Sustainability Assessment System for Housing in Germany - Concept, Experiences, Opportunities

Andrea Immendoerfer

Researcher

Karlsruhe Institute of Technology - KIT
Germany

andrea.immendoerfer@kit.edu

Prof. Thomas Luetzkendorf, Karlsruhe Institute of Technology - KIT, Germany, thomas.luetzkendorf@kit.edu
Mr. Andreas Rietz, Federal Institute for Research on Building, Urban Affairs and Spatial Development, Germany, andreas.rietz@bbr.bund.de

Summary

Design construction, operation and management of housing have substantial impact on sustainable development. Hence systems for defining and assessing sustainability in housing exist in many countries already. These tend to concentrate on environmental and health aspects, i.e. the environmental dimension of sustainability. Often they take on the perspectives of builders and developers. Often qualitative assessment criteria are being used in order to define and assess specific qualities of buildings.
In many countries these existing systems face further development (compare also Haapio et al, 2008 [1]), other countries are only beginning to establish and introduce sustainability assessments for housing. In the following this paper aims to support such processes by sharing the experiences made in Germany.

Alongside single family houses and two-family houses, blocks of flats provide a substantial share of the German housing stock. The latter are often commissioned and managed by professional housing providers. These have specific targets and requirements that have to be taken into account when developing any sustainability assessment system. It is therefore important that such companies are directly involved in the development process. This paper covers the process of developing a sustainability assessment system for blocks of flats with the involvement of relevant representatives of the German housing industry. It also covers the risks and opportunities of such systems from the point of view of the housing sector as well as possible uses for the assessment results within a housing company. At the same time connections to national sustainability policies and the range of assessment criteria are being shown. The paper will demonstrate how sustainability assessment systems can deal with issues regarding the building location, issues regarding functionality of the building as well as those relating to economic sustainability. Furthermore it will show how greater inclusion of LCA and LCC into assessment criteria can be brought about.

Keywords: housing, assessment system, stakeholders, targets, sustainability indicators, set of indicators

1. Introduction and Objectives

When putting sustainability principles into practise, housing plays a particularly important role, as the construction, operation and management of housing are inextricably linked to the provision of essential needs of society. The way housing is designed influences the way people live and interact and moreover it has impacts on health, wellbeing as well as security of the occupants. At an elemental level housing fulfils the need for shelter and privacy, but it also plays a role in self-fulfilment and defining social status of occupants. Satisfying fundamental needs while at the same time meeting environmental and social targets during planning, construction and operation of buildings, and while also ensuring affordability and economic viability are all part of sustainable development.

It is therefore only appropriate to define the contribution that housing can make to sustainable development, to analyse it and to assess it.

Most countries with established sustainability assessment systems also have system variations for housing. Useful analyses and comparisons have been undertaken by Liu et al (2010) [2] and others. Examples of key systems are given in the table, which is however not exhaustive.

Table 1: Existing assessment systems for housing

Name	Country	Weblink
LEED (Leed for Homes)	North-America + internationally	http://www.usgbc.org/DisplayPage.aspx?CMSPageID=147
Green Star („Multi-unit-Residential“)	Australia	http://www.gbca.org.au/green-star/
CASBEE	Japan	http://www.ibec.or.jp/CASBEE/english/overviewE.htm
Green Building Evaluation Standard	China	http://www.risn.org.cn/Norm/xxbz/ShowCalib1.aspx?CalibID=60043&IsEdit=False
Code for Sustainable Homes	UK	http://www.communities.gov.uk/planningandbuilding/buildingregulations/legislation/codesustainable/
Minergie	Switzerland	http://www.minergie.ch/
TQB	Austria	www.oegnb.net
HQE (La certification NF Logement Démarche HQE®)	France	http://www.qualitel.org/

Often such efforts are closely linked to national grant and support programmes for new housing.

The development and application of assessment and certification systems serve several purposes. On the one hand the stakeholders involved such house builders, developers, housing associations etc. can be influenced. On the other hand, such systems serve in some countries as a tool for politicians and or grant providers to assess the future-proofing / future viability of new housing and its compatibility with political objectives.

