POLICIES AND RESEARCH OF LOW CARBON CONSTRUCTION IN DENMARK

HARPA BIRGISDOTTIR
Low carbon construction

Certification

Building Code

Research

Building Code

Certification

Research

Low carbon construction
LCA on buildings carried out within the building sector
- First motivation through certification -

Year 2011

- **Tool:**
  - SBi develops an Excel LCA tool to perform LCA for DGNB certification in Denmark

- **Data:**
  - Building materials:
    - The German Ökobau database
    - EPDs
  - Operational energy:
    - Danish data representing year 2011
    - Static approach

- **Benchmark:**
  - Adapted from German benchmark applied within DGNB
Certified buildings in Denmark
DGNB certifications in Denmark

- Flex
- Existing offices
- City districts
- Schools / institutions
- Hospital
- Residential
- Office

November 2018
Why am I showing you statistics?
Important data for development of benchmarks

GWP

[Graph showing GWP for different cases with labels:
- Operation (B6)
- End of life (C3,C4,D)
- Replacements (B4)
- Production (A1-A3)]
Political visions

The Danish Government: Political strategy for buildings 2014
Including a vision for Voluntary Sustainability Class in the Building Code

SBi receives Rockwool prize to work further with development of the Voluntary Sustainability Class together with the building sector

Preparation of VSC by the agency (SBi and technical groups). Suggestions delivered to the minister

Waiting for a decision from the minister

LCAbyg
LCCbyg
Several publications

SBi – 26/03/2019
First – why voluntary class?

- Positive experiences with voluntary classes for the operational energy
Focus in Research and Development

- Development of a national **tool** LCAbyg
  - First version launched in April 2015, current version 3.2 (financed by the Agency and SBi)
  - New beta version introduced in January 2019 focusing on LCA in early design stages (financed by external funding and SBi)

- Development of robust **methodology**

- Development of **benchmarks** for DGNB and Voluntary Sustainability Class
National tool - LCAbyg

About 3000 registered users in total
National tool - LCAbyg

- **Methodology:**
  - Reference study periods 80-120 years
  - Forecasting future low carbon development of energy supply

- **Data:**
  - Building materials:
    - The German Ökobau database
    - EPDs
  - Operational energy:
    - Danish data representing year 2015-2050
    - Static approach for 2015 (available)
    - Forecasting from 2015-2050 (recommended)

- **Benchmark:**
  - First benchmarks: Office and Residential developed from data from Danish DGNB certification
  - Second benchmarks: Based on more robust data under development in 2019
Resent results for an office building based on recommended method

![Diagram showing GWP kg CO₂-equivalents/m² over reference study period (years)]

- **GWP embodied**
- **GWP building operation**
- **Regulated**
- **Not regulated**

**Graph Details:**
- X-axis: Reference study period (years)
- Y-axis: GWP kg CO₂-equivalents/m²

**Note:**
- SBi – 26/03/2019
- SBi report 08:2017
What is happening with the blue line?

Production of materials (A1-A3)

Replacements:
- Floor (15 years)
- Windows (30 years)
- Heatingsystem (30 years)
- Facade (30 years)

Replacements:
- Floor (15 years)

Replacements:
- Roof (40 years)

GWP-embodied

GWP-building operation
Consequences of using static versus forecasting

\[ \text{kg CO}_2/\text{m}^2 \]

\[ \text{kg CO}_2/\text{m}^2 \]
Consequences of how results are presented
Benchmarks – why is this so complicated?

- Enough building cases
- Representing different building types
- Based on robust methodology
- Based on robust data
Experiences with benchmarks from certification

Usually enough to lower operational energy
- No focus on embodied

GWP

[Graph showing GWP values for different cases with categories for Operation (B6), End of life (C3,C4,D), Replacements (B4), and Production (A1-A3)].
Ongoing development of benchmarks

2018: Recent benchmarks for DGNB certification based on

- Offices (16 cases)
- Residential (7 cases)

2019: Ongoing development for the Voluntary Sustainability Class in the building code

Knowledge and experiences from participation in:

- IEA Annex 57 (completed)
- IEA Annex 72 (ongoing)
Political focus on Circular economy

- Advisory board for circular economy
- Recommendations to the government (June 2017)
- Strategy from the government (September 2018)
Circular economy – carbon – what are the benefits and when?
Upcycle – Design for disassembly

Residential, single-family
129

Residential, multi-family
77
Circular economy – carbon – what are the benefits and when? Upcycle – Design for disassembly
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Upcycle – Design for disassembly

<table>
<thead>
<tr>
<th>Construction</th>
<th>GWP in kg CO₂-eq/m²/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upcycle building – regular construction</td>
<td>4.7</td>
</tr>
<tr>
<td>Upcycle building – upcycled construction</td>
<td>3.6</td>
</tr>
<tr>
<td>DfD building</td>
<td>6.7 (-2.4)</td>
</tr>
</tbody>
</table>
Testing of Level(s) in Denmark

• Currently 17 building projects are being tested in Denmark

• SBi has the role of evaluating the Danish experience from the process

• Workshops together with the 17 projects

• Final report in autumn 2019
Concluding remarks

- Focus on the blue line (embodied)
- Understanding by practitioners
- Robust calculations/data
- Cool (but robust) tools enhancing the understanding of embodied impacts
References

- **IEA EBC Annex 57 ‘Evaluation of Embodied Energy and CO2eq for Building Construction’**. Birgisdottir, Harpa; Moncaster, Alice; Houlihan Wiberg, Aoife; Chae, Chang; Yokoyama, Keizo; Baloukti, Maria; Seo, Seongwon; Oka, Tatsuo; Lützkendorf, Thomas; Malmqvist, Tove. Energy and Buildings, Bind 154, 11.2017, s. 72-80.

- **Analysing methodological choices in calculations of embodied energy and GHG emissions from buildings** Rasmussen, Freja Nygaard; Malmqvist, Tove; Moncaster, Alice; Houlihan Wiberg, Aoife; Birgisdottir, Harpa. Energy and Buildings, Bind 158, 01.2018, s. 1487–1498.


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- **Life cycle assessment benchmarks for Danish office buildings**. Rasmussen, Freja Nygaard; Birgisdottir, Harpa. Life-Cycle Analysis and Assessment in Civil Engineering: Towards an Integrated Vision. red. / Caspeele; Taerwe; Frangopol. Taylor & Francis, 2019. s. 815-821.