New sustainable building policy in Maastricht

Municipalities towards a 0-impact built environment

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Abstract

The roadmap towards a 0-impact built environment is not only a technical challenge, but also an implementation challenge. Although the technical know-how is improving and demonstration projects are successful, a wide replication of new building concepts or new technologies is not yet common practice in the Netherlands. Dutch municipalities have therefore adapted climate and sustainable building policies, which – on the long term – could contribute to a 0-impact of the built environment. However, the Dutch national building legislation, does not allow them to impose higher building standards than the minimum requirements. Successful implementation of building policies thus depends on the willingness of stakeholders to adopt higher standards and the quality of project management during all phases of the design and building projects. This process requires an easy-to-use and reliable assessment tool, like GPR Building. This paper will focus on the implementation of sustainable building policy using GPR in the city of Maastricht.

1. Introduction

The Dutch building regulations set minimum standards for new buildings, including a minimum energy performance. Many municipalities, including Maastricht, aim to improve the building quality and reduce the (carbon) footprint of the built environment. However, the national regulations do not allow these municipalities to impose higher standards to project developers and architects. Policy development is therefore based on stakeholder involvement preferably in an early stage of the building process.
In the past, municipalities prescribed certain sustainable measures to architects and developers in order to fulfil its policy. These lists were subject of much debate and protest, because they were felt to hinder the creative process of building design. In addition, the environmental quality of the building was based on the number of sustainable measures taken, rather than on the quality of the building or its environmental impact. A solution was found in a performance based methodology: to agree upon a minimum performance regarding both building quality and reduction of the environmental footprint. To measure the achieved quality, performance based tools like GPR Building (called GPR Gebouw in Dutch) are being used.

In this paper we will first discuss the new sustainable building policy in Maastricht which was developed by W/E consultants in close collaboration with the municipality. The involvement of stakeholders and the differences between the old and new policy is also addressed. Secondly we give a brief description of the performance based tool GPR Building. The retrofitting of the monumental Boosten dwellings in Maastricht is used as a case study to illustrate the it.

2. New sustainable building policy in Maastricht

The City of Maastricht aims to reduce its environmental footprint. The policy focuses on an overall reduction of CO_2-emissions, air pollution and emissions from materials (including CO_2 and heavy metals). Due to the aging of the people and the closing of certain industries, the number of inhabitants in Maastricht is diminishing. Policy in Maastricht therefore also focuses on the reduction of the number of dwellings in the context of urban planning. Furthermore Maastricht aims at both the state-of-the art projects (like a zero-emissions swimming pool), as at an overall improvement of the built environment.

As most stakeholders still have to become conscious of the necessity of realising zero impact or zero energy buildings, the introduction of a generic policy for all building projects is considered as a first step towards reaching this goal on the long term. Besides, the municipality of Maastricht is not allowed to impose its sustainable and/or CO_2 targets on project developers, making stakeholder involvement the most important way to achieve its goals.

In the next paragraphs, we will briefly describe the process of stakeholder involvement, which started in December 2008. This process resulted in January 2010 in a proposal, made up together by the municipality of Maastricht and W/E consultants, on how to implement a new sustainable building policy in Maastricht. As this paper was written, the proposal had not yet been approved by the aldermen and the City Council. The priorities made in the final policy can therefore differ from the ones described below.

Stakeholder involvement

Stakeholders in sustainable building include: project developers, social housing agencies, building industry and architect association. Several municipal departments, like the building and monuments department, project development and spatial development are also considered as stakeholders.
From the start of the project, stakeholders have been involved. First, a kick-off meeting was organised, during which different stakeholders presented their experience with sustainable building. Next, everyone was invited to take part in a sustainable building course to get acquainted with the tool GPR Building. In a next stage, several pilot projects were carried out by the stakeholders. This resulted in a number of recommendations for the new sustainable building policy.

Old versus new sustainable building policy

The former sustainable building policy in the Netherlands was based on the national criteria for sustainable building, consisting of a checklist as to which sustainable measures could be taken. Although the method had been developed by the Building Research Centre (SBR) and had been approved by the (building) industry, the opposition against it grew, for several reasons. The number of measures did not relate tot the environmental impact, some materials with a high impact were missing, architects felt obstructed in their design and it was difficult to check if the number of measures agreed on had been taken.

