

786: Sustainability Indicators in Buildings

Identifying Key Performance Indicators

Lone FEIFER^{1 2}

¹Aarhus School of Architecture, Aarhus, Denmark

²VELUX Group, Hoersholm, Denmark

ABSTRACT: What makes a building sustainable, or green – and how is the one better than the other? This paper aims to investigate a method on how to identify a sustainable building in an overview, looking into possible measures and targets by method of performance indicators as a benchmark system. Is it viable to obtain a result which can be communicated on several levels, also to decision makers being laymen? A common understanding of indicators system and terminology within sustainable construction could form a platform for navigation and communication of degrees of sustainability. An investigation of the categories and indicators of the upcoming international standard CEN TC 350 is performed. A methodology is elaborated into a system and with an output usable for levelled communication, thus sourcing a common awareness of sustainability in the particular building. As illustration, indicators are set up in an overview, and a case study is performed. .

Keywords: Key performance indicators, communication, stakeholders, triple bottom line

1. INTRODUCTION

Buildings represent a major troubleshooter in regards to solving the imminent task of decreasing carbon emissions. Consuming more than 40% of the energy spent in industrialized countries, the building sector is an obvious place to look for leverage on the three-part challenge to minimize energy consumption and carbon emissions, secure political independency of energy availability and create economical growth through incentives and innovations in the building sector. Buildings are not consumers of energy - the users of buildings are. Who are these consumers, and thus the stakeholders?

The stakeholder landscape when discussing buildings is very broad, with multiple interests, - some private interests, some professional, some short-term, some long-term, all depending on the individual approach. There is one overshadowing common interest for all, namely the public interest of leveraging the huge potential of buildings into a tool solving some of the global challenges. This paper seeks to investigate which indicators are available to count and account for sustainable buildings, for the public stakeholder in this matter. The approach taken is deliberately banal, inspired by the Albert Einstein citation “*you do not really understand something unless you can explain it to your grandmother*”. If we are going to be able to address and handle the challenge, we need common denominators that can be understood and handled by peers, professionals, policy makers, politicians and the public in general.

Today all designs are sustainable and with environmental focus – at least allegedly. Ever since green became the new black, the building sector is as struck by the desire to go green - and the claim to be sustainable has become as well a claim to fame. The term “green” is in substantial risk to become a

mainstream hygiene factor, addressing the subject only on a superficial level, and not necessarily reflecting the long-term effects or actual impacts.

Is there today such a thing as a public common denominator within indicators of sustainability? This paper wishes to investigate and discuss appropriate tools, knowledge and awareness for ordering, expecting and using sustainable buildings, as well as discuss the motive of sustainability as such.

2. INDICATORS OF TODAY

2.1. Terminology – green and/or sustainable

A green building covers measures like limiting consumption of non-renewable fuels, water, land, materials, emissions of greenhouse gas and other emissions; minimizing impacts on site ecology, solid waste or liquid effluents, improving indoor air quality, natural lighting and acoustics and securing maintenance of performance. A sustainable building features all of the same measures, and in addition addresses longevity, adaptability and flexibility of the object, accounts for the efficiency of resources spent, addresses safety and security, includes social and economic considerations and regards urban and planning issues [1].

Sustainability is the capacity to endure, to sustain. In regards to ecology, the term describes how biological systems remain diverse and productive over time, examples of sustainable biological systems are long-lived and healthy wetlands and forests. In regards to humans, sustainability is the potential for long-term maintenance of well being, which has environmental, economic, and social dimensions. So when discussing buildings, the core issues are long-term maintenance and well being of the users, seen under the aspects of environmental, economic, and social dimensions.

2.2. Dimensions, standards and schemes

Environmental, economic and social dimensions are used as protection components of sustainable development introduced at the first Conference of the Parties (COP) in Rio 1992 [2]. These three dimensions are subsequently used as interdependent and mutually reinforcing pillars of sustainability. An approach agreed by the ICLEI – Local Governments for Sustainability in 2007 uses the “Triple Bottom Line” - also known under the abbreviation of TBL or 3BL. The dimensions of environmental, economic and social are popularised into “people, planet, and profit”. The TBL uses the very same pillars in the attempt to capture an expanded spectrum of values and criteria for measuring organizational (and societal) success: economic, ecological and social.

