Today’s agenda

• Introduction to Nordic Harmonization of LCA – Maria Tiainen, Finnish Ministry of the Environment
• Introduction to webinar and project overview – Morten Ryberg, Sweco DK
• Findings and recommendations
  • LCA practice and regulations on the Nordic countries – Kai Kanafani, BUILD
  • Key variables for setting limit values and recommendations on a process for setting and following limit values for buildings – Maria Balouktsi, BUILD
  • Recommendations for environmental building stock monitoring – Nicolaj Langkjær, Sweco DK
• Q&A and next steps – Morten Ryberg, Sweco DK
Nordic Harmonization of LCA
- Limit Values and Monitoring of decarbonization in the building stock

Sweco, BUILD, EFLA and LCA Support
26 01 2024
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We will note down and, if possible, answer all questions in the Slido Q&A
Using Slido for polls
Which country are you joining us from?
Using Slido for Questions and Comments

Webinar: Harmonised CO2-eq Limit Values for Buildings and Mo...
Audience Q&A Session
Which country are you joining us from?
Limit values and decarbonization of the building stock
- Introduction

Morten Ryberg
Sweco

Nordic Sustainable Construction
What type of organisation are you part of?
Nordic Harmonisation of LCA

1. Analysis of Nordic LCA-practices
2. Data for LCA
3. BIM for LCA - calculating the climate impact of buildings through digitalization
4. GHG limit values and reporting of the decarbonization of the Nordic building stock
Task 4 Overview

4.1 Setting and assessing limit values
- Analysis of the different regulatory needs and LCA requirements
- Analysis of variables that impact limit values
- Recommendations for an optimal process for setting and following limit values for buildings

4.2 Process for monitoring the decarbonization of the building stock
- Analysis of policies and methods for setting decarbonization goals
- Utilization of statistics and data for monitoring building stock carbon emissions
- Recommendations on process for monitoring decarbonization of the building stock

4.3 Report on monitoring decarbonization of the building stock
- Approaches and recommendations for monitoring the decarbonization
- Recommendations for setting limit values to incentivize decarbonization of properties
Overall Project Timeline

Start June ‘23

EAG Meeting, Oct ‘23
EAG Meeting, Jan ‘24

Webinar, Jan ‘24
EAG Meeting, April ‘24

Final report launch, summer ‘24

4.1 Setting and assessing limit values
Analysis of the different regulatory needs and LCA requirements
Analysis of variables that impact limit values and impact assessment
Optimal process for setting and following limit values for buildings

4.2 Process for monitoring the decarbonization of the building stock
Availability of statistics and data for building stock emission modelling
Analysis of policies and methods for setting decarbonization goals
Recommendations for monitoring building stock carbon emissions

4.3 Final report - decarbonization of building stock
Preparing final draft for internal and external review
Publication process

Nordic Sustainable Construction
What type of organisation are you part of?
TASK 4.1
- LCA methods and limit values

Kai Kanafani & Maria Balouktsi
BUILD AAU

Nordic Sustainable Construction
Nordic Sustainable Construction

Nordic Harmonization of Life Cycle Assessment

Task 4

Limit Values And Reporting

Task 4.1
Task 4.2
Task 4.3

Setting And Assessing Limit Values

Task 4.1.1
Task 4.1.2
Task 4.1.3

Task 4.1 A
Regulatory Needs

Task 4.1 B
Influential Variables

Task 4.1 C
Recommendations

Task 4.1 D
Impact Assessment
Task 4.1 A

Current approaches and harmonization potential

- Current status and roadmap for building carbon regulation
- National LCA definitions
- Preconditions for carbon regulation

Nordic Sustainable Construction

Please pose questions and comments in Slido slido.com #4196709
# Legislation Schedule

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<tbody>
<tr>
<td>Denmark</td>
<td>Danish Building Regulation</td>
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<td>Finland</td>
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<td>Norway</td>
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<td>Sweden</td>
<td>Klimatdeklaration</td>
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<td>Estonia</td>
<td>Climate Declaration</td>
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<tr>
<td>Iceland</td>
<td>Climate Declaration</td>
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<td>Europe</td>
<td>Taxonomy and EPBD</td>
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</tbody>
</table>

Integration in national legislation ✝ Limit values (to be) integrated
Test phase of coming regulation Draft method publication
Preliminary method development Declaration scope extension
Roadmap

"Blue" indicates proposals, not final decisions.

