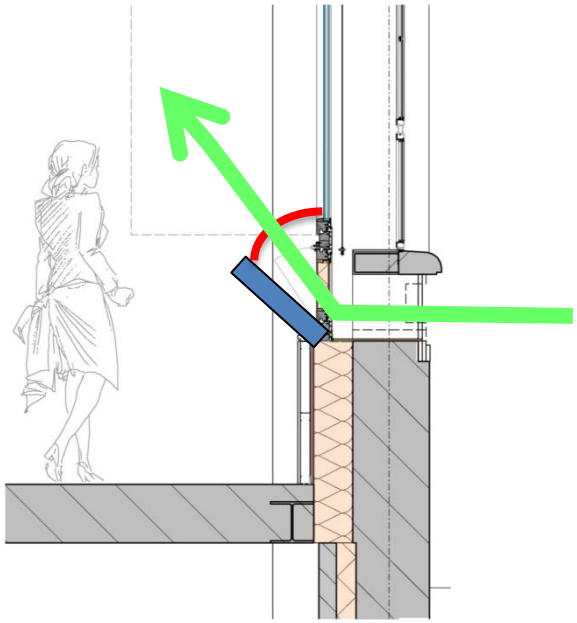
*Source : A2M office*

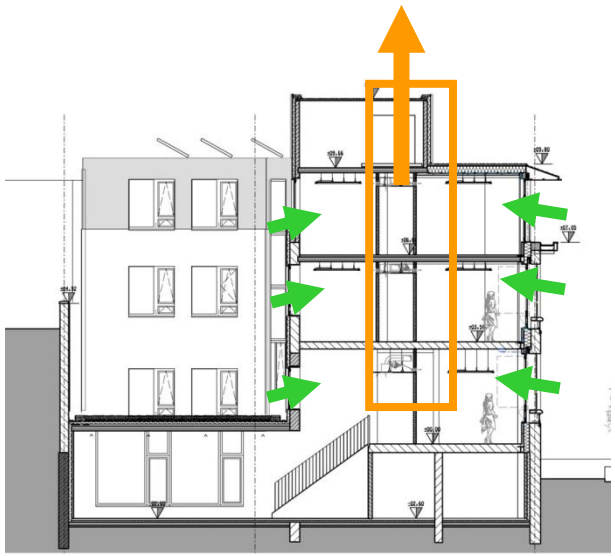
# Sustainable renovation of non residential buildings

## Innovative, replicable or successfull concepts

Take advantage of the old windows:

- Passive cooling strategy

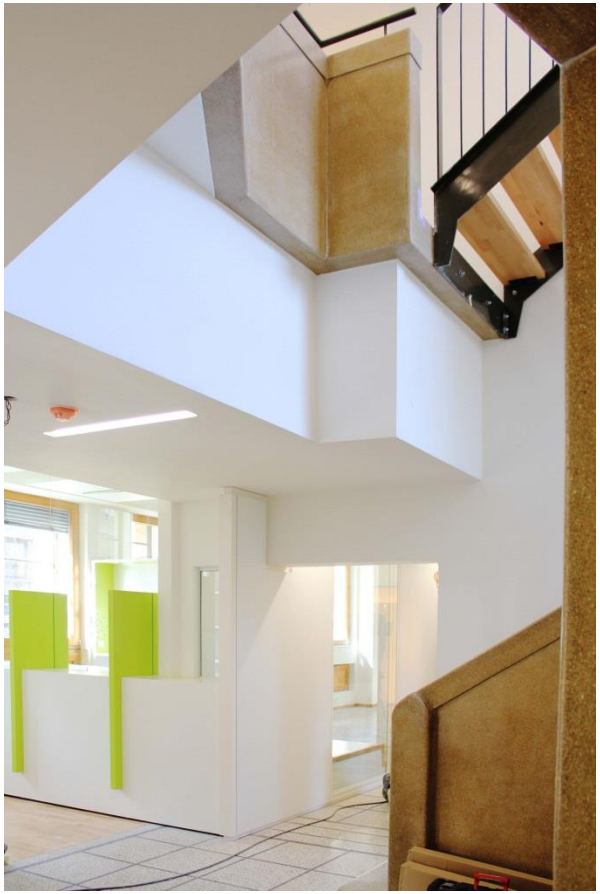


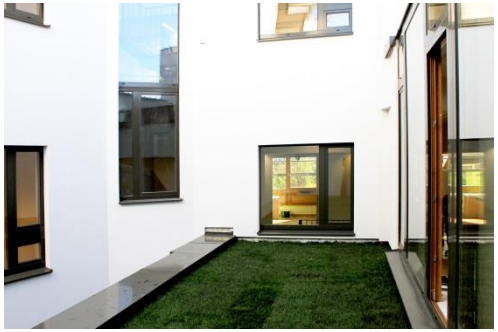


*Source : A2M office*

# Sustainable renovation of non residential buildings

## Innovative, replicable or successfull concepts





*Source : A2M office*

# Sustainable renovation of non residential buildings

## Innovative, replicable or successfull concepts

*Source : A2M office*

# Sustainable renovation of non residential buildings

## Innovative, replicable or successfull concepts

## When compactness rhymes with comfort and quality of spaces

Renovation of School in Schwanenstadt, Austria

Architect: Heinz Plöderl, PAUAT Architekten

# Sustainable renovation of non residential buildings

## Innovative, replicable or successfull concepts

*Source : Claudia Dankl*

Built in the 1960s, undergone numerous expansions

Renovation meeting Passive House Standard

Two different schools in the same building

Heating demand:

- After: 14.1 kWh/m²
- 88.5 % of reduction

### Summary of U-values [W/m²K]

| | before | after |
|---|---|---|
| roof/attic | ~ 3.3 | 0.101 |
| floor/slab | ~ 0.6 | 0.154 |
| walls | ~ 2.3 | 0.130 |
| ceilings | ~ 3.3 | 0.130 |
| windows | ~ 1.3 | 0.8 |

# Sustainable renovation of non residential buildings

## Innovative, replicable or successfull concepts

*Source : Claudia Dankl*

- Extension from 4140 m² to **6214 m² useable area**
- **External insulation**
- Use of **prefabricated façade elements**
- **No significant impacts on school activity** during renovation