The Technical Committee CEN/TC 350, under the EU Commission, is preparing a suite of standards for a system to assess buildings using a lifecycle approach, known as “Sustainability of construction works”. The standards provide principles, requirements, methodologies and calculation rules for the environmental, economic and social performance of buildings taking technical characteristics and functionality of a building into account. The series of standards aims for the assessment of environmental, social and economic performance of a building, to be made on an equal footing, on the basis of the same technical characteristics and functionality of the object of assessment. The standards are not yet released.

Performance Indicators are quantifiable performance measurements used to define success factors and measure progress toward the achievement of business goals. The measures are typically referred to as KPIs (Key Performance Indicators) and used within a balanced scorecard as a method of consolidations.

A comparison between the two main European assessment schemes, DGNB and BREEAM within the three dimensions, outlines that the priority and weighting from one scheme to another can be substantially different [3]. One calculation tool for assessments, the iisBEE calculation tool [4], overcomes national barriers by refraining from the use of absolute values, leaving this up to the final users to discuss and implement. The tool is open-source and global, with an approach to meet different ambition levels within sustainability – from 0 as acceptable practice to 5 as best practice. Each project using this tool can discuss and assess which level is to be met, and in the final output see this reflected in 7 performance categories. Some of the categories are close to the TBL dimensions also used in the CEN/TC 350, however split further into categories, and the aspect of culture and heritage has been added.

2.3. Illustrative field study

Two British researchers - H. Alwaer and D.J. Clements-Croome [5] performed a field study on key performance indicators in assessing sustainable intelligent buildings. The research made first a study on identifying the key issues related to sustainable intelligent buildings (environmental, social, economic and technological factors) and to develop a conceptual model for the selection of the appropriate KPIs; secondly the research performed a critical test to stakeholder’s perceptions and values of selected KPIs intelligent buildings. 20 stakeholders of the construction industry were invited to review and score the 115 individual indicators. The indicators were derived from the most frequent UK systems (BREEAM, DQI, SPeAR), supplemented with major international schemes (LEED, CASBEE, AIIB, SBC and HK-BEAM), and additional indicators related to health and well being and their effects on productivity and well being of users, as well as automation, intelligence and user control of the indoor environmental quality, air quality, temperature, daylighting and sound in the buildings were included.

In order to test an objectively optimal model, the researchers developed a conceptual Sustainable Built Environment Tool, which was then tested in practice on the very same stakeholders.

3. INDICATORS OF TOMORROW

3.1. A levelled approach

Is it possible to outline a set of common denominators which can serve as a future basic KPI tool? The assumption is tested on the general principles of sustainability in building construction described in ISO 15392:2008. The objectives of an assessment being: to determine the impacts and aspects of the building and its site, and to enable the client, user and designer to make decisions and choices that will help to address the need for sustainability of buildings [6]. The basis of the study is formed by the CEN TC 350 standards, using the structure of TBL in combination with the LCA principle [6d]. The - not yet released - standards outline content and a set of suggested framework indicators for environmental performance [6b], social performance [6c] and economic performance [6d].

The framework of the three dimensions in a brief outline:

Economical dimension contains four general indicators, covering the cost of a building up front and seen over years, maintenance and costs for operations, suitability for conversions and number of refurbishment cycles. The social dimension covers five indicators, mainly the impacts of a building related to its occupants, expressed by quantifiable indicators. There are 3 general indicators within the environmental dimension, limited to the assessment of environmental impacts and aspects of a building on the local, regional and global environment. The quantifiable indicators are expressed mainly as a life

cycle assessment (LCA) and with some additional quantifiable environmental information.

The indicators have a further level of information and grouping around the indicators – from 1 to 15 different numbers. The values of each informative indicator add up to the general indicator level. See Table 1 for example on one category.