The development and implementation of assessment and certification systems for housing have to take account of the specific characteristics of housing. These are for example:

- the importance of the social aspects of housing as part of social sustainability
- the structure of ownership of housing with individual owner occupiers on the one hand and professional landlords with large portfolios on the other
- the role of the home as a focal point and safe haven for occupants

Despite a multitude of existing sustainability assessment systems on the international market, the need for further development and the exchange of experiences persist for various reasons:

- Many countries still do not yet have their own systems that are tailored to national and regional issues and would like to develop suitable systems.
- Existing systems also still do not always reflect national and regional issues or the state of art of international standardisation.
- Available systems do not always match the specific aims, objectives and interests of particular stakeholders such as small house builders, developers or landlords.
- Available systems do not always address the specific characteristics of particular building types (such as for example single family houses or blocks of flats).
- Many available systems originally mainly focused on environmental and health related issues and used a “bottom up” approach, these now face a fundamental overhaul in order to encompass the full complexity of sustainability that goes together with a “top down” approach, as propagated in current scientific research efforts.

Starting from the results of a research project supported by the German Ministry for Transport, Building and Urban Development (BMVBS) and the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) this paper provides recommendations and suggestions for the development of sustainability assessment systems, which concentrate on multi-unit dwellings and the interests of large housing companies. The process of involving interested stakeholders is being addressed as well as certain methodological issues of the development process.

2. Background

Initially the German situation and point of departure will be explained. Compiling this information can be seen as an exemplary necessary step in system development.

2.1 Political Targets and National Strategic Indicators

The sustainability principles for the construction and housing sector had already been defined by a seminal study by the government, the so called “Enquete Commission on the protection of man and environment” [3] in the late nineteen-nineties, stating the following principles and goals:

Social dimension of sustainability in housing:
- Safeguarding availability and affordability of housing
- Creating a positive, healthy and integrative social environment
- Increasing home ownership, decoupling homeownership from increased landuse
- Creating/ safeguarding jobs

Economic dimension of sustainability in housing:
- Minimisation of life cycle costs of buildings
- reduction in costs for refurbishment and conservation in comparison to new-build
- optimisation of expenditure on technical and social infrastructure
- reduction of expenditure on subsidies

Environmental dimension of sustainability in housing:
- reduction of land use, sprawl and soil sealing
- resource preservation
- avoiding harmful substances in buildings and in the environment
- Reducing CO_2 emissions from buildings

Furthermore Germany has a sustainability strategy, which comprises the key principles of intergenerational justice, quality of life, social cohesion and international responsibility which also reflect on construction and housing. This strategy contains a number of indicators and goals, as stated in Table 2. In so far the work presented here presents an example of how sustainability assessment systems can be aligned with national targets and indicators.

Table 2: Topics and goals for sustainable development in Germany [4]

Topic	**goal**
Resource protection	using resources economically and efficiently
Climate change mitigation	reducing greenhouse gases
Renewable energy	strengthening a sustainable energy supply
Land use	sustainable use of land
Biodiversity	preserving species – protecting habitats
Providing for future economic stability	creating favourable investment conditions – securing longterm prosperity
Economic prosperity	raising economic output by environmentally and socially compatible means
Air quality	ensuring a healthy environment
Crime	increasing personal security

2.2 Drivers

In addition to the political aims mentioned above and resulting targets for resource preservation and climate change adaptation and mitigation, the German housing industry sees the following drivers for sustainability assessments:

- Corporate social responsibility and the desire to have greater quality control increase in importance in the housing sector.
- In order to move from price-focussed competition to quality focused competition sustainability certification can play a role as an indicator for quality.
- The housing industry sees a need for tools and checklists that support a target definition process as well as the design and construction process.
- There is some evidence emerging of an increased interest in sustainability related data and certification by banks and finance institutions. German property surveyors have integrated energy efficiency as part of valuation criteria already.

