IEA EBC Annex 72:
Assessing life cycle related environmental impacts caused by buildings

Environmental benchmarks for buildings

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Subtask 3 Leader: Harpa Birgisdottir, Aalborg University, Denmark

Final event:
SBE ’22, Berlin, Germany, 21 September 2022
Context
The position of ST1 and ST3 „Benchmarks“ and the interrelations to other ST’s and results

Guidelines for designers & recommendations for industry, policy, research

Benchmarks

Aids and tools

Data & Date bases

Assessment methods

Case studies and surveys
Benchmarks and limit values
Target groups for application, needs and recent developments

- Target setting in client’s brief
- Orientation in design process
- Funding programmes
- Legal requirements
System of benchmarks and target values

Definitions and job sharing

ANNEX 72 EBC

- **Limit value**: the upper or lower acceptable performance level on a performance scale.
- **Reference value**: performance level that represents state of the art or best practice. A reference value is subject to temporal changes.
- **Target value**: performance level that represents an objective that goes beyond the reference value. Target values can follow a top-down or bottom-up approach. A subdivision into short-term, medium-term and long-term target values is recommended.
Existing Benchmarks (kg CO$_2$e/m$^2$·y) based on a survey for residential buildings: (a) whole life carbon (b) embodied carbon

### a) Existing Benchmarks for Residential Buildings

<table>
<thead>
<tr>
<th>Case</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>AU</td>
<td>New construction</td>
</tr>
<tr>
<td>BE</td>
<td>New construction</td>
</tr>
<tr>
<td>CH</td>
<td>New construction, Refurbishment</td>
</tr>
<tr>
<td>CZ</td>
<td>New construction</td>
</tr>
<tr>
<td>DE1</td>
<td>New construction</td>
</tr>
<tr>
<td>DE4</td>
<td>New construction</td>
</tr>
<tr>
<td>FR</td>
<td>New construction</td>
</tr>
<tr>
<td>HU</td>
<td>New construction</td>
</tr>
<tr>
<td>NZ</td>
<td>New construction</td>
</tr>
</tbody>
</table>

#### a) Limit values, Reference values, and Target values

- **Limit value**
- **Reference value**
- **Target value**

### b) Existing Benchmarks for Residential Buildings

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>CA</td>
<td>New construction</td>
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<tr>
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<td>New construction, Refurbishment</td>
</tr>
<tr>
<td>DE2</td>
<td>New construction</td>
</tr>
<tr>
<td>ES</td>
<td>New construction</td>
</tr>
<tr>
<td>NO</td>
<td>New construction, Refurbishment</td>
</tr>
</tbody>
</table>

#### b) Limit values, Reference values, and Target values

- **Limit value**
- **Reference value**
- **Target value**
Granularity
Sub-division of benchmarks

- Benchmark values typically for use in regulation or certification
- Orientation/guide values typically for use in the building design process
The “net zero” benchmark
A special type of target
Bottom-up vs top-down target values

Need to integrate science-based target to be in line with 1.5 °C pathway?

Top-down

- Political targets
- Science-based targets (budgets) (e.g. GHG emissions neutrality or net zero emissions approach)

Bottom-up

- Existing technical or economic optimum/ feasibility
- Statistical analyses
- Reference buildings

 Nearly zero level as intermediate solution?

To what life cycle stages does it apply?

What offset/ balancing options are allowed?

What type of buildings?

What method?

What database?

What type of buildings?

What method?

What database?
Typology of benchmarks
Checklist for interpretation (selected aspects only)

❖ Indicator / impact category
❖ Object of assessment / functional equivalent
❖ Included building components based on a building model
❖ Included life cycle stages based on a life cycle model
❖ Reference study period
❖ Bottom up versus to down approach
❖ Static versus dynamic approach
❖ Source of data, appropriateness in relation to time and region
❖ ...