Table 1: Setup of the Environmental Category with indicators and informative indicators

Indicator	Informative
Environmental Impacts	Abiotic depletion potential
	Acidification of land and water resources;
	Destruction of the stratospheric ozone layer;
	Eutrophication;
Resource Input	Formation of ground-level ozone;
	Global warming potential;
	Use of non-renewable primary energy;
	renewable primary energy;
Additional Environmental Information	secondary materials;
	secondary fuels;
	freshwater resources
	Components for reuse;
	Materials for recycling;
	Materials for energy recovery;
	Non-hazardous waste to disposal;
	Hazardous waste to disposal ;
	Radioactive waste to disposal
	Exported energy

The output of the score is a radar / spider web format, used in several assessment schemes e.g. DGNB, SPeAR and iisBE Tool. .

3.2. Case study

Finally, a case analysis was performed, where the LCA calculation of the Model Home 2020 project LichtAktiv House, a modernisation of a German

Settler’s House, was matched against the suggested CEN/TC 350 indicator scheme system.

As basis for the environmental assessment, the report on LCA from TU Darmstadt was for the environmental impact category [7], for the other informative indicators the general project information was the outline. The values used in the scheme are subjective and based on a very general assumption of practice parameters. The social and environmental categories are exemplified in figures 1 & 2.

4. RESULTS

The results of the various schemes and scales show a large variation. Some focus on a single indicator, leaving out the long-term consequences, some refrain from considering the expected service life. The research paper by Alwaer and Clements-Croome [5], which first groups the indicators of main schemes, and then test a conceptual model with broad indicators, evidently shows, that categories and indicators turn out with very different weightings, even amongst peers placed in the same skill group. Different individuals of the same skill group (e.g. architects) give different weightings based on their preferences and experiences of buildings. Even by taking the average between the stakeholders, the aggregated results give different weightings which could skew the final assessment results. Also, it is a clear result that the different test persons interpret the priority levels very differently and open, leading to a large variation in the assigning of scores, also within the same system [4]. The general result is a degree of inconsistency about the relative importance of different KPIs across stakeholders. The evaluations are skewed with a subjective judgement, because there is no consensus-based knowledge on the sustainability indicators. As a fact, there are very different, even contradictory estimates and views about the sustainability indicators amongst the professionals.