# Sustainable renovation of non residential buildings

## Innovative, replicable or successfull concepts

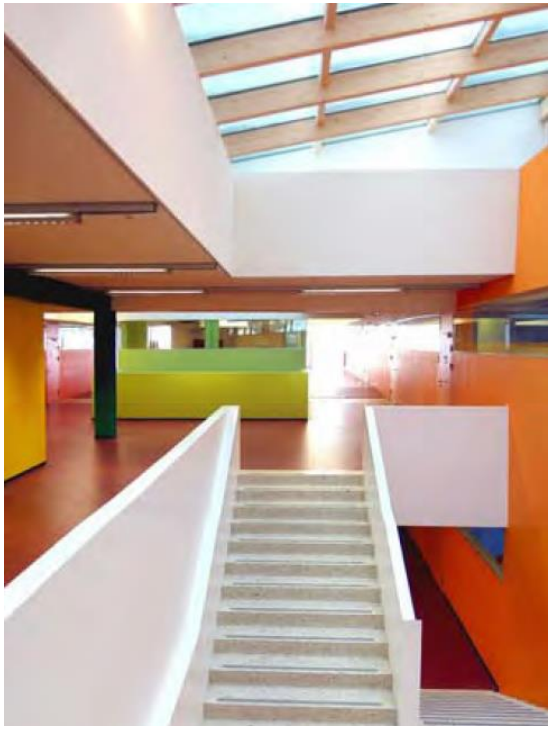
Prefabricated façade elements

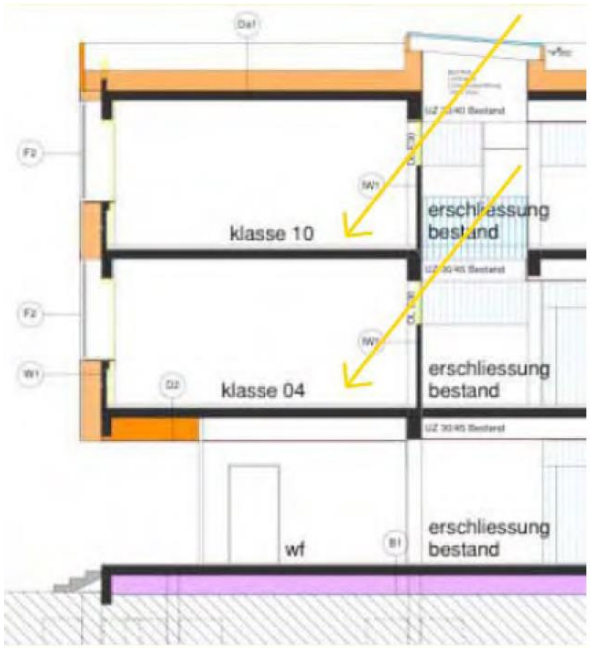

Source : Claudia Dankl


after renovation

# Sustainable renovation of non residential buildings

## Innovative, replicable or successfull concepts






*Source : Claudia Dankl*

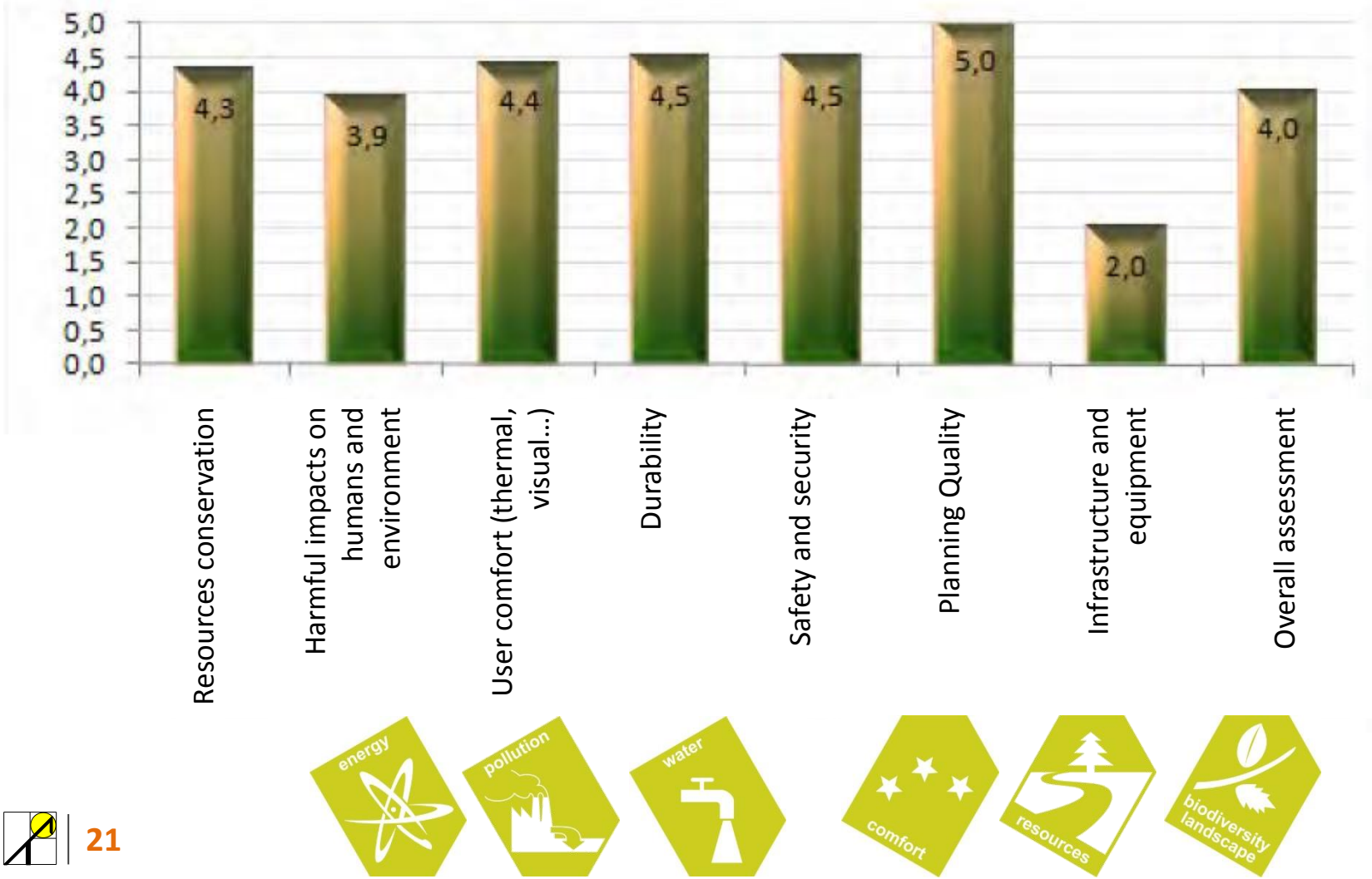
New areas allow improvement of:

- **Daylight** (skylight, supply of light in classrooms…)
- **Quality of collective spaces and classrooms**

# Sustainable renovation of non residential buildings

## Innovative, replicable or successfull concepts

### Total Quality Building assessment



# Sustainable renovation of non residential buildings

## Innovative, replicable or successfull concepts

## When compactness rhymes with comfort and quality of spaces

Renovation of Norwegian Tax Authority in Oslo, Norway

Architect: LPO Achitects AS, Oslo

# Sustainable renovation of non residential buildings

## Innovative, replicable or successfull concepts

Built in 1980

Building situated in the center of Oslo, close to a highway with heavy traffic.

