Potential of sustainability in existing buildings - An assessing method

Elen M. K. Hvide[1], Svein Bjørberg[2], Marit S. Valen[3], Tore Haavaldsen[4]

Abstract

Today as in the future there is a great demand for sustainable buildings. This is not only true for new buildings but also to a large extent existing buildings. In order to achieve sustainable buildings many factors are to be considered. For this reason it is of strong interest to find tools and methods that are focusing on the potential of sustainability in existing buildings, not only considering the economical aspect but also taking into account the social and environmental aspects. This paper describes the indicators that are relevant for studying the buildings potential for sustainable development and presents a new method for assessing existing buildings. Existing methods found in the literature are evaluated and the best of these tools are extracted and adapted to a tool that can be used on existing buildings. In order to identify the factors that affect the existing buildings' sustainability, depth interviews and a survey among Norwegian property companies and engineering consultants have been conducted. The method is validated through case studies and we believe this will be a useful tool for engineering consultants and real estate companies for evaluation of building performances of building portfolios. The method may help to increase the focus on factors that have an influence on buildings' sustainability, including evaluation of theoretical and realistic potential, and to give useful information to the owner on how to develop a building portfolio.

Keywords: Potential for sustainability, assessment method, building portfolios, input to strategies

1. Introduction

The importance of striving for sustainable buildings is high, both today and for the future. This is not only true for new buildings, but also to a large extent existing buildings. In order to ensure that existing buildings will keep up with today's demand; it is of interest to identify the buildings' physical and technical factors that influence the sustainability of a building. There are many factors that must be taken into account in order to achieve sustainable buildings,

[1] Master of Science; Elen Marie Kyrkjebø Hvide; Multiconsult; PB 265 Skøyen, 0213 Oslo; elen.marie.kyrkjebo.hvide@multiconsult.no
[2] Professor; Svein Bjørberg; NTNU/Multiconsult; PB 265 Skøyen, 0213 Oslo; svein.bjorberg@multiconsult.no.
[3] Associated Professor; Marit Støre Valen; Department of Civil and Transport Engineering; NTNU; Høgskoleringen 7A, 7491 Trondheim; marit.valen@ntnu.no
[4] Professor; Tore Haavaldsen; Department of Civil and Transport Engineering; NTNU; Høgskoleringen 7A, 7491 Trondheim; tore.haavaldsen@ntnu.no

such as energy efficiency, use of durable materials and facilitation of universal design, as well as good indoor air quality, aesthetics and heritage values that must be maintained and preserved. For these reasons, it is important to explore how to understand the potential for sustainability of the existing buildings. There are currently several methods that in various ways assess aspects of sustainability in buildings, such as BREEAM IN-use (Building Research Establishment Environmental Assessment Method), SURE (Sustainable Refurbishment), SIA (Sustainable Impact Assessment), LCA and LCC methodologies. BREEAM In-Use assesses mainly the environmental performance of existing buildings (BRE Global, 2011), in addition to some aspects of the buildings' social performance. SURE presents a guideline for sustainable refurbishment (Almås, et al., 2011), SIA assesses the impacts of a project or action in a greater context (OECD, 2010) and LCA (Life Cycle Assessment) is a methodology analysing the environmental impact of buildings during its lifetime. As LCA, the LCC methodology does similarly analyse the impacts of a building during its lifetime, however, only the economic impacts. A Norwegian assessment tool, Multimap, does also assess some sustainable aspects of the building by assessing the technical condition and other building factors for building portfolios (Bjørberg, Larssen, & Listerud, 2012). The Multimap method is based on the Norwegian standard for assessment of technical condition surveys for construction works (Norwegian Standard NS 3424, 1995) and uses the registration of technical condition and key numbers to estimate the costs of a technical upgrading of the buildings. Many existing assessment methods are aimed for construction of new buildings and for application in the design phase. However, there is a lack of methods assessing all aspects of sustainability in preliminary phases and for greater building portfolios. The SIA is for instance considering social, economic and environmental aspects of sustainability. Nevertheless it focuses on evaluating the *impacts* of a project that is considered for implementation, more than evaluating the today's situation as a basis for further decision making for a building portfolio. Most property investors want to invest in buildings that have a realistic potential for further development. This is primary to obtain economic profit, but the potential for further development may also include a positive environmental and social development of the building. A methodology for assessing buildings' potential for sustainability for building portfolios, can be a useful tool for property investors, engineering consultants and building owners. This is also the background for this paper. This paper describes a new assessment method to assess existing buildings' realistic potential for sustainability, developed through a master thesis from Norwegian University of Science and Technology (NTNU) (Hvide, 2012).