2.3 Housing Market and Stakeholders in Germany

Table 3: Ownership structure of German housing market [7]

Owners	number of dwelling units	percentage
professional landlords - housing co-operative	2’217’000	5,6%
professional landlords communal	2’434’000	6,1%
Public sector housing providers	206’000	0,5%
professional landlords - privat housing companies	4’059’000	10,2%
professional landlords - churches and charities	301’000	0,8%
private landlords - in single family houses / duplex houses	5’421’000	13,7%
private landlords - flats	9’089’000	22,9%
Owner-occupiers – in single family houses / duplex houses	12’812’000	32,3%
Owner-occupiers - flats	3’081’000	7,8%
Total	**39’617’000**	**100%**

Certain characteristics of the German housing market set it apart from its European neighbours

and require a tailored approach for sustainability assessments. With 43% [5] home ownership levels are comparatively low in Germany. Therefore the rental market plays a more important role in Germany than in some other EU-countries. The rental market is dominated by smaller private landlords, while large professional landlords and housing companies, which tend to be better organise still make up a substantial share of around 40% of the rental market. An exact break down is given in Table 3 above.

According to recent research by BBSR a requirement of altogether 2,9 million dwellings has been predicted for Germany for the next 15 years [6]. This means an average in the region of 200 000 new dwellings per year. Of these over a third will be in blocks of flats.

2.4 Systems for the Assessment of Housing

The development and implementation of tools for the specification and assessment of housing is not new, though none of the previous systems have had great market penetration or are as comprehensive as a sustainability assessment system needs to be. Two such systems, that do cover a range of aspects relevant to sustainability and which were investigated in the early stages of the project, namely “Wohnwertbarometer” [8] and “Geprüfte Lebensqualität in Siedlungen” (tested neighbourhood quality) by TÜV Rheinland [9] were both developed for very specific housing companies and tailored to their specific needs.
What is new now is the comprehensiveness of the endeavours to specify, assess and communicate features of new-build housing. This is currently being reflected in 3 activities in Germany.

a) The development and implementation of a sustainability assessment system for new housing through the private organisation DGNB, as a system variation of the DGNB sustainability certificate, which is particularly geared towards developers.

b) The development of a concept for sustainability assessments in collaboration with the prefab housing industry.

c) The development of a concept for the sustainability assessment of new-built multi-unit dwellings in collaboration with the housing industry (representatives of large social and commercial landlords), professional bodies and science, supported by the German Ministry for Transport, Building and Urban Development and the Federal Institute for Research on Building, Urban Affairs and Spatial Development, which particularly focuses on the points of view of large stock holders in the housing industry.

This paper is primarily based on the developments described under c).

3. Approach

In the following the general approach to the system development will be covered – some universally valid findings gathered will be presented here.

3.1 Involving Interested Stakeholders

On initiative of the German housing industry and in order to develop a system that would meet the needs of the housing industry, a working group was set up in summer 2009 to form part of the existing “Round Table on Sustainable Construction”. The working group comprises important representatives of the German housing industry and of relevant professional and consumer associations, as well as representatives from several ministerial departments. In particular several

large housing providers are represented, presenting the perspective of large portfolio holders. The work of the group receives scientific support, which is paid for from the research initiative “future building” of the German Ministry of Transport, Building and Urban Development.

3.2 Defining Roles, Goals and Requirements of the Scheme

The discussions of the working group led to valuable insights into possible roles for assessment systems in so far as that they can serve as a tool for various purposes and stakeholders throughout the building lifecycle. In particular the following roles have been identified:

- **Signalling Quality:** Housing providers can signal the quality of their buildings vis-a-vis clients (buyers or tenants). However this is conditional to there being a demand. From the point of view of the client this is desirable and aids transparency. Willingness to pay may increase, if certain qualities can be presented effectively.

- **Source of information / basis for decision making for third parties:** Information and assessment results can serve as source of information for surveyors, valuers, financiers and insurers. They may be offered voluntarily or demanded by them. Typically such parties are not interested in highly aggregated information but in certain relevant data that can be integrated into their own systems. Assessment results can serve as a decision making aid when buying, renting or procuring a property. They may also influence decisions regarding financing and grant allocation.

- **Source of information for internal and external steering and decision making**: relevant data and assessment results can be included in a portfolio analysis and inform portfolio management.

- **Part of sustainability reporting**: relevant information and assessment results can form part of sustainability reporting and thus influence public perception and image.

- **Supporting quality assurance:** An assessment system has the potential to serve as a checklist during the planning process starting from the appropriate wording of project targets. Additionally, on the principle that four eyes see more than two the data analysis required for the assessment can help uncover weaknesses in documentation and/ or actual construction.