Renovation not completed now

Primary energy demand:

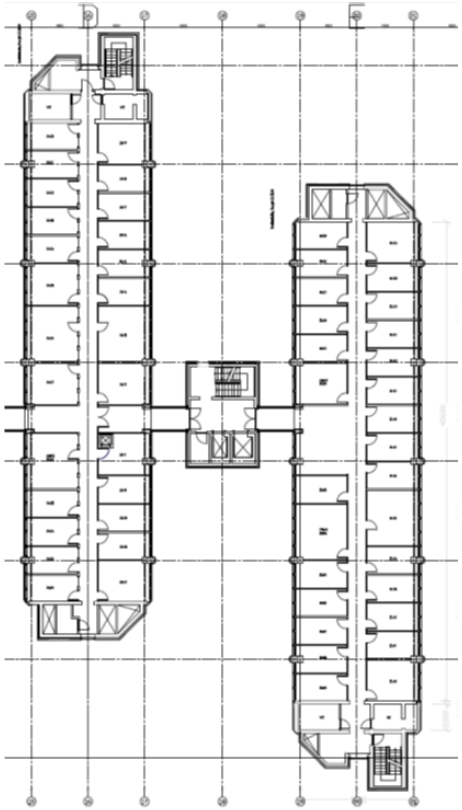
- Before : 170 kWh/m²
- After : 84 kWh/m²

### Summary of U-values [W/m²K]

| | Before | After |
|---|---|---|
| Roof/attic | ~ 0,2 – 1,0 (average 0,5) | 0,12 |
| Floor/slab | ~ 0,1 | 0,1 |
| Walls | ~ 0,2 – 0,4 | 0,17 |
| Ceilings | ~ 0,3 | 0,12 |
| Windows | ~1,8 | 0,72 |

# Sustainable renovation of non residential buildings

## Innovative, replicable or successfull concepts



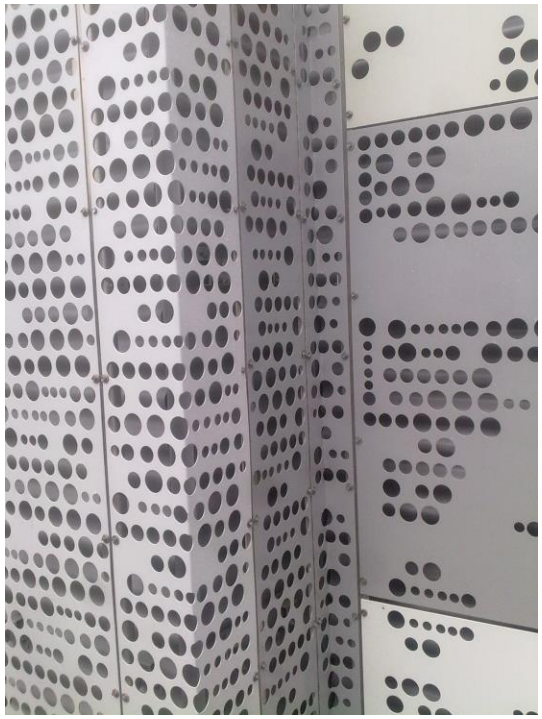
Typical floor plan
**before renovation**

Typical floor plan
**after renovation**

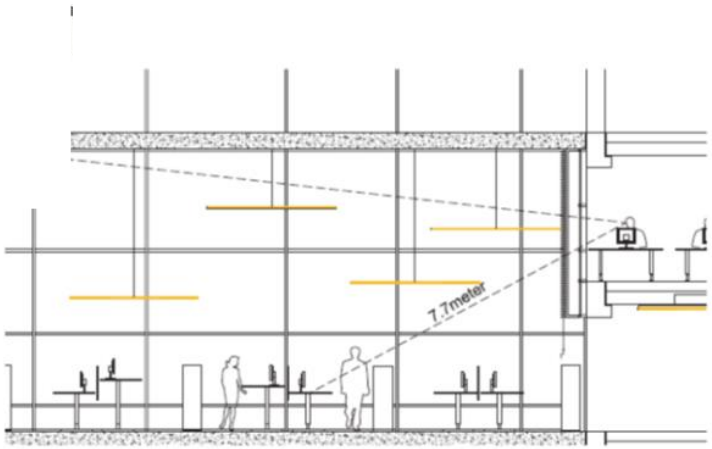
- Extension of the **useable area**
- New area used for **working area and meeting rooms**
- **Improvement of compactness** by reducing the façade development
- Use **of high insulated pre fabricated façades** (aluminium with specific design)

# Sustainable renovation of non residential buildings

## Innovative, replicable or successfull concepts



- **Low emission** and sustainable **materials** with high durability
- **Reduction of water use**
- Building waste during entire life cycle
- **Indoor Air Quality**
- Clean building processes
- **Lowering energy for transportation** (building users)



