Social LCA of buildings

Life cycle of buildings

Reuse, recycling

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Life cycle of buildings

- Building performance
  - Materials
  - Components
  - Elements
  - Occupants
  - Workers

- Resource extraction
- Production
- Construction
- Use
- End of life
- Disposal
- Reuse, recovery, recycling

Environmentally sustainable
Economically sustainable
Socially sustainable

MARIA ISABEL TOUCEDA GOMEZ - SOCIAL LIFE CYCLE ASSESSMENT OF BUILDINGS
Normative framework for buildings

- EU directives
  - Cost-optimality of minimum energy performance (EU) No 244/2012

- National regulations
  - Energy performance and renewable energy production

- Voluntary framework
  - CEN Committee TC 350 - Sustainability of construction works
CEN TC 350 Sustainability of construction works

- Work program
- Framework
- Building
- Product

NOTE: At present, technical information related to some aspects of social and economic performance are included under the provisions of EN 15804 to form part of EPD.
• Boundaries

Figure. Information modules in the life cycle of buildings. Source: EN 16309:2014
### Social performance categories

<table>
<thead>
<tr>
<th>Social performance categories</th>
</tr>
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<tbody>
<tr>
<td>Accessibility</td>
</tr>
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<td>Health and comfort</td>
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<td>Loadings on the neighbourhood</td>
</tr>
<tr>
<td>Maintenance</td>
</tr>
<tr>
<td>Safety / security</td>
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<tr>
<td>Sourcing of materials and services*</td>
</tr>
<tr>
<td>Stakeholder Involvement*</td>
</tr>
</tbody>
</table>

*Not considered yet in the last version of the standard (not ready for standardisation)*
EN 16309:2014 Methodology social assessment

- List of indicators

<table>
<thead>
<tr>
<th>Social performance categories</th>
<th>Social aspects</th>
<th>Indicators (some examples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessibility</td>
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</table>

- Thermal characteristics

- Building fabric related:
  - operative temperature;
  - humidity;
  - air velocity and distribution;
  - type of activities in the room;
  - type of users (e.g. activities, clothing).

- User and control system-related
  - operating T can be controlled [y/n]
  - humidity can be controlled [y/o]
  - air velocity and distribution can be controlled [y/n]
  - Etc.

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EN 16309:2014 Methodology social assessment

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<td>Loadings on the neighbourhood</td>
<td></td>
<td>Building fabric related:</td>
</tr>
<tr>
<td>Maintenance</td>
<td></td>
<td>Substances and particles (declared emissions or assessed concentration)</td>
</tr>
<tr>
<td>Safety / security</td>
<td></td>
<td>CO (ppm), CO₂, Radon [Bq/m³]</td>
</tr>
<tr>
<td>Sourcing of materials and services*</td>
<td></td>
<td>Ventilation rate (e.g. l/s)</td>
</tr>
<tr>
<td>Stakeholder Involvement*</td>
<td></td>
<td>Risk of mould growth</td>
</tr>
</tbody>
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**Characteristics of indoor air quality**

- Substances and particles (declared emissions or assessed concentration)
- CO (ppm), CO₂, Radon [Bq/m³]
- Ventilation rate (e.g. l/s)
- Risk of mould growth

**User and control system-related**

- Control of ventilation [y/n]
- Measurement and display of CO₂ level [y/n]
- Measurement of humidity [y/n]

*Not considered yet in the last version of the standard (not ready for standardisation)
• **Impact assessment**

  - No valuation methods
  - No reference points of performance
  - But these could be defined by regulations, label schemes, etc.
Conclusions

- Only the use-stage is covered
- Enables measuring and describing social performances
- Does not provide valuation methods, nor levels of performance.
- Societal aspects are excluded (e.g. equitability)
Assessing socioeconomic impacts of retrofitting
Context

Environmental targets
• Energy performance

Economic growth
• Create employment, fight against social dumping

Social cohesion
• Combating poverty

➢ The increase of retrofitting relies on public incentives
Goal

“To include socioeconomic aspects in life cycle assessment methodologies to assist decision making related to housing retrofitting”
Approach

Nature, Society

Environmental LCA

Workers

Safe & healthy working conditions

Job creation in fair conditions

Well-being & dignity

Health

Natural environment

Natural resources

World Health Org.

Social Hotspot Database

Nature, Society

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Approach

Nature, Society

Environmental LCA

- Indoor air quality
- Mould and adequate indoor temperatures
- Economic affordability

Users

Natural environment

Natural resources

Health

UNEP/SETAC

WHO

Well-being & dignity

Factors leading to poverty

UNEP/SETAC

Factors leading to poverty

Factors leading to poverty

Facets leading to poverty

Facets leading to poverty

Facets leading to poverty

Facets leading to poverty

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Approach

Nature + Society

Environmental LCA

Natural environment
Natural resources
Health
Well-being & dignity

The “State”

Contribution to economic growth

Social services

MARIA ISABEL TOUCEDA GOMEZ - SOCIAL LIFE CYCLE ASSESSMENT OF BUILDINGS
MERREDI DE L’INFO. L’ANALYSE SOCIALE DU CYCLE DE VIE (ASCV). 9 DÉCEMBRE 2015
Case study - FLORAIR social housing