Nordic Sustainable Construction
### Buildings covered

<table>
<thead>
<tr>
<th>BUILDING TYPE</th>
<th>DENMARK</th>
<th>ESTONIA</th>
<th>FINLAND</th>
<th>ICELAND</th>
<th>NORWAY</th>
<th>SWEDEN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BR18</td>
<td>Proposed climate declaration</td>
<td>Proposed climate declaration + limit value</td>
<td>Proposed climate declaration</td>
<td>TEK17</td>
<td>Proposed limit values 2025 (likely in line with climate declaration 2022)</td>
</tr>
<tr>
<td>SINGLE-FAMILY HOME</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>✔</td>
<td>✓</td>
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<tr>
<td>OTHER RESIDENTIAL BUILDING</td>
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<td>✓</td>
<td>✓</td>
<td>✔</td>
<td>✔</td>
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<td>OFFICE</td>
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<td>✓</td>
<td>✓</td>
<td>✔</td>
<td>✔</td>
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<td>RETAIL AND RESTAURANT</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✔</td>
<td>✔</td>
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<td>SCHOOL AND DAYCARE</td>
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<td>✓</td>
<td>✓</td>
<td>✔</td>
<td>✔</td>
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<td>✓</td>
<td>✓</td>
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<td>✔</td>
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<td>HOSPITAL AND HEALTH</td>
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<td>✔</td>
<td>✔</td>
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<td>SPORTS FACILITIES</td>
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<td>✓</td>
<td>✔</td>
<td>✔</td>
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<td>CULTURAL AND OTHER PUBLIC</td>
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<td>RELIGIOUS</td>
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<td>SUMMER COTTAGES</td>
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<td>✔</td>
<td>✔</td>
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<tr>
<td>OTHER</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>RENOVATION PROJECTS</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

#### SIZE OF BUILDINGS

- **2023-2025:**
  - > 1000 m²: unspecified
  - From 2025: no size requirement, just building type

- **Proposed Climate Declaration Scope**
  - permitted buildings under scope classes 2 and 3 in BR

- **Proposed Limit Value Scope**
  - no size requirement, just building type

- **Current Literature**
  - > 100 m²: unspecified

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**LIMIT VALUE SCOPE**

- ✓ = included

**CLIMATE DECLARATION SCOPE**

1. Exceptions apply
2. When building permit is needed (additional exemption rules for Sweden)
3. Included when in blocks
4. Only buildings subject to energy requirements
## Compliance system

<table>
<thead>
<tr>
<th></th>
<th>DENMARK (PROPOSED)</th>
<th>ESTONIA (PROPOSED)</th>
<th>FINLAND (PROPOSED)</th>
<th>ICELAND (PROPOSED)</th>
<th>NORWAY</th>
<th>SWEDEN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TECHNICAL COMPLIANCE CONTROL</strong></td>
<td>10% of cases checked</td>
<td>Not decided yet</td>
<td>Not decided yet</td>
<td>Not decided yet</td>
<td>Yes</td>
<td>10 % of cases checked</td>
</tr>
<tr>
<td><strong>EXTERNAL VERIFICATION</strong></td>
<td>No</td>
<td>Not decided yet</td>
<td>Not decided yet (possibly BIM file)</td>
<td>Not decided yet</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>REPORTING STAGE</strong></td>
<td>As-built</td>
<td>Building permit</td>
<td>Building permit + As-built</td>
<td>Building permit + As-built</td>
<td>As-built</td>
<td>As-built</td>
</tr>
<tr>
<td><strong>PUBLIC BUILDING LCA REGISTER</strong></td>
<td>No</td>
<td>Not decided yet</td>
<td>Not decided yet</td>
<td>Not decided yet</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Carbon limit approach

**Target approach (top-down)**
- Panetary boundary for Climate Change
- National sector-specific carbon budgets

**Empirical approach (bottom-up)**
- Observation of best practice (case sample / archetypes)
- Trajectory based on observed distribution

Examples of target-based initiatives:
- Reduction Roadmap (DK)
- DG Environment report (EU)
Selected technical variables

Reference unit
- Varies considerably
- Bound to existing building regulations
- DK: Area correction for adjacent spaces
- EU/Level(s) requires Usable Floor Area (UFA)

Scenario-based climate data
- All countries propose to use future scenarios for module B6 (also required by Level(s))
- No country proposes this for other modules (e.g. B4)

Energy exported to grid
- Included in DK (module D), FIN (Handprint)
- SWE: Declared separately, since B6 is lacking
- EU/Level(s): Exported energy in module D
Readiness

How to enable the industry to perform compliant LCA?