2. Methodology

The research method for the development of an assessment method included several methodology approaches. A literature study on existing methods assessing sustainability in some way (primarily BREEAM, SURE and MultiMap) was done to extract the best of these methods and adapt it to a tool that could be used for building portfolios. Further on, building factors affecting buildings' potential for sustainability was discussed in in-depth interviews with Norwegian property companies. In addition to the interviews, a survey that included rating of several building factors' influence on sustainability was also conducted. For validation of the developed assessment tool, two case studies were carried out.

3. Objectives

The main objective was to develop a method that could be used to evaluate the realistic potential for sustainability in existing buildings, especially with regard to building portfolios. Such a method could be a useful tool for real estate agents when strategizing further development of building portfolios. By getting a certain indication of the buildings' realistic potential for sustainability, decisions on whether to upgrade, refurbish, rebuild, sell or demolish can be made on a good basis. The criteria for the method were as follows:

- The method should give a result that indicates if the building has the potential to be developed further in a sustainable way (which includes a positive interaction between environmental, social and economic aspects). When considering a real estate portfolio it should provide a good basis for deciding which buildings should be retained, sold or demolished

- The method should be used in preliminary phases as an input to a decision base, and should therefore only do evaluation based on easily retained information. It should not depend on detailed numeric values.

- The method is intended to serve as a tool for engineering consultants, in order for them to make recommendations to property owners on future strategies for their building properties.

- In efforts to collect data for the method, it should be kept as simple as possible without involvement of too many people. People that could be involved: operating personnel, role of the core business management (CEO) and a representative from the owner.

- The tool should be user friendly for both consultants and other users involved in the assessment, and tool should visualize the results.

4. Results

4.1 Existing assessment methods

Based on the criteria listed above, existing assessment methods were evaluated, in order to detect if any of the methods were suited for this type of assessment, and also to identify relevant indicators and approaches to evaluate buildings' potential for sustainability. The methods evaluated were MultiMap, LCA (and Recipe, a method based on LCA methodology), BREEAM In-Use, SURE, SIA and LCC. Common to many of the evaluated methods is that implementation of the methods is too resource intensive and time consuming to assess a large amount of buildings in preliminary phases. For instance, BREEAM In-Use requires documentation to fulfil many of the requirements, which will be too comprehensive to obtain when evaluating a building portfolio. SURE is also considered as too comprehensive due to the many indicators that are supposed to be measured quantitatively that may require special equipment and more detailed inspections of the buildings. MultiMap,

however, has a more suitable level of detailing required for assessments of building portfolios, as there are few indicators to assess in addition to few people required for the assessment. However, it does not assess all aspects of sustainability, which is a criterion for the method as wanted. SIA covers the economic, social and environmental aspects of what is evaluated. Nevertheless is the method considered as too general and not specified for sustainability within buildings. A summary of the evaluation of the methods is presented in Table 1.

Table 1 Evaluation of existing assessment methods (Hvide, 2012)

Existing methods	**Aspects of sustainability**	**Level of detailing**	**Application**
MultiMap	Assessment of technical condition, usability and adaptability. Mainly assessing economic and social aspects.	Low/medium detailing level. Approx. ten indicators for each module (e.g technical condition, usability, adaptability)	Existing buildings
LCA (and ReCiPe LCIA method)	Assessment of environmental impacts.	High detailing level. Requires quantitative values.	Buildings and other products and activities.
BREEAM In-Use	Mainly assessment of environmental impact, but also some social impacts such as indoor climate and comfort.	High detailing level. Requires quantitative values andl documentation.	Existing buildings
SURE (Sustainable Refurbishment)	Assessment of economic, environmental and social impacts.	Medium/high detailing level. Assesses many indicators and requires several quantitative measurements.	Existing buildings (mainly when planning a refurbishment)
SIA (Sustainable Impact Assessment)	Assessment of economic, social and environmental aspects of sustainability	Low detailing level. Very overarching. Requires only the main features.	Projects. Applies mainly to new constructions or new actions, rarely existing buildings.
LCC (Life cycle Costs)	Assessment of economic impacts	High detailing level. Requires quantitative measurements.	Buildings and other products.