The new performance-based policy distinguishes itself on the following issues from the former approach:

- Lists of required measures are replaced by performance based agreements
- Municipalities and private parties make clear and verifiable agreements (ambitions)
- The sustainability of different designs or projects can be compared

To implement the performance based policy, Maastricht has chosen the GPR Building tool for the following reasons:

- Both the environmental impact and the quality of the building are measured, so that the same tool can be used to monitor different policy goals
- The targeted ambitions can be monitored throughout the design process
- Easy and quick to use, file sharing is possible through the webbased software
- A consumer label gives users insight into quality attained (1 to 5 stars).

In section 3 we will discuss the design and use of GPR Building in more detail.

A new policy for implementation of Sustainable Building

The new policy approach in Maastricht focuses on a high stakeholder involvement. At the start, the sustainability targets are kept at a relatively low level, in order to stimulate all parties to participate in the new process. For new buildings, the aim is now to achieve a minimum GPR score of 7 on each of the five indicators. The policy applies to all new buildings in Maastricht. For existing buildings, the aim is to apply the methodology to all projects, in order to obtain more knowledge on sustainability levels of the existing building stock and the retrofitting potential. The same applies for monumental buildings. Targets for municipal buildings are higher, to set a good example: new municipal buildings should obtain a minimum GPR score of 7,5 on each indicator, whereas existing buildings which are to be refurbished should be improved by 2 points on each indicator as compared to the original building.

A communication strategy is an important part of the policy implementation. Different stakeholders, like consumers, architect, project developers but also the civil servants involved, have to get acquainted with the new policy and the tool which is being used.
The progress of the policies is monitored on a (half) yearly basis, through reviews of GPR-building scores of completed projects. One person in the building department is responsible for monitoring, whereas several building inspectors will assist the project manager to monitor the progress during the design process.

The results have to be communicated to a broad audience, projects will also be published on internet.

After two years the ambitions are evaluated and the targets could be raised, eventually reaching the zero-emission level.

3. GPR Building as a performance-based tool

As we indicated above Maastricht has introduced GPR Building to measure and monitor the performance with respect to sustainable building. GPR Building is a software tool, which can be used to assess both the environmental impact and the design quality of new and existing buildings. GPR Building differs from other sustainability tools in its simplicity and quickness to use. An assessment is made in in less than half a day of work, and the influence of a design choices is immediately visible in the indicator score.

In 1995, the first version of the tool was developed by the municipality of Tilburg and W/E consultants. Stakeholders, like architects, project developers, social housing corporations and consumer organisations have been involved from the start. It has gone through several stages of development and is now licensed to more than 300 municipalities and building professionals across the Netherlands. GPR Building has been recognised as a national standard for sustainable procurement by the Dutch public authorities.

Essential in the present GPR methodology, is the dual approach of environmental impact on the one hand and building quality on the other. A building is only considered to be sustainable if it has a high performance on both energy and materials and it will fulfil its function for a long time, to the satisfaction of the user and with a minimum impact on the occupants health. This therefore implies a high-quality building in the broadest sense of the term. This is depicted with the two arrows in Figure 1.

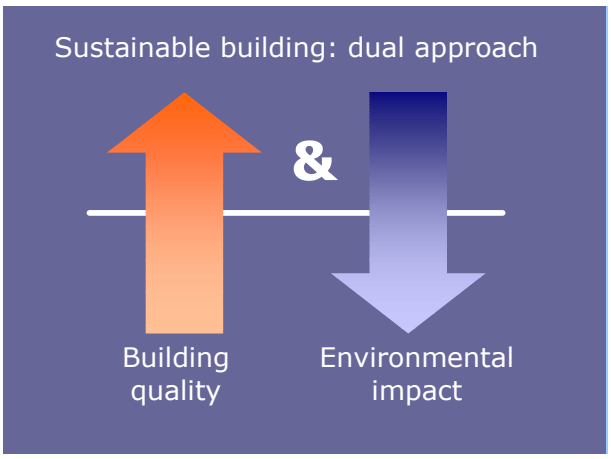


Figure 1: GPR Building aims to raise building quality and reduce the environmental load of buildings

GPR Building can be used for both the design of new and the retrofit of existing buildings. It is suitable for residential, office and school buildings. Versions for other building categories, like industry, train stations, swimming pools and sports buildings are currently in development, as well as a version for area development.