1) Experience, competence, education
2) Precedence, voluntary schemes
3) Available data infrastructure

Scope

Data infrastructure
<table>
<thead>
<tr>
<th>SCOPE</th>
<th>DATA INFRASTRUCTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Life cycle</strong></td>
<td><strong>Generic module impacts</strong></td>
</tr>
<tr>
<td>NO/SWE omit EoL stages</td>
<td>Novel modules A4-5, C1-2 (FIN, EST, DK*)</td>
</tr>
<tr>
<td>DK/FIN/IS include biogenic carbon</td>
<td>Allowed for as-built reporting (all: Yes)</td>
</tr>
<tr>
<td>All lack some use-stage modules</td>
<td></td>
</tr>
<tr>
<td>EU/Level(s) require full scope</td>
<td></td>
</tr>
<tr>
<td><strong>Building and processes</strong></td>
<td><strong>Generic inventory data</strong></td>
</tr>
<tr>
<td>FIN/SWE omit site preparation</td>
<td>Material quantity and design (DK: informative)</td>
</tr>
<tr>
<td>and evt. deep foundations</td>
<td>Product service life (FIN, EST, DK)</td>
</tr>
<tr>
<td>SWE omits services in small</td>
<td></td>
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<tr>
<td>buildings</td>
<td></td>
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<tr>
<td>FIN/SWE include fixed furniture</td>
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<tr>
<td></td>
<td><strong>Generic impact data</strong></td>
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<tr>
<td></td>
<td>Construction products (FIN, EST, SWE, DK)</td>
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<td></td>
<td>Building services (DK)</td>
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<tr>
<td></td>
<td>Transport processes (DK*, FIN, SWE)</td>
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<tr>
<td></td>
<td>A5 energy or waste (EST, FIN, NO, SWE, DK*)</td>
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<tr>
<td></td>
<td><strong>Calculation tools</strong></td>
</tr>
<tr>
<td></td>
<td>Pivotal role of tools in all countries</td>
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</tbody>
</table>
**Task 4.1 B**

**Analysis of variables**

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**Literature study on existing limit value reports**

Existing limit value reports from Nordic countries and some other European countries to collect the parameters/variables identified as having a notable influence in each context.

**Parameter analysis**

Performed with two generic case models, based on a typical apartment building and a detached home. Base: real cases, adjusted to represent more straightforward and simple models.

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<table>
<thead>
<tr>
<th>BUILDING STOCK DATA (as a basis for limit values)</th>
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<tbody>
<tr>
<td>Building stock approaches (pros/cons)</td>
</tr>
<tr>
<td>Building inventory quality</td>
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</table>

<table>
<thead>
<tr>
<th>SCOPE (building parts, life cycle processes)</th>
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<tbody>
<tr>
<td>Foundation types/ site preparation</td>
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<tr>
<td>Basement parking</td>
</tr>
<tr>
<td>Landscaping/ external works</td>
</tr>
<tr>
<td>Construction site process (AS)</td>
</tr>
<tr>
<td>Building services and refrigerants</td>
</tr>
<tr>
<td>Internal finishes/ fixed furniture</td>
</tr>
<tr>
<td>Often missing B/C modules</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>METHOD (normalisation, handling of scenario-based future processes)</th>
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<tbody>
<tr>
<td>Reference unit</td>
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<tr>
<td>Future emissions discounting</td>
</tr>
<tr>
<td>Future decarbonisation scenarios</td>
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</table>

<table>
<thead>
<tr>
<th>CLIMATE DATA</th>
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</thead>
<tbody>
<tr>
<td>Generic climate data</td>
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<table>
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<tr>
<th>BUILDING DESIGN</th>
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<tbody>
<tr>
<td>Foundations/ Internal walls (amount)</td>
</tr>
<tr>
<td>Structural frame/ Facade (type)</td>
</tr>
<tr>
<td>Basements/ Balconies (presence)</td>
</tr>
</tbody>
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<tr>
<th>LIMIT VALUE PROGRESSION (future technologies, design, etc.)</th>
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<tbody>
<tr>
<td>Best available technology today</td>
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<tr>
<td>Future technology</td>
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</table>
Building stock data for first generation limit value(s): two broad approaches for creating a building data base

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sampling/ Real buildings</th>
<th>Archetype</th>
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</thead>
<tbody>
<tr>
<td>Cases sample needed</td>
<td>Large, necessary for validity</td>
<td>Small, only needed for verification</td>
</tr>
<tr>
<td>Systematic error probability</td>
<td>Low, due to specific case analysis</td>
<td>High, due to complex theoretical modelling</td>
</tr>
<tr>
<td>Parameter control</td>
<td>Low-moderate, large samples allow varying the emission data and the share of cases with certain properties (i.e. structural frame) depending on the depth of data available</td>
<td>High, building specifications can be changed at will, though requiring high technical expertise</td>
</tr>
<tr>
<td>Suitability for as-is analysis of the building stock</td>
<td>Without mandat. declarations: Low-moderate, representativity depends on case number and selection, related national statistics needed With mandat. declarations: High, due to a complete sample</td>
<td>Low-moderate, representativity depends on data input</td>
</tr>
<tr>
<td>Suitability for developing building stock scenarios or top-down target-based limit values</td>
<td>Moderate, depending on available best practice cases, however difficult to isolate cause/effect of parameters Optional: emission data and case selection (i.e. structural frame) allow scenarios</td>
<td>High, due to high parameter control, though requiring high technical expertise</td>
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</table>
## Scope context- and location-specific aspects