# Sustainable renovation of non residential buildings

## Innovative, replicable or successfull concepts

# Sustainable renovation of non residential buildings

## Innovative, replicable or successfull concepts

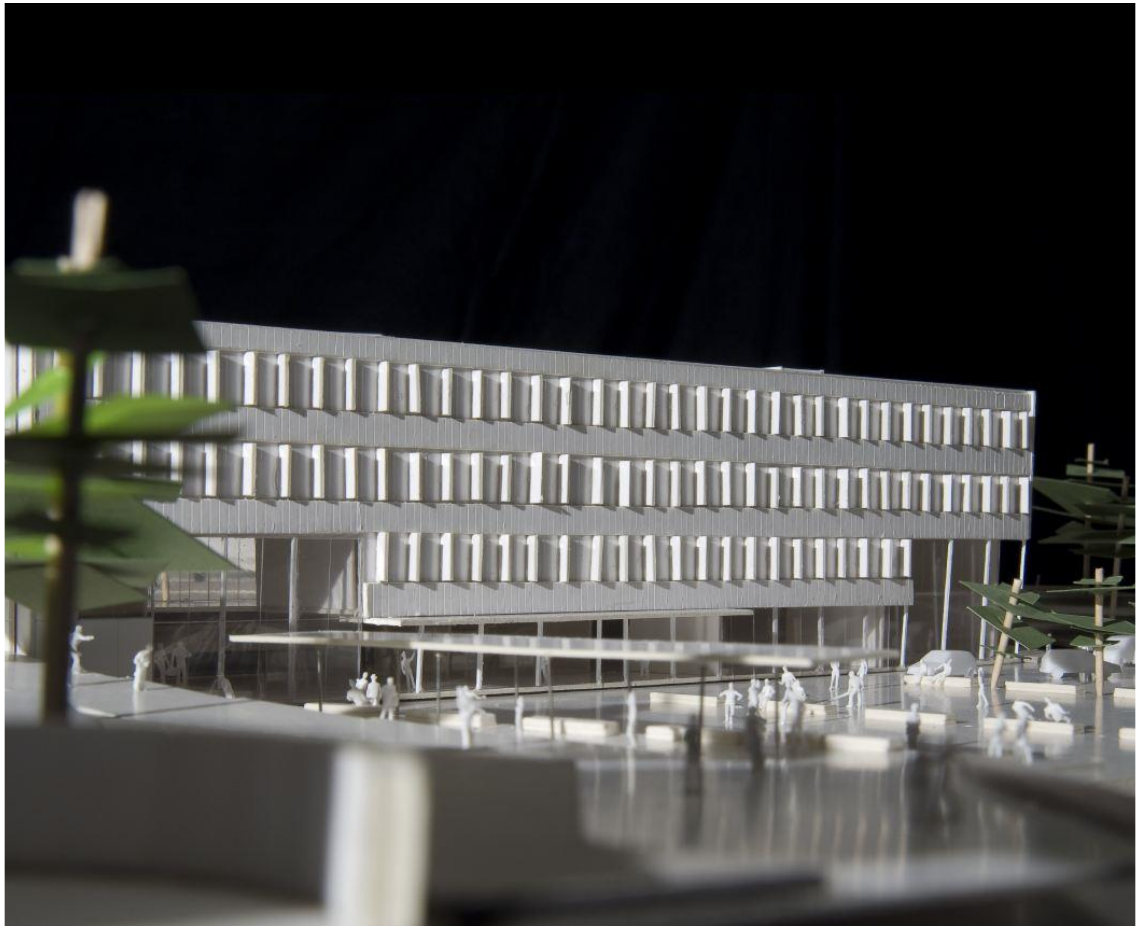
### When renew means « make new by transforming"

Renovation of Riva Bella school, Wallonia, Belgium

Architect: aa-ar office, sprl Alain Richard

# Sustainable renovation of non residential buildings

## Innovative, replicable or successfull concepts



*Source : aa-ar office, sprl Alain Richard*

Existing semi-prefabricated building, built in 1970
Renovated in 2010/2012

Two functions, similar but distinct in one place (two schools)

Major refurbishment: conservation of the metallic structure, slab and floors

**Specific goal : renew i.e. make new by transforming**

Low energy renovation – energy was not the first priority

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Four axes of thinking:

- **Prefabrication and reuse**
- Restore **links with the city** and the built environment
- **Energy and thermal issue** in renovation
- Users **participation**