“Quantify changes in sustainability due to renovation” (Δ_{retrofit-no retrofit, 30 years})

- Social housing, 60’s
- 182 households very low gross income (average 17856 €)
- Very low energy retrofitting
  226.91 kWh/m²y → 29.15 kWh/m²y
- Works:
  - External insulation façade panels
  - New windows double glazing
  - Roof: insulation + water tightness
  - Ventilation system type D
Boundaries of assessment

Quantify changes due to renovation

Operational energy

Sales

Transport

Works in situ

Repair, maintenance

USE (retrofitted-no retrofitted)

30 years

End of life

Background processes

Foreground processes (Belgium)

Housing in use

No-retrofitting scenario

Sales

Transport

Works in situ

Repair, maintenance

USE (retrofitted-no retrofit)

30 years

End of life

Quantify changes due to renovation

(Δretrofit-no retrofit, 30 years)
Workforce involved

Metal products - Belgium

Metaux Mozambique – 2 %

54 % damage to labour rights and decent work

Figure. Contribution to damage to labour rights and decent work. Source: Social Hotspots database.
Results (per household)

- **Workers**

<table>
<thead>
<tr>
<th>Safe &amp; healthy working conditions</th>
<th>PREVIOUS</th>
<th>RETROFIT</th>
<th>$\Delta_{(30 \text{ years})}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal accidents and diseases (foreground)</td>
<td>1.3E-05</td>
<td>4.1E-05</td>
<td>2.8E-05 [N]</td>
</tr>
<tr>
<td>Fatal accidents and diseases (background)</td>
<td>0.00094</td>
<td>0.00113</td>
<td>1.8E-04 [N]</td>
</tr>
</tbody>
</table>

**Damage to health**

(-) 0.104 DALY

DALY = Disability adjusted life years

(-) is avoided damages

**Social Hotspot Database method**

**Damage to labour rights and decent work**

<table>
<thead>
<tr>
<th>Job creation:</th>
<th>PREVIOUS</th>
<th>RETROFIT</th>
<th>$\Delta_{(30 \text{ years})}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreground proc.(BE)</td>
<td>104</td>
<td>371</td>
<td>267 [wh fair]</td>
</tr>
<tr>
<td>Background processes</td>
<td>4503</td>
<td>4920</td>
<td>416 [wh]</td>
</tr>
</tbody>
</table>

*wh= working hours

**Working hours with low risk of damage**

- Sector Ave Wage being lower than Country’s Minimum Wage
- Sector Ave Wage being lower than Country’s Non-poverty Guideline
- Wages being under $2 per day
- Child Labor in sector, Total
- Forced Labor by Sector
- Excessive working time by sector
- A country lacks or does not enforce Coll Bargaining rights
- A country lacks or does not enforce Freed. Of Ass. Rights
- A country lacks or does not enforce the Right to Strike
- Migrant workers are treated unfairly

$\Delta$ (30 years) = 315  
30  
5

Fair job creation + 272 working hours

$\Delta$ (30 years) = 267 + 5
Results (per household)

- Users

<table>
<thead>
<tr>
<th>Indoor environment</th>
<th>PREVIOUS</th>
<th>RETROFIT</th>
<th>Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence of mould</td>
<td>Yes</td>
<td>No</td>
<td>Yes→No</td>
</tr>
</tbody>
</table>

**WHO method**

mould - risk of asthma

Damage to health

(-) 0.054 DALY

\[ \text{DALY} = \text{Disability adjusted life years} \]

(-) is avoided damages

**Affordability**

<table>
<thead>
<tr>
<th>Operating costs (PV 30y- gas, ely,wtr)</th>
<th>PREVIOUS</th>
<th>RETROFIT</th>
<th>Δ_{(30 \text{ years})}</th>
</tr>
</thead>
<tbody>
<tr>
<td>-37023</td>
<td>-26376</td>
<td>10646 [€]</td>
<td></td>
</tr>
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</table>

\[ \Delta = (-) 3.32\% \]

(+ is an improvement)

>10% fuel poverty

Utility costs (gas + water + electricity) / household purchasing power

Fuel poverty index

Disposable income

(+ 3.32 %)

(+ is an improvement)

Utility costs (gas + water + electricity) / household purchasing power

Fuel poverty index

Disposable income

(+ 3.32 %)

(+ is an improvement)
### Results (per household)

#### The State

<table>
<thead>
<tr>
<th>Investments &amp; return (The &quot;State&quot;)</th>
<th>PREVIOUS</th>
<th>RETROFIT</th>
<th>( \Delta_{(30 \text{ years})} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment: works</td>
<td>0.00</td>
<td>34253</td>
<td>-34253 [€]</td>
</tr>
<tr>
<td>Repair &amp; maintenance</td>
<td>1729</td>
<td>978</td>
<td>+750 [€]</td>
</tr>
<tr>
<td>VAT: works (received)</td>
<td>0</td>
<td>-2154</td>
<td>+2154 [€]</td>
</tr>
<tr>
<td>VAT: energy (received)</td>
<td>-4477</td>
<td>-2629</td>
<td>-1848 [€]</td>
</tr>
<tr>
<td>VAT: maintenance (received)</td>
<td>-98</td>
<td>-55</td>
<td>-42 [€]</td>
</tr>
<tr>
<td>Contribution to social security</td>
<td>-102</td>
<td>-539</td>
<td>+437 [€]</td>
</tr>
<tr>
<td>Additional rent</td>
<td>0</td>
<td>-4700</td>
<td>+4700 [€]</td>
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**Avoided costs**