### EXAMPLES OF MAXIMUM CONTRIBUTIONS INDICATED IN NATIONAL STUDIES (dependent on scope and building type)

<table>
<thead>
<tr>
<th>Description</th>
<th>Max contribution (%</th>
<th>Max absolute impact (kgCO₂e/m²/yr.)</th>
<th>Country (report)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Deep foundations/ Soil stabilisation</td>
<td>up to 30%</td>
<td>&gt; 4</td>
<td>FI (Bionova report, 2021)</td>
</tr>
<tr>
<td>Should the limit value influence suitable construction locations / zoning?</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2. Basement parking</td>
<td>up to 17%</td>
<td>&gt; 1.7</td>
<td>DK (BUILD 2023:21)</td>
</tr>
<tr>
<td>Should the limit value affect available parking space?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. External works/ Landscaping</td>
<td>up to 28%</td>
<td>&gt; 3</td>
<td>NO (ZEN report, 2021)</td>
</tr>
<tr>
<td>Should the limit value affect landscaping and infrastructure?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Construction site (A5)</td>
<td>up to 18%</td>
<td>&gt; 1.7</td>
<td>DK (BUILD 2023:14)</td>
</tr>
<tr>
<td>Should the limit value interfere with site conditions?</td>
<td></td>
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</tbody>
</table>

Significant influence on total GWP, but what aspects should the limit value affect?
**Scope**

Often missing building parts and B/C modules

- Excluding replacements (B4) in the scope undermines the relevance of certain building items
- Refrigerant leakage (B1) can significantly increase the contribution of building services to buildings’ whole life impact
Method

Reference area unit

- Big differences, implications for basements, balconies, etc.
- Normalizing results per resident or building user could help account for how efficiently the space is used

LCA results normalized (scope, data) using different reference area units; Nordic countries & LEVEL(s)
Method: Approach to future scenarios (B and C modules)

A shift towards more dynamic considerations are discussed in some countries...

A. Future emissions with simplified discounting:
- ~10-20% lower LCA result when simplified discount factors are applied
- promotes use of wood as C3 impacts (+1) are also discounted

B. Future emissions with material type specific decarb. scenarios:
- Up to ~25% lower LCA result when considering the most ambitious future decarb. for both operational and embodied part (B4, C3 of non-wood products)
- more product-neutral method, -1/+1 method for wood is preserved

Application of technological factors (from literature) per broad product category

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Even if Nordic countries were using the same assessment scope and method, comparability is still hindered by differences in data. Great variations in some values used for similar products in national databases – reflect differences in conservative factors, background data, or actual differences in the products.
Building Design

- presence of a basement leads to lower emissions per m² in cases with high emissions, and slightly higher emissions per m² in cases with low emissions.

- Structural frame and façade choices become constrained with tight limit values, not considering future material decarbonization opportunities.

Emb. GWP: 6 kgCO₂e/m²·yr

Emb. GWP: 7 kgCO₂e/m²·yr

no case with brick façade feasible

only 2 concrete frame cases still feasible

Combined analysis of influence of:
- type of structural material
- type of façade material
- amount of internal walls
- presence of basement
- presence of balconies

• presence of a basement leads to lower emissions per m² in cases with high emissions, and slightly higher emissions per m² in cases with low emissions.

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only 2 concrete frame cases still feasible

Combined analysis of influence of:
- type of structural material
- type of façade material
- amount of internal walls
- presence of basement
- presence of balconies

• presence of a basement leads to lower emissions per m² in cases with high emissions, and slightly higher emissions per m² in cases with low emissions.

• Structural frame and façade choices become constrained with tight limit values, not considering future material decarbonization opportunities.

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• Structural frame and façade choices become constrained with tight limit values, not considering future material decarbonization opportunities.
Carbon Limit Progression
How much can limit values be tightened?

Product-specific EPDs
Optimised products today (within a product category)
Future decarb. of material production processes
Design optimisation and alternative material choices
Improved operational performance
Location optimisation
Improved construction processes

What reduction level could be achieved without additional effort from the building actors?