- **Supporting target definition and contractual certainty**: an assessment system can serve as a checklist for a precise agreement regarding qualities as well as regarding documentation and checking, which in turn can lead to better contractual certainty for all involved.

- **Design tool:** Awareness of assessment criteria during the design process can help the complex task of sustainable design.

These findings strengthen the case for sustainability assessment, due to their multiple uses.
As discussions moved on to focus on the practicalities of an assessment system a set of guiding principles were defined, which reflect the specific position of the German housing industry, its concerns and requirements. Particularly important issues are:

- the social sustainability of housing
- covering aspects relating to the location of the building appropriately
- ensuring transparency of results and information
- giving priority to individual results over aggregated results

Above all, extra cost resulting directly or indirectly from certification is of great concern – the system has to be designed in a way that it can be applied without undue additional expenditure – either for the certification process itself or for additional work during the construction and design process. Moreover, it is considered important that the assessment system is entirely voluntary and that it is commissioned by the housing provider for their own internal purposes. Results should not be made public (e.g. by an independent certification authority) unless the housing provider itself chooses to make them public.

In conclusion the aim was defined, that links have to be established between individual buildings and the general aims of a company and the specific market conditions.

3.3 Analysis of Risks

Before tackling relevant indicators and assessment methods, the working group discussed the risks of introducing an assessment system. Since the work of the group was particularly influenced by the thinking and requirements of large housing providers, a view of sustainability assessments being closely related to and complementary to portfolio management practices dominated. It is fair to say that many representatives of the housing industry had considerable concerns regarding the introduction of such a system. In particular they saw the following risks:

- Parts of the housing industry are very worried that a certification system for new buildings could indirectly lead to negative effects on non-certified existing housing stock and in fact lead to stigmatisation of older stock and buildings in difficult locations, although this does not appear to have happened in other countries.

- Some members of the working group were very concerned, that if a certification system is available this may gradually lead to higher regulatory requirements. For example local authorities may require as part of planning permission that a particular standard be reached – either meeting all requirements of the system or requirements relating to individual indicators. Alternatively, funding may be conditional to such standards being reached.

- The housing industry is concerned about the additional effort and expense in terms of money and time that a new assessment system may require. The affordability of housing in particular is a great social concern, which cannot be compromised by undue expense for sustainability measures or the expense for the certification process. Some housing providers find it increasingly difficult to provide affordable housing, with requirement resulting from climate change targets and other regulatory requirements putting pressure on improving relevant qualities [10].

The fear of stigmatisation of existing stock was raised repeatedly and constitutes a major obstacle that would need to be overcome if the German housing industry were to fully embrace sustainability assessments.

3.4 Development of a Basic Structure with Sets of Criteria

For the development of a basic structure and main criteria groups a top-down approach was used (see also the SB11-paper by Lützkendorf et. al. “Next generation of sustainability assessment – top down approach and stakeholders needs”). The groups of criteria and individual indicators were deduced from the overarching sustainability concerns, since any sustainability assessment has to cover at least the environmental social and economic dimensions of sustainability.
For the assessment of sustainability in new-build housing the housing providers see certain particular needs, which will be presented here:

- Every new construction project represents a reaction to the context and environmental conditions at the site. The design has to respond to soil conditions, solar orientation, noise leves, likely impacts from climate change and other local risks, which can all lead to additional construction challenges. An assessment should reflect and assess in how far the building has indeed risen to the demands of the site. Therefore any assessment should be preceded by a detailed description of site conditions.

- A new building commissioned by a housing provider/ landlord will always be considered as part of overall company policies and react to current and future market conditions. Prognoses regarding demographic change as well as well as those regarding changes in ways of living and lifestyles have to be taken into account. This will have immediate impacts on the design process. It has to be demonstrated whether and in how far a building is able to respond to current and future market requirements.

- Relevant company policies as well as information regarding trends and expected future market developments should also be stated up front as a preface to the assessment.

- A sustainability assessment for housing should not only focus on the required input into the production, construction and operation. Decisive for sustainability is a long, useful life of the building, which is determined by technical durability on the one hand and longterm functionality on the other. Fulfilling functional requirements of current and future users is therefore fundamental and is at the same time part of the social quality of a building.