The methods discussed above do all have many relevant elements appropriate for an assessment method for sustainability of buildings. However, for a method aimed at assessing a large amount of buildings, many of the existing methods are too comprehensive for implementation in preliminary phases. For further development of a method assessing sustainability for a building portfolio, these elements were adapted, and some adjusted, from the methods listed in Table 1:

- The same approach as in MultiMap and SURE; evaluate today´s situation, decide a level of ambition for the future, and evaluate the gap between these.
- Assessment of various indicators categorized in economic, social and environmental aspects.
- The use of several indicators influenced from SURE and BREEAM In-Use, however, adjusted to fewer indicators.

4.2 Theoretical and realistic potential for sustainability

A buildings' potential for sustainability is in this paper referred to as the opportunities that lies within a building to ensure building users' needs today and in the future in a sustainable way, which includes a positive interaction between the environmental, the social and the economic aspects.

In the process of evaluating a building's potential for sustainability, one should be aware of what conditions that restrict or enhance this potential. These conditions could be economical, physical building conditions or for instance planning regulations. A building's potential could be regarded as the possibilities to improve a building standard from its current situation to a preferred standard. A building's potential for sustainability is also dependent on the future purpose of the building. This paper distinguishes between a theoretical and realistic potential. A theoretical potential is considered as the potential that is possible to achieve in *theory*, when not taking restricting conditions of a building into consideration. A realistic potential, however, is a potential that takes into account the opportunities that *in reality* can be exploited, also considering the restricting conditions of the building.

4.3 Interviews and surveys

In the process of determining how to evaluate buildings' sustainability in the method, real estate companies were interviewed about sustainability in existing buildings. From the interviews it appeared that today's building tenants have high requirements to the environmental standard of buildings. The requirements for environmental standard is however not consistent with the tenants' willingness to pay and other requirements, such as a tenants' requirements for large glass facades that require a lot of energy for cooling. For most companies it is the economic aspects of sustainability that is the main driver. The possibility for economic sustainability is therefore a requirement for whether or not it is possible to improve the building's social and environmental sustainability. Several companies state that factors as indoor air quality, energy efficiency, life cycle thinking and the opportunity for economic profit is essential factors that need to be considered in order to obtain sustainable buildings.

A survey was also conducted in which the respondents were to rank specific building conditions and to what extent they had impact on the buildings' social, environmental and economic sustainability. The respondents included mostly professionals within building consultancy, but also representatives from a real estate company. The survey results can be interpreted as if most of the respondents considered the buildings' energy demand, use of renewable energy sources and to which extent buildings have good indoor climate as essential factors for buildings' sustainability. To ensure economic sustainability, as well as social and environmental sustainability, a long-term perspective on investments and the possibility to have long leases were also ranked as significant.

Based on the interviews, the survey and the evaluation of existing assessment methods, a method was developed and relevant indicators of sustainability in buildings were identified.

4.4 The method

The method is based on a process including several steps that should be iterated to finally determine the building's *realistic* potential for sustainability (see Figure 1). The reason for why the process should be iterated is that while carrying out the different steps in the process, one might have to do some adjustments in the previous steps to be able to finally determine the realistic potential possible to exploit. This could include lowering the level of ambition for the building or for instance changing the purpose of the building.

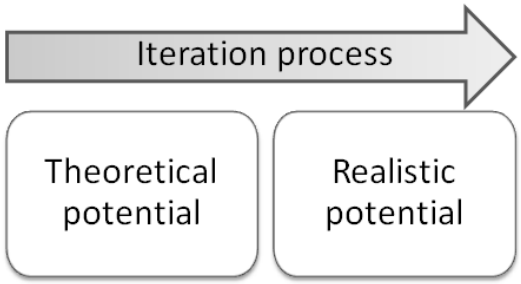

Figure 1: Theoretical to realistic potential by iteration (Hvide, 2012)

Figure 2 presents the different steps. In several steps there are certain indicators that should be evaluated on the basis of the building condition as it is today and further ambitions for the building in the future. A set of indicators have been chosen that are to be scored to a degree of sustainability from 0 (best) to 3 (worst) based on the building as it is today and how it's desired to be, as an assessment in which the compliance of demand and performance is evaluated (as described in Figure 3).