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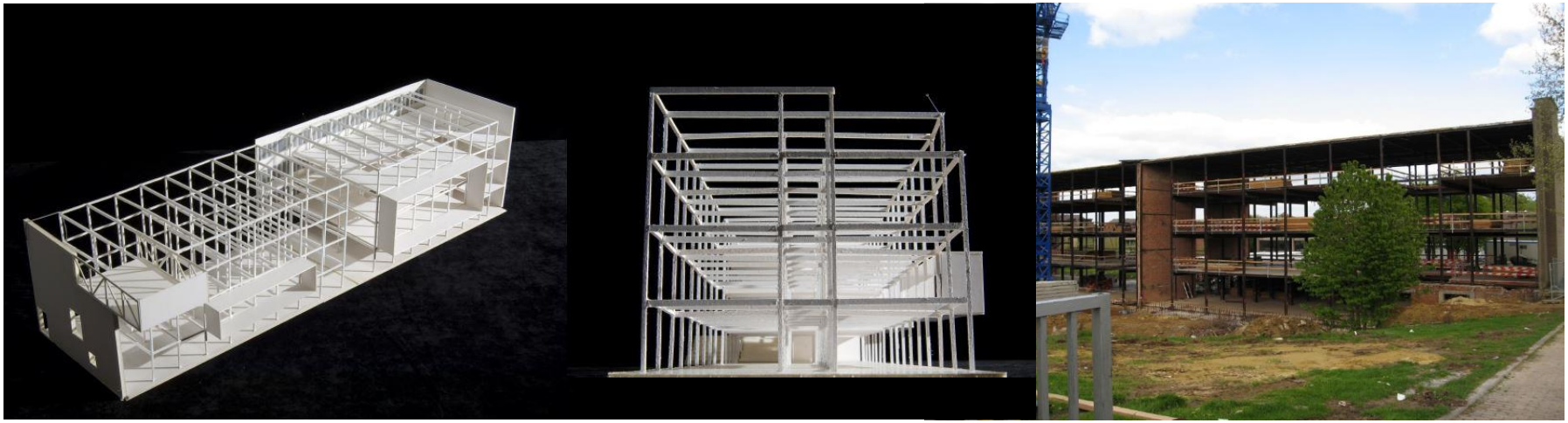
### Enhance the structural mesh



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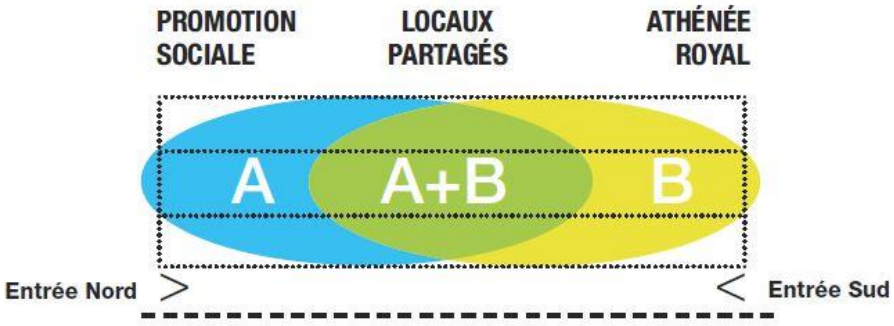


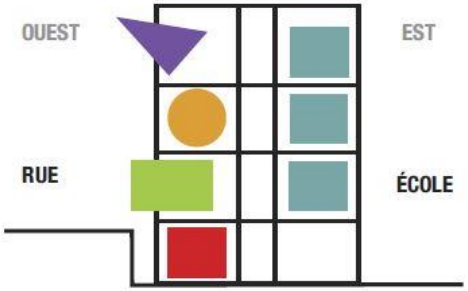

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### Reuse what is reusable, recycle the rest

- Metallic structure
- Concrete floors
- Furniture and equipments
- Partition walls