Indicators

A building is rated on five indicators on a scale of 1 (worst) to 10 (best). The key performance indicators are: Energy, Environment (assessing the environmental impact), Health, User quality, and Long term value (assessing the building quality). Each indicator is divided into several sub-indicators (Figure 2). When assessed, the building performance is rated per indicator, but the main indicators are not aggregated into one overall score. Thus, policy makers can focus on the topics which are most relevant to a specific situation: in school buildings, for instance, the focus is often on energy, environment and health, whereas in residential buildings all indicators will be equally important.

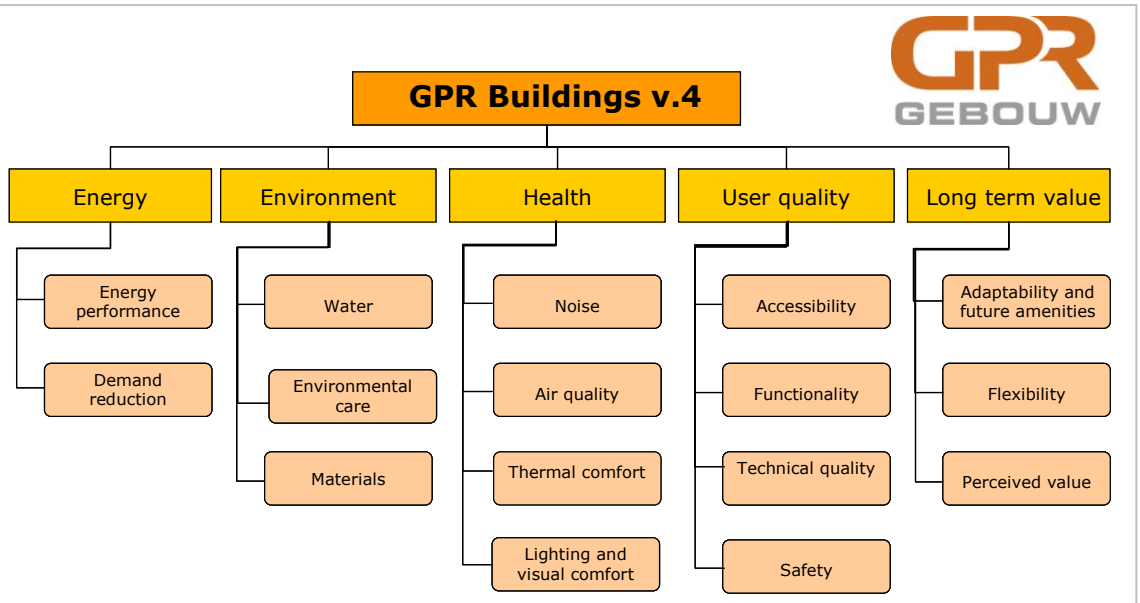


Figure 2: GPR Building rates buildings on 5 indicators

The GPR-score for the modules and sub-modules is calculated on the basis of a multi-criteria analysis, except for the modules Energy and Materials (these are explained in the next paragraphs). Each sub-module consist of several criteria, the user has a choice between different design options (Figure 3). Each option is awarded a number of points. The points are first aggregated to the level of a sub-module (score of 1 to 10) and then aggregated to a module score. When a choice is made, the score changes immediately, thus stimulating the choice for a better alternative.