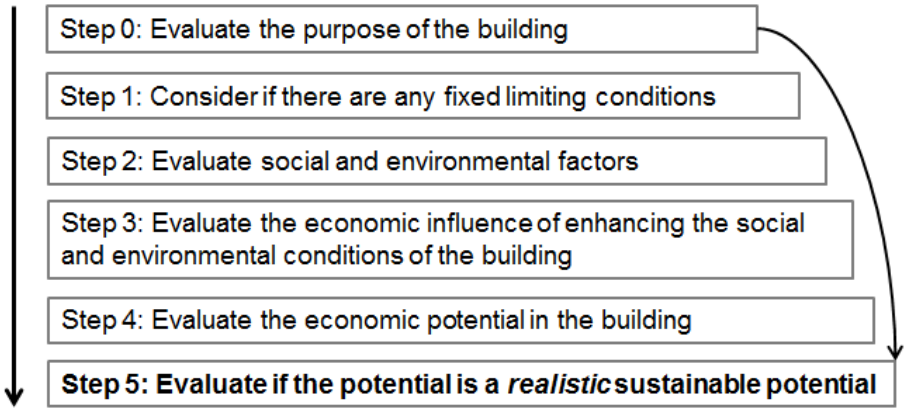

Figure 2: The various steps in the method (Hvide, 2012)

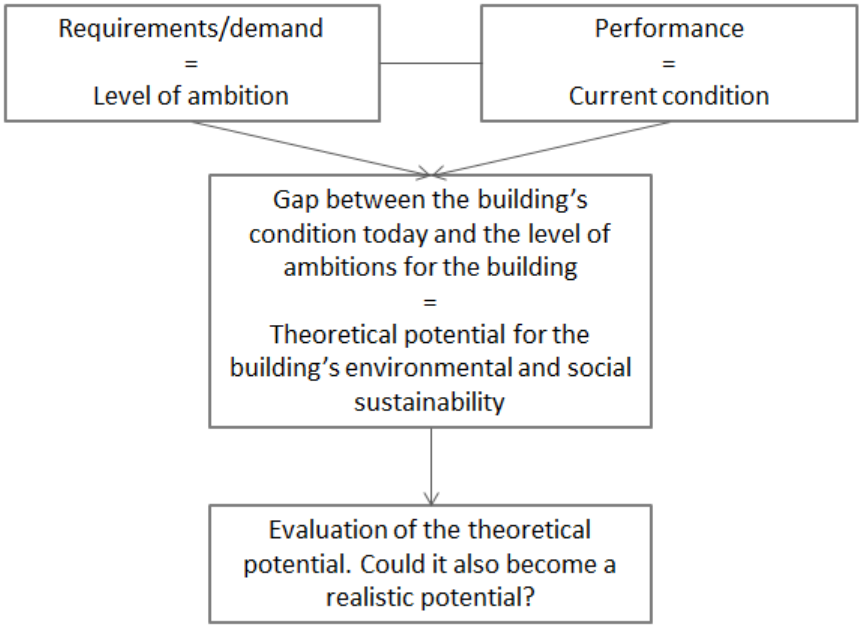

Figure 3: Gap model for evaluation realistic potential adapted and developed from a figure in NS 3424 (Norwegian Standard, 1995)

In **step 0** the building owner should, if possible, decide the purpose of the building. In **step 1**, the building owner must evaluate if there are any building conditions that restrict further development of the building, such as special building regulation, conservation status etc. Further on, in **step 2**, the indicators for the building's environmental and social aspects should be evaluated, by finding the gap between the buildings conditions' current situation and the future ambitions. When evaluating the current situation of these indicators, a person that knows the building well should do the registration, such as the operation manager of the building. Registration of the level of ambitions for the indicators should be done by someone representing the building owner or property investor. Figure 4 presents how the scoring is visualised in a spider diagram, illustrating the gap, which represents a theoretical or realistic potential for environmental and social sustainability. A line along the periphery of the circle indicates highest degree of sustainability. Each of the indicators has also been given a weightage so that the potential could be summarized in a percentage number, indicating the buildings' degree of sustainable potential. For building portfolios these percentage numbers may give an indication to what buildings that have the greatest potential for a sustainable development.

Step 3 is about evaluating the economic impact of enhancing the gap of the indicators evaluated in step 2. Each indicator has been given an *economical influence factor* that indicates how costly an improvement of the indicator will be. In the case studies a self-chosen factor was used, however, this should preferably be a factor generated from a selection of empirical data. By comparing the economic influence factor with the gap of the indicators, it will give an indication on which indicators that are most costly to improve.