What reduction level could be achieved by actual changes in design, energy performance, etc.?

Nordic Sustainable Construction
Possible reduction with no great effort

Today’s best available technology must be seen as the typical practice in the future construction – needs to be reflected in the limit value progression.
Nordic Harmonization of Life Cycle Assessment

Task 1  Task 2  Task 3

Task 4

Limit Values And Reporting

Task 4.1  Task 4.2  Task 4.3

Setting And Assessing Limit Values

Task 4.1 A  Task 4.1 B  Task 4.1 C  Task 4.1 D

Regulatory Needs  Influential Variables  Recommendations  Impact Assessment
Task 4.1 D
Impact assessment

Areas of change

- Architecture - Culture
- Technical requirements
- Product technology
- Environment
- Economy

Analysis of expected changes different limit values scenarios are expected to cause or require

Actors and levels of change

- Investor developers
- Owners
- Authorities
- Users citizens
- Consultancies
- Contractors
- Suppliers
- Micro level (project)
- Meso level (city/region)
- Macro level (branch/country)
- Activists
- Developers
- Investors
- Owners
- Users citizens
- Consultancies
- Contractors
- Suppliers
- Meso level (city/region)
- Macro level (branch/country)
What variables are suited to be harmonized across regions?
What location-sensitive variables should be out of scope for the initial limit values?
Nordic Sustainable Construction

Nordic Harmonization of Life Cycle Assessment

Task 1  Task 2  Task 3

Task 4

Limit Values And Reporting

Task 4.1  Task 4.2  Task 4.3

Setting And Assessing Limit Values

Task 4.1 A
Regulatory Needs

Task 4.1 B
Influential Variables

Task 4.1 C
Recommendations

Task 4.1 D
Impact Assessment
# Recommendations

For developing and implementing limit values

## VARIABLE

<table>
<thead>
<tr>
<th>Competence building</th>
<th>RECOMMENDATION</th>
<th>HARMONIZATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Voluntary declaration scheme</td>
<td><strong>EU</strong>: New learning material is being developed in ongoing EU-project</td>
</tr>
<tr>
<td></td>
<td>Iterative stakeholder feedback</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Academic and professional education</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Stakeholder involvement</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Consultation groups for evaluating experiences and discussing key decisions</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Generic data</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Generic impact data for products and processes close data gaps</td>
<td><strong>Nordic</strong>: structure and content of the national generic climate databases (e.g. product categories and variants, indicators, applied conservative factors), guidelines for EPD developers by the national program operators</td>
</tr>
<tr>
<td></td>
<td>Generic service life secure harmonized assessments</td>
<td><strong>EU</strong>: Construction Products Regulation and EcoDesign Directive will make environmental product data mandatory in the long term</td>
</tr>
<tr>
<td></td>
<td>Generic process/module impact data and standard components and systems aid implementation</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EPD availability &amp; digitalization</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EPD data shall be digitally accessible and exchangeable for improved feasibility</td>
<td><strong>Nordic</strong>: Common platform with mapping tables for conversion</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Building model</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Define structure and level of detail of building model</td>
<td><strong>EU</strong>: Level(s) may define overall principles</td>
</tr>
<tr>
<td></td>
<td>Use classification standard and allow conversion</td>
<td></td>
</tr>
</tbody>
</table>
Recommendations
For developing and implementing limit values

**VARIABLE** | **RECOMMENDATION** | **HARMONIZATION**
--- | --- | ---
Building database | Collect detailed building stock data  Existing LCA from voluntary schemes might be useful  Define sample and eventually archetypes representative for building stock  Case analyse parameters may relate to limit value differentiation | **Nordic:** Possible Nordic case database with harmonized parameters and structure will boost learnings on low-carbon solutions and barriers

Carbon limit differentiation | Building sample analysis shall support the necessary differentiation after type, size or other building parameters  The actual optimization potential might differ between buildings | **Nordic:** Common criteria for differentiating limit values  
**EU:** EPBD requires limit value roadmaps to per building type and climate zone

Trajectory towards full scope | Implementation of declarations/limit values may require a gradually expanding scope  Alternatively, generic/standard data and definitions can fill gaps and speed up implementation | **EU/Nordic:** Trajectories depend much on the harmonization of life cycle scope and scenarios
## Recommendations