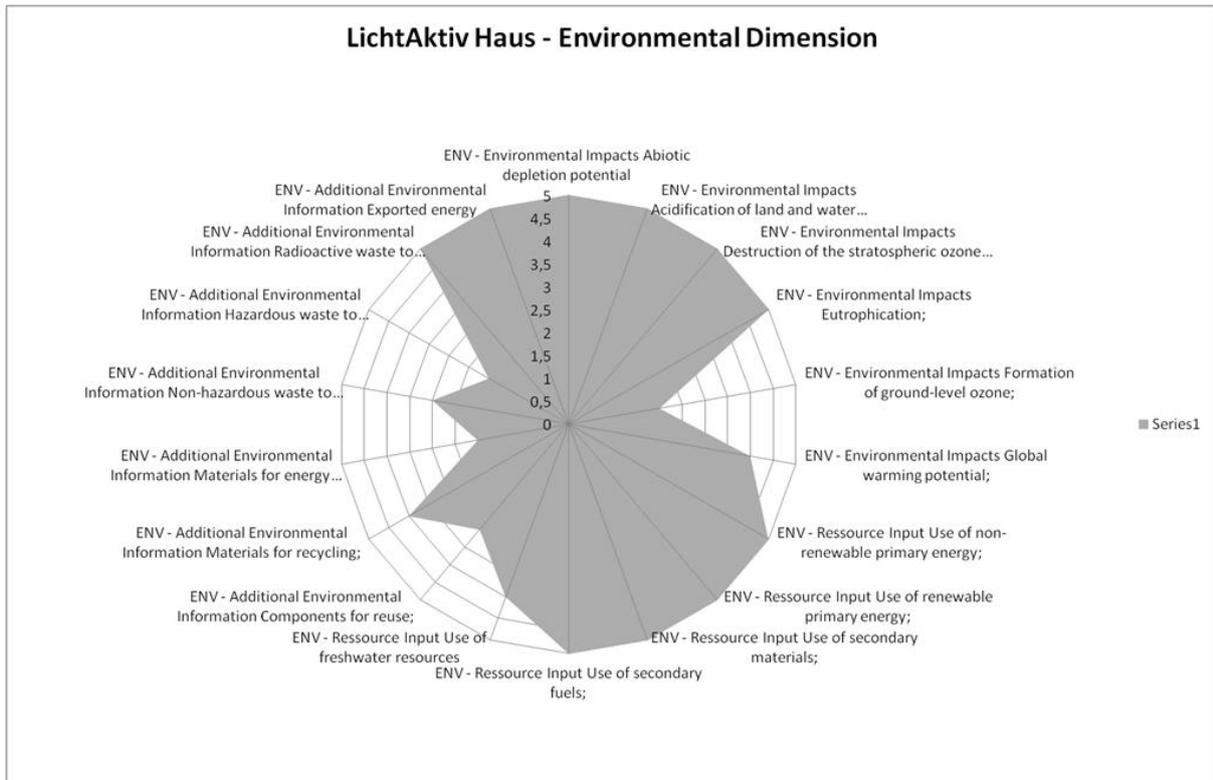


Figure 1: Output of the indicators within the social dimension, validated from 1-5 where 1 is below current practice and 5 is best practice.

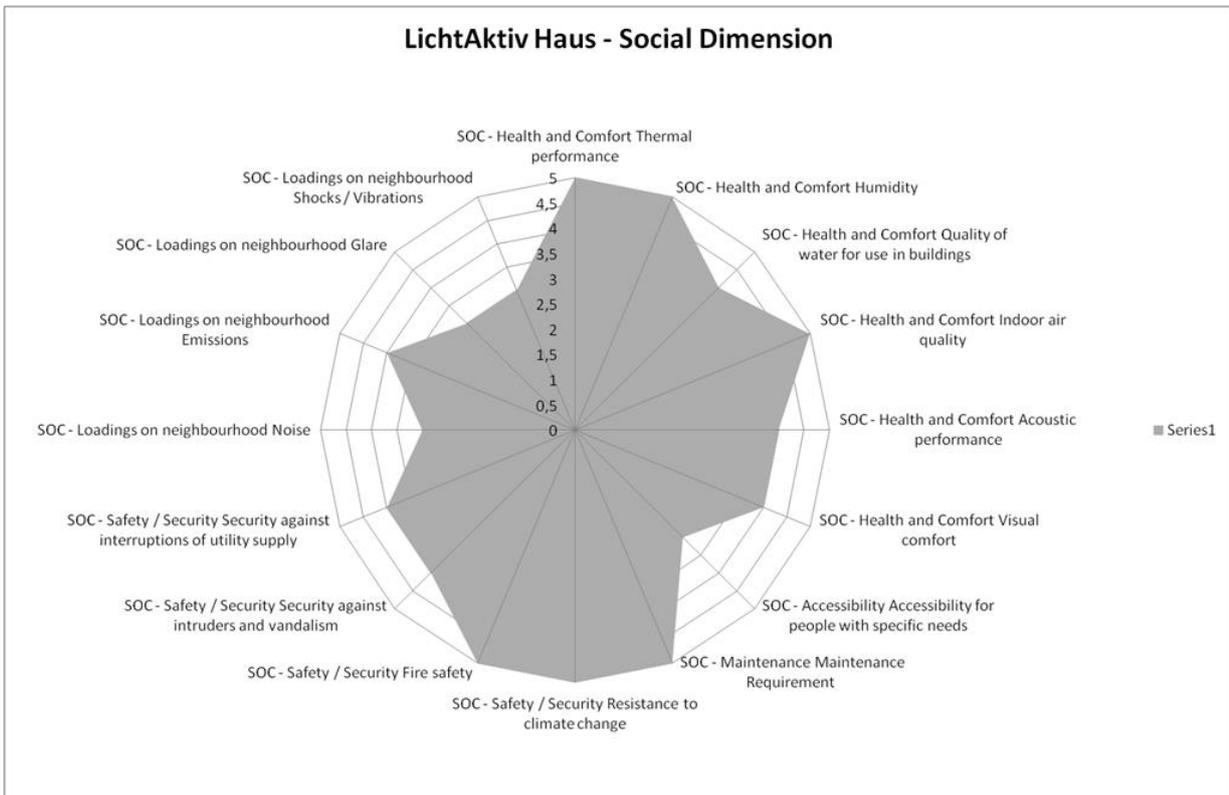


Figure 2: Output of the indicators within the social dimension, validated from 1-5 where 1 is below current practice and 5 is best practice.