The structure of the proposed sets of criteria are aligned with those used by the two systems for offices currently used in Germany (BNB and DGNB), and is shown in Figure 1.

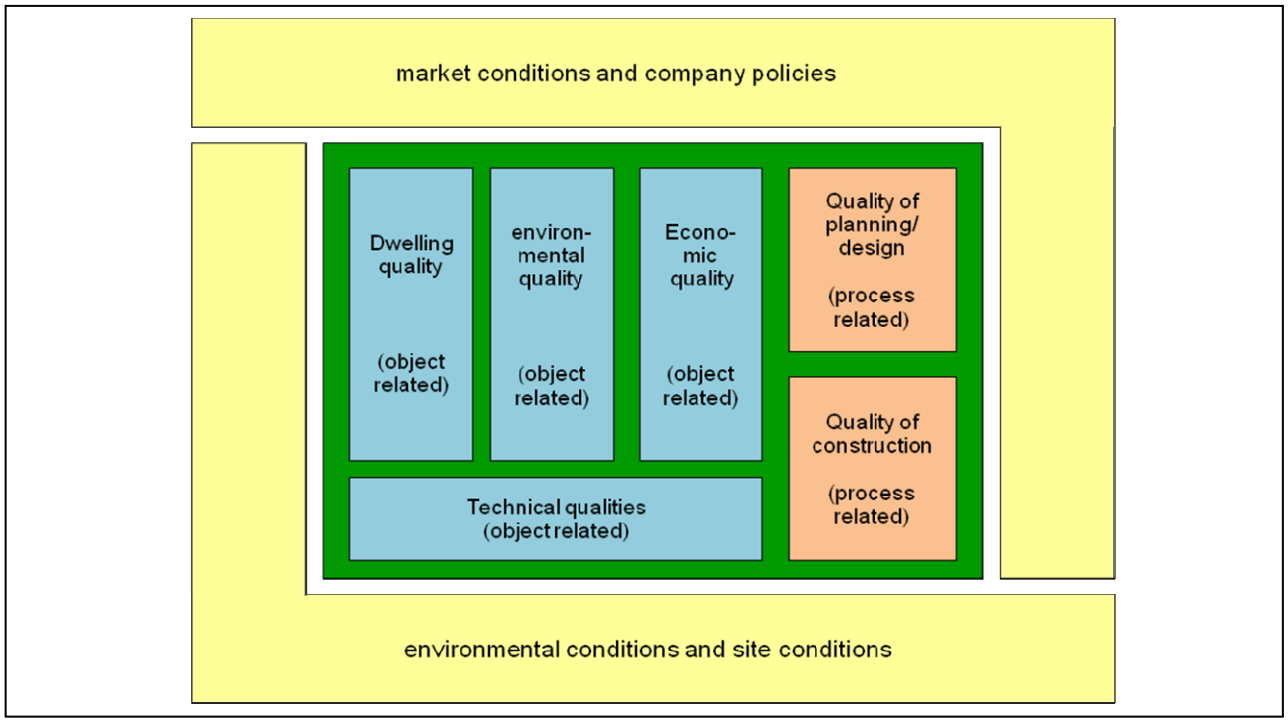

Figure 1: Proposal for a structure of assessment criteria and sets of indicators; [Lützkendorf, 2010]

In line with emerging CEN and ISO standardisation [11] [12] on sustainability assessments, work on the new assessment system has covered the three pillars of sustainability: environmental, social and economic sustainability. For greater clarity of structure and to retain a level of analogy to the existing German systems, two further groups of criteria were added. There is a set of technical

qualities that reflects basic fitness for purpose of the building. Furthermore, there is a set of criteria relating to management processes throughout the lifecycle of the building, which is looked at separately to those qualities relating to the substance of the building. From these key topics a set of indicators was developed in order to cover all topics relevant to sustainability.

