IEA SHC task 47:
Renovation of Non-Residential Buildings towards Sustainable Standards

SUBTASK D:
ENVIRONMENTAL AND HEALTH IMPACT ASSESSMENT
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

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

Subtask D focuses on school renovation

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

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<th>Office</th>
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Sustainable building renovation, BREEAM assessment

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Sustainable building renovation, BREEAM assessment

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<th>Category</th>
<th>Office</th>
<th>Retail</th>
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<th>Prisons</th>
<th>Courts</th>
<th>Multi-residential</th>
<th>Other buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LE03</strong> Mitigating ecological impact</td>
<td>2.0%</td>
<td>2.0%</td>
<td>2.0%</td>
<td>2.0%</td>
<td>2.0%</td>
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</tr>
<tr>
<td><strong>LE04</strong> Enhancing site ecology</td>
<td>3.0%</td>
<td>3.0%</td>
<td>3.0%</td>
<td>3.0%</td>
<td>3.0%</td>
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</tr>
<tr>
<td><strong>LE05</strong> Long term impact on biodiversity</td>
<td>2.0%</td>
<td>2.0%</td>
<td>2.0%</td>
<td>2.0%</td>
<td>2.0%</td>
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### Pollution

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</tr>
</thead>
<tbody>
<tr>
<td><strong>Pol01</strong> Impact of refrigerants</td>
<td>2.3%</td>
<td>2.3%</td>
<td>2.5%</td>
<td>2.3%</td>
<td>2.3%</td>
<td>2.3%</td>
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<td>2.3%</td>
<td>2.3%</td>
</tr>
<tr>
<td><strong>Pol02</strong> NO\textsubscript{x} emissions from heating/cooling</td>
<td>2.3%</td>
<td>2.3%</td>
<td>1.7%</td>
<td>2.3%</td>
<td>2.3%</td>
<td>2.3%</td>
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<td>2.3%</td>
<td>2.3%</td>
<td>2.3%</td>
<td>2.3%</td>
</tr>
<tr>
<td><strong>Pol03</strong> Surface water run-off</td>
<td>3.8%</td>
<td>3.8%</td>
<td>4.2%</td>
<td>3.8%</td>
<td>3.8%</td>
<td>3.8%</td>
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<td>3.8%</td>
<td>3.8%</td>
<td>3.8%</td>
</tr>
<tr>
<td><strong>Pol04</strong> Reduction of night time light pollution</td>
<td>0.8%</td>
<td>0.8%</td>
<td>0.8%</td>
<td>0.8%</td>
<td>0.8%</td>
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<td>0.8%</td>
<td>0.8%</td>
<td>0.8%</td>
</tr>
<tr>
<td><strong>Pol05</strong> Noise attenuation</td>
<td>0.8%</td>
<td>0.8%</td>
<td>0.8%</td>
<td>0.8%</td>
<td>0.8%</td>
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### Innovation

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<th>Other buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inn01</strong> Innovation</td>
<td>10.0%</td>
<td>10.0%</td>
<td>10.0%</td>
<td>10.0%</td>
<td>10.0%</td>
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</tr>
</tbody>
</table>
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
Sustainable renovation of non residential buildings

Innovative, replicable or successful 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 successful concepts

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]

<table>
<thead>
<tr>
<th></th>
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<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof/attic</td>
<td>3,47 W/m²K</td>
<td>0,12 W/m²K</td>
</tr>
<tr>
<td>Floor/slab</td>
<td>3,39 W/m²K</td>
<td>0,32 W/m²K</td>
</tr>
<tr>
<td>Walls</td>
<td>2,05 W/m²K</td>
<td>0,23 W/m²K</td>
</tr>
<tr>
<td>Frame</td>
<td>5,86 W/m²K</td>
<td>1,58 W/m²K</td>
</tr>
<tr>
<td>Glazing</td>
<td>4 W/m²K</td>
<td>0,81 W/m²K</td>
</tr>
</tbody>
</table>

Source: A2M office
Sustainable renovation of non residential buildings

Innovative, replicable or successful 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
Sustainable renovation of non residential buildings