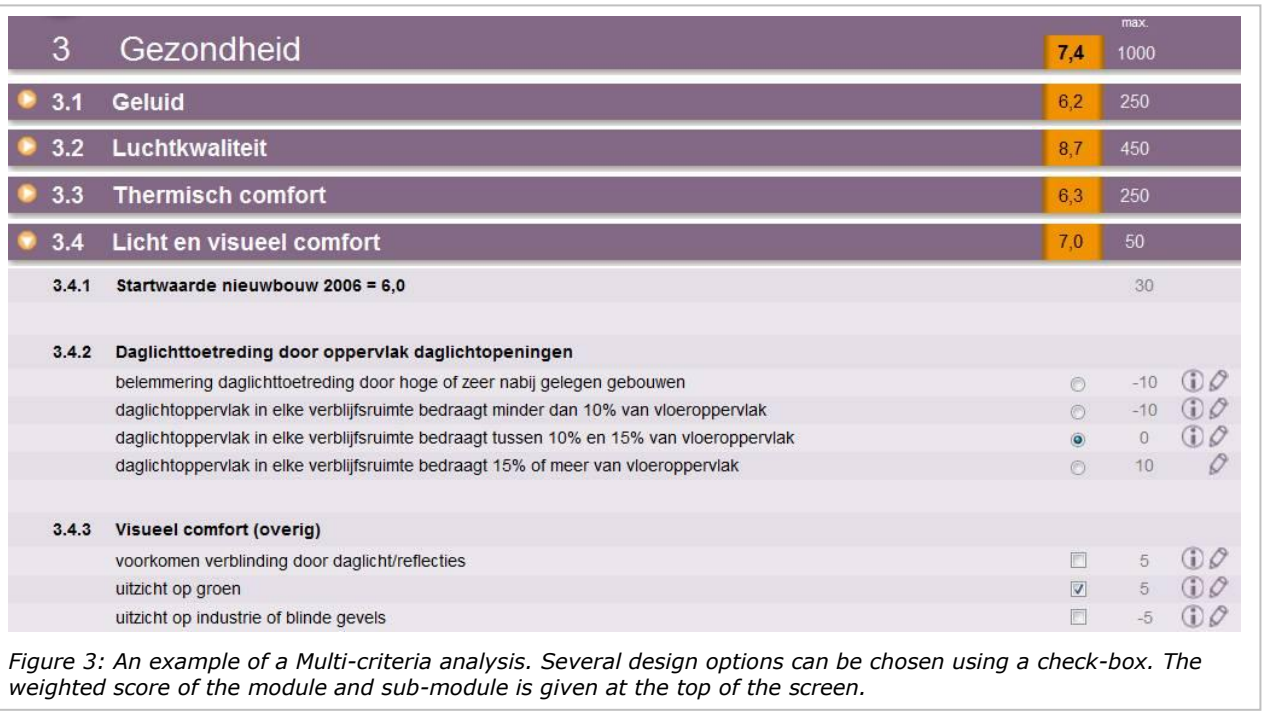


Figure 3: An example of a Multi-criteria analysis. Several design options can be chosen using a check-box. The weighted score of the module and sub-module is given at the top of the screen.

Energy and Materials performance

The Energy performance is based on the Dutch National standards for new and existing buildings. The GPR calculation only uses a restricted number of parameters in comparison to these standards, thus facilitating the user in making a performance calculation in an early design stage.

The GPR score is determined by the calculated primary energy use per square meter of usable area of the building. A GPR score of 6 for Energy represents the primary energy use per m2 surface that meets the

energy performance requirements in the Building Act 2006. The maximum score of 10 is obtained when the building has no CO_2 emissions (Figure 4)