3.5 Development Of Individual Indicators

In a general sense, indicators to be developed have to be associated with one of the main groups of criteria, though it may make sense to point out multiple effects across the different dimensions of sustainability. Individual criteria should show clear links to the overarching goals of the assessment, i.e. what concerns are being addressed by the indicator or what negative impacts are being avoided. The following elements have to be developed: indicator definition, units to be measured, assessment rules and assessment scales. These can be presented in the form of a concise file for each indicator. The project followed these principles.

3.6 Developing Rules for Weighting and Partial and Full Aggregation of Results.

In order to summarize these results further for each criteria group (as a partial aggregation of results) or to fully aggregate all indicator result into one over-all result for the assessment, suitable rules must be defined. Indicators may be given different weights within a group and the main groups may be weighted differently as part of an overall result. Objective methods should always be employed for the process of weighting and aggregation, such as rules for calculating global warming potential, analysing user satisfaction for example through Predicted Mean Vote etc. If this is not possible, the interested stakeholders have to resort to generally accepted methods and conventions, such as expert opinions or surveys.
In this specific case, the working group felt that in fact un-aggregated results for each indicator were, at least initially, preferable to aggregated result which would summarise results of several indicators, the main indicator groups or even the results of all indicators. However, as the scheme develops and in response to suggestions from the scientific advisors and from assessors during the pilot phase, aggregation may be re-considered in order to make results more concise.

3.7 Development of Presentation Format

Discussions regarding presentation formats for assessment results are all too often focused on the design of a certificate, medal or label. However, in order to respond to the aims and applications set out above it is crucial that part-results for groups of indicators and specific indicators be shown in disaggregated form. Possible forms of representation are:

- Strength/ weaknesses Profile expressed as table with numeric results
- Strength/ weaknesses Profile (graphical representation, linear or as columns)
- Individual results shown within a spider graph

As part of the research project a form was developed that allowed the capturing of information relating to site and context of the project as well as individual scores for each indicator in the form of a profile.

3.8 Piloting a System

It is advisable and indeed common practise to pilot any new system using practical examples. Ideally, a range of possible cases and variations should be simulated, that can occur in implementation. When testing, it is often a problem that issues relating to the design process can be difficult to capture later on, though this won't be an issue for future application, when starting at design stage.

In order to test the indicators and assessment methods developed for the project, the system at hand was tested on 5 very different residential properties, which had all been recently completed. The range of projects covered different geographical regions, building shapes and sizes (7- 53 units) and heating strategies (district heating, biomass boiler, conventional gas boiler with solar hot water heating). It was found to be particularly useful to have a range of very different projects, varying in size, energy strategy and building shape. This allowed and required the investigation of potential problem areas relating to the treatment of one-off solutions and system boundaries (e.g. whether two linked buildings are to be treated separately or together, whether to include underground car parking in LCA or not).

4. Experiences Gained from Development of Certain Specific Indicators

From the discussion of the working group certain novel indicators emerged, which may be able to fill certain gaps in the indicator systems currently used, in particular when addressing economic sustainability.

4.1 Assessment of Environmental Performance – LCA

Since Germany is fortunate enough to have LCA data for buildings readily available, environmental quality can be assessed using an LCA approach. The calculations and assessments include production stage, use stage and end of life. The following environmental impacts were considered as part of the assessment of environmental performance:

- GHG
- ozon depletion potential
- photochemical ozone creation potential
- acidification potential
- eutrophication potential

There had been concerns as to how viable it was to include a life cycle assessment for comparatively small housing projects. However, time requirements for data collection, preparation and entry as well as the actual calculation proved to be moderate. At this stage architects are not used to conducting LCA and LCC calculation. However, a system such as the one used in this case (LEGEP [12]), which is specifically designed for architects and quantity surveyors, linking the bill of quantities to LCA and LCC may allow construction professional to integrate LCA these into their service offerings.

4.2 Assessment of Economic Performance – LCC

In recent years lifecycle costing has developed in Germany to a level that it can be applied readily. Relevant data and methodologies have been developed, which are published via the web platform www.nachhaltigesbauen.de, which is accessible to the general public.
The Lifecycle costing calculations undertaken as part of this piece of research encompassed the following costs: construction, operation (heating, hot water supply), cleaning in use, services,

ongoing repairs, maintenance and cyclical replacements. The first 50 years of the life cycle of the building are being considered. A dynamic net present value method was employed. The energy price increase factor was set to 4% per year, the interest rate was set to 3,5%. All other parameters were set in accordance with German standards or other industry guidance.

