Research needs:
Development of benchmarks

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Abstract

Currently, in sustainability assessment systems a gradual transition from a predominantly qualitative to predominantly quantitative evaluation approach is taking place. The state of the international and European standardization presupposes the application of methods of life cycle analysis (LCA and LCC etc.). Thus, the question of the development of appropriate assessment criteria and benchmarks arises.

In SuPerBuildings various ways for the development and introduction of benchmarks have been discussed. These are related to (1) the state of national or European standardization and legislation, (2) best practice experiences, (3) the existing technical, economic or ecological optimum (e.g. cost-optimal solutions for energy efficiency) or (4) political targets (e.g., the near-zero-energy level in the EU).

The results of a life cycle assessment and life cycle costing of a building are strongly influenced by databases, assumptions, calculation tools, and the regional context (climate, building tradition, price level, etc.). Benchmarks must therefore always form a single unit with the database (e.g. with ecological data for construction products), the system boundaries and conventions, and the calculation tool. Only then the results can be interpreted in a meaningful way. Highly recommended is a detailed presentation of the results - e.g. an allocation of LCA and LCC results over the different life cycle phases.

Presently, many benchmarks are published for the performance of buildings during the use phase. However, they are only useful when their system boundaries are transparent. Therefore, SuPerBuildings calls for greater transparency in information about benchmarks and other values in the literature.

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RESEARCH NEEDS: DEVELOPMENT OF BENCHMARKS

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Main questions

- What are the **basic principles** for the **development of benchmarks** ?
- How to select and qualify **reference buildings** for the establishment of benchmarks ?
- How to **establish interrelated and consistent benchmarks** when dealing with the development and use of a **system of indicators** ?

Defining benchmarks is a task!

Lead Market Initiative for Europe

Develop voluntary performance targets to enable the implementation of incentives and other policy measures to promote sustainable buildings and construction practices	**Define a framework, assessment method and benchmarks for assessing the sustainability performance of buildings and of the construction value chain**	2008 - 2011
Develop European standards that allow taking into account sustainability aspects in construction design.	Expand the scope of Eurocodes in order to integrate other sustainability aspects in construction design, such as energy and environmental aspects.	2008 - 2011
Define the framework for technical assessment adapted to a rapid certification of innovative products to sustainability criteria.	Adopt the Construction Products Regulation, providing for better procedures to obtain European Technical Approvals and for better recognition in Member States for sustainability issues.	2008

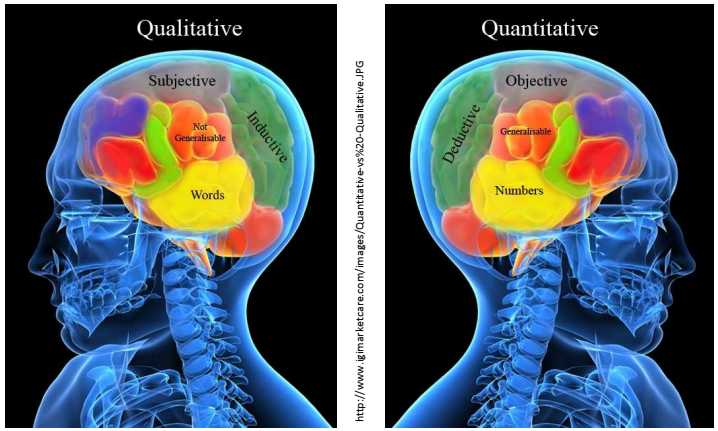
Annex I to the communication from the commission to the council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions (COM(2007) 860 final SEC(2007)

Topics and trends

The sustainability assessment methods for buildings are changing from a predominantly qualitative approach to a predominantly quantitative approach.

- The development of international (ISO TC 59 SC 17) and particularly European standards (CEN TC 350) have initiated a **new level of performance based assessment criteria.**
- So far, the major issues related to the definition and evaluation of quantitative data were the **type of calculation methods** and the **availability of data.** In some countries the availability of inventory data has been solved – EPDs
- **Crucial issue** becomes the definition, calculation and interpretation of „**benchmarks**“.