In **Step 4**, the building's economical potential is evaluated to determine if it's possible to exploit the building's potential in an environmental, social *and* economic way. This step is to ensure that the economic conditions are economic feasible for the building owner, however, not at the expense of environmental and social conditions. As when evaluating the

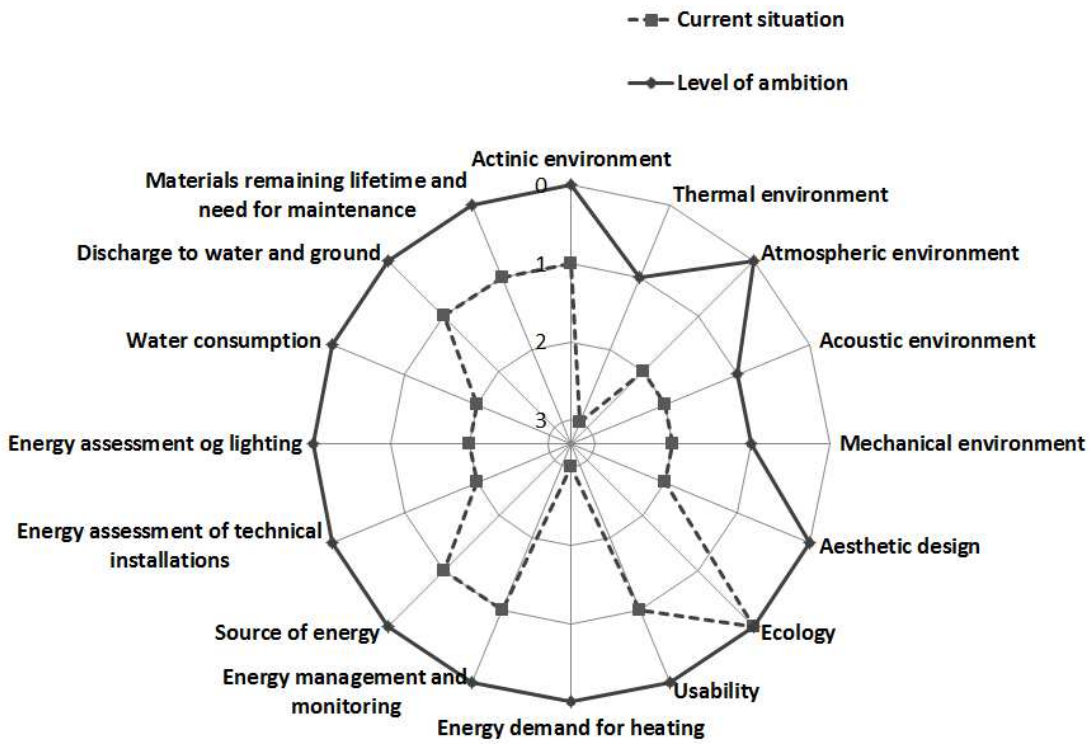

Figure 4: Illustration of the gap between current situation and future ambitions (Hvide, 2012)

environmental and social potential, the economic potential is also evaluated by identifying the gap for the selected economic indicators with respect to the current situation and the future ambitions.

Finally, in **step 5**, one should evaluate whether the realistic potential is found, based on the previous steps, or if it's necessary to iterate the steps and to do some adjustments to be able to identify the realistic potential for sustainability in the building.

4.5 Indicators influencing buildings' potential for sustainability

The indicators that were identified are categorized into how the environmental, social and economic impacts of the building. In addition to this, there are certain building conditions that cannot easily be changed or improved. These building conditions are identified and intended to be evaluated in step 1, in order to early detect if there are any conditions limiting the possibilities to exploit the potential for sustainability in the buildings. The other indicators (environmental, social and economic) are evaluated later in step 2 and 4, as these are more easily changed. The indicators are mainly qualitative indicators that can be evaluated based on normally easily accessible information about the building. For each indicator it's given a description of what conditions categorize as the different degrees of sustainability (from 0 to 3), so that the registration of the indicators are not subject to different interpretations by the persons doing the registrations. An example of this is shown in Table 2. Descriptions for the rest of the indicators are not presented in this paper, but are presented and discussed with the persons doing the registration when using the method in practise.

Table 2: Matrix of descriptions for an indicator's different degrees of sustainability (Hvide, 2012)

Degree of sustainability	0	1	2	3
Energy source for heating	The building has an energy supply that covers 70 % of the energy demand for heating with renewable energy	The building has an energy supply that covers 52.5 % of the energy demand for heating with renewable energy.	The building has an energy supply that covers 35 % of the energy demand for heating with renewable energy	The building has an energy supply that covers 18.5 % of the energy demand for heating with renewable energy.