For developing and implementing limit values

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>RECOMMENDATION</th>
<th>HARMONIZATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building reference area</td>
<td>Also declare results per useful floor area (UFA) to get EPBD-ready.</td>
<td><strong>EU:</strong> UFA required for mandatory declarations for &gt;1,000 m² buildings by 2028</td>
</tr>
<tr>
<td></td>
<td>Analyze adjacent spaces (basement, attic, external stairs/ramps and balconies)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Optional: Consider occupancy-related units (e.g. impact per user) to reduce total area</td>
<td></td>
</tr>
<tr>
<td>Cost-effectiveness</td>
<td>Disclose roadmap for scope and limit values early on.</td>
<td><strong>EU:</strong> EPBD requires national limit value roadmaps by 2027 – principles yet to be defined</td>
</tr>
<tr>
<td></td>
<td>Monitor industry readiness.</td>
<td><strong>Nordic:</strong> Different national decarbonization goals and pathways have to be respected</td>
</tr>
<tr>
<td></td>
<td>Monitor building stock for calibrating feasible carbon levels</td>
<td></td>
</tr>
<tr>
<td>Carbon regulation of renovations</td>
<td>Develop carbon declaration method.</td>
<td><strong>Nordic:</strong> Align scope, method and data</td>
</tr>
<tr>
<td></td>
<td>Test regulation on voluntary basis.</td>
<td></td>
</tr>
</tbody>
</table>
TASK 4.2
- Monitoring the decarbonization of the building stock
Nordic Harmonization of Life Cycle Assessment

Task 1  Task 2  Task 3

Task 4

Limit Values And Reporting

Task 4.1  Task 4.2  Task 4.3

Monitoring the decarbonization of the building stock

Task 4.1 A
Policies and strategies for decarbonization

Task 4.1 B
Process for monitoring the decarbonization of the building stock

Task 4.1 C
Forecasting and modelling of future scenarios
Environmental building stock modelling

A  Product life cycle
B  Energy analysis
C  Material flow
D  Financial flow

- National climate declarations
- B6 (LCA)
- National accounts (reduction goals)
Which environmental building stock modeling approach do you see best fit for assessing decarbonization efforts?
Building stock carbon monitoring

1. Archetype modeling with LCA/energy modelling (*Bottom up*)
   Archetypes with emissions factors are defined. Monitoring on building stock level is achieved by utilizing data on newly added m² pr. archetype to the building stock.

2. Sample LCA/Energy model (*Bottom up*)
   Sampling carbon emission reporting (climate declaration). Monitoring is enabled with complete sample.

3. Financial modeling (EIOA) (*Top down*)
   Typically, environmental input-output analysis. Emission factors are accounted to financial flows. Monitoring is already established.
Building stock carbon monitoring

1. **Archetype modeling with LCA/energy modelling (Bottom up)**
   Archetypes with emissions factors are defined. Monitoring on building stock level is achieved by utilizing data on newly added m2 pr. archetype to the building stock.

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   Typically, environmental input-output analysis. Emission factors are accounted to financial flows. Monitoring is already established.
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Possibility to investigate cause and effect on building level

Possibility to investigate effect on macro level
Financial flow modeling (EIOA)

- Comparable with strategic national Co2 reduction goals
- Reporting is already established (national accounts)

Industry-specific total emissions

- Comparable with CO2 limit values in climate declarations
- Affordability bias
- Identification of solutions on building level
- Doesn’t allow to research emission causes on micro level
# Existing data landscape