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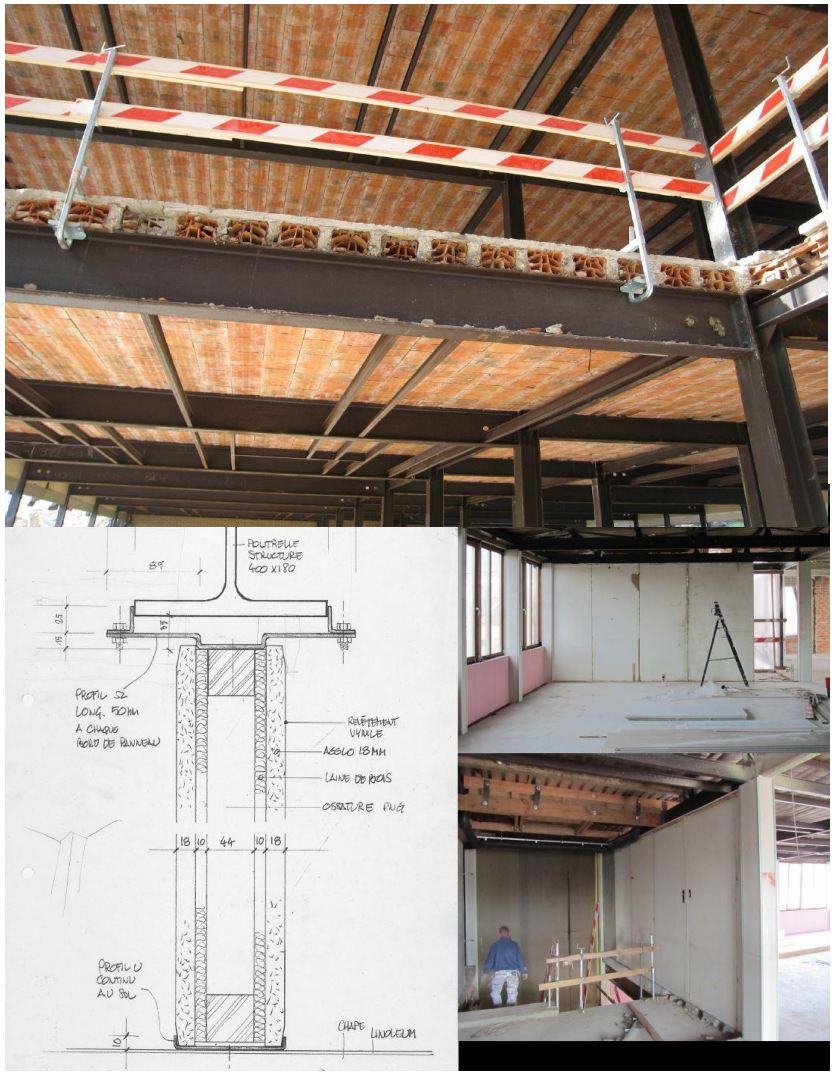

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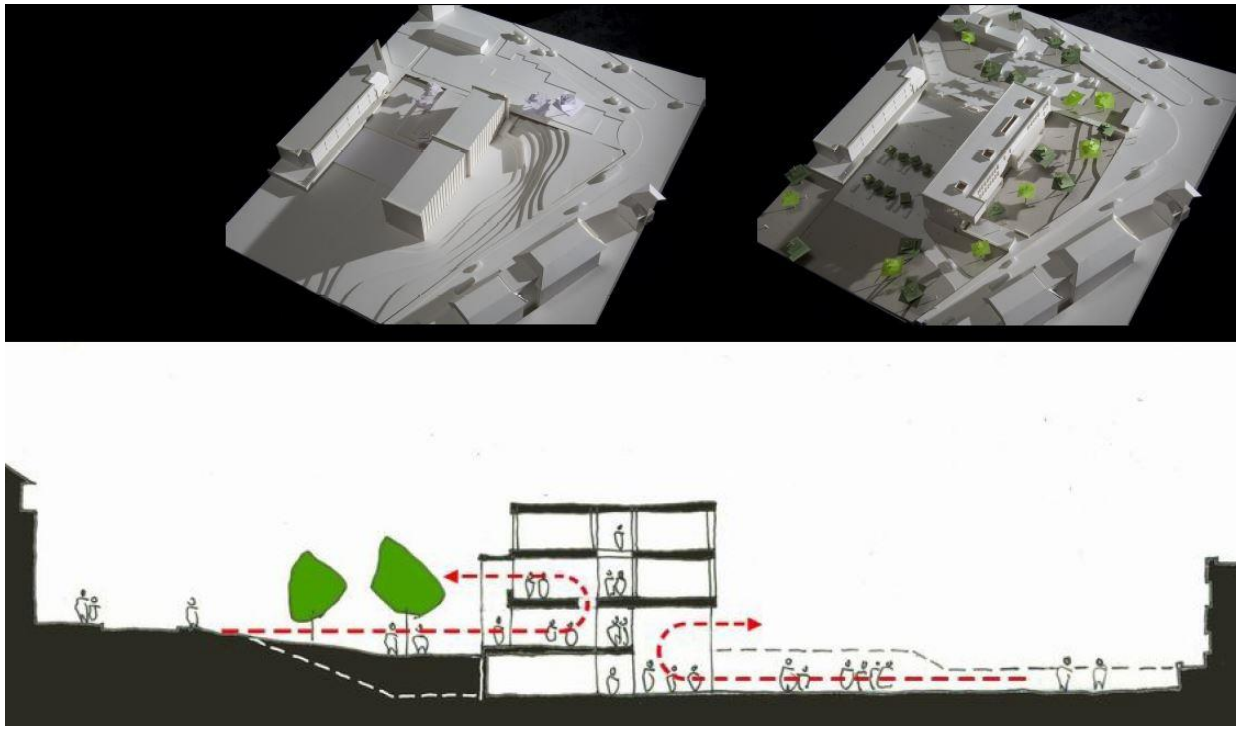
## Innovative, replicable or successfull concepts

