CRAVEzero

Towards the definition of a nZEB cost spreadsheet as a support tool for the design

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CRAVEzero
Cost Reduction and market Acceleration for Viable nearly zero-Energy buildings

Initial investment
Calculated yearly energy demand

Life Cycle Cost
Design
Construction
End-of-Life
Operation
Maintenance

Time dimension

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Cost Reduction and market Acceleration for Viable nearly zero-Energy buildings

01 Data collection
Case studies

02 Life Cycle Cost
Methodology

03 Normalisation

04 Spreadsheet

05 Comparative analysis
Results

06 Sensitivity analysis
# CRAVEzero

Cost Reduction and market Acceleration for Viable nearly zero-Energy buildings

<table>
<thead>
<tr>
<th></th>
<th>Data collection</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Case studies</td>
<td>04</td>
<td>Spreadsheet</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Life Cycle Cost Methodology</td>
<td>05</td>
<td>Comparative analysis Results</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>Normalisation</td>
<td>06</td>
<td>Sensitivity analysis</td>
<td></td>
</tr>
</tbody>
</table>

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Cost Reduction and market Acceleration for Viable nearly zero-Energy buildings

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Life Cycle Cost

Main references: ISO 15686-5:2008 + Code of measurement for cost planning

- Phases to be considered
- Brakedown of building elements

\[ LCC = \sum_{n=1}^{p} \frac{C_n}{(1+d)^n} \]

LCC = NPV (40 years) for the costs associated to each phase

REF: ISO 15686 - Buildings and constructed assets -- Service life planning -- Part 5: Life-cycle costing
Life Cycle Cost

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04 Spreadsheet

05 Comparative analysis
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Normalisation

Construction costs:  
Cost index from http://constructioncosts.eu

Energy costs:  
Average prices from Eurostat

Climate conditions:  
Heating degree days

Building surface:  
Gross floor area
Normalisation

Construction Cost Index

<table>
<thead>
<tr>
<th>Country</th>
<th>Index</th>
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</thead>
<tbody>
<tr>
<td>France</td>
<td>103.87%</td>
</tr>
<tr>
<td>Austria</td>
<td>100.67%</td>
</tr>
<tr>
<td>Germany</td>
<td>96.62%</td>
</tr>
<tr>
<td>Italy</td>
<td>91.63%</td>
</tr>
<tr>
<td>Sweden</td>
<td>134.19%</td>
</tr>
</tbody>
</table>

Energy costs:
Average prices from Eurostat

Climate conditions:
Heating degree days

Building surface:
Gross floor area
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01 Data collection
Case studies

02 Life Cycle Cost
Methodology

03 Normalisation

04 Spreadsheet

05 Comparative analysis
Results

06 Sensitivity analysis
LCC Spreadsheet
CRAVEzero nZEB spreadsheet

<table>
<thead>
<tr>
<th>General project information</th>
<th>Whole Life Cost</th>
<th>Construction cost</th>
</tr>
</thead>
</table>

**Whole Life Cost**

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Sheet 1</th>
<th>Sheet 2</th>
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</thead>
<tbody>
<tr>
<td>Cost Breakdown</td>
<td>Building</td>
<td>HVAC</td>
</tr>
<tr>
<td></td>
<td>1200</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>1200</td>
<td>300</td>
</tr>
</tbody>
</table>

**Construction cost**

<table>
<thead>
<tr>
<th>Cost Item</th>
<th>Sheet 1</th>
<th>Sheet 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>1200</td>
<td>300</td>
</tr>
<tr>
<td>Labor</td>
<td>1200</td>
<td>300</td>
</tr>
</tbody>
</table>

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Section 1: Investment cost
- Share for design/materials/labour
- Design cost (preliminary, etc.)
- Cost for materials and labour
- Brakedown for building elements

Section 2: Life Cycle Cost
- Yearly LCC
- Brakedown for life cycle phases
- Energy and maintenance
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Methodology

03 Normalisation

04 Spreadsheet

05 Comparative analysis
Results

06 Sensitivity analysis

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## Comparative Analysis

### LCC breakdown

<table>
<thead>
<tr>
<th>Design cost</th>
<th>Labor cost</th>
<th>Maintenance cost</th>
<th>Cost of materials</th>
<th>Net energy consumed</th>
<th>Building site management</th>
</tr>
</thead>
<tbody>
<tr>
<td>GreenHome</td>
<td>Héliades</td>
<td>Alizari</td>
<td>NHTol</td>
<td>Parkcarré</td>
<td>More</td>
</tr>
<tr>
<td>IsolaA</td>
<td>IsolaB</td>
<td>Solallén</td>
<td>VålaGård</td>
<td>Aspen</td>
<td>Schertler</td>
</tr>
</tbody>
</table>