From a more qualitative to a more quantitative assessment



http://www.igimarketcare.com/images/Quantitativ-e-vs%20-Qualitative.JPG

Benchmarks ("in use")

Offices - pan-Europe

	Building CO_2 ($kgCO_2eq/m_2/pa$)	Building primary en... (kW...
Benchmark	56	
+/-	12	

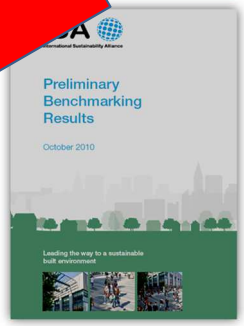
Offices - Belgium

	Building CO_2 ($kgCO_2eq/m_2/pa$)	pri... (kW...	...ion ($m^3/m^2/pa$)
Benchmark	49		0.18
+/-	9	81	0.04

Offices - Germany

	Building CO_2 ($kgCO_2eq/m_2/pa$)	Building primary energy ($kWh/m^2/pa$)	Water consumption ($m^3/m^2/pa$)
Benchmark	77	375	0.66
+/-	32	141	0.55

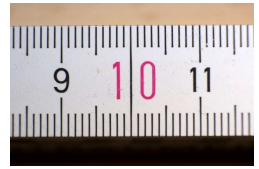
System boundaries ???
Functional equivalent ???
Life cycle stage ???
Climate conditions ???



http://www.internationalsustainabilityalliance.org/filelibrary/ISA_Benchmarking_Results_October_2010.pdf

What is needed?

- Framework for benchmarks
- Rules to create benchmarks
- Sources for benchmarks
- Methods to create generic benchmarks
- Methods to create benchmark systems for indicator systems



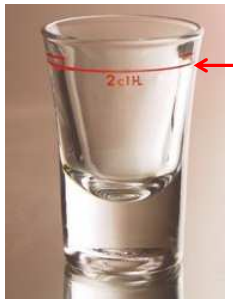
Reference levels – ISO 21931-1

Reference levels and/or **scale of values** can be used in the quantification of indicators within the assessment method. Reference levels shall be documented and justified.

NOTE: The reference level and scale of values may be related to
*- **building codes/regulations**,*
*- **user requirements**, and/or*
*- **evaluation of conditions** in the area where the building is located.*

Quantitative information on the environmental performance may be referred to a **predefined baseline**. In such a case, the reason or **basis for setting the baseline shall be clearly documented**.

We need some „benchmarks“ and „baselines“....



Systematic framework of limit- and target-values

For the completed assessment of sustainability of buildings appropriate **assessment scales** in the form of **reference values** or **benchmarks** are essential. The following scalable and adaptable structure of evaluation could serve as a basis:

- **Limit value** – the lowest acceptable value of an evaluation scale
- **Reference value** – the present state of the art – an average or median value
- **Best practise** – values that have been reached (measured) in experimental or demonstration projects
- **Target value** – the upper limit of the scale – the highest theoretically possible level – when exceeded a bonus can be granted

Sources for benchmarks

- **a) National laws and standards**
- **b) Experience based and statistical values**
- c) **The technical or economic optimum**
- **d) Political targets**
- **e) Labels, self-commitment**
- **f) Calculation results**

a) National laws and standards

Depending on how explicit the **national prescriptions** of each country are formulated, they can be used as **target or reference values**

In countries with a low level of prescriptions, a **specific value scale** can be established which differs from the minimal legal prescriptions.

In certain countries prescriptions and standards are from the beginning **performance based**.

In many countries the introduction of sustainability evaluation methods **has led to the introduction or adaption of legal prescriptions** and standards.

b) Experience based and statistical vales

Benchmarks can be based on the **statistical interpretation of a large set of data** (average, median, upper, lower or specific quartile values)

The **resulting values** depend strongly on the type, form, age and quality of the "basic population" of the sample buildings

The **functional equivalent** of the evaluated building must correspond to the functional equivalent of the sample buildings

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c) Technical or economic optimum

Benchmarks can also be constructed from theoretical values, in particular **technical and economic optimum values**.

These values change with time and technological progress. They might depend on the technical and economic optimum of a certain moment and technology.

For example, operational energy benchmarks can take the form of normative u-value or insulation thickness

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d) Political targets

Politically motivated targets that can be pure or environmental policy-oriented.

Examples are the formulation of **European targets** for net zero energy (new) buildings by 2020 and by 2050 for the building stock.

Political target values are often developed in a **top-down way** (e.g. the limit of two degrees temperature increase related to climate change).

These targets must be **"translated"** into building specific targets.

These indicators and targets are often not rooted in scientific propositions; they **represent political conventions** and are formulated taking into account their political feasibility.

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e) Labels, self-commitment

- **Labels and self-commitment by branches**

The **Minergie Label** in Switzerland and the **Passivhaus Label** in Germany.
From the requirements of such labels have emerged to some extend **generally recognized benchmarks**.

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f) Calculation results

- **Benchmarks for LCA and LCC**

The values are directly depending on specific database with the rules, assumptions and conventions, normally associated in a calculation tool.