When looking into the future kaleidoscope of the CEN/TC 350 there is a suggestive outline that the overall dimensions of environmental, social and economical could become predominant as meta-categories. The indicator measures for social and economic sustainability are still in their infancy, and the economical aspect is quite inactive or considered a hygiene factor in many of the projects – making it difficult to compare.

Several of the informative indicators under environmental, e.g. eutrophication and acidification of land and water resources will mean very little to most professionals yet. However the idea of measuring the impact rather than the performance is the merging trend, supported strongly by the financial calculations of the added value of sustainable buildings.

The CEN/TC 350 indicator analysis remains as an exercise in the garage. Mainly because standards are not released yet, the indicator sets are not finalized, still under discussion and final revision; consensus is still years ahead of us. However the picture drawn up is clear and can be used to communicate projects sustainability aspirations and benchmarks within a relative group of weights, and supports the point that a benchmark must stay simple and be able to give with different levels of overview. We may as well start using it now.

5. DISCUSSION

Different people have different views and levels of understanding about sustainability issues. A standardised platform for assigning relative importance to different sustainability impacts is required if there is to be a consistent basis for decision-making [4].

The stakeholder picture within the construction business is very broad. Typically different individuals or groups are responsible for different levels within building sectors, each with their viewpoint, perspective and interest on the problems at hand, implications and solutions. Where developers could be looking for a return on investment, open towards a service life discussion linked to investment interest, quantity surveyors could regard sustainable intelligent buildings as being significantly more expensive from the outset - the difference of estimating cost or monetary value. The added value gained by being sustainable must be properly accounted for, and experience along with feedback flows can provide useful evidence for future designs.

The differing views of the assessor, the building architect and the building engineer on multiplier level lead to subjective results [4] This means, that effective project value requires an ongoing dialogue between all decision makers to negotiate appropriate compromises and balance stakeholder views. Thus, by recognizing KPIs as a tool to reach consensus among stakeholders, it seems useful to discuss a procedure to do so as a future topic.

The problem with any statement, certification, assessment, assumption, and result in the field of construction is, that the minute it has been stated, the next minute, it is questioned. This is a culture and an educational discipline to put up questions as for results of sustainable buildings. So when the culture is to question any fact put up, what will remain? The subjective conviction and belief, typically driven by accumulated experience and ability to create consensus in the group, using the big storage of common knowledge. However, no indicators, performance categories and impact weightings are common knowledge yet; then it is pointless to keep developing further schemes, matrix, indicator systems and benchmarkings, without a common denominator and agreed starting point of the yardstick.

By defining three levels, differentiated by complexity, communication and target groups (Table 2), the approach can be targeted according to target group.

Table 2: Setup of communication levels according to target groups and corresponding complexity

Label	Target Group	Complexity
Performance Category	Politicians & Public	3
General Indicators	Policy Makers & Press	12
Informative Indicators	Peers & Professionals	69

The level of detailing could follow the framework of the CEN/TC 350 standards, and be used accordingly, leaving each target group within their comfort zone and still discussing the same issue at hand. The benefit of using the CEN/TC 350 as platform is, that the particular national, private, corporate or political interests are taken care of in the one and same model, giving the overall consensus framework.

If the point of departure is shared as far as the three levels, a lot of common luggage can be shared initially, still allowing for differences of opinion, but with a completely different consensus to begin with.

