Detailed Case Studies – main results, conclusions and lessons learnt from the analysis of real case studies from the residential building stock of participating countries

Renovating Buildings with Cost-Effective Reductions in Energy and Carbon Emissions – Findings from IEA EBC Annex 56

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1. Which buildings are “Detailed Case Studies” in the IEA EBC Annex 56?

2. Objectives of the analysis

3. Strategy to test the methodology

4. Renovation packages and results

5. Conclusions and lessons learnt
What are Detailed Case Studies?

• The Detailed Case Studies are both residential and non-residential buildings

• Which serve as model projects for renovations in each individual country

• The specific aim of the case study activity of this project was to provide significant and useful feedback from practice on a scientific basis.
Detailed Case Studies

- **Austria** – multi-family building
- **Czech Republic** – elementary school
- **Denmark** – multi-family building
- **Portugal** – two-family building
- **Spain** – multi-family building
- **Sweden** – multi-family building
<table>
<thead>
<tr>
<th>Country</th>
<th>Before</th>
<th>After</th>
<th>Site</th>
<th>Building type</th>
<th>Year(s) of construction</th>
<th>Year(s) of renovation</th>
<th>Gross Heated Floor Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td></td>
<td></td>
<td>Johann-Böhmstraße, Kapfenberg</td>
<td>Multi-family building</td>
<td>1960 – 1961</td>
<td>2012 – 2014</td>
<td>2845 m²</td>
</tr>
<tr>
<td>Czech Republic</td>
<td></td>
<td></td>
<td>Kamínky 5, Brno</td>
<td>Elementary School</td>
<td>1987</td>
<td>2009 – 2010</td>
<td>9909 m²</td>
</tr>
<tr>
<td>Denmark</td>
<td></td>
<td></td>
<td>Traneparken, Hvalsø</td>
<td>Multi-family Building</td>
<td>1969</td>
<td>2011 – 2012</td>
<td>5293 m³</td>
</tr>
<tr>
<td>Portugal</td>
<td></td>
<td></td>
<td>Neighborhood RDL, Porto</td>
<td>Two-family Building</td>
<td>1953</td>
<td>2012</td>
<td>123 m²</td>
</tr>
<tr>
<td>Spain</td>
<td></td>
<td></td>
<td>Lourdes Neighborhood, Tudela</td>
<td>Multi-family Building</td>
<td>1970</td>
<td>2011</td>
<td>1474 m²</td>
</tr>
<tr>
<td>Sweden</td>
<td></td>
<td></td>
<td>Backa röd, Gothenburg</td>
<td>Multi-family Building</td>
<td>1971</td>
<td>2009</td>
<td>1357 m²</td>
</tr>
</tbody>
</table>
Objectives of the Case Studies

The main objectives of this work were:

• To test the methodology

• To reach an in-depth understanding of the performance of the selected Case Studies

• To understand barriers and constraints for high performance renovations

• To support decision-makers and experts with profound, science based information for their future decisions

• To show successful renovation projects in order to motivate decision-makers and stimulate the market towards more ambitious renovations.
Definition of different renovation measures and packages

- Different energy efficiency levels of the building envelope
- Different energy sources for heating and DHW
- Different (mechanical) ventilation solutions
- Renewable energy generation on-site

Performing parametric studies

- Life Cycle Costs
- Carbon emissions
- Primary energy
- Co-benefits

Analysis of the influence of the different renovation measures on the total results
Results – „Case Study Kapfenberg, Austria“

Life Cycle Costs [EUR/(m²a)]

Carbon emissions [kg CO₂eq/(m²a)]

source: IEA EBC Annex 56
Results – „Case Study Kapfenberg, Austria“

source: IEA EBC Annex 56
Results – „Case Study Kapfenberg, Austria“

source: IEA EBC Annex 56
Results – „Case Study Kapfenberg, Austria“

- Insulation of the roof
- Insulation of the exterior wall
- Reference case

Life Cycle Costs [EUR/(m²a)]

Carbon emissions [kg CO₂eq/(m²a)]

source: IEA EBC Annex 56
Results – „Case Study Kapfenberg, Austria“

- Solar thermal installation
- Insulation of the roof
- Insulation of the exterior wall

Life Cycle Costs [EUR/(m²a)]

Carbon emissions [kg CO₂eq/(m²a)]

Reference case

source: IEA EBC Annex 56
Results – „Case Study Kapfenberg, Austria“

- New windows
- Insulation of the exterior wall
- Insulation of the roof
- Solar thermal installation

**Source:** IEA EBC Annex 56
Results – „Case Study Kapfenberg, Austria“

Life Cycle Costs [EUR/(m²a)] vs Carbon emissions [kg CO₂eq/(m²a)]

- Reference case
- Mech. Ventilation system
- Insulation of the exterior wall
- Insulation of the roof
- New windows
- Solar thermal installation

source: IEA EBC Annex 56
Results – „Case Study Kapfenberg, Austria“

Life Cycle Costs [EUR/(m²a)]

Carbon emissions [kg CO₂eq/(m²a)]

- PV system
- Mechan. ventilation
- Insulation of the exterior wall
- Insulation of the roof
- New windows
- Solar thermal installation

Reference case

source: IEA EBC Annex 56
Results – „Case Study Kapfenberg, Austria“

Cost-effective renovation measures

- Insulation of the exterior wall
- Insulation of the roof
- New windows
- Solar thermal installation
- Mech. ventilation
- PV system

Life Cycle Costs [EUR/(m²a)]

Carbon emissions [kg CO₂eq/(m²a)]

Reference case

source: IEA EBC Annex 56
Overall results – carbon emissions

source: IEA EBC Annex 56
Overall results – total primary energy

IEA EBC Annex 56

Source: IEA EBC Annex 56
Selected conclusions and lessons learnt (1/2)

• A switch to renewable energy sources reduces the carbon emissions more significantly than energy efficiency measures on one or more envelope elements.

• When the goal is to achieve high carbon emissions reductions, it is more cost effective to switch to renewable energy sources and carry out less far-reaching renovations on the building envelope than to focus on energy efficiency measures alone.

• Synergies can be achieved when a switch to renewable energy sources is combined with energy saving measures on the building envelope.

• The calculation results have shown that high carbon emissions and Primary Energy reductions are possible, where the corresponding renovation packages are also cost effective.

• However, results have also shown that not all investigated renovation measures bring a reduction of carbon emissions, primary energy and/or Life Cycle Costs. Moreover higher values, compared to the reference case, were calculated in some Case Studies.
• Missing good examples for successful renovations are often the biggest barriers for renovations towards nearly zero energy and emissions.

• The investigated Case Studies are such good examples, but more are needed.

• This means that national initiatives have to be launched to promote these kinds of building renovations. One of these initiatives could be the financial support or funding programs via direct funding or via research projects.

• A further important step towards cost effective building renovations is the consideration of the whole building life cycle. That means the Life Cycle Costs of the renovation packages should be regarded over the life cycle of the building and the building element. The investment costs should not be taken as main decision criterion.
Thank you for your attention!

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