Energy in Buildings and Communities Programme
International Energy Agency (IEA)
**Absolute versus net zero**

Options to define and achieve (net) zero GHG emission buildings

<table>
<thead>
<tr>
<th>Net Zero emission approaches</th>
<th>Absolute Zero</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net balance (Aa)</td>
<td>Net balance (Ab)</td>
</tr>
<tr>
<td>potentially avoided emissions</td>
<td>allocation</td>
</tr>
</tbody>
</table>

Accounting for the potential benefits caused by exported energy produced on-site:

- Attributes the pro rata share of GHG emissions caused by on-site energy production to the exported energy
- Investment in projects, which lead to potential CO₂/GHG emission reductions elsewhere such as investments in solar or wind power plants*
- Investment in CO₂/GHG emission reduction projects such as CCS equipment in coal power plants*
- Investment in projects, which remove CO₂ from the atmosphere, but with potential reversibility, such as biological fixation*
- Investment in projects, which remove CO₂ from the atmosphere, such as BECCS or DACCS*
- Use of construction materials/operational energy with zero GHG emissions (including supply chain emissions)

*contribution to initial financing and implementation, or purchase of corresponding emission certificates

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(net-)zero GHG emission buildings
Scope and system boundary

<table>
<thead>
<tr>
<th>LIFE CYCLE SCOPE</th>
<th>PROPOSED TERM TO REFLECT EACH BROAD SCOPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1-3 A4-5 B1 B2-3 B4 B5 B6.1 B6.2 B6.3 B7 B8 C1-2 C3-4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Net) zero Scope 1 regulated operational GHG emission</td>
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<td></td>
<td>Alternatively: (net) zero B6.1 (scope 1) GHG emission</td>
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<tr>
<td>+ + + + +</td>
<td>(Net) zero upfront embodied GHG emission (Scope 3)</td>
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<tr>
<td></td>
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</tr>
<tr>
<td>+ + + + +</td>
<td>(Net) zero life cycle-based GHG emission (Scope 1-3)</td>
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operational
embodied
life cycle
How to reach net zero GHG emission buildings
Supplementation of benchmarks by recommendations on how they can be achieved

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<td>1.1 Sufficiency: e.g. reduce (conditioned and unconditioned) floor space (m²) per capita</td>
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<td>1.3 Consistency/ Renewability: maximise the use of on-site** generated renewable energy</td>
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<td>2 Responsible Procurement: purchase low emission energy and products</td>
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Residual GHG emissions after application of reduction principles

3.1 GHG emission removal: Type C approach
3.2 GHG emission reduction: Type B approach
3.3 Balancing with potentially avoided emissions: Type Aa approach

Recommended route to (net) zero GHG emission buildings
## How to reach net zero GHG emission buildings

Supplementation of benchmarks by recommendations on how they can be achieved

### GHG emissions of a conventional design

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(1) **Reduce** via low carbon design strategies
How to reach net zero GHG emission buildings
Supplementation of benchmarks by recommendations on how they can be achieved

(1) Reduce via low carbon design strategies

(2) Reduce via low carbon purchasing strategies

GHG emissions of a conventional design

Operational GHG emissions

1.1 Sufficiency: e.g. reduce (conditioned and unconditioned) floor space (m²) per capita

1.2 Efficiency: reduce material and energy demand per m²

1.3 Consistency/Renewability: maximise the use of on-site* generated renewable energy

2 Responsible Procurement: purchase low emission energy and products
How to reach net zero GHG emission buildings

Supplementation of benchmarks by recommendations on how they can be achieved

Recommended route to (net) zero GHG emission buildings

1. Reduce via low carbon design strategies
   1.1 Sufficiency: e.g. reduce (conditioned and unconditioned) floor space (m²) per capita
   1.2 Efficiency: reduce material and energy demand per m²
   1.3 Consistency/Renewability: maximise the use of on-site generated renewable energy

2. Reduce via low carbon purchasing strategies
   2. Responsible Procurement: purchase low emission energy and products

3. Offset and/or balance
   3.1 GHG emission removal: Type C approach
   3.2 GHG emission reduction: Type B approach
   3.3 Balancing with potentially avoided emissions: Type Aa approach
Conclusions and recommendations

- Benchmarks cannot be defined and applied in isolation; they form an inseparable unit with the respective method and data basis used to derive them.

- It is necessary to complement benchmarks currently based on technical and/or economic feasibility by target values derived from planetary boundaries following a top-down approach.

- Paris Agreement and its 1.5°C target calls for life cycle-based “(net) zero GHG emission” buildings including CO₂ removals.

- To improve environmental performance of buildings benchmarks and target values for further impacts are needed, e.g. resource consumption, risk to local environment.

- The benchmarks / target values relating to the life cycle can be sub-divided, into embodied / operational parts (among others), for guide / communication purposes.
Main results
available from spring 2023

Rules and recommendations for the benchmarking and target-setting for the lifecycle-based environmental performance

Target groups
- Designer
- Researcher
- Policy maker
- Industry

Application cases
- Design and decision making
- Sustainability assessment
- Standardisation
- Legislation
- Research