The indicators used for evaluation in the method are presented in Table 3. The indicators considered as most relevant for the buildings' sustainability, is selected based on the results of the interviews and the survey, in addition to the study of existing assessment methods, mainly BREEAM, SURE and MultiMap.

Table 3 Indicators assessed in the method (Hvide, 2012)

Indicators on limiting conditions: • Planning regulation • Conservation status • Availability to the property • Local area • Adaptability **Social indicators:** • Actinic environment (primarily radiation in terms of lighting) • Thermal environment (temperature, air moisture, airflow) • Atmospheric environment (air quality) • Acoustic environment (noise from persons, equipment etc.) • Mechanical environment (inclusive design, physical design) • Aesthetic design • Ecology (green areas) • Usability	**Environmental indicators:** • Energy demand for heating • Energy management and monitoring • Source of energy • Energy use for technical installations • Energy use for lighting • Water consumption • Discharge to water and ground **Economic indicators:** • Time perspective of investment • Time period of leases • Added value due to branding • Green leases • Loss of rents when rebuilding, refurbishment etc. • Grants due to sustainable measures

5. Discussions

In the discussion of the method's validity and reliability, the registration of the scoring of indicators has been the primary concern. To obtain objectivity during the registration process of the scoring of indicators is an issue that may affect the validity of the results. However, by giving detailed descriptions for each indicator's degree of sustainability, the objectivity is to a large extent obtained.

A consideration of whether the indicators should be quantitative instead of qualitative was done in relation to obtain objectivity during the registration. Quantitative indicators may be easier to measure and also more comparable. However, as this method is supposed to be used in preliminary phases (when strategizing what to do with the buildings), using quantitative indicators might require special equipment and resources, which may be too time consuming and resource intensive in early phase planning. The use of qualitative indicators is therefore considered as best for this assessment method.

6. Conclusions

Based on literature studies, interviews and survey results, indicators for buildings' potential for sustainability have been identified. Buildings' sustainability is influenced by environmental, social and economic factors, and an interaction between these. In more detail, it's the factors as indoor environment, energy efficiency, lifecycle thinking and possibilities for economic profit, which also should include sustainability for building owners, building users and the society.

An assessment method for realistic sustainability potential in buildings has been developed. Within the process of the method, selected indicators are to be scored to a degree of sustainability from 0 (best) to 3 (worst) based on the building as it is today and how it's desired to be, as an assessment in which the compliance of demand and performance is evaluated. Based on the results generated from the various steps in the method, the building owner and engineering consultants obtain a good basis to evaluate the buildings' realistic potential for sustainability. The method is considered as best suited for evaluating office and commercial buildings, but also residential blocks and hotels. However, the method is not considered suitable for buildings of conservation value, as a protection status may restrict the possibilities to do other sustainable measures. The method is validated through case studies. However, experiences from case studies suggest that the description of the various degrees of sustainability should be improved to ensure that the all registrations in a building portfolio are comparable and objectivity is obtained.

The method may contribute to increase the focus on the factors that influence buildings' sustainability. If the method could be of use for real estate agents and engineering consultants to develop buildings in a sustainable way, existing buildings may play a great role in the development of sustainable buildings.

References

Almås, A.-J., Huovila, P., Vogelius, P., Marteinson, B., Bjørberg, S., Haugebølle, K., et al. (2011). A Nordic Guideline on Sustainable Refurbishment of Buildings. *World Sustainable Building Conference .* Helsinki.

Bjørberg, S., Larssen, A. K., & Listerud, C. (2012). MultiMap- a Tool for Strategic Analysis of Building Portfolios. *IALCCE.* Wien.

BRE Global. (2011). *BES 5058: ISSUE 1.2 BRE Environmental and Sustainability Standard.* Bre Global Ltd.

Hvide, E. M. (2012). *Potential for sustainability in existing buildings - a development of an assessment method.* Trondheim: NTNU.

Norwegian Standard. (1995). *NS 3424 Analysis of Tilstandsanalyse av byggverk - Innhold og gjennomføring (English title: Condition Surveys for Construction Works – Contents and execution).* Standard Norge.

OECD. (2010). *Guidance on Sustainable Impact Assessment.* OECD.