

Building passport as a tool to evaluate sustainability of building

Maija Virta¹, Frank Hovorka², Antti Lippo³

¹*Shilpakruti Marketings Pvt. Ltd*

2133/60 11th Cross, Wilson Garden, Bangalore 560027, India

virtamk@gmail.com

²*Caisse des Dépôts Consignations*

Direction Achats Immobilier Logistique, Service Achats – SDA000,

56, rue de Lille – 75356 PARIS 07 SP, France

frank.hovorka@caissedesdepots.fr

³*Green Building Council Finland*

Kalevankatu 44 A 8, 00180 Helsinki, Finland

antti.lippo@figbc.fi

Abstract

Today the sustainability of building is often evaluated using building labeling tools like LEED, BREEAM, DGNB or HQE. One of the weaknesses of these tools is that they weight the different areas of sustainability as one or two ratings (e.g. BREEAM excellent) but leave the real performance measures to the background and therefore the designed or real performance information is not visible. In this paper we present the alternative or complementary tool to present the building's performance indicators, mainly energy and carbon, as a one illustration. It includes both the embodied and life time carbon and a possibility to evaluate them during the life time of building. It also illustrates the level of energy performance certificate (new building) and display energy certificate level (existing building). Also indoor environment quality and life time cost are among the indicators. KPIs are specified either based on national regulation or based on EN 15978-standard.

.Keywords – sustainability, energy efficiency, carbon emission, ,building passport

1. Introduction

Sustainability has become an important factor in real estate industry. There is clear evidence that sustainability does not only reduce the operation cost of building but has a positive impact on vacancy rates, rent income and also the value of building. Therefore it is important to have a transparent and objective way to evaluate sustainability of buildings over their life time. People should be healthy and feel comfortable in buildings. Green lease and maintenance contracts also highlight the measures and the importance of

managing the performance of a building in a sustainable way. In the other hand the built environment is in the key role when reducing the greenhouse gas emissions in our societies. That is why we need measures and tools that lead to improved indoor environment quality, more efficient building performance and to real carbon emission reduction.

In most cases sustainability and cost efficiency goes hand by hand. The operation and maintenance costs are reduced as buildings use less energy and sustainable solutions often needs less maintenance, repair and replacement. In terms of investment cost, it is very important to focus on sustainability in a very early phase of a project. In that case the additional investment cost is only 0...5 % depending on the case.

Building tenants will benefit in terms of reduced operation cost but also as healthier and more productive people as a result of good indoor environment quality. As the salary costs are the major cost of many companies today, even the modest improvement in worker's productivity pays back investments made to ensure good indoor environment. If the annual salary cost of a worker is 25.000 €, one percentage increase of productivity (5 min per day) reduces the salary cost by 250 € per month i.e. 10-20 €/m². This can offset even 5-8 % higher rent. Well-informed tenants are ready to make longer contracts and accept higher rent in sustainable buildings, but they require continuous feedback from the indoor environment quality.

Several international studies demonstrate that sustainable buildings maintain their value better in the future. The increased future value pays the investment back faster than if only calculating the reduced operation costs. As an example, 10 % energy saving reduces the energy costs by 2 €/m² but increases (or prevents the reduction) the value of building by 1 % i.e. 35 €/m². The future value of property is especially important for big property owners but also for banks as properties are often guaranteeing loans.

Owners are also concerned about life cycle cost to operate the building. Unfortunately still most of the decisions during the design and construction phase are made based on the investment cost only. There are examples where e.g. 2 times more expensive air handling unit is the most profitable solution to the owner over the life time.

That is why both the private property owners and building professionals should commit to reduce carbon emissions also in voluntary basis. We need practices and tools that are cost effective and simple to use in any building or project. But in the other hand we need practices and measures that support the professional property owners to demonstrate the performance of their buildings in international property market.

2. Key Performance Indicators of Sustainable Buildings have been Specified in Finland

Green Building Council Finland has focused on last two years to determine the key performance indicators (KPI) for sustainable buildings that ensure the sustainable operation over the life time. Both LEED and BREEAM certification tools have been used in Finland, but as they do not evaluate the actual performance of a building, it is important to set also other measures for construction projects and management of existing buildings.

The focus need to be in sustainable real estate and project management. Data need to be collected and followed already in pre-design and design phases from planning documents and later from the building management system and building's users. The objective is that performance evaluation becomes part of the normal design, maintenance and portfolio management. By following the key performance indicators and making decisions accordingly, we can:

- improve the user satisfaction and wellbeing;
- make sure that spaces are efficiently used;
- reduce the operation and maintenance costs;
- reduce the environmental load.