## Database information gathering

<table>
<thead>
<tr>
<th>#</th>
<th>Database name</th>
<th>Brief description</th>
<th>Responsible organization</th>
<th>Link to organization</th>
<th>Link to database</th>
<th>Data type</th>
<th>Relevant key data</th>
<th>Coverage area</th>
<th>Accessibility</th>
<th>Access cost</th>
<th>Format</th>
<th>Responsible for data update</th>
<th>Update frequency</th>
<th>Integration</th>
<th>Legal C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BBR - Building and Housing Register</td>
<td>In BBR (Building and Housing Register), you can find information about all buildings and residences in Denmark. There is a lot of information available for each individual building, such as its location, its usage, size, and age.</td>
<td>Ministry of Taxation (Stadsholderrådet (Vurderingsstelselene))</td>
<td><a href="http://brurat.dsf">http://brurat.dsf</a></td>
<td><a href="http://brurat.dsf">http://brurat.dsf</a></td>
<td>Building register</td>
<td>Area, Facade material, Roof material, Type of heating, Number of floors</td>
<td>Nationwide</td>
<td>Public</td>
<td>Free</td>
<td>Structured database</td>
<td>Building owner</td>
<td>Continuously</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Protected and listed buildings</td>
<td>FBB is the registry of protected and listed buildings in Denmark maintained by the Danish Agency for Culture and Palaces. FBB contains information about approximately 7,100 protected buildings in the country and about 370,000 buildings whose preservation value has been assessed. Additionally, FBB includes basic information about over 4 million buildings in Denmark. This information is sourced from the Building and Housing Register (BBR) and is automatically updated.</td>
<td>Ministry of Culture (Kulturministeriet (Stifts- og kulturbestemmelser))</td>
<td><a href="http://viss.dsf">http://viss.dsf</a></td>
<td><a href="http://www.lige.dsf">http://www.lige.dsf</a></td>
<td>Register for preserved buildings</td>
<td>Area, Facade material, Roof material, Type of heating, Number of floors, Material description</td>
<td>Nationwide</td>
<td>Public</td>
<td>Free</td>
<td>Structured database</td>
<td>Data comes from BBR and Ministry of Culture</td>
<td>Continuously</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Waste data system (ODG)</td>
<td>The Waste Data System is a web-based database that collects information about waste streams in Denmark. According to the Waste Data System Order, companies responsible for waste treatment are required to report to the Waste Data System. During reporting, they need to specify the source of the waste, the type of waste, and how the waste should be treated. Companies reporting waste data have the ability to edit and retrieve their own waste data, while certain waste data is publicly accessible.</td>
<td>Ministry of Environment (Miljøministeriet (Miljøbestemmelser))</td>
<td><a href="http://odg.mst">http://odg.mst</a></td>
<td><a href="http://www.ade.mst">http://www.ade.mst</a></td>
<td>Waste register</td>
<td>Type of waste (sector), Type of waste (category), Amount of waste</td>
<td>Nationwide</td>
<td>Public</td>
<td>Free</td>
<td>Structured database</td>
<td>Companies responsible for waste treatment</td>
<td>Minimum yearly, also possible to update continuously</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Energy label</td>
<td>Energy labeling makes the energy consumption of buildings visible and serves as a type of product declaration. The energy performance certificate also provides an overview of energy-related improvements.</td>
<td>Ministry of Climate, Energy and Utilities (Klima-, Energibolig- og brugeringsministeriet (Energibestemmelser))</td>
<td><a href="http://inventeringen.dsf">http://inventeringen.dsf</a></td>
<td><a href="http://inventeringen.dsf">http://inventeringen.dsf</a></td>
<td>Energy label register</td>
<td>Calculated energy demand</td>
<td>Nationwide</td>
<td>Public</td>
<td>Free</td>
<td>Structured database</td>
<td>Energy labeling of buildings can only be carried out by companies that are certified to perform energy labeling. Certification requires a national management system</td>
<td>Continuously</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>
Archetype or sampling approach for monitoring
Recommendation 1
Archetype modeling

- Suitable for developing building stock scenarios or top-down target-based limit values
- Smaller representative samples can be used for monitoring the entire building stock

- Risk of systematic errors
- Representativity depends on data input
- Database infrastructure doesn’t exist
Archetype modeling
Available attributes from existing building information databases
Archetype modeling
National emission factors
The introduction of climate declarations in the Nordic countries in the forthcoming years.

The EU Energy Performance of Building Directive Article 7 states that Member States shall ensure that the life-cycle Global Warming Potential (GWP) is calculated in accordance with Annex III and disclosed through the energy performance certificate of the building.
Recommendations 2
Complete sample of climate declarations

- With mandatory climate declarations, the suitability for as-is analysis of the building stock is high
- With complete sample, the suitability for developing building stock scenarios or target-based limit values is high
- A large or complete sample of building stock is needed for validity
- Database infrastructure doesn’t exist
Recommendations 2
Complete sample of climate declarations

To ensure uniformity in the reporting of LCA results, a common standardized reporting format must be developed. LCA results should also be collected in a database to ensure that knowledge of buildings' CO2 footprint can easily be shared, analyzed, and inspire across the sector.
Energy Data for building operations
Monitoring the decarbonization of the building stock

Task 4.1 A
Policies and strategies for decarbonization

Task 4.1 B
Process for monitoring the decarbonization of the building stock

Task 4.1 C
Forecasting and modelling of future scenarios
National and international policies and strategies for decarbonization

Task 4.2 A

<table>
<thead>
<tr>
<th></th>
<th>2030</th>
<th>2035</th>
<th>2040</th>
<th>2045</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>70%</td>
<td>55%</td>
<td></td>
<td></td>
<td>110%</td>
</tr>
<tr>
<td>Estonia</td>
<td>50%</td>
<td></td>
<td>70%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finland</td>
<td>60%</td>
<td>50%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iceland******</td>
<td>55%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norway</td>
<td></td>
<td></td>
<td></td>
<td>10 TWh**</td>
<td>*</td>
</tr>
<tr>
<td>Sweden</td>
<td>63%</td>
<td>50%***</td>
<td>75%</td>
<td>100%****</td>
<td></td>
</tr>
<tr>
<td>Europe</td>
<td>40%</td>
<td>42,5%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Renewable energy portion
- National carbon neutrality goal
- Carbon reduction compared to 1990-levels