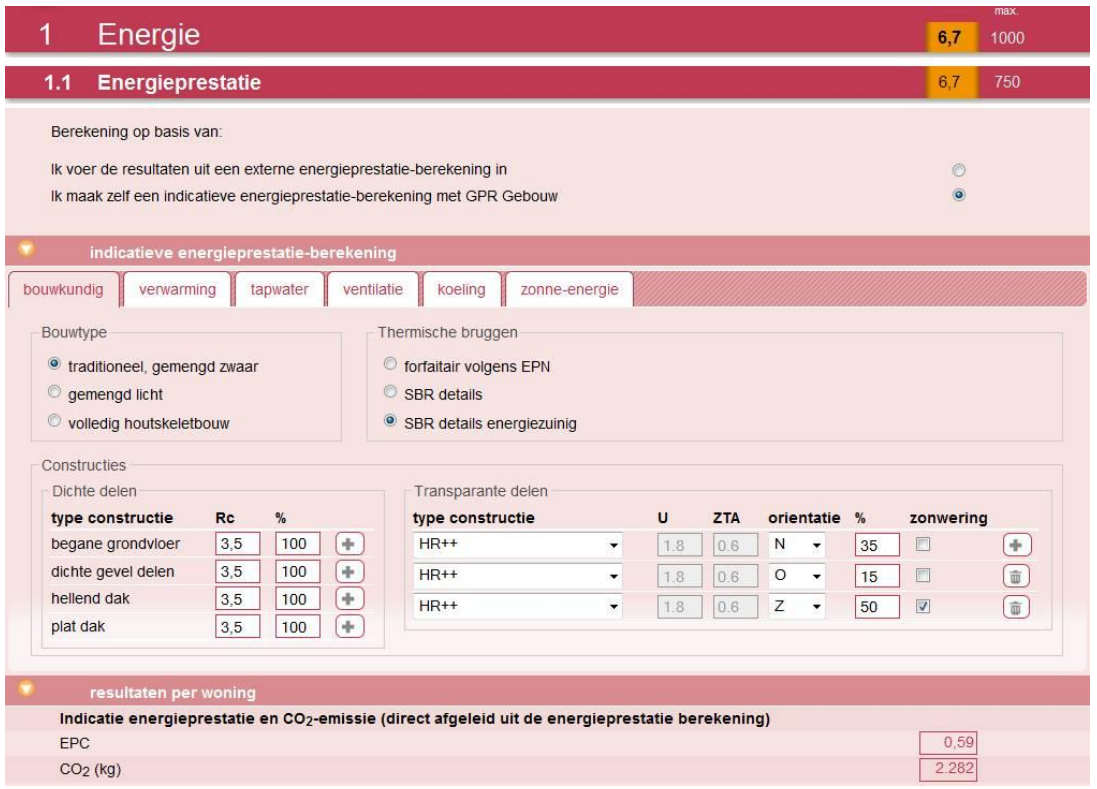


Figure 4: Energy module. The two lowest figures represent the indicative energy performance (EPC) and the CO_2 emissions of this specific building.

The score of the sub-module Materials is based on the method of life cycle assessment (LCA), which has broad support both nationally and internationally. The environmental burden related to the material use of a building is expressed in terms of an LCA-profile, composed of nine separate environmental impact indicators. The nine indicators are subsequently aggregated into one index, called the “environmental shadow costs” of a building, which is expressed in euro’s per square meter of usable floor area (heated and unheated) per year (Figure 6).

The LCA (materials) databases and the methodology for calculating the environmental impacts of a building have recently been harmonized on a national level. Harmonization of the three major calculation tools used in the Netherlands for environmental impacts assessment of buildings (GPR Buildings, GreenCalc and BREEAM-NL) is still in progress. Once this harmonisation project is completed all tools will present identical outcomes for the environmental load of materials in a specific building, although their user interface and application scope will still be different. It is foreseen that in the course of 2011 the evaluation of material aspects by means of the harmonized assessment method will become mandatory in the recast of the Dutch Building Code.

Due to the LCA approach, the CO_2 emissions of a building, related to both energy *and* materials can be calculated in kilograms per square meter of usable area (heated and unheated) per year (Figure 5).