### Restore links with the city



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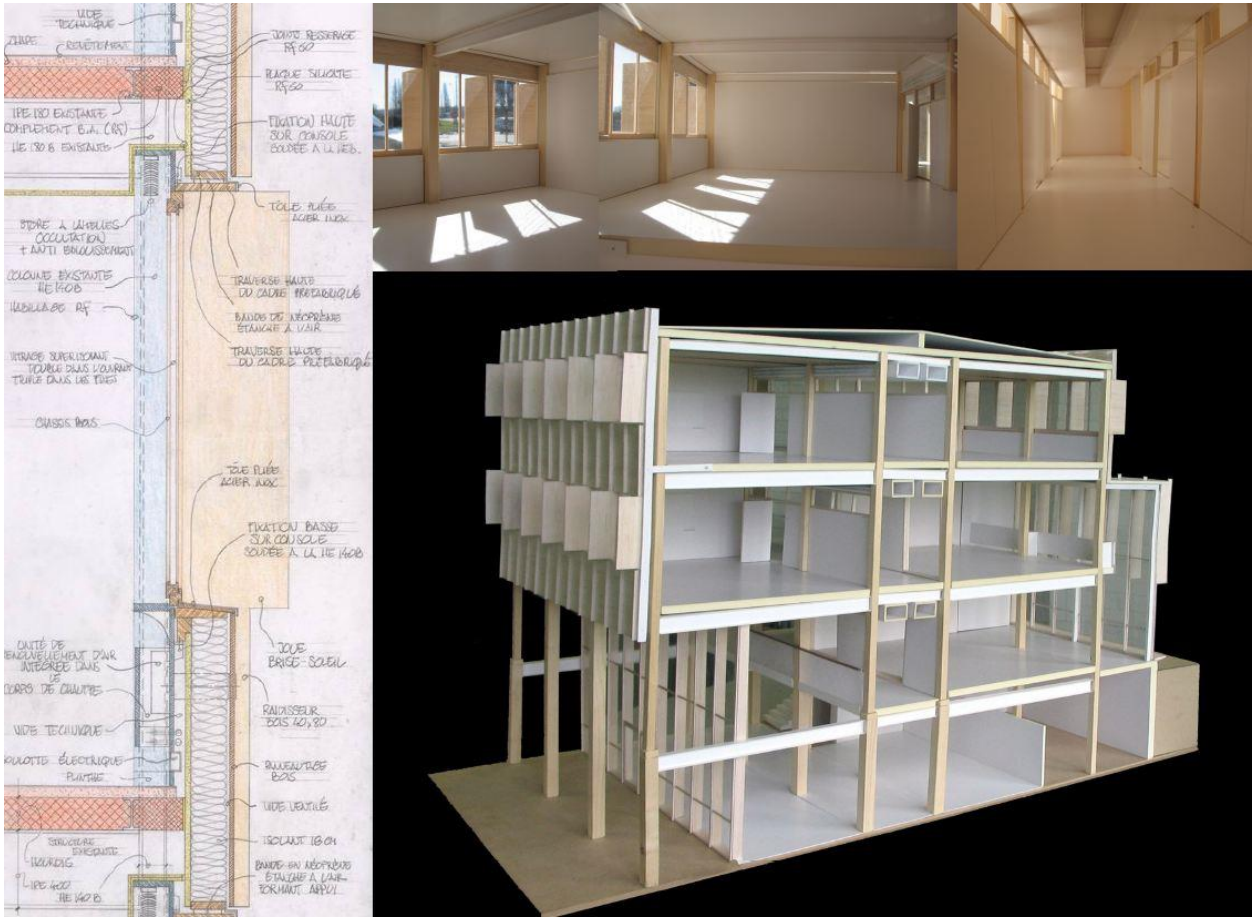
## Innovative, replicable or successfull concepts

### Energy and thermal issue



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# Sustainable renovation of non residential buildings

## Innovative, replicable or successfull concepts

### Energy and thermal issue

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## Innovative, replicable or successfull concepts

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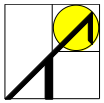
# Thank you for your attention

## Any questions?



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