* Norway aims to become a low-carbon society by 2030
** Norway aims to reduce energy consumption in buildings by 10 terawatt-hours by 2030
*** Sweden aims to improve energy efficiency by 50% in terms of energy usage by the year 2030 compared to levels in 2005
**** The government of Sweden changed the term from "renewable" to "fossil-free" in the summer of 2023 to include nuclear power
***** Iceland aims to reduce the dependence of fossil fuels and promoting the use of renewable energy sources and climate-friendly fuels
Forecasting and modeling of futures scenarios

Task 4.2 C

• Review of 4 initiatives/research papers including different elements for forecasting and scenario modelling

• Elements are categorized:
  • Emission factor
  • Building stock
  • Building design

• Recommendations for forecasting and modelling of futures scenarios based on the analysis findings
<table>
<thead>
<tr>
<th>Building emissions factors</th>
<th>Building stock</th>
<th>Building design</th>
</tr>
</thead>
</table>
| Environmental modelling of building stocks – An integrated review of life cycle-based assessment models to support EU policy making | • Energy and material production efficiency  
• Change in heating, cooling and illumination  
• Recycling and reuse of materials.  
• Energy consumption and future electricity mix changes | • Building stock size and renovation plan  
• Building stock growth based on population  
• Building typology requirement change | • Dwelling size development  
• Building characteristics change due to climate  
• Rate of timber and low impact concrete typologies |
| Dynamic Environmental Sustainability Assessments of the Built Environment: Coupling MFA and LCA | • Energy decarbonization  
• Less carbon intensive materials (Materials within Europe & less waste)  
• Reduced energy from construction site  
• Reduced heat and electricity requirement in buildings | • Growth in building stock based on students and faculty  
• Model the lifetime of research and educational purposed buildings the same as residential | • Increase in area-to-user ratio  
• New construction with less carbon intensive material for the load bearing structure |
| IEAs pathway to 1.5-degre | • Energy decarbonization  
• Tripling renewable energy and other low emissions energy resources  
• Increase the amount of energy demand from the building sector | | |
| UKGBC’s Whole Life Carbon Roadmap | • Decrease the operational carbon emissions  
• Decrease in average energy usage  
• Reuse materials for a reduction in virgin material demand  
• Reduction in embodied emissions | • Increase in building stock based on population  
• Reduction in demand of office and residential buildings  
• Retrofit existing homes | • Reduction in material usage through design efficiency |
Recommendations
Forecasting and future scenarios

Emission factors
- Energy decarbonization
- Reduced energy and heating demand
- Recycled materials
- Material production optimization

Building stock
- Building stock size
- Building stock typology
- Renovation rate (size)
- Population size and demographic development

Building design
- Building size (area requirements)
- Building characteristics (architecture)
- New “low carbon” materials
- Design efficiency
A draft report on “Monitoring the decarbonization of the building stock” (Task 4.2) will be published for commenting to webinar participant.

Please comment before **15-02-2024**
Audience Q&A Session
Next steps

Start June '23

EAG Meeting, Oct '23
EAG Meeting, Jan '24
EAG Meeting, April '24
Webinar, Jan '24
Final report launch, summer '24

4.1 Setting and assessing limit values
- Analysis of the different regulatory needs and LCA requirements
- Analysis of variables that impact limit values and impact assessment
- Optimal process for setting and following limit values for buildings

4.2 Process for monitoring the decarbonization of the building stock
- Availability of statistics and data for building stock emission modelling
- Analysis of policies and methods for setting decarbonization goals
- Recommendations for monitoring building stock carbon emissions

4.3 Final report - decarbonization of building stock
- Preparing final draft for internal and external review
- Publication process

Nordic Sustainable Construction
Inputs to project draft reports

• The 1\textsuperscript{st} draft report on "Setting and Assessing Limit Values in Nordic Countries" has already been sent you.
• You can also find it via the webinar website
• We would greatly appreciate your inputs and comments by Feb. 2\textsuperscript{nd}.
  • Please send these to sm-dk-lca-and-co2-limits@sweco.dk

• The 2\textsuperscript{nd} draft report on "Monitoring decarbonization of the building stock " will be made available for commenting after the webinar.
• It will also be available via the webinar website
• We would appreciate your inputs and comments by Feb. 15\textsuperscript{th}.
  • Please send these to sm-dk-building_stock_decarbonization@sweco.dk
Thank you for your time!