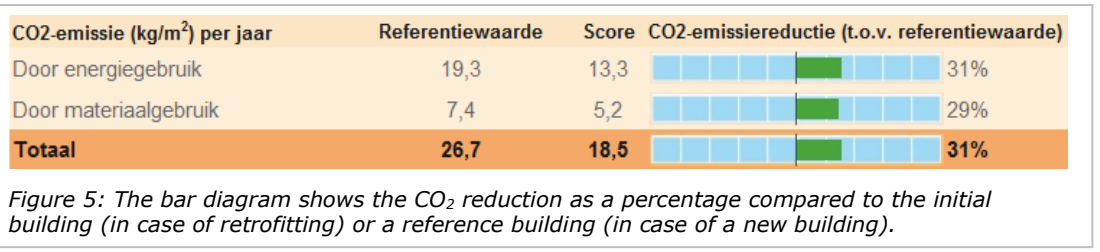
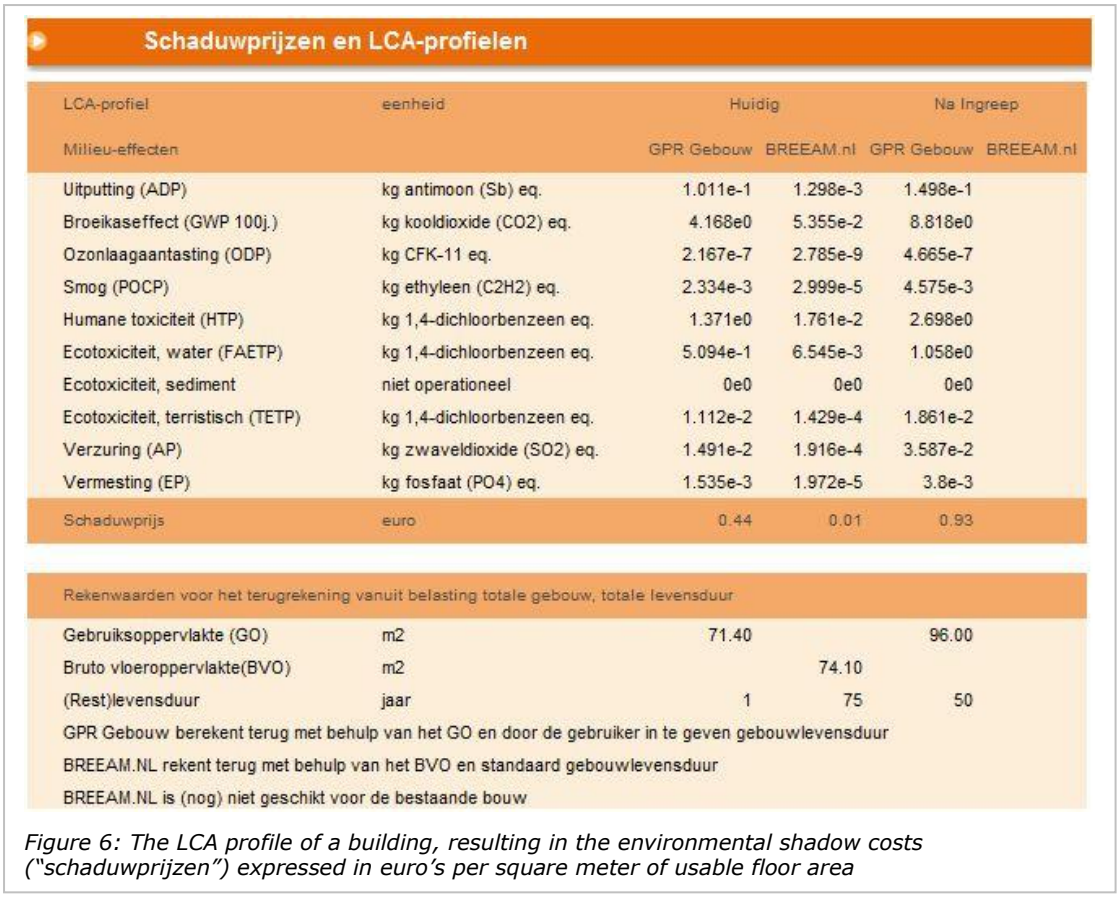


Figure 5: The bar diagram shows the CO_2 reduction as a percentage compared to the initial building (in case of retrofitting) or a reference building (in case of a new building).



Schaduwprijzen en LCA-profielen

LCA-profiel	eenheid	Huidig		Na Ingreep	
Milieu-effecten		GPR Gebouw	BREEAM.nl	GPR Gebouw	BREEAM.nl
Uitputting (ADP)	kg antimoon (Sb) eq.	1.011e-1	1.298e-3	1.498e-1	
Broeikaseffect (GWP 100j.)	kg kooldioxide (CO2) eq.	4.168e0	5.355e-2	8.818e0	
Ozonlaagaantasting (ODP)	kg CFK-11 eq.	2.167e-7	2.785e-9	4.665e-7	
Smog (POCP)	kg ethyleen (C2H2) eq.	2.334e-3	2.999e-5	4.575e-3	
Humane toxiciteit (HTP)	kg 1,4-dichloorbenzeen eq.	1.371e0	1.761e-2	2.698e0	
Ecotoxiciteit, water (FAETP)	kg 1,4-dichloorbenzeen eq.	5.094e-1	6.545e-3	1.058e0	
Ecotoxiciteit, sediment	niet operationeel	0e0	0e0	0e0	
Ecotoxiciteit, terristisch (TETP)	kg 1,4-dichloorbenzeen eq.	1.112e-2	1.429e-4	1.861e-2	
Verzuring (AP)	kg zwaveldioxide (SO2) eq.	1.491e-2	1.916e-4	3.587e-2	
Vermesting (EP)	kg fosfaat (PO4) eq.	1.535e-3	1.972e-5	3.8e-3	
Schaduwprijs	euro	0.44	0.01	0.93	

Rekenwaarden voor het terugrekening vanuit belasting totale gebouw, totale levensduur				
Gebruiksoppervlakte (GO)	m2	71.40		96.00
Bruto vloeroppervlakte(BVO)	m2		74.10	
(Rest)levensduur	jaar	1	75	50

GPR Gebouw berekent terug met behulp van het GO en door de gebruiker in te geven gebouwlevensduur