6. CONCLUSION

The quintessence of a sustainable building is that it can ensure human wellbeing on a long-term basis. A certification or an assessment must give an assurance of physical surroundings, which will secure and maintain the wellbeing of the users. This is the main interest of the public as key stakeholder within sustainable buildings, and any attempt to bring, sell, promote or convince, legislate, pioneer, conquer, promote or demonstrate should be measured on a scale of what will matter most to the public - long-term. The decision-makers are to

legislate the framework and have policy-makers formulate quantifications of the currency with which we can cash a future independency of fossil fuels. They are today presented with a wide range of statements and postulates – some are for real, some will work, some will not - and how will we know? We may not know before in the next generation, and even then, we need someone to investigate this, and to communicate it, and bring it into the common consensus bag of common knowledge.

The economical dimension and the profit aspect are in fact the weakest dimension in terms of indicators. Public interest is that sustainable buildings stay within financial reach and social accessibility. It is highly problematic, that the financial aspect is not really a part of the discussions. This dimension cannot be left out, sustainability must, in order to mean a difference, be within social reach, and that means that it cannot only be available for the well-off private or public clients. Can you actually put a price on wellbeing, or rather on the absence of it? The consequences of a failing health, of lack of efficiency and absence of workers, early need for care, exceed surely the economical calculations of the upfront costs of constructing a sustainable building. Prevention goes above and beyond treatment, also when it comes to buildings.

The successful transformation of the individual understanding into high quality indicators stands out as the dilemma, no matter the grouping and levelling of indicators and categories.

Policymakers and politicians are not professionals and will never be. Therefore the construction industry should start simplifying, planners should decipher the concept of sustainable buildings, take it out of the rocket science universe and keep it simple. The most imperative need is to keep it on a simple level, as a minimum when explaining it to politicians, or to your grandmother, as Einstein said.

Even though the issue is very complex, it could be concentrated to three levels by consensus. Politicians stay on top, they got time for 3 bullet points, policy makers can handle the complexity of 12 levels, and peers and professionals go all the way to the informative indicator level, where you must know your way through the 69 (and counting) indicator informatives - like acidification and eutrophication, and so forth.

The grouping of performance categories and deriving indicators in the CEN TC/350 could become a common denominator, subject to be challenged and discussed, but leaning on the very same framework would mean a great difference. How the weighting and subjective assessments is made, will be a whole other challenge, which employs aspects of general education at the schools, information to the public and much more educational aspects in general, if a satisfying level of common knowledge within this field should be reached.

Health is our maybe most precious resource, we must be sure to programme accordingly since we depend on this for future wellbeing through a healthy triple bottom line. We need grandmother to live for as long, that we have time to explain the whole issue about sustainable buildings to her, and we will then need to have our grandchildren explain us the next steps, that is, if we live that long.

7. ACKNOWLEDGEMENTS

Thanks to Nils Larsson for making his work accessible and for inspiration in general, to Lars-Ove Persson for making it feasible and to Peter Lawaetz for making it possible.

8. REFERENCES

- [1] Larsson, N. (November 2010). Building performance assessment, SB Method and SBTool.
- [2] Report of the United Nations Conference on Environment and Development, R. d.-1. (1992).
- [3] Birgisdottir, H. (n.d.). Retrieved 12 2010, from Comparison of how the concept of sustainability is covered in Assessment Schemes DGNB & BREEAM, by Harpa Birgisdottir, SBI: http://www.dk-gbc.dk/media/8958/101029_dkgbc_styregruppe_breeam_dgnb.pdf
- [4] iiSBE Tool 2010: <http://www.iisbe.org/sbtool-2010>
- [5] H. Alwaer, D. Clements-Croome. (2010, April). Key performance indicators (KPIs) and priority setting in using the multi-attribute approach for assessing sustainable intelligent buildings. Building and Environment # 45 (4).
- [6] prEN 15643
 - a. General Framework
 - b. Framework for the assessment of environmental performance
 - c. Framework for the assessment of social performance
 - d. Framework for the assessment of economic performance
 - e. prEN 15804: Environmental product declarations – core rules for the product category of construction products
 - f. prEN 15978 Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method
- [7] Manfred Hegger, T. B. (2010). Ökobilanzierung VELUX Model Home 2020 „LichtAktiv Haus“ Hamburg. Fachbereich Architektur, Fachgebiet Energieeffizientes Bauen. Darmstadt: Technische Universität Darmstadt..