It is important to focus not only on the target setting (project, annual and long term planning) but verify the measures once the building is completed and then to continuously follow up the KPIs over the life time.

We recognized several user groups. The primary target has been to define KPIs for professional property owners and developers. They operate with large building stock and they have the knowhow and financial resources to invest on tools and consulting work. In apartment buildings the decision making power is often in the hands of apartment owners and therefore the process to measure KPIs need to be more cost effective and measures need to be understood by non-professionals. Same is valid with single-family house owners.

When the KPIs are specified, it is important to consider different aspects of sustainability: social, economic and environmental. In buildings this means, that following aspects need to be considered:

- wellbeing and health of users;
- environmental aspects;
- energy efficiency;
- use of resources (e.g. water and materials);
- life cycle cost and value of building.

The specification of each KPI also varies depending on the process where it will be used. We recognized three major processes:

- development of building (new or refurbishment);
- technical maintenance of building;
- building use (tenants).

Key performance indicators are chosen so that each aspect of sustainability can be measured in all three processes.

The main focus has been finding indicators for Finnish buildings. But to make sure that they are supporting also the needs of international property business, they are based on international standards and practices. This way the Finnish property market can fulfill easier the requirements of international investors. It is also important that different evaluation and reporting systems use the same calculation specification as this way the extra work to specify same KPI with different specifications can be avoided. Most of the chosen indicators are based on CEN TC 350 standard package.

KPIs can be used for different purposes. One is to evaluate and manage the operation of a building over the years. This case the best benchmark values are the values of previous years. Second way is to compare building to other buildings with same purpose. This can be done in a property portfolio level or based on a national or international database. Unfortunately only few KPIs have a good database for general comparison; especially because the specification has not been uniform. The template is used to format your paper and style the text. All margins, line spaces, and text fonts are prescribed. Please do not alter them.

Sustainability evaluation needs to be based on the life time evaluation of building and its usage. Service life planning is the basis of all evaluations made in design phase. There are several areas to be considered:

- predicted service life of building and major components (defined by developer);
- usage of spaces and possible changes over life time;
- indoor environment quality in different usages;
- environmental impacts over life time (including deconstruction and re-use of materials);
- lifetime costs.

Target setting in the pre-design phase is very important. The same KPIs shall be followed over the life time of building, even the way they are specified may be different. Targets can be set for various issues, but in this project we choose the following areas:

- indoor environment quality;
- energy efficiency;
- carbon footprint;
- life cycle economy.

We recognized indicators in each area, which were then specified more detailed. There were three other areas we recognized important: waste water efficiency, waste management efficiency and abiotic resource depletion. Specification of these indicators will be done in the second phase of the project.

Table 1. Selected Key Performance Indicators in Finland.

Indicator	Project phase		Operation phase	
Indoor environment	Indoor environment class (EN 15251)	A/B/C	User satisfaction (thermal comfort, IAQ, lighting and acoustics separately)	%
Carbon footprint	Life time carbon footprint (EN 15978)	kgCO ₂ /m ²	Operational carbon footprint (GHG protocol)	kgCO ₂ /m ² ,a
Energy	Calculated primary energy consumption (EN 15217)	kWh/m ² ,a	Measured energy use (electricity, heating, and district cooling separately)	kWh/m ² ,a
			Unoccupied electricity power	kW/m ²
Economy	Life cycle cost (EN 15643-4)	€/m ²		

Finland has long traditions specifying indoor environment quality in each construction project using Finnish “Indoor Climate Classification”. It specifies the target levels for thermal comfort, indoor air quality (IAQ), lighting and acoustics in three different categories: individual, good and standard. Some of these measures are rather expensive to measure over life time and individual measurements do not necessarily give comprehensive picture of entire building. Therefore we choose to use Actual Percentage of Dissatisfied occupants as an index to follow the life time indoor environment quality. This is measured using Occupant Satisfaction Measurement questionnaire as a tool to collect data in each area of indoor environment: thermal, IAQ, lighting and acoustics. In those areas of building where dissatisfaction is high, more detailed analysis is needed to improve the situation.

Energy indicators are rather well established. Calculated primary energy consumption (based on EN 15217) is already mandatory in Finland in all buildings, even it more describes the ability of building performing well than the actual energy performance. Therefore we introduced two other indicators

for existing buildings: a measured energy use and an unoccupied electricity power. For users and maintenance people it is important to follow-up annually the real energy use of building; in which only the heating energy is corrected using annual weather data. One problem in Finland is an increased electricity use of buildings when they are not occupied, like offices during the night. This is why we choose to follow the electricity power in a week average during the night and to compare that to the power needed during daytime.