BREEAM.NL rekent terug met behulp van het BVO en standaard gebouwlevensduur

BREEAM.NL is (nog) niet geschikt voor de bestaande bouw

Figure 6: The LCA profile of a building, resulting in the environmental shadow costs ("schaduwprijzen") expressed in euro's per square meter of usable floor area

Due to the scaling of the 1-10 scores for materials impact a building which gets a perfect score (10) on both the Energy and Materials indicators would have very low environmental impacts but it would not yet be a true zero emission building. The use of materials will almost inevitably result in emissions somewhere within the system boundary. Only when the remaining impact of the materials can be compensated by e.g. CO_2-mitigation i.e. when the building generates more renewable energy than it consumes, we could perhaps consider it as a zero-impact or zero-emission building. Of course such a scheme only works if all environmental impacts are converted to one single indicator such as shadow costs. One can debate whether such a compensation scheme based on shadow costs is an allowable way for reaching the zero impact objective.

GPR Building versus BREEAM-NL

The Dutch Green Building Council has recently developed a Dutch version of the well-known BREEAM tool which originates from the UK, named BREEAM-NL. Because of its international recognition BREEAM has attracted a lot of attention among project developers and building owners. In some ways BREEAM-NL can be seen as an alternative method for evaluation of sustainable buildings. It is important to note, however, that BREEAM does not include an evaluation of material impacts based on LCA methods (however BREEAM-NL does include the LCA methodology, as it calculates the environmental impact using the Materials module of GPR Building). Eventually it is foreseen, that the two tools BREEAM-NL and GPR Building will become complementary: the aim is to make GPR Building suitable as a pre-assessment tool of BREEAM-NL. This is a logical development as the two tools serve a different purpose: GPR Building is primarily a design tool, which can be used to set policy targets and monitor these. It focuses not only on environmental aspects but also on the quality of the building. It takes an architect two to four hours to obtain an accurate sustainability score of a building and identify sustainable alternatives for the chosen design solutions. BREEAM-NL on the other hand, aims at certification of both the design process and the obtained result. It focuses on environmental as well as management issues. In general, the BREEAM-NL assessment and consultancy during a project has to be carried out by a BREEAM expert, thus raising the project costs. The advantage is that the assessment may result in a BREEAM certificate, which can be considered as more or less internationally recognised quality label for buildings.

4. Case study: the Boosten dwellings

The Boosten is a monumental, residential area in Maastricht, named after the architect Alphonse Boosten (Figure 7). The area consists of 128 dwellings, owned by the social housing corporation Servatius. The aim of the project was to retrofit these dwellings in a sustainable way, while preserving the monumental character. As the original dwellings were rather small (71 m2), 57 out of 128 dwellings were turned into 31 new ones of 96 m2 each. The case study focuses on these dwellings, their GPR score is given in Figure 9.

Figure 7: The monumental character of the Boosten dwellings (built in 1930), preserved after retrofitting

The concept used to renovate these dwellings is called Comfort+. It relates to the quality level which is obtained: the quality of the retrofitted dwellings is higher than the Building Standard would demand for newly built dwellings. The concept which has been used is called "box-in-a-box": the original outer walls are preserved, while insulation and an inner-wall are inserted as if it were a box (Figure 8). The inner wall is a prefabricated and insulated metal-stud construction in which the tubing for low-temperature heating is incorporated. This concept ameliorates both the thermal and acoustic insulation of the dwelling considerably. Each dwelling is equipped with an individual ground-source heat pump.

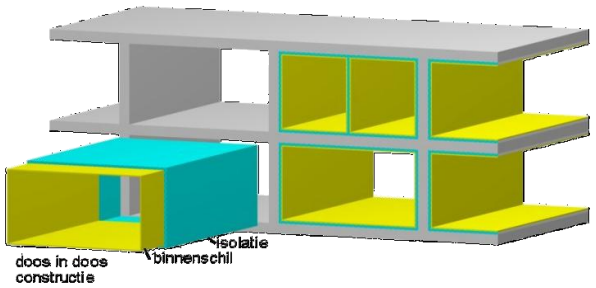


Figure 8: The box-in-a-box concept is used to retrofit the Boosten dwellings

The GPR score in Figure 9 shows that the selected retrofitting concept improves the dwellings significantly. All indicators improve, except for the Environment indicator which drops back from 7,1 to 5,4. The box-in-a-box concept has a positive impact on the energy use of the building (i.e. reduction of use) and on the indoor air quality (Health). However, it uses a lot of new materials, resulting in a lower score on the materials aspect (Environment). The environmental impact could have been improved if more sustainable materials – like FSC-certified wood – would have been used.