In certain countries (e.g. in Germany LEGEP) **the existence of a calculation tool becomes the basis for the elaboration of the benchmarks**.

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The reference building approach I

- **Selection and evaluation of a type representative building**

For a specific building type (based on use) **a representative building** is chosen and reference values are obtained. Target values and limit values can be determined as percentage values of the reference value.

- **Statistical interpretations**

For a specific building- and use-type a large number of buildings is evaluated and a „solution space“ is used to define reference values and best values for benchmarks.

The results are like always strongly influenced by the size and quality of the sample and its homogeneity, as well as the level of sustainability.

A series of unsolved till now methodological problems exist.

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The reference building approach II

- **Generic reference building**

The building that is evaluated is decomposed into elements that in turn are compared to the element of the reference building.
This method is used for the German Energy Standard (EnEV2009).
The buildings with a complicated geometry and unfavourable orientation lead to oversized benchmarks.

- **Budgets on basis of use zones**

To avoid geometric and orientation prerequisites the method of benchmarks for **budgets per use zones** can be of interest.
This is used partially in Germany in Cost Estimation and for energy calculations.

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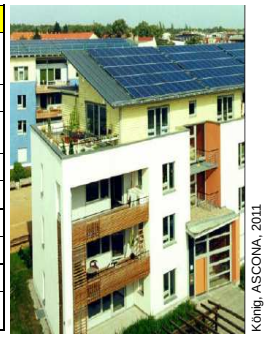
Benchmarks for LCA – Example from Germany

Indicator	Unit	Limit value	Reference value	Target value
Global Warming Potential (GWP)	kg CO_2-equ./m² Net Floor Area (NFA) and Year	23.8	17.0	11.9
Ozone Depletion Potential (ODP)	kg R_{11}-equ./ m² NFA*a	0.0000020	0.0000010	0.00000070
Photochemical Ozone Creation Potential (POCP)	kg C_2H_4-equ./ m² NFA*a	0.014	0.010	0.007
Acidification Potential, (AP)	kg SO_2-equ. / m² NFA*a	0.070	0.050	0.035
Nutrification Potential (NP)	kg PO_4-equ. / m² NFA*a	0.007	0.005	0.0035
Primary Energy non-renewable	kWh PE nrn/ m² NFA*a	105.0	75.0	52.5
Primary Energy renewable	kWh PE rn/ m² NFA*a	35.0	25.0	17.5
Total Primary Energy	kWh PE total/ m² NFA*a	140.0	100.0	70.0
Percentage Primary Energy renewable	%	5	8	20



König, ASCONA, 2011

Apartment Buildings, full life cycle 50a, oekobau.dat database, LEGEP-tool, 2011

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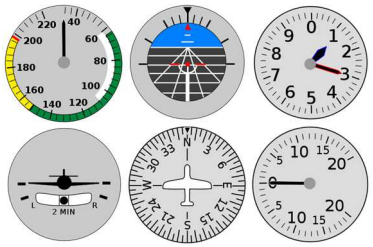
Systems of indicators = system of benchmarks ?



How to create a system of benchmarks to assess the results of different indicators ?

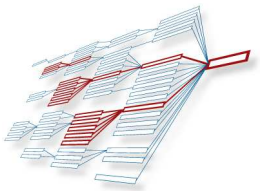
http://www.aboutflight.com/handbook-of-aeronautical-knowledge/ch-7-flight-instruments/chapter-7-summary

Complex performance targets

How to balance single indicator–benchmarks to reach to a consistent result?

A solution is the application of complex integrated planning and evaluation tools. They allow:

- to **produce simultaneously results for a multitude of criteria** (typically LCA and LCC)
- to support the constitution of benchmarks for new criteria by calculating a representative building with a number of alternatives to generate different values.
- to **compare the results of known values** (mass, costs etc.) for which a lot of empirical data exist with less well known indicators to judge the plausibility of the latter
- to estimate if the **overall results are "balanced"**
- to support the design and construction process before the evaluation phase (in particular the labelling phase).



Conclusions and outlook

- The development of **appropriate benchmarks for LCA and LCC** has proved to be **problematic**
- These problems are **specific for building life cycle analysis** and constitute a challenge for the researchers and tool developers
- The **transparency** must be ensured.
- The **basic data**, the **calculation methods** and **tools**, as well as the **benchmarks** should form an **inseparable unit**. Only these lead to a logical evaluation result.
- Even when the standardization do not and cannot provide benchmarks, **the processes and the principles that guarantee the certainty and transparency** have to be regulated.
- **Further action** is needed.