### LCC breakdown – average

- **Design**: 32%
- **Construction**: 49%
- **Energy**: 12%
- **Maintenance**: 2%
- **Other**: 5%
- **Building site management**: 0%
Comparative Analysis

Correlation between energy cost and U-value

R² = 0.56

Construction cost breakdown

- Building envelope cost
- Building structure cost
- Building services cost
- RES cost
- Other cost

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Case studies

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Methodology

03 Normalisation

04 Spreadsheet

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Results

06 Sensitivity analysis
Sensitivity Analysis

Case study: Résidence Alizari

Figure 1. Sensitivity index (s%) of boundary and assumptions – Résidence Alizari.

Figure 2. LCC variability according to the variations of boundaries and assumptions – Résidence Alizari.
Conclusions and Further Development

• An **operative methodology** for an EU-wide evaluation of life cycle cost.

• Overview of the main results for **11 exemplary case studies** was reported…

• …providing useful **benchmarks** for nZEB comparison and increasing the reliability of LCC.

  o Starting point for the development of an effective **LCC tool** (beta version available at cravezero.eu).

  o The broad application of the LCC analysis can foster the market uptake of nZEBs, highlighting the **cost-effectiveness and benefits during the life cycle**.
Thank you!

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www.cravezero.eu
References

- Kirk SJ, Dell'Isola AJ. Life cycle costing for design professionals; 1995.
- Langdon D. Life cycle costing (LCC) as a contribution to sustainable construction: A common methodology. Literature Review, Davis Langdon Management Consulting. 2007.
## LCC spreadsheet

### CRAVEZero nZEB spreadsheet

<table>
<thead>
<tr>
<th>Category</th>
<th>Cost 192 €/m²</th>
<th>Cost 773 €/m²</th>
<th>Cost 581 €/m²</th>
<th>Cost 1285 €/m²</th>
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</thead>
<tbody>
<tr>
<td><strong>Investment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design</td>
<td>Preliminary</td>
<td>10 €/m²</td>
<td></td>
<td>773 €/m²</td>
</tr>
<tr>
<td></td>
<td>Definitive</td>
<td>- €/m²</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Executive</td>
<td>182 €/m²</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Construction</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Materials</td>
<td>Building Elements</td>
<td>340 €/m²</td>
<td></td>
<td>581 €/m²</td>
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<tr>
<td></td>
<td>Building Services</td>
<td>197 €/m²</td>
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<td></td>
</tr>
<tr>
<td>Labor</td>
<td>Other</td>
<td>- €/m²</td>
<td></td>
<td>1285 €/m²</td>
</tr>
<tr>
<td><strong>LCC (40)</strong></td>
<td>Building site management</td>
<td>- €/m²</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Operation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td>Consumed</td>
<td></td>
<td>313 €/m²</td>
<td>146 €/m²</td>
</tr>
<tr>
<td></td>
<td>Heating</td>
<td></td>
<td></td>
<td>75 €/m²</td>
</tr>
<tr>
<td></td>
<td>Cooling</td>
<td></td>
<td></td>
<td>11 €/m²</td>
</tr>
<tr>
<td></td>
<td>DHW</td>
<td></td>
<td></td>
<td>57 €/m²</td>
</tr>
<tr>
<td></td>
<td>Household el.+ aux.</td>
<td>188 €/m²</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maintenance</strong></td>
<td>Produced</td>
<td></td>
<td>167 €/m²</td>
<td>366 €/m²</td>
</tr>
<tr>
<td></td>
<td>Envelope</td>
<td></td>
<td></td>
<td>152 €/m²</td>
</tr>
<tr>
<td></td>
<td>HVAC</td>
<td></td>
<td></td>
<td>201 €/m²</td>
</tr>
<tr>
<td></td>
<td>RES</td>
<td></td>
<td></td>
<td>13 €/m²</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
<td></td>
<td></td>
<td>0 €/m²</td>
</tr>
</tbody>
</table>

Normalised gross surface

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Example Case Study Parkcarré (K&M)
LCC Case Study analysis
Comparative analysis – case studies

Design cost (% - €/m²)

Investment/maintenance €/m²

Investment cost vs. Maintenance cost normalized

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LCC Case Study analysis

Comparative analysis – case studies

Breakdown of investment cost for construction element

Construction costs breakdown