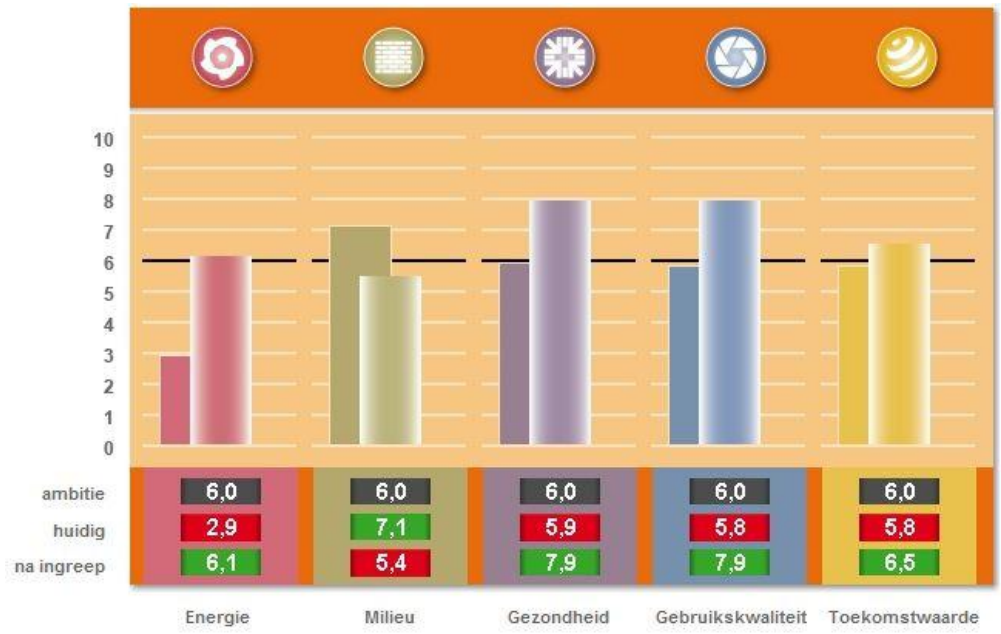


Figure 9: Sustainability score of the Boosten dwellings in GPR Building

The sustainability of the dwellings was further improved by additional measures, like water-saving equipment. The Health indicator has mainly improved due to a better indoor air quality (mechanical ventilation and less accumulation of dust due to floor/wall heating), a better acoustic insulation and a high thermal comfort. The improvement of the score on User Quality is mainly due to the amelioration of the social safety and the technical quality of the retrofitted dwellings. The preserved monumental character of the dwellings is part of the Long Term Value indicator.

5. Conclusions

We conclude with a summary of success factors and key action points for cities that want to develop sustainable building policy.

1. The implementation of sustainable building policy mainly depends on the acceptance by stakeholders, as it can not be imposed by law. Key success factors are in our view:
   - Performance-based agreements
   - an easy-to-use and reliable sustainable building tool
   - basic knowledge of sustainable building among all stakeholders
   - sufficient monitoring during the design stage and upon completion of the project
   - a good communication of the obtained results
2. The GPR Building tool has proven to be successful in the Netherlands. It is now being used by over 200 municipalities and professionals. The dual approach of sustainability (raising the quality of the building and minimising its environmental impact) is acknowledged by stakeholders. It is easy to use and reliable, due to its combination of:
   - the nationally harmonized LCA approach for material impacts,
   - compliance with the Dutch Energy Performance standards,
   - multicriteria analysis with a rating method based on realistic case studies for other other quality aspects.
3. The case study has shown, that retrofitting of an existing dwelling can improve the overall sustainability score, including a significant improvement on Energy. However, at the same time a lower score on the Environmental indicator was observed. Finding a way to improve all indicators at the same time is necessary to reach 0-impact buildings. Another way may be to produce more energy than consumed, thus compensating inevitable materials impacts by negative CO_2 emissions (e.g. energy+ building).
4. A successful implementation of performance-based sustainable building can be considered as a first step towards a 0-impact built environment. Municipalities can slowly raise targets and ask stakeholders to do the same, in order to achieve zero-impact buildings on the long term.