Innovative, replicable or successful concepts

Source: A2M office
Sustainable renovation of non residential buildings

Innovative, replicable or successful concepts

Source: A2M office
Sustainable renovation of non residential buildings
Innovative, replicable or successful 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 successful concepts

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]

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>roof/attic</td>
<td>~ 3.3</td>
<td>0.101</td>
</tr>
<tr>
<td>floor/slab</td>
<td>~ 0.6</td>
<td>0.154</td>
</tr>
<tr>
<td>walls</td>
<td>~ 2.3</td>
<td>0.130</td>
</tr>
<tr>
<td>ceilings</td>
<td>~ 3.3</td>
<td>0.130</td>
</tr>
<tr>
<td>windows</td>
<td>~ 1.3</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Source: Claudia Dankl
Sustainable renovation of non residential buildings
Innovative, replicable or successfull concepts

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

Source: Claudia Dankl
Sustainable renovation of non residential buildings
Innovative, replicable or successful concepts

Source: Claudia Dankl

Prefabricated façade elements

before renovation

after renovation
Sustainable renovation of non residential buildings
Innovative, replicable or successful concepts

New areas allow improvement of:
- **Daylight** (skylight, supply of light in classrooms...)
- **Quality of collective spaces and classrooms**

Source: Claudia Dankl
Sustainable renovation of non residential buildings
Innovative, replicable or successful concepts

Total Quality Building assessment

[Diagram showing assessment metrics with values: Resources conservation 4.3, Harmful impacts on humans and environment 3.9, User comfort (thermal, visual...) 4.4, Durability 4.5, Safety and security 4.5, Planning Quality 5.0, Infrastructure and equipment 2.0, Overall assessment 4.0]
Sustainable renovation of non residential buildings
Innovative, replicable or successful concepts

When compactness rhymes with comfort and quality of spaces
Renovation of Norwegian Tax Authority in Oslo, Norway
Architect: LPO Architects AS, Oslo
Sustainable renovation of non residential buildings

Innovative, replicable or successfully 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]

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</tr>
</thead>
<tbody>
<tr>
<td>Roof/attic</td>
<td>~ 0.2 – 1.0 (average 0.5)</td>
<td>0.12</td>
</tr>
<tr>
<td>Floor/slab</td>
<td>~ 0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Walls</td>
<td>~ 0.2 – 0.4</td>
<td>0.17</td>
</tr>
<tr>
<td>Ceilings</td>
<td>~ 0.3</td>
<td>0.12</td>
</tr>
<tr>
<td>Windows</td>
<td>~ 1.8</td>
<td>0.72</td>
</tr>
</tbody>
</table>
Sustainable renovation of non residential buildings
Innovative, replicable or successfull concepts

- 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 prefabricated façades (aluminium with specific design)

Typical floor plan before renovation

Typical floor plan after renovation
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 successful 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 successful concepts

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

Source: aa-ar office, sprl Alain Richard
Sustainable renovation of non residential buildings
Innovative, replicable or successfull concepts

Four axes of thinking:
- Prefabrication and reuse
- Restore links with the city and the built environment
- Energy and thermal issue in renovation
- Users participation

Source: aa-ar office, sprl Alain Richard
Sustainable renovation of non residential buildings
Innovative, replicable or successfull concepts

Enhance the structural mesh

Source: aa-ar office, sprl Alain Richard
Sustainable renovation of non residential buildings
Innovative, replicable or successful concepts

Reuse what is reusable, recycle the rest

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

Source: aa-ar office, sprl Alain Richard
Sustainable renovation of non residential buildings

Innovative, replicable or successfull concepts

Restore links with the city

Source: aa-ar office, sprl Alain Richard
Sustainable renovation of non residential buildings

Innovative, replicable or successful concepts

Energy and thermal issue

Source: aa-ar office, sprl Alain Richard
Sustainable renovation of non residential buildings
Innovative, replicable or successful concepts

Energy and thermal issue

Source : aa-ar office, sprl Alain Richard
Sustainable renovation of non residential buildings

Innovative, replicable or successful concepts

Source: aa-ar office, sprl Alain Richard
Thank you for your attention

Any questions?

Architecture et Climat
www-climat.arch.ucl.ac.be
sophie.trachte@uclouvain.be