<table>
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<tr>
<th>Contribution to growth (30 y)</th>
<th>(-) 26142 [€]</th>
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* (-) cost is an expense; (+) is received

Life cycle costing methods
Application

- Six endpoint results ... *and now?*

- Exhausting data collection

- Extract conclusions for similar situations
  - Housing typology
  - Household typology
  - Housing conditions before works

- Some examples to optimize policies
  - Identify priorities for intervention
    
    (*households, housing typology and conditions*)
**Application- case study**

- Social housing
- Heating deprivation, mould before works
- Ver low-energy retrofitting

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<tr>
<th>Natural resources (Surplus cost [$])</th>
<th>Natural environment [species*year]</th>
<th>Damage to human health [DALY]</th>
<th>Fair working hours [wh]</th>
<th>Contribution to growth [\€]</th>
<th>Purchasing power [%]</th>
</tr>
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<tr>
<td>-6000</td>
<td>-0.0020</td>
<td>-0.4</td>
<td>4000.00</td>
<td>-30000.00</td>
<td>25.0%</td>
</tr>
<tr>
<td>-4000</td>
<td>-0.0015</td>
<td>-0.3</td>
<td>3000.00</td>
<td>-20000.00</td>
<td>20.0%</td>
</tr>
<tr>
<td>-2000</td>
<td>-0.0010</td>
<td>-0.2</td>
<td>2000.00</td>
<td>-10000.00</td>
<td>15.0%</td>
</tr>
<tr>
<td>0</td>
<td>0.0000</td>
<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
<td>10.0%</td>
</tr>
<tr>
<td>2000</td>
<td>0.0005</td>
<td>0.1</td>
<td>-1000.00</td>
<td>10000.00</td>
<td>5.0%</td>
</tr>
<tr>
<td>4000</td>
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**IMPROVEMENT**
## Application – housing stock level

- **Typologies** + **relevant scenarios**

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<th>Household</th>
<th>House conditions</th>
<th>Works</th>
<th>Degree of intervention</th>
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<tr>
<td>Income, tenure</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Q75</td>
<td>Mould+Very low T</td>
<td>Min requirem.</td>
<td>Local Minimum</td>
</tr>
<tr>
<td>Q50</td>
<td>Very low T (&lt;16°C)</td>
<td>Low E</td>
<td>Conventional Complete</td>
</tr>
<tr>
<td>Q25</td>
<td>Mouldy app.</td>
<td>Very low E</td>
<td></td>
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<td>Social housing</td>
<td>Heating deprivation</td>
<td>Passive</td>
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<tr>
<td></td>
<td>Thermal comfort</td>
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**Typologies**

- Social housing

**SCENARIOS**

- **Household Income, tenure**
- **Previous**
- **Post-works**
- **Sourcing**
- **Degree of intervention**

- Q75 Mould+Very low T: Local Complete
- Q50 Very low T (<16°C) Low E: Conventional Complete
- Q25 Mouldy app. Very low E: Minimum
- Social housing Heating deprivation: Passive Thermal comfort

- **Works**

- **House conditions**

- **Sourcing**
- Local
- Conventional

- **Degree of intervention**

- Minimum
- Complete

**FLORAIR**

- Scenario 0 (baseline - no retrofit)
- Scenario 1 (as built)
- Scenario 2 (cost-optimum)
- Scenario 3 (baseline - no retrofit)
- Scenario 4 (as built)
- Scenario 5 (cost-optimum)
- Scenario 6 (baseline - no retrofit)
- Scenario 7 (as built)
- Scenario 8 (cost-optimum)
Application - comparison

- **Two typologies in similar conditions**
- Private household - income average quartile Q25
- Heating deprivation, mould before works
- Very low-energy retrofitting

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![Image of building with labels indicating natural resources, environmental impact, and economic metrics.](image-url)
### Application – housing stock level

#### Typologies + relevant scenarios

<table>
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<th>Natural resources (Surplus cost [$])</th>
<th>Natural environment [species*year]</th>
<th>Damage to human health [DALY]</th>
<th>Fair working hours [wh]</th>
<th>Contribution to growth</th>
<th>Purchasing power [%]</th>
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Conclusions

- Impacts on retrofitting are highly related to
  - Housing conditions before retrofitting (temperature, mould, energy)
  - Household income, ownership
  - Origin of products, materials, workforce
- Necessary the monitoring of the housing stock
- A better performance in one aspect implies other consequences

*Decision making as a combination of objectives, thresholds, limits, ranges (e.g. fuel poverty line) based on baseline conditions*
Questions and discussion

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