NET ZERO GHG EMISSION BUILDINGS
synopsis and assessment of current concepts and recommendations

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International Collaboration to Accelerate Change”
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Buildings construction and operations accounted for
36% of global final energy use and
39% of energy-related carbon dioxide (CO2) emissions in 2017

Note: Construction industry is an estimate of the portion of the overall industry sector that applies to the manufacture of materials for buildings construction, such as steel, cement and glass.
MITIGATION POTENTIAL OF SECTORS AND AREAS OF ACTION

Compared to other sectors and fields of action, buildings have a comparatively great potential for reducing greenhouse gas emissions. The scope of the reduction is influenced, among other things, by the level of abatement costs.

IPCC projections of CO2 mitigation potential in 2030 (IPCC, 2007) identifies the building and construction sector as the sector with the largest mitigation potential.

BUILDING AS OBJECT OF ASSESSMENT AND LEVEL TO ACT

There are various levels of action in the construction and real estate industry, including:

- National, regional, institutional building stock
- Regional development
- Urban development
- Neighbourhood/district
- Individual buildings

All activities in the construction and real estate industries can ultimately be traced back to measures related to:

- New construction
- Reconstruction
- Refurbishment

of buildings. These measures can influence the other levels of action.

Relevant actors are:

- Building permit authorities/legislators
- Building owners/investors
- Financiers
- Design professional and consultants
- Construction material industry
- Construction companies
ASSESSING OPERATIONAL AND EMBODIED EMISSIONS – CURRENT TRENDS

- There is a downward trend in operational emissions relating to an improved energy performance and increasing use of renewable energy.
- The relative and absolute values of embodied impacts (here embodied GHG emissions) increase.
- The consideration of the entire life cycle, the limitation of the upfront/initial emissions, as well as the development of overall goals and guidance values for operational and embodied GHG emissions are necessary.

BUILDINGS IN THE CONTEXT OF SUSTAINABILITY ASSESSMENT

There are design goals as well as assessment criteria on topics such as:
- Resource conservation
- Greenhouse gas (GHG) emissions (contributing to climate change)

In the near future, a “budget” of GHG-emissions in the life cycle of a building will become part of a clients brief and/or legal requirement – expressed as part of environmental requirements.
BUILDINGS IN THE CONTEXT OF SUSTAINABILITY ASSESSMENT

- How can buildings and their life cycle be modeled?
- How can the life cycle assessment (LCA) method be applied in a practical manner?
- How can the required data on construction products and processes be determined and made available in databases?
- How can LCA be integrated into the design, which tools are suitable?
- Which benchmarks and design targets result in relation to the limitation of primary energy consumption and greenhouse gas emissions in the life cycle of buildings?
- Which terms need to be defined and which system boundaries to be considered?

In connection with the content and goals of this contribution, the questions shown on this slide arise. In particular, the topic of the development and application of benchmarks should be dealt with.

PROVIDING ANSWERS BASED ON JOINT RESEARCH ACTIVITIES AROUND THE WORLD

IEA EBC Annex 72 - Assessing Life Cycle Related Environmental Impacts Caused by Buildings

- Cradle: Preconstruction stage
- Gate Site: Construction process stage
- Hand-Over: Use stage
- End of Use: End of life stage (scenario)
- Grave: End of life

Embodied Impacts:
- Production
- Construction
- Maintenance, repair and replacement
- End of life

Operational Impacts:
- Operational energy and water use

Whole Building Life Cycle

Net Zero
IEA EBC ANNEX 72: Subtasks

Subtask 1: Context-specific methodology guidelines:
- developing and extending the methodology guidelines

Subtask 2: Building assessment workflows and tools:
- description and development of national or regional building assessment tools, in particular embedding of life cycle assessment approach into BIM (Building Information Modelling)

Subtask 3: Case studies:
- analyzing building case studies using the methodology agreed in Subtask 1

Subtask 4: Building sector LCA databases:
- development and supply of life cycle assessment databases targeted to the building sector

Subtask 5: Dissemination:
- communication and dissemination of the results

EXPLAINING THE “PACKGAGE”

To support the design and decision-making process in the direction of resource efficient and climate friendly buildings one needs:

a) Assessment methods (terms, definitions, system boundaries)
b) LCA-data for construction products and processes
c) Design & assessment tools
d) Benchmarks and target values

a) to d) form a system.
METHODOLOGICAL BASICS

- Modelling a building & its life cycle and check of completeness
- Rules for calculation, assessment and compensation
- Dealing with:
  - uncertainty and range of input parameters
  - building integrated / site related generation of energy
  - imported and exported energy
  - decarbonisation of grid and production processes

RULES AND RECOMMENDATIONS FOR (further development of) ASSESSMENT METHODS

TERMS AND DEFINITIONS

- Carbon positive building
- Climate neutral building
- Carbon neutral building
- Carbon free construction
- (Net-)zero carbon building
- (Net-)zero emission building
- (Net-)zero GHG emission building
- Paris building
- Low carbon building
- … others?
INTEGRATION INTO DESIGN AND DECISION MAKING PROCESS – THE STEPS

- Target setting in clients brief
- Early design
- Building permit
- “As built”
- Monitoring

Taking into account available information, data and related uncertainty = consequences for assessment

MODELLING OF THE BUILDING AND ITS LIFE CYCLE
... can and will help us to simulate the energy demand and to assess operational GHG-emissions ...