4.3 Assessment of Economic Performance – New, Additional Indicator

A comprehensive definition and assessment of economic performance continues to be difficult. In addition to LCC the economic value of a property and cost/ benefit ratios should be considered more strongly. The following proposal has been developed by representatives of the German housing industry within the working group.

Ratio of investment cost to market value
Limiting additional costs for sustainability features and assessment were of particular concern. Or put more positively, it was felt that additional costs for high quality, sustainable buildings must be reflected adequately in the value of the property. Therefore an indicator was created that compares the construction costs to the market value of the resulting building. There was agreement that this must not rely on a costly valuation report from a third party, but on figures that can be compiled internally by the housing company. The methodology developed for this purpose is the calculation of a ratio of investment costs to market value. In how far this method is appropriate has to be investigated further.

5. Conclusions and Outlook

Currently many existing assessment systems are facing an overhaul, due to recent developments in international standardisation ISO TC 59 SC 17 and the requirements on sustainability assessments that these state. Furthermore a general move away from solely concentrating on environmental and health issues in favour of encompassing all sustainability issues is noticeable. It remains to be seen whether this leads to existing assessment systems becoming more similar in content or not.

This paper provides recommendations that can support the development of new systems from scratch or further development of existing systems. In particular new indicators for the assessment of environmental performance and economic performance are being proposed, which are based on a life cycle approach and use LCA and LCC. That future developments in the field of sustainability assessments will move further in this direction can be expected.

During the course of the research project presented here, it emerged that large housing providers have considerable concerns regarding the introduction of sustainability assessments, which need to be overcome. In particular, there are fears that singling out certain high-quality buildings with positive assessments results may lead indirectly to a more critical view of the other properties. For such companies it is important that instruments for sustainability assessments are compatible with sustainability reporting and portfolio management practices.

Acknowledgements

The authors wish to express their thanks to the German Ministry for Transport, Building and Urban Development and then the Federal Institute for Research on Building, Urban Affairs and Spatial Development for funding this research. Furthermore thanks go to the members of the working group, who have supported the work with numerous recommendations and ideas.

References

[1] Haapio A, Viitaniemi P, *"A critical review of building environmental assessment tools",* Environmental Impact Assessment Review 28 (2008) 469–482, 2008
[2] Liu G et al, *"Longlife Comparison of worldwide certification systems for sustainable buildings"*, *Conference proceedings Comparison of worldwide certification systems for sustainable buildings,* 2010
[3] Deutscher Bundestag, *"Schutz des Menschen und der Umwelt – Ziele und Rahmenbedingungen einer nachhaltig zukunftsverträglichen Entwicklung",* Drucksache 13/11200, 1998
[4] Federal Statistical Office of Germany, *"Sustainable Development in Germany"*, Federal Statistical Office of Germany, 2010
[5] LBS, "Markt für Wohnimmobilien 2010*", Bundesgeschäftsstelle Landesbausparkassen, 2010, p.31*
[6] BBSR, *"Wohnungsmärkte im Wandel. Zentrale Ergebnisse der Wohnungsmarktprognose 2025"*, BBSR-Berichte KOMPAKT 1/2010
[7] GdW: *"Wohnungswirtschaftliche Daten und Trends 2008-2009"*, 2008
[8] HEGGER M. (editor), *"WohnwertBarometer Erfassungs- und Bewertungssystem nachhaltiger Wohnqualität (final report)",* Technical University Darmstadt, 2009
[9] THS: "*Qualitätsmanagement bei der THS - Lebensqualität in Siedlungen"*, THS, 2007
[10] VOGLER I., *"Nachhaltigkeit von neu errichteten Wohngebäuden – Wege zur Beschreibung und Bewertung"*, Mauerwerk 14 Heft 4, 2010
[11] CEN/TC 350, EN 15643-1:2010, *"Sustainability of construction works — Sustainability assessment of buildings — Part 1: General framework",* 2010
[12] ISO 15392:2008, *"Sustainability in building construction - General principles",* 2008
[13] www.legep.de - *accessed March 2011*