To describe the environmental impact of building we choose to use carbon footprint as an indicator. EN 15978 introduces 20 other indicators, but we choose only one to make sure it is properly implemented and later we can introduce more of them. Life time carbon footprint is calculated during the design process and it takes into account the carbon emissions from cradle to grave:

- embodied carbon of construction materials;
- construction work and transportation of materials;
- calculated life time energy use and maintenance of building;
- end of life: deconstruction, reuse, recycling and waste.

Operational carbon footprint is an annual measure to follow the environmental impact of the building and its use. This is calculated using Green House Gas protocol, and it comprises the annual energy use and traffic generated by the use of building (traffic between homes and workplace as well as business traveling).

Fourth indicator group is the economy. Today the decision making during the design and construction project is mainly based on investment costs. But as we are aware, the operation cost of building is very much influenced by the decisions made during the design. That is why all decision during the design and construction should be made based on life cycle costs. This indicator was specified according EN 15643-4 standard. A value of building will be the best indicator to follow the life time economy of building, and there is lots of research made to integrate the sustainability indicators to value evaluation process. However this was also decided to leave to the second phase of the project.

It is important to follow up how well the objectives are achieved. This needs to be done annually, but a special attention should be paid during the first year of operation. During that period the seasonal commissioning of all technical systems and user satisfaction evaluation are recommended to ensure the reliable operation of building and wellbeing of users in different seasons.

Collection and storage of information need to be planned already in design phase. This may require e.g. more measurement equipment to be installed in the building. Building Information Modeling (BIM) system helps to follow the targets both in design and in operation face, but it is also a good tool for data storing and management over life time.

3. Building Passport is Introduced to Communicate the Performance of a Building

Sustainability indicators are followed in order to manage building design and maintenance processes more efficiently and towards right direction. Another objective is to communicate the quality of building to its users and owners. This objective requires an easy way to communicate the life cycle planning and key performance indicators. “Building passport” will present in a simple format both the “birth certificate” and “health certificate” of a building.

The “birth certificate” presents the life cycle planning and key performance indicators specified during the design process or after a first year of operation. This part remains unchanged over the years until the building is refurbished. It describes the ability of building to be operated in a sustainable manner. Investors and owners can use the “birth certificate” to compare different buildings in different locations.

The “health certificate” is updated annually based on the real performance of a building. It compares the operation of building to the operation of previous years. “Health certificate” helps maintenance people to operate building more efficiently and it also tells users if they should change their behavior in the building. Annual indicators are also used to plan the short and long term repairs and retrofitting.

Building passport can be printed in various formats. The simplest one only describes the selected indicators of building either in project phase or during the operational phase. The more comprehensive version can also describe the service life planning in terms of energy and carbon.

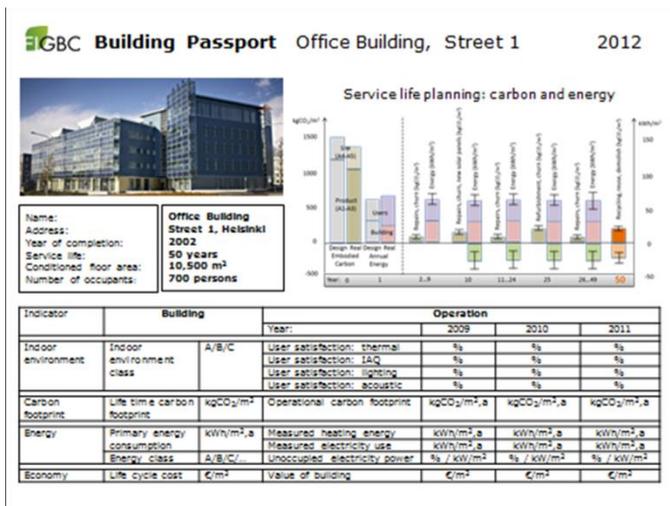


Fig. 1 An example of a building passport format, where both building and operation indicators are presented.

4. Discussion

Building passport is not a certificate of sustainable performance of building as LEED or BREEAM certificates are. It just describes in an easy and transparent format the performance of building to anybody it may concern. However the indicators have been chosen to give a triple bottom line picture of building's operation i.e. environmental, social and economic performance. And therefore a good performance in all indicators also is a sign of sustainable operation.

It was important to specify the common way to calculate / measure indicators as this allows to comparison of different buildings and projects over the life time. It also gives a more solid basis for various players to promote their solutions and products.

Every building should have a building passport available to communicate between owner, investor, maintenance people and tenants. It is also important to set targets in each construction project based on life time operation and to follow the targets afterwards. Building Passport gives a more comprehensive picture of building operation compared to energy certificate only.

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