**CREATION, APPLICATION AND INTERPRETATION OF BENCHMARKS**

- System of performance levels
- (net)zero as top down target based on planetary boundaries
- Legally binding benchmarks & design targets / guiding values
- Reference unit for benchmarks
- Examples and case studies

**RULES AND RECOMMENDATIONS FOR CREATION AND INTERPRETATION OF BENCHMARKS AND TARGET VALUES**
WHAT IS MEANT BY “ZERO”?  

- (net) zero operational?  
- (net) zero life cycle  
- Zero carbon?  
- Zero GWP100?  
- Zero GHG-emissions

OPTIONS TO DEFINE AND ACHIEVE (NET) ZERO GHG-EMISSION BUILDINGS

<table>
<thead>
<tr>
<th>Net Zero emission approaches</th>
<th>Zero emission a.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net balance</td>
<td>Economic compensation</td>
</tr>
<tr>
<td>potentially avoided emissions</td>
<td>allocation</td>
</tr>
<tr>
<td>Accounting for the potential benefits caused by exported energy produced on-site</td>
<td>Attributes the pro rata share of GHG emissions caused by on-site energy production to the exported energy</td>
</tr>
</tbody>
</table>

PERFORMANCE LEVEL & BOUNDARIES

Representation of benchmarks according to the specific values

- Limit value (Benchmark)
- Reference value (Benchmark)
- Target value short term
- Target value long term

Performance level

- "nearly zero"
- "(net) zero"

Possible types of application
Selected examples only

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
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<tbody>
<tr>
<td>Building related operational GHG-emissions</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
</tr>
<tr>
<td>User related operational GHG-emissions</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
</tr>
<tr>
<td>Upfront/initial embodied GHG-emissions</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
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<tr>
<td>GHG-emissions from replacement, deconstruction</td>
<td></td>
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</table>

GRANULARITY OF BENCHMARKS

Job sharing between mandatory target values and informal guiding values to support the design process

User related operational

Building related operational

Building related embodied

Type 1
Type 2
Type 3

SIA 2040: guide and target values
residential buildings

<table>
<thead>
<tr>
<th>Guide</th>
<th>Primary energy, non-renewable kWh/m²</th>
<th>Greenhouse gas emissions kg/m²</th>
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<tbody>
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<td>Construction</td>
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<td>New building</td>
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<td>Guide value</td>
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<td>20</td>
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<tr>
<td>Guide value operation</td>
<td>60</td>
<td>70</td>
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<td>Guide value mobility</td>
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<td>30</td>
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<td>Target value</td>
<td>120</td>
<td>16.0</td>
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<tr>
<td>Additional requirement construction + operation</td>
<td>90</td>
<td>12.0</td>
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Technical bulletin SIA 2040 (2017) SIA Energy Efficiency Path
Requirements for residential buildings (all kind)

+ embodied GHG-emissions (A1-A3, B4, C3-C4)*
+ operational GHG-emissions (B6.1, B6.3)

= life cycle based GHG-emissions (RSP = 50 years)

<table>
<thead>
<tr>
<th>Primary Energy, non renewable kWh/m²a</th>
<th>GHG Emissions kg CO₂-Äqu./m²a</th>
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</thead>
<tbody>
<tr>
<td>Level I (PLUS)</td>
<td>96</td>
</tr>
<tr>
<td>Level II (PREMIUM)</td>
<td>64</td>
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</tbody>
</table>

* Including HVAC-systems, and BIPV (partial allocation to the building)

SYNTHESIS

- Embodied environmental impacts gain importance and need (more) attention
- Paris Agreement and its 1.5° C target calls for high ambition “net zero emission” buildings
- Growing demand for life cycle based GHG-emission results in the context of EPBD, LEVEL(s), TAXONOMY, BWR/CPR
- Guidelines, data, tools and expertise are ready for application in many countries: time for life cycle based policy measures like legal binding requirements to limit GHG-emissions in the life cycle of buildings
THE Monte Verità DECLARATION
On a built environment within planetary boundaries

Introduce legally binding maximum target values for GHG-emissions of new constructions and of refurbishments by 2025 latest with a roadmap to net zero by 2035.

MORE INFORMATION IS AVAILABLE …

https://annex